

Towards Enhanced Psychosocial Well-Being for Persons Living with Dementia: An Integrative Review of Meaningful Activities in Long-Term Care

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Abstract

INTRODUCTION: Meaningful engagement in clinical interventions or technology-mediated activities can support the psychosocial well-being of persons living with dementia. However, meaningfulness is often assumed rather than explicitly conceptualized in both academic context and in care practice.

OBJECTIVES: This review aims to examine how interventions and activity provision can support psychosocial well-being and how meaningful engagement is shaped by the conditions surrounding their provision, with particular attention to people with moderate and advanced dementia in long-term care facilities.

METHODS: An integrative review was conducted through article searching in databases including PubMed, Scopus, and the ACM Digital Library dated from 2014 through 2025. In this review, 60 publications were synthesized for answering proposed objectives and questions.

RESULTS: We identified six activity forms and five recurring mechanisms through which activities acquire psychosocial value and are considered meaningful. The central finding is that meaningfulness is not an inherent property of an intervention or technology-mediated activity. It was shaped by the changing relationship between the person, activity, other stakeholders, and care environment. Activities are more likely to become meaningful when they connect with the person's identity and retained abilities, permit supported forms of agency, are facilitated within responsive relationships and workable care routines.

CONCLUSION: This review advances a person-centered design agenda that shifts attention from isolated interventions toward activity-care ecosystems. It extends previous intervention- and technology-centered reviews by explaining how meaningful engagement can be co-produced, evaluated, and sustained in everyday dementia care.

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Keywords: Meaningful activity, psychosocial well-being, non-pharmacological intervention, technology-mediated activity, dementia, engagement

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1. Introduction

Dementia is a major global public-health challenge and a leading cause of disability and dependency among older adults. It is not a normal part of aging, but a syndrome associated with progressive changes in memory, communication, emotional regulation, and the ability to perform daily activities. Beyond cognitive and functional decline, persons living with dementia

(PLWD) may experience loneliness, depression, agitation, reduced autonomy, and loss of social connection. These challenges are particularly salient in long-term care (LTC), where residents often require substantial assistance with everyday life. Although LTC facilities are organized to meet physical and clinical care needs, their capacity to meet psychosocial needs may be more limited. Consequently, opportunities for choice, self-expression, personally relevant activity, and sustained interpersonal engagement can be difficult to provide [1].

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Engagement in meaningful activities is widely recognized as an important means of supporting quality of life and well-being among PLWD [2]. Activity engagement has been associated with reduced behavioral and psychological symptoms of dementia (BPSD), improved affect, and greater social interaction [3]. However, meaningfulness is often assumed in both academic studies and practice rather than explicitly conceptualized. Activities may be described as "meaningful" because they have a therapeutic purpose or elicit observable engagement, without sufficient consideration of what makes an experience personally significant. An activity cannot be assumed to be meaningful simply because it is clinically beneficial, enjoyable, or designed for dementia care. Rather, meaningfulness may emerge from the fit between an activity and the person's identity, life history, preferences, retained abilities, present emotional state, relationships, and immediate care context.

The established literature on activity provision in dementia care has developed principally through psychiatry, nursing, occupational therapy, and gerontology [4]. Within these fields, non-pharmacological interventions encompass approaches intended to manage BPSD, maintain functioning, support activity, and moderate mood or behavior [5]. Their effects often depend on how facilitators tailor content, pacing, and support to individual needs [6]. At the same time, implementation may require time, staffing, continuity, and training that are difficult to sustain in many LTC facilities. These constraints have helped motivate interest in interactive systems that might extend the range, adaptability, or availability of meaningful activities.

Human-computer interaction (HCI) and design research has increasingly explored interactive technologies for PLWD and their caregivers. However, much of this work has emphasized caregiver support, safety, monitoring, and compensation for cognitive or functional impairment [7–9]. Earlier reviews also found that comparatively few studies examined how PLWD themselves used technology [10]. Technologies for people at earlier stages have often supported memory and independent living, whereas systems intended for later stages have frequently prioritized safety, monitoring, or care delivery [11]. Pleasure, identity, agency, playfulness, emotional expression, and relational connection have received less systematic attention, particularly for people with moderate to advanced dementia in LTC. Thus, this review concentrates on activity engagement and the psychosocial well-being of PLWD rather than on monitoring, instrumental utility, or caregiver outcomes alone.

The growing influence of person-centered care has shifted dementia research beyond an exclusive emphasis on impairment and behavioral management toward support for personhood and psychosocial well-being [6].

HCI and design studies have explored how interactive systems can provide accessible interaction, sensory and physical stimulation, and opportunities for social and emotional engagement [12, 13]. Such technologies may increase access to personally relevant content, translate small gestures into perceptible responses, scaffold facilitation, or provide a shared focus for interaction. Technology does not, however, create meaningfulness independently and should not be regarded as a straightforward substitute for relational care. Its contribution depends on how it is organized, personalized, facilitated, and integrated into everyday practice [14].

The literature uses several overlapping terms for describing "meaningful activities", including *recreational activities* [15], *leisure activities* [12], *restorative activities* [16], and *design for playfulness* [13, 17]. Rather than treating these labels as separate intervention domains, this review uses "meaningful activities" as an integrative concept: *personally or relationally significant participation that corresponds to a person's identity, history, preferences, retained abilities, and present emotional state, and that supports psychosocial well-being through recreational, leisure, restorative, sensory, creative, embodied, social, or playful experience*. Psychosocial well-being is correspondingly understood to include quality of life, pleasure, emotional comfort, communication and social connection, identity, agency, dignity, and a sense of belonging.

Despite growing research across dementia care and HCI, the relationships among activity forms, experiential mechanisms, and enabling or constraining conditions remain insufficiently synthesized. The literature spans established non-pharmacological interventions rooted in clinical and care disciplines and technology-mediated approaches emerging from HCI and interaction design. Reviews of non-pharmacological interventions commonly organize activities according to therapeutic categories or clinical outcomes, whereas HCI research often focuses on particular technologies [4, 5, 8]. These parallel classifications make it difficult to determine which psychosocial mechanisms an activity supports, how its mediation shapes engagement, and why an approach succeeds for some people or settings but not others. Evidence concerning moderate to advanced dementia is especially fragmented, while the relational and organizational conditions of LTC are often treated as background rather than as integral components of the activity.

To address these gaps, this integrative interdisciplinary review examines literature across dementia care, gerontology, occupational therapy, HCI, and design. It integrates conventional non-pharmacological and technology-mediated activities, with particular analytic attention to people with moderate to advanced dementia

in LTC. The review is guided by the following research questions:

1. **RQ1.** What forms of meaningful activity, and which underlying experiential mechanisms, have been used to support the psychosocial well-being of PLWD in LTC?
2. **RQ2.** What conditions enable or constrain meaningful engagement for PLWD in LTC, and what implications do they present for future dementia-care design?

This review makes three contributions. First, it integrates dementia-care and HCI literature to distinguish experiential mechanisms of meaningful activity from the technologies and care arrangements through which activities are delivered. Second, it identifies personalization, supported agency, relational facilitation, sensory accessibility, and contextual integration as qualities that may contribute to psychosocial well-being. Third, it develops a person-centered design agenda that connects resident experience with facilitation, organizational implementation, evaluation, and ethical reflection. Through this synthesis, the review seeks to move dementia-care design beyond compensatory support and behavioral control toward activities that enable pleasure, identity, expression, connection, and agency in everyday life.

2. Methods

2.1 Review Design and Scope

This study adopted an integrative review design with a critical and interpretive synthesis. An integrative approach was appropriate because the review brought together heterogeneous scholarship from dementia care, gerontology, occupational therapy, HCI, and design research. The purpose was not to estimate the comparative effectiveness of a narrowly defined intervention, but to examine the forms and mechanisms of meaningful activity and the conditions that enable or constrain engagement. The review process was informed by the stages described by Whittemore and Knafl [18]: problem identification, literature searching, data evaluation, data analysis, and presentation.

The unit of analysis was the publication rather than a unique intervention or dataset. The primary evidence base concerned PLWD. Particular analytic attention was given to people with moderate to advanced dementia and to LTC, but dementia stage and setting were not used as absolute exclusion criteria. Publications involving people with mild dementia or settings outside LTC were retained when they provided relevant evidence about an activity form, experiential mechanism, mediation approach, or implementation condition. A limited number of adjacent HCI and design publications involving older adults or people with

cognitive disabilities were used to clarify transferable design concepts; these sources were identified as contextual and were not treated as direct evidence of psychosocial outcomes for PLWD.

Consistent with the definition presented in Section 1, psychosocial well-being encompassed experiences and outcomes related to emotional comfort and pleasure, social connection and communication, identity, agency, dignity, belonging, and quality of life. Eligible activities could be non-digital or technology-mediated, but they were required to include an experiential or participatory component. Technologies used exclusively for assessment, diagnostic screening, surveillance, safety monitoring, or clinical decision support were outside the scope of the review.

2.2 Search Strategy and Eligibility

PubMed, Scopus, and the ACM Digital Library were searched for English-language publications dated from 2014 through 2025. The final search was conducted on 27 January 2026. The searches combined terms concerning dementia ("dementia," and "Alzheimer"), activity and engagement ("meaningful activity," "meaningful engagement," "engagement," and "activity engagement"), and institutional care ("long-term care," "nursing home," "care home," "residential aged care," and "institutional care"). Because terminology differs a cross dementia-care and HCI research, supplementary searches used terms for established activity forms and emerging technologies. Backward and forward citation searching of key reviews and conceptually influential publications was used to identify additional sources.

The following search strings were used:

- Search string 1 - PubMed: (dementia* OR Alzheimer* OR "people with dementia") AND ("meaningful activit*" OR "meaningful engagement*" OR engagement* OR "activity engagement*") AND ("long-term care"* OR "long term care"* OR "nursing home"* OR "care home"* OR "residential aged care"* OR "institutional care"*)
- Search string 2 - Scopus: (dementia OR Alzheimer* OR "people with dementia") AND ("meaningful activit*" OR "meaningful engagement" OR engagement OR "activity engagement") AND ("long-term care" OR "long term care" OR "nursing home*" OR "care home*" OR "residential aged care" OR "institutional care")
- Search string 3 - ACM Digital Library: (dementia OR Alzheimer OR Alzheimer's) AND ("meaningful activity" OR "meaningful activities" OR "meaningful engagement" OR engagement OR "activity engagement") AND ("long-term care" OR "long

term care" OR "nursing home" OR "nursing homes"
OR "care home" OR "care homes" OR "residential
aged care" OR "institutional care")

Publications were eligible as direct evidence when they: (1) concerned PLWD; (2) described, evaluated, reviewed, or conceptualized an activity intended to support meaningful engagement or psychosocial well-being; (3) described an experiential or participatory component; and (4) provided sufficient information to determine their relevance to at least one research question. Peer-reviewed journal articles and conference proceedings papers were eligible. Other types of papers such as selected short papers, extended-abstract proceedings, stand-alone abstracts without a substantive proceedings paper, editorials, non-scholarly commentaries, and publications that did not describe the activity approach in sufficient detail were excluded. Their evidential roles are identified in the Appendix A (Table A.1).

2.3 Study Selection, Data Charting, and Evaluation

Following deduplication, first author screened titles and abstracts against the eligibility criteria, then assessed potentially eligible publications in full text. During full-text assessment and charting, publications were distinguished according to whether they provided direct empirical evidence, review-level evidence, or contextual and conceptual support. A structured charting form was used to record authorship, publication year, venue, publication or study type, population, setting, dementia stage, activity or intervention, mode of mediation, and psychosocial outcomes examined. Additional analytic fields captured facilitation arrangements, forms of personalization, opportunities for agency and self-expression, relational involvement, and reported enabling or constraining conditions. For research involving people with moderate to advanced dementia, particular attention was given to adaptations that reduced reliance on verbal communication, memory, abstract reasoning, precise motor performance, or sustained attention. A single formal risk-of-bias instrument was not applied because the evidence base included empirical, review, conceptual, and design-oriented publications with substantially different methodological purposes, and the review did not seek to produce pooled effect estimates. Instead, each publication was considered in relation to its relevance to the research questions, methodological transparency, contextual specificity, and evidential role. Claims about intervention outcomes were derived from empirical studies or reviews, whereas contextual and design-oriented publications primarily informed interpretation of activity mechanisms and design implications.

2.4 Data Synthesis

The synthesis proceeded in three stages. First, the publications were descriptively mapped according to population and setting, activity or intervention, mode of mediation, facilitation arrangement, and reported psychosocial outcomes. Second, first author coded the publications according to both their experiential form and the mechanisms through which they appeared to support psychosocial well-being. The first author compared the codes iteratively and grouped them into broader categories. Because one activity could support several experiences simultaneously, the categories were treated as overlapping rather than mutually exclusive. Third, a comparative thematic synthesis examined the individual, relational, technological, and organizational conditions under which meaningful engagement was enabled or constrained. Because the publications differed substantially in design, population, intervention, outcome measurement, and duration of exposure, no meta-analysis or comparative ranking of effectiveness was undertaken. The findings are therefore presented as a conceptual and thematic synthesis rather than as pooled estimates of intervention effects.

3. Results

3.1 Characteristics and Scope of the Reviewed Literature

The Results draw on 60 distinct publications. They comprise primary intervention and evaluation studies, qualitative and mixed-methods research, evidence syntheses, and conceptual or design-oriented publications. The literature varied substantially in population, setting, study design, duration, and outcome measurement. Studies of screen-based, conversational, and immersive technologies more often involved people with mild or moderate dementia or were conducted outside LTC, whereas tactile, multisensory, environmental, and robotic work more frequently addressed later-stage or institutional care. Appendix A (Table A.1) characterizes every publication cited in the Results and identifies its population, setting, dementia stage, activity or intervention, mode of mediation, outcomes examined, and evidential role.

The literature also differed in how activities were conceptualized. Dementia-care publications commonly framed activities as non-pharmacological interventions intended to address behavioral and psychological symptoms, maintain functioning, or improve quality of life [5, 19]. HCI and design publications more often emphasized sensory experience, interaction, playfulness, communication, engagement, and technology acceptance. Despite these disciplinary differences, the synthesis revealed substantial overlap in the experiential mechanisms that activities sought to support. The following sections

therefore distinguish activity forms and mechanisms from the care arrangements and technologies through which they were delivered.

3.2. RQ1: Forms and Proposed Experiential Mechanisms of Meaningful Activity

The synthesis identified six overlapping activity forms and five proposed experiential mechanisms that may help explain how participation acquires personal or relational significance. Across the reviewed literature, meaningful activity was organized into forms including: (1) sensory engagement; (2) reminiscence, identity, and biographical continuity; (3) social and relational connection; (4) environment-based engagement; (5) physical and embodied engagement; and (6) playful and recreational engagement. These categories describe the primary experience enabled by an activity rather than its clinical label or technological format. They were not mutually exclusive, for instance, music could provide sensory pleasure, evoke autobiographical memories, encourage movement, or create a shared focus for social interaction, while a robotic pet could offer companionship, prompt conversation and emotional expression, and invite tactile engagement. Therefore, psychosocial value often arises through combinations of mechanisms rather than through a single therapeutic function.

Sensory Engagement. Sensory activities engaged PLWD through seven sense or multimodal experiences. Conventional approaches such as sensory interventions utilize different human senses and aim to provide engaging sensory experiences to stimulate PLWD through sensory enhancement or calm PLWD through relaxation approaches. This includes: 1) the use of the singular sensory system, such as auditory (e.g., music therapy, sound therapy/white noise) [20, 21], visual (e.g., art therapy) [22], tactile (e.g., massage/touch, reflexology, reiki, and acupuncture), or olfaction (e.g., aromatherapy); and 2) the integrative use of multimodal sensory systems, such as tactile, visual, auditory, olfaction even gustatory (e.g., Snoezelen/ Multisensory Stimulation Therapy) [23]. See full detailed categories with examples of traditional non-pharmacological interventions, descriptions, and reported effectiveness in Table 1.

Technology-mediated sensory activities extended these mechanisms through interactive sound, projection, lighting, responsive textiles, or multisensory environments. These sensory-based designs are where most interactive technologies for PLWD are allocated, as they: 1) demonstrate significant social and emotional benefits to improve vitality, self-esteem, social relationships and participation [20]; 2) do not require complex cognitive reasoning, therefore, are suitable for various stages of

PLWD. Existing designs in the forms of products, systems, services, and agents address either one particular sensory channel or multiple sensory channels.

Most efforts of technology-mediated sensory activities for PLWD emphasize sensuous engagement through auditory and tactile modalities. On the one hand, a large proportion of work focuses on music and sound-related technologies. The role of music has demonstrated well-recognized benefits for PLWD [25, 26]. A review by Creech et al. [25] indicates that music-related technologies for PLWD mainly focus on five purposes: using technology to access preferred music, using music technology to reminisce, music technology to support singing, music perception and appreciation, and collaborative musicking. With the development of HCI technologies, “musicking” in literature collaborates closely with tangible interaction for PLWD. As a result, “Musicking Tangibles” is an innovative approach that can promote self-independence and personhood beyond the cognitive stimulating and positive emotional benefits that general music enjoyment can provide [27]. An example is Sentic by Thoolen et al. [26]. There is beginning evidence that sound also has great potential in engaging PLWD by bringing playfulness, stimulating conversations, and building connections with others.

In addition, a growing body of work focused on sensory-based designs with haptic and tactile related experience. Previous works indicate that such experiences can be particularly beneficial for PLWD in the later stages [28]. Playful sensory artifacts such as interactive textiles, especially with heat features, can comfort and soothe those with a chair/bed tied with severe verbal communication impairment [23]. The LAUGH project provided several examples (e.g., Hug, a long-arm pillow with a beating heart to give a hug; Steering Wheel, a tangible wheel to simulate a personalized driving experience; Giggle balls, softballs in the shape of smiling faces that giggle when held in hand) to demonstrate the use of haptic/tangible quality in design for playfulness [17]. Therapeutic touch that uses motor and sensory functions of the brain is more likely to be effective in motivating active participation.

In line with the pursuit for immersive experiences in the field of HCI research, sensory-based technology mediated activities for PLWD aim to provide engagement in multiple sensory modalities. For example, Bennett et al. [29] developed a resonant interface rocking chair to emphasize stimulation of proprioception and vestibular senses with the auditory sense. The chair plays music when activated by a rocking motion; A commercially available projector - Tovertafel, which transforms an ordinary dining table into a sensory-stimulating game space was reported in study [30]. This product was initially developed for PLWD in advanced stages and was designed to motivate users to

Table 1. Conventional interventions involving sensory engagement and improvements reported in the reviewed literature

Intervention	Description	Improvements Observed
Music Therapy	Engagement in music-related activities such as listening, singing, and instrument playing [20].	Reported outcomes included lower stress, boredom, agitation, and abnormal vocalization, together with reminiscence, movement, social interaction, and improved attention or concentration.
Art Therapy	Artistic self-expression through drawing, painting, and other creative activities.	Reported outcomes included improved self-esteem, social interaction, and meaningful stimulation [22].
Complementary Therapies	Includes aromatherapy, massage, reflexology, reiki, and acupuncture for relaxation and healing purposes.	Reported outcomes concerned agitation, anxiety, depression, and restlessness; rigorous evidence was limited [24].
Sound Therapy (White Noise)	White-noise exposure, including white noise presented during walking [21].	Reported outcomes included agitated behavior, mental status, activities of daily living, walking time, state anxiety, and fear of falling [21].
Multisensory Stimulation Therapy (Snoezelen Therapy)	Sensory-enriched spaces targeting vision, touch, hearing, smell, taste, and movement with minimal cognitive demand [23].	Reported outcomes included reduced agitation and improved mood, although durable effects on BPSD remain inconsistent [23].

be actively engaged through interactive features, colorful and intriguing images projection, and sound effects.

To summarize, across these examples, the proposed experiential mechanism was not sensory stimulation alone. Meaningful engagement was more likely when sensory content was recognizable, pleasurable, responsive to the person's actions, or capable of supporting interaction with others.

Reminiscence, Identity, and Biographical Continuity. Since memory appears to be the most noticeable challenge in PLWD, reminiscence that evokes memory and counteracts the loss of self-identity is another major area of meaningful interventions for PLWD. Reminiscence activities used photographs, music, familiar objects, recorded voices, personal narratives, and life-history materials to evoke autobiographical memories and support continuity of identity. In addition to the commonly acknowledged benefits of reminiscence in emotional memories and personhood, one huge positive contribution of reminiscence activities is to take a more active role in conversations and social interaction.

Of all reviewed approaches both conventional and technology-mediated, we concluded that reminiscence supported psychosocial well-being through three related mechanisms: recognition of personally relevant content, expression and reinforcement of identity, and participation in reciprocal conversations. Among which, conventional forms included reminiscence therapy and simulated presence therapy, delivered individually or in groups through conversation and non-digital prompts [24, 31]. See Table 2.

Non-digital reminiscence activities used cues such as photographs, music, familiar objects, and conversation about personally significant events. Digital systems broadened the range of materials that could be assembled and presented, particularly through tablets

integrating photographs, video, audio, and other biographical content. CIRCA, for example, uses photographs, video, and music to scaffold free-flowing conversation between a person with dementia and a relative or caregiver [32]. It functions as a communication aid for memory sharing, conversation, expression of personhood, and relationship building.

Although screen-based systems were common, the reviewed literature also examined tangible interfaces for reminiscence [33, 34]. These systems used personally or culturally familiar objects as prompts for memory, storytelling, and social interaction [33, 34], and can reduce demands associated with menus and abstract screen navigation while inviting touch, recognition, and discussion. Conversational agents were also investigated as they have been used to generate personalized reminiscence prompts. Morales et al. developed a Spanish-language conversational system using preferences, lifestyle information, and personal history to support reminiscence dialogue [35]. MindTalker combined personal photographs with a large language model to enable less scripted reminiscence conversations [36]. These studies indicated potential for self-expression, companionship, and social connectedness, while also identifying concerns about conversational accuracy, privacy, dependency, and trust. Their applicability to people living with advanced dementia and to routine LTC remains uncertain.

Social and Relational Connection. Social interaction plays a crucial role in maintaining quality of life, especially for people living in LTC who are at high risk of social isolation. The reviewed interventions and systems supported social and relational engagement in two ways: some were designed as direct interaction partners, while others served as social catalysts around which residents, caregivers, relatives, or peers could interact. The latter

Table 2. Conventional reminiscence interventions and improvements reported in the reviewed literature

Intervention	Description	Improvements Observed
Reminiscence Therapy	Reliving past experiences, especially those that are positive and personally significant, through digital or non-digital cues, or discussion with another person or a group [24].	Reported outcomes included improved mood, lower depressive symptoms, greater self-esteem and social connectedness, a stronger sense of meaning in life, and changes in BPSD. Some reports also described increased agitation.
Simulated Presence Therapy	A variation of reminiscence therapy using audiotapes made by family members containing scripted telephone conversations about cherished memories from earlier life [31].	Reported findings were mixed: some studies described reductions in agitation or other behavioral symptoms and improvements in quality of life, whereas others found no benefit or increased agitation; review-level certainty was limited [31].

function was particularly evident when robots, digital media, or shared artifacts stimulated conversation and co-participation rather than replacing interpersonal contact. Social and relational activities sought to address loneliness, isolation, and loss of social roles through relationships with caregivers, family members, peers, or animals and, in some cases, through simulated or robotic partners.

Conventional approaches included one-to-one interaction, staff- and group-based contact, animal-assisted therapy, simulated animal or human interaction, and structured or individualized activities [20]. Reported psychosocial outcomes included companionship, positive affect, communication, belonging, and reduced passivity or agitation, see Table 3.

Technology applications supporting social connection clustered into five areas: (1) mobile, tablet, and online toolkits intended to support family relationships, inter-generational communication, or dementia awareness, including DemYouth [40], Ticket to Talk [41], and Care and Connect [42]; (2) telepresence systems for remote face-to-face communication [43]; (3) tangible prompts designed to balance participation in conversation [44]; (4) shared tablet applications that scaffold resident-visitor interaction through multimodal and playful activities, such as A Better Visit [45]; and (5) social robots and conversational agents.

The reviewed social robots and embodied conversational agents were used primarily for companionship, emotional support, communication, and therapeutic facilitation [46, 47]. Zoomorphic robots formed a prominent group. PARO, a baby-seal robot, was used to support comfort, mood, pain-related experiences, and emotional engagement [48]. Other zoomorphic systems included Joy for All cats and dogs [49], JustoCat [50], CuDDler [51], and LOVOT [52]. LiveNature combined an ambient nature display and tangible water pump with a robotic sheep [53]. Humanoid robots studied directly with PLWD included Pepper [54], NAO [55], and MARIO [56]. Related studies of Ryan with older adults and assistive robotics in acute hospital care were retained

as contextual design evidence rather than treated as direct evidence for PLWD in LTC [46, 57]. Across these systems, studies described intended functions or short-term outcomes involving emotional support, communication, social connection, and therapeutic engagement. EVA facilitated therapy for dementia-related behavioral symptoms [58], while Hiro supported interactive doll therapy [59]. Embodied conversational agents could likewise support social connection and daily life.

Environment-Based Engagement. Environment-based activities modified the physical or mediated care environment to influence comfort, orientation, movement, and connection with familiar places. Conventional interventions included bright-light therapy, wandering areas, access to outdoor spaces, and enhanced environment [60, 61], see Table 4.

Technology-mediated environments use projection, large displays, lighting, sound, and other components to transform everyday care spaces into sensory-enriching experiences. Commercial mobile projection systems such as Qwiek.up illustrate this design direction; the cited design-driven living-lab literature provides implementation context rather than direct evidence of the product's psychosocial effects [62]. HealingSpaces extends virtual nature experiences into physical space by coordinating a tablet with smart lights, speakers, and projectors [63]. It offers forest and seaside scenes with stimulating or calming ambient configurations intended to support focus, engagement, and relaxation. AmbientEcho combines a simulated window, virtual scenes, a digital photo frame, ambient light, and music to provide personalized media experiences in residential dementia care [64]. When the system detects identity-related artifacts, such as a necklace or colored disc, it presents preconfigured personal media.

Movement-responsive environments offered residents more direct influence over an experience. Virtual Forest [65] and Tovertafel [30] linked hand and arm movements to projected content through movement-sensing technologies. LiveNature combined a large display presenting a Dutch farm landscape with a

Table 3. Conventional interventions involving social and relational connection and improvements reported in the reviewed literature

Category	Intervention	Description	Improvements Observed
Human, Animal, and Simulated Social Interaction	One-on-One Interaction	Individualized social contact through family visits, volunteer visits, staff interaction, or therapy [5].	Reported outcomes included improved interpersonal relationships, connectedness, and emotional well-being and reduced verbal agitation.
	Staff and Group Contact	Group social interactions such as games or structured group activities [5].	Reported outcomes included greater social connectedness, less boredom, improved mood, and opportunities to enact social roles.
	Animal-Assisted Therapy	Interactions with domestic or farm animals in care settings [37].	Reported outcomes included positive emotion, communication, motivation, and reduced passivity or agitation; findings and study designs varied.
	Simulated Animal/Human Interaction	Simulated interaction using dolls, family recordings, robotic pets, social robots, or animal videos [20].	Reported outcomes included companionship, enjoyment, relaxation, social interaction, and fewer behavioral problems.
Structured and Individualized Activities	Group-Structured Activities	Organized group activities such as games and reading roundtables [24].	Reported outcomes included improved engagement, mood, social interaction, and quality of life and reduced boredom or behavioral problems.
	Individual-Structured Activities	Manipulative games, work-like tasks, and physical activities such as walking, dancing, and sports.	Reported outcomes included engagement and self-identity, improved affect and sleep, reduced stress and agitation, and improved cognitive functioning [38].
	Individualized Activities	Activities tailored to individual needs, preferences, personalities, and interests.	Reported outcomes included reduced passivity and apathy, increased positive affect and engagement, and improvements in behavioral problems [39].

Table 4. Conventional environment-based interventions and improvements reported in the reviewed literature

Intervention	Description	Improvements Observed
Bright-Light Therapy	Providing bright light exposure during specific periods or within the living environment [60].	Pilot findings suggested improvements in diurnal rhythms, sleep disturbance, mood, and restlessness [60].
Wandering Areas	Dedicated wandering areas designed to reduce hazards and support manageable wandering behaviors [61].	The reviewed literature associated supportive walking areas with lower agitation, restlessness, and anxiety, although evidence varied.
Enhanced Environment	Access to outdoor areas and familiar domestic layouts and sensory cues [61].	Reported outcomes included improved mood and reductions in some agitated, aggressive, exit-seeking, or trespassing behaviors; findings varied across environmental features and studies.

tangible water pump and robotic sheep, allowing residents to simulate feeding and petting an animal [53]. These designs connected bodily action with immediate visual, auditory, or tactile feedback.

Virtual and augmented environments extended environmental engagement by simulating or blending otherwise inaccessible places and experiences. Matsangidou et al. [66] used participatory design to develop a VR-based "out-of-world" experience intended to provide relaxation and personally meaningful experiences beyond institutional constraints. The Closer to Nature installation combined a digital nature display with tangible artifacts to recreate aspects of feeding and petting farm animals for PLWD in LTC [67]. Evidence remained preliminary, the small Virtual Forest pilot, for example, reported increased pleasure and alertness but also greater fear

or anxiety during the experience for some participants [65].

Environmental technologies varied in the agency they afforded. Some presented predetermined sensory content to residents, whereas others responded to movement, object use, or identity-related cues. This distinction between passive exposure and responsive participation recurred across the reviewed interventions and systems.

Physical and Embodied Engagement. Walking, dancing, sports, manipulative tasks, gestural interaction, and exercise-based games required physical or embodied participation. Conventional physical activities were associated in the reviewed literature with engagement, affect, sleep, physical functioning, and opportunities for social participation [38]. Meaning could arise from movement itself, the familiarity of a previous occupation

or leisure practice, or participation alongside other people.

Exergames for PLWD combine physical movement with game feedback, cognitive stimulation, and, in some configurations, social participation. A systematic review reported cognitive, physical, motivational, and social outcomes while also identifying accessibility limitations [68]. Individual studies involving PLWD or LTC residents examined stepping games, Wii- or Kinect-based activities, and other interactive exercise platforms, with reported outcomes involving mobility, balance, executive function, well-being, and social functioning [69]. A nursing-home study without a dementia-specific sample was retained as contextual evidence [70]. Direct evidence concerning accessibility for residents with advanced cognitive, sensory, or physical impairment remained limited. Tovertafel and Virtual Forest similarly incorporated embodied interaction by allowing hand or arm movement to influence projected content [30, 65]. Such systems may enable participation without requiring sustained verbal communication or complex navigation because bodily action produces an immediate and perceptible response. Related mixed-reality research emphasized embodied and multisensory participation. Feng et al. [71] examined an AR display combined with a social robot. Lee et al.'s broader study with older adults was retained as contextual design evidence rather than direct dementia evidence [72], while Desai et al. [73, 74] proposed familiar, meaningful, and sensory-rich blended-reality experiences, including sound-based prompts.

Playful and Recreational Engagement. Playful and recreational activities foregrounded pleasure, curiosity, spontaneity, and participation rather than clinical performance or a single correct outcome. Structured group games, reading activities, sing-alongs, manipulative games, and individualized leisure activities were common non-digital examples [24, 38]. HCI and design research extended these approaches through tangible games, creative applications, and playful artifacts. Tovertafel, for example, used projected graphics and sound to encourage residents to reach, touch, follow, and interact with virtual objects on a shared table [30]. The LAUGH artifacts similarly employed humor, sound, movement, warmth, and familiar forms to invite open-ended interaction [17]. These examples were designed to enable participation without requiring cognitive accuracy or completion of a predetermined therapeutic task.

Playfulness frequently overlapped with other mechanisms. Games could support physical movement and social interaction, while sensory objects could prompt curiosity, comfort, or conversation. The literature therefore presented play not as a discrete technology or

intervention but as an experiential quality that could make participation enjoyable and personally rewarding.

To conclude, across the six activity forms, the synthesis identified five recurring experiential mechanisms through which activities were associated with psychosocial value. They are personal and biographical resonance; sensory and emotional stimulation; active or embodied participation; relational connection; and opportunities for choice or self-expression. The activity forms describe an experience's primary focus, whereas the mechanisms describe how participation may acquire personal or relational significance; consequently, the same mechanism can operate across several activity forms. Across the heterogeneous literature, reported experiences and outcomes varied with personal relevance, retained abilities, opportunities for agency, facilitation, and care context. These patterns informed a conceptual account of meaningfulness as a person-centered, relational, and situated quality. The proposed mechanisms organize the evidence and generate directions for future research, they do not establish causal pathways from activity participation to psychosocial benefit.

3.3 RQ2: Conditions Enabling or Constraining Meaningful Engagement

The synthesis identified four interrelated domains of conditions, individual, relational, technological, and organizational, that enabled or constrained meaningful engagement among PLWD in LTC. These domains recurred across activity forms and modes of technological mediation and help explain variation in reported experiences and outcomes.

Individual conditions included biographical identity and personal characteristics, such as lifelong experiences, hobbies, preferences, and dislikes; dementia stage; cognitive and communicative abilities; sensory and motor capacities; current emotional state; and fluctuating attention. Together, these conditions shaped how a person encountered an activity and what support was required. Across the reviewed literature, personalization of activities according to individual conditions was evident in both conventional and technology-mediated activities. A stimulating multisensory environment, for example, could engage one resident but overwhelm another. Activities therefore required sensitivity to the person's response in the moment rather than reliance solely on a fixed profile or diagnostic stage [17, 33, 38, 64].

Activities aligned with familiar experiences, retained abilities, and current support needs were commonly associated with attention, positive affect, engagement, and reduced passivity. Familiarity did not, however, guarantee a positive response. Reminiscence and simulated-presence interventions could evoke agitation or distress when they prompted an unfavorable

comparison between past and present circumstances or activated difficult memories. Personally significant content could therefore carry both positive and negative emotional associations [31].

The synthesis also suggests that current personalization was more often content-based (e.g., selecting preferred music, media, sensory settings, or life-history profiles) rather than interaction-based (e.g., adaptive interaction paradigm according to user attention and sensory needs). For PLWD with more advanced impairment, whose verbal communication and abstract reasoning may be limited, sensory, tactile, musical, and embodied activities may provide particularly accessible routes to engagement.

Relational conditions concerned who introduced, facilitated, and participated in an activity; how the person's responses were interpreted; and whether participation was directive or reciprocal. Caregivers, family members, volunteers, and peers could provide encouragement, emotional reassurance, and practical scaffolding. The quality of facilitation shaped the resulting experience. Skilled facilitators introduced activities in an understandable way; prepared or reoriented residents before and after an activity when needed; adapted content to personal histories and interests; interpreted verbal and non-verbal responses; and adjusted the pace, complexity, and level of support as interaction unfolded. Well-matched facilitation could enable participation, whereas inaccurate judgments about a person's state or needs could contribute to fatigue, frustration, or distress. Facilitation could also be repetitive and demanding for staff, requiring them to recognize changing conditions, combine several strategies, and tailor support to the individual [32, 45, 47].

For people with more advanced dementia in LTC, successful facilitation tended to reduce reliance on verbal communication, memory, and correct task performance. Instead, it drew on familiar actions, short sentences, repetition, reassurance, and supported participation. Technology-mediated activities did not remove the need for such facilitation, although some systems structured or assisted it through designed procedures. Most systems still depended on facilitators for setup, personalization, prompting, interpretation, troubleshooting, or evaluation. This pattern challenges the assumption that technology can simply replace staff-led activity provision or enable fully independent participation.

Conversely, meaningful engagement was constrained when PLWD were positioned solely as passive recipients or when participation depended on compliance with predetermined tasks. Tangible, movement-responsive, and open-ended systems created opportunities for residents to influence an activity through touch, gesture, movement, selection, or vocalization [26, 29, 30].

Technological conditions concerned the features of technologies and the ways in which they mediated activity. Table 5 organizes seven recurring modes of mediation according to their mechanisms, activity configurations, facilitation requirements, and reported benefits and constraints.

Technology-mediated activities could support reminiscence, relaxation, enjoyment, and personalized engagement by providing access to varied content, multimodal feedback, adjustable sensory intensity, and interactions tolerant of repetition and variable input. These possibilities coexisted with constraints. Screen-based systems offered broad access to multimedia but could impose demands associated with menus, symbols, touch accuracy, and abstract navigation. Tangible and embodied systems could reduce some of these demands by establishing a more direct relationship between physical action and digital response, particularly when screen interaction or verbal dialogue imposed a high cognitive load. Environmental and immersive technologies created sensory-rich experiences but varied in the extent to which residents could influence their content. Robotic and conversational systems introduced social responsiveness, although speech recognition, conversational accuracy, trust, and transparency remained recurring challenges [47].

Further constraints included limited acceptability or accessibility, sensory overload, and interactions that required memory or correct task performance. Immersive systems using VR or AR introduced practical demands related to equipment, visual or physical discomfort, orientation, and facilitator support. Conversational agents and robots raised additional concerns about response accuracy, trust, privacy, deception, and users' understanding of system capabilities.

Technologies intended for people with more advanced dementia often emphasized receptive or responsive engagement rather than self-initiated participation. In many configurations, professionals selected, organized, and facilitated the activity, while residents primarily received content or responded to prompts. Such support may be necessary, but it can also restrict opportunities for agency and reinforce dependence on staff-led engagement. This pattern identifies a need for accessible opportunities to choose, initiate, influence, or decline an activity. Graded prompts, simplified choices, familiar content, and adaptive assistance could help residents express preferences and participate through their retained abilities.

Organizational conditions, spanning the physical care environment, staffing arrangements, activity provision, and institutional care philosophies, shaped whether PLWD could access and sustain meaningful engagement in LTC. The synthesis identified five interrelated domains: organizational care values,

Table 5. Modes through which technology mediated meaningful activities for PLWD, including mechanisms, activity configurations, facilitation, and reported benefits and constraints

Mode of technological mediation	Typical technologies and examples	Mechanisms supported	Activity configuration and facilitation	Reported benefits and constraints
Screen-based and ICT mediation	Tablets, multimedia applications, communication platforms, photo-sharing systems, and multifunctional activity systems. Examples include CIRCA [32] and A Better Visit [45]	Reminiscence, communication, social connection, games, creative expression, and access to preferred media	Commonly used in resident-caregiver or resident-family dyads; facilitators typically select content, initiate activities, and support navigation	Can broaden access to varied and personalized multimedia content and scaffold shared interaction. Constraints include abstract navigation, small interface elements, touch-accuracy demands, and dependence on caregiver configuration [32, 45, 75].
Game- and exergame-based mediation	Interactive exercise platforms, motion-controlled games, and digital recreational activities	Physical movement, cognitive stimulation, playfulness, social interaction, and embodied participation	Commonly delivered in staff-facilitated individual or group sessions; challenge level, physical demands, and safety often require facilitator oversight	Can combine movement with immediate feedback and may support motivation, mobility, affect, and social participation. Constraints include motor demands, task complexity, fatigue, safety concerns, and limited accessibility for people with more advanced dementia [68–70].
Conversational mediation	Screen-based virtual agents, voice assistants, chatbots, embodied conversational agents, and personalized reminiscence agents. Examples include MindTalker [36]	Conversation, storytelling, self-expression, reminiscence, companionship, and entertainment	Some systems are designed for partially independent interaction, but personalization and setup commonly require assistance from caregivers, family members, or researchers	May offer familiar verbal interaction and personalized or adaptive dialogue. Constraints include speech-recognition performance, conversational accuracy, privacy, trust, reliance on support, and users' understanding of system capabilities [47].
Tangible and embodied mediation	Interactive objects, textiles, furniture, physical controls, and movement-responsive interfaces. Examples include Musicking Tangibles [27], Sentic [26], and a resonant rocking chair [29]	Sensory pleasure, music-making, embodied participation, playfulness, agency, reminiscence, and self-expression	Can support individual or shared participation through touch, manipulation, rocking, reaching, or other familiar bodily actions	Can reduce reliance on text, menus, and verbal instructions and make action-response relationships more perceptible. Constraints include limited configurability, physical-access requirements, and the need to match feedback to retained abilities [26, 29].

the physical environment, staff resources, activity organization, and opportunities for relationships and social interaction [5, 32, 38, 39, 61]. Table 6 summarizes the enabling and inhibiting factors within each domain and their implications for dementia-care design.

At the broadest level, an organization's care philosophy established the values and policies guiding everyday practice. Person-centered care supported engagement by treating empathy, respect, reassurance, familiar communication, and appropriate touch as essential care practices. Engagement was further enabled when meaningful activity was incorporated into daily routines rather than treated as an optional or separately scheduled program. The physical environment provided the material conditions for engagement. Spatial layout, familiarity, lighting, and access to shared or outdoor spaces influenced residents' comfort, orientation, and opportunities for autonomy. Safety concerns, mobility limitations, and insufficient supervision, however, often restricted physical activity and outdoor access. Environmental design therefore needed to balance protection with opportunities for independent or supported participation.

Staff shortages, multitasking, and fragmented care teams reduced the time and continuity available for personalized engagement. Inadequate handovers could also prevent caregivers from applying consistent strategies or drawing on residents' histories and preferences. Structured activities could be infrequent or poorly matched to residents' interests and retained abilities, leaving residents inactive for extended periods. Apparent lack of motivation should therefore be understood partly as a mismatch among the person, activity, support, and context rather than solely as an individual limitation. Meaningful activity also depended on relational continuity. Caregivers sometimes lacked effective ways to engage residents with advanced cognitive impairment, while residents could have limited contact with family members, close friends, peers, or familiar staff. Organizational practices that supported personal knowledge, accessible communication, and sustained social contact strengthened the relationships through which activities became meaningful.

To conclude, the above findings related to four conditions indicate that dementia-care design should be socio-technical and responsive to routine practice. It should support continuity of personal knowledge,

Table 5. Modes through which technology mediated meaningful activities for PLWD, including mechanisms, activity configurations, facilitation, and reported benefits and constraints (continued)

Mode of technological mediation	Typical technologies and examples	Mechanisms supported	Activity configuration and facilitation	Reported benefits and constraints
Environmental mediation	Projection, ambient displays, lighting, soundscapes, scent, and multisensory room-based systems. Examples include Qwiek.up (supported here by contextual implementation literature [62]), HealingSpaces [63], AmbientEcho [64], LiveNature [53], and Tovertafel [30]	Sensory stimulation, relaxation, environmental familiarity, playfulness, movement, reminiscence, and shared attention	Usually configured by care staff or researchers and delivered individually or in groups; some systems present predetermined content, whereas others respond to movement or personal objects	Can transform familiar care spaces into sensory-rich settings. Constraints include passive participation, sensory overload, and installation or maintenance demands [30, 53, 62–64].
Immersive and blended-reality mediation	VR, AR, and MR environments and games. Examples include MemHolo [76], and sound-based MR prompts [73, 74]	Relaxation, escape from institutional constraints, cognitive stimulation, embodied exploration, and contextually meaningful experience	Generally requires researcher or caregiver assistance with equipment setup, instruction, orientation, and monitoring; most studies involved guided sessions	May provide access to otherwise unavailable places and experiences and combine sensory, spatial, and embodied interaction. Constraints include equipment tolerance, cybersickness, disorientation, cognitive demands, and limited evidence involving people with advanced dementia [66, 73, 74, 76].
Robotic mediation	Zoomorphic robots such as PARO [48], Joy for All cats and dogs [49], JustoCat [50], CuDDler [51], and LOVOT [52]; the robotic sheep within LiveNature [53]; and humanoid robots such as Ryan [46], Pepper [54], NAO [55, 57], MARIO [56], EVA [58], and Hiro [59]	Companionship, emotional support, tactile engagement, communication, play, therapeutic facilitation, and stimulation of interaction with others	Robots may function as direct interaction partners or as social catalysts; staff commonly introduce the robot, moderate interaction, and interpret residents' responses	Can provide responsive, embodied, and repeatable social or sensory interaction. Constraints include cost, novelty effects, technical reliability, variable acceptance, anthropomorphic misinterpretation, and the risk of substituting technology for human contact [46, 48, 56].

embed adaptable micro-activities into everyday care, and facilitate safe social and physical participation without replacing human relationships. Because researcher-led evaluations provide limited evidence of practical feasibility, technologies should also be assessed through naturalistic, longitudinal deployment, with attention to workload, organizational integration, sustained use, and residents' psychosocial well-being.

4. Discussion

4.1 Answers to the Research Questions

This integrative review examined which forms of meaningful activity have been used to support the psychosocial well-being of PLWD, how those activities may acquire meaning and value, and which conditions shape their use in LTC contexts.

In response to RQ1, the synthesis identified six overlapping forms: sensory engagement; reminiscence, identity, and biographical continuity; social and relational connection; environment-based engagement; physical and embodied engagement; and playful and recreational engagement. Across these forms, five recurring mechanisms helped explain psychosocial value: personal and biographical resonance, sensory and emotional stimulation, active or embodied participation,

relational connection, and opportunities for choice or self-expression. Identifying activity form clarifies what residents are offered and how participation is mediated, whereas examining mechanisms helps explain why and under what conditions benefits may occur. The same activity may produce different outcomes depending on its personal relevance, facilitation, social context, and fit with the resident's retained abilities. These findings explain why apparently similar activities can elicit different responses and why no activity type can be assumed to be universally meaningful. This distinction is particularly relevant in LTC, where staffing, routines, environmental constraints, and residents' changing abilities influence implementation. For people with moderate to advanced dementia, sensory, tactile, musical, embodied, and relational participation may remain accessible when verbal communication, episodic memory, or abstract reasoning is limited.

In response to RQ2, meaningful engagement emerged from alignment across individual, relational, technological, and organizational conditions rather than from any condition acting alone. Personal relevance has limited value if a resident cannot access or influence an activity, while accessible technology may still fail when facilitation is overly directive or its setup cannot be accommodated within everyday routines. This

Table 6. Organizational conditions enabling or constraining meaningful engagement for PLWD in LTC

Domain	Condition and representative sources	Enabling factors	Inhibiting factors	Design implications
Organizational care values	Person-centered care culture [19, 38]	Care responsive to individual preferences and abilities; staff training and supervision in person-centered care and communication	Standardized activities that disregard personal interests; insufficient support for applying person-centered approaches	Embed dignity, consent, empathy, and personal preferences in care protocols, training, scheduling, and quality assessment
Physical environment	Environment supporting movement and outdoor access [61]	Accessible walking and outdoor areas; familiar, legible surroundings; opportunities for supported movement	Restrictive or inaccessible layouts; poorly matched sensory conditions; environments that limit orientation and independent movement	Provide secure walking areas and accessible outdoor spaces that balance resident autonomy with safety
Staff resources	Workforce capacity and facilitation [19, 49]	Staff availability; training, supervision, and practical support for introducing and sustaining activities	Competing care demands and limited staff capacity for facilitation and observation	Protect time for relational care, strengthen handovers, and reduce administrative and coordination burdens
Activity organization	Activity availability and motivation [5, 38]	Activities tailored to interests, life history, and retained sensory, cognitive, and motor abilities	Materials or task demands that exceed retained abilities; limited personal relevance	Help staff personalize activity provision without replacing human relationships
	Compatibility with everyday care routines [49, 62]	Flexible individual and group use; staff involvement in adaptation and implementation	Competing workloads; setup and maintenance requirements; contextual restrictions on shared use	Embed personally relevant, adaptable micro-activities in everyday care through workflow-aware design
Relationships and social interaction	Communication and personal knowledge [19, 45]	Communication skills; familiar memories and topics; carers' knowledge of the person's identity and preferences	Impersonal prompts; difficulty accessing or communicating personal memories; potentially distressing reminiscence	Support the sharing of residents' histories, interests, preferences, and effective communication strategies across care teams
	Social connectedness [32, 43]	Shared activities and supported contact with family, peers, and caregivers	Limited opportunities for social contact; dependence on others to arrange and facilitate technology-mediated interaction	Facilitate shared activities and communication among residents, staff, and families without replacing human relationships

interdependence helps explain why positive responses in researcher-supported sessions do not necessarily translate into sustained use in LTC. Disengagement should therefore be considered a possible mismatch among the person, activity, facilitation, and setting rather than attributed automatically to dementia-related impairment. For person-centered design, this finding shifts attention from isolated products toward activity-care ecosystems. Systems should make personalization and adjustment practical for caregivers, provide residents with intelligible opportunities to initiate, shape, or refuse participation, and fit care practices without displacing interpersonal contact.

4.2. Reflections and Implications

Meaningfulness as a Person-Centered, Relational, and Situated Quality. This review examined what meaningfulness entails in activity engagement, particularly for PLWD in LTC. The findings indicate that meaningfulness is not an intrinsic property of an activity, intervention, or technology, but a person-centered, relational, and situated quality. A person-centered account begins with the resident rather than with a predefined

activity type. An experience becomes meaningful when it connects with the person's preferences, retained abilities, and present concerns. Studies of personhood, individualized leisure, and personalized reminiscence similarly emphasize identity and personal relevance [38, 45]. The same activity may evoke pleasure and recognition for one resident, yet indifference, confusion, or distress for another.

Meaningfulness is relational because it is co-produced through interactions among facilitators, peers or relatives, and the material or technological features of an activity. Observable participation alone does not establish this quality. Attendance, task completion, screen touches, or time on task may indicate involvement, but the significance of a response depends on its interpersonal and temporal context. For people with moderate to advanced dementia, engagement may instead be expressed through sustained attention, facial expression, rhythmic movement, touch, relaxation, vocalization, or an attempt to connect. Studies of playful tables, robotic companions, and multisensory activities illustrate the importance of such subtle expressions [28, 30, 51]. Their interpretation should draw on the

immediate interaction and on knowledge held by people familiar with the resident.

Meaningfulness is also situated because it can change across occasions as attention, sensory tolerance, emotional state, and willingness to interact fluctuate. Personalization should therefore be treated as an ongoing process of noticing and responding, rather than as the one-time configuration of a profile. The relevant design question is consequently not whether an intervention is meaningful in general, but for whom, at what moment, and under which relational and care conditions it becomes meaningful.

Designing for Supported Agency of PLWD in LTC. Design for moderate to advanced dementia should begin with retained capabilities rather than documented losses. A person who cannot follow complex instructions may still respond to rhythm, melody, warmth, movement, or another person's emotional tone. Multisensory, tactile, and playful designs demonstrate how participation can be supported without depending primarily on episodic memory, linguistic accuracy, or abstract navigation [13, 17, 23, 28, 29]. Supported agency in this context refers to the person's ability to initiate, modify, or refuse an activity with whatever assistance is appropriate. A glance that activates further content, a reach that changes a projection, a vocalization that pauses a system, or a choice between two familiar objects can each provide meaningful influence. Tangible and movement-responsive systems show how small actions can be translated into immediate and perceptible effects [26, 29, 30, 65]. Open-ended interaction can further reduce the risk that residents with dementia are positioned as failing a task for which there is a single correct response.

Accordingly, activities for people with more advanced dementia should establish a clear relationship between action and feedback, tolerate repetition and delayed responses, minimize dependence on text or symbolic instructions, and offer multiple modes of participation. Sensory intensity and interaction complexity should be adjustable, while stopping or declining an activity should be simple and consequential. Systems should also avoid communicating failure when a resident does not respond as expected.

From Standalone Technologies to Activity-Care Ecosystems. The seven modes of technological mediation are components of activities rather than categories that determine outcomes. For example, a tablet can act as a repository of personal media, a prompt for shared conversation, or an individual entertainment device; a robot can function as a direct interaction partner, a tactile object, or a social catalyst; and a projection system can create passive ambience or respond to residents' movements. A person-centered activity-care ecosystem should address three interdependent layers: resident, facilitator, and organization. The resident-facing layer

should enable perceptible, accessible, and emotionally safe engagement. The facilitator layer should support preparation, adjustment, interpretation, and recovery from technical problems. The organizational layer should address ownership, maintenance, staff training, information handover, privacy responsibilities, and compatibility with daily workflows.

Design should also prioritize shared use where this supports the person's preferences. Communication tools, reminiscence applications, and social technologies can provide a common resource around which residents, caregivers, families, and peers interact [32, 40, 41, 43, 45]. Their contribution may lie less in replacing conversation than in redistributing interactional demands, making personal material accessible, and allowing the resident to participate without carrying the full burden of remembering or initiating a topic. Similarly, robots and environmental systems may be valuable when they stimulate contact among people rather than becoming substitutes for it [48, 53, 54, 56]. The relevant outcome is therefore not technology use alone, but whether the overall configuration expands opportunities for personally significant engagement within everyday care.

Evaluating Meaningful Engagement for PLWD. Determining whether an activity is meaningful for PLWD is essential for developing and evaluating future activity provision. However, meaningful engagement is difficult to operationalize for PLWD because meaningfulness is subjective and situated, whereas evaluation typically depends on observable or measurable outcomes. The field therefore lacks a consistent approach for determining whether participation in an activity is meaningful to the person and whether it contributes to broader psychosocial well-being.

Evaluations of conventional non-pharmacological interventions have employed diverse outcomes, including quality of life, behavioral symptoms, cognitive and physical functioning, medication use, emotional responses, and interaction with caregivers. Many such interventions were initially developed to reduce behaviors that are distressing or difficult to manage in care settings. Consequently, a substantial body of research has evaluated effectiveness primarily in terms of reductions in agitation, anxiety, apathy, or other BPSD [8, 19]. Although these outcomes remain clinically important, their measures and methods vary considerably across studies and provide only a partial account of how an activity is experienced. In particular, the reduction of an observable symptom does not necessarily demonstrate that the activity is personally meaningful or that the person's psychosocial well-being has improved.

As dementia care has increasingly adopted person-centered and strengths-based approaches, evaluation has begun to incorporate "engagement" as an indicator of the

person's psychological and emotional involvement in an activity. Engagement is commonly approached through three complementary dimensions: the experiential dimension concerns the person's subjective experience and is generally assessed through self-report; the behavioral dimension concerns observable expressions of attention, affect, action, and social orientation; and the peripheral dimension uses physiological parameters as indirect indicators of affective or attentional states [77]. For PLWD, particularly those at more advanced stages, conventional retrospective self-report may be difficult because of cognitive and communication impairments. Nevertheless, the resident's perspective should be sought wherever possible through brief questions, supported communication, and choices anchored in the immediate situation. Reports from relatives or care professionals can provide valuable contextual knowledge, but they represent proxy perspectives rather than direct substitutes for the person's experience [78]. Physiological measures may offer additional information, although their use can be intrusive and their meaning is often ambiguous. These constraints explain why engagement research in dementia care has relied predominantly on structured observation of verbal, affective, bodily, and social behavior.

Behavioral observation nevertheless requires careful interpretation. Engagement is often treated as inherently positive, implying that any observable participation is preferable to non-engagement. Yet the occurrence or duration of engagement does not establish its valence or personal significance. Observable activity may indicate curiosity and enjoyment, but it may also reflect compliance, anxiety, confusion, or an inability to disengage. Conversely, quiet observation or attentive listening may constitute meaningful participation for a person with advanced dementia. Existing observational instruments address different aspects of this complexity. For example, the Observational Measurement of Engagement considers attention, attitude, action, duration, and refusal [79], whereas the Engagement of a Person with Dementia Scale captures positively and negatively valenced expressions across several behavioral modalities [80]. ELICSE provides a more detailed account of how engagement is expressed through bodily behavior during an activity [81]. However, reviews have found neither a uniform definition of engagement nor a single instrument appropriate for every research context [82, 83].

Based on the findings of this review, evaluation in LTC should distinguish three related but non-equivalent questions: whether PLWD are engaged in an activity, whether that engagement is meaningful to them, and whether the experience contributes to psychosocial well-being. These questions concern different levels of inference. For instance, consider a personalized music session for a resident with advanced dementia in LTC.

A person might remain attentive without finding the music personally significant, or experience a meaningful encounter without showing a measurable improvement in broader well-being. Thus, in this case the engagement can be assessed through structured observation of length of participation, attention, humming, even rhythmic movement and interaction with others. Assessing meaningfulness would require additional evidence, such as self-reported musical history and preference through answering brief questions or family member's knowledge. And psychosocial benefit would be assessed separately through changes in emotional comfort, distress, or social connection before, during, and after the session. Engagement should therefore be treated as proximal evidence concerning the quality of an encounter rather than as a surrogate for meaningfulness or psychosocial benefit. Future evaluation should combine the person's expressions and preferences with structured observation, contextual knowledge from familiar others, and outcome measures aligned with the proposed mechanism of the activity. Repeated assessment in everyday care is also needed to establish whether a positive encounter develops into a sustained psychosocial benefit. Meaningfulness is unlikely to be captured by a single measure; it should instead be understood through converging evidence concerning how the person participates, experiences the activity, and benefits from it over time.

Ethical Implications for Technology-Mediated Activities. An activity may be experienced as meaningful without being ethically unproblematic. This tension requires particular attention when technologies are designed for PLWD, whose changing cognitive and communicative abilities may affect how technological systems and their intentions are understood. Although the principle that technology should support rather than replace human care is well established, the increasing use of artificial intelligence (AI)-enabled embodied agents introduces a related concern that remains comparatively underexamined in dementia care: the possibility of robotic deception. Robotic deception broadly refers to situations in which a robot's representations or signals create a misleading impression of its nature, capacities, or intentions [84].

Companion robots illustrate the complexity of this issue. An animal-like robot may provide comfort and invite affection, yet its appearance and behavior may also encourage a person to perceive it as alive, emotionally responsive, or capable of genuine companionship. Such interpretations may become ethically concerning when they produce distress, dependency, misplaced trust, or confusion about the system's actual capacities. Family members and care professionals may also experience discomfort when a resident forms an attachment to what they perceive as a toy. This discomfort is often

connected to concerns about dignity and infantilization, particularly when the robot adopts childlike or highly *cute* characteristics [85, 86]. The same characteristics, however, may contribute to the robot's acceptability and emotional value. Baby-schema features, soft textures, responsive movements, and apparently vulnerable behavior can elicit affection and caregiving responses, thereby supporting engagement and enabling PLWD to occupy an active and reciprocal role. Removing these features in the name of transparency may consequently reduce the qualities that make the interaction comforting or meaningful. Moreover, talking to a robot as though it were alive, caring for it, or assigning it a social role does not necessarily demonstrate that a person holds a literal false belief. These behaviors may instead reflect imaginative engagement, habitual social responding, or self-initiated engagement in a playful interaction [87, 88]. Deception should therefore not be inferred solely from anthropomorphic language or behavior.

The ethical dilemma is not simply whether deception is present, but when a potentially misleading impression becomes unacceptable. Some forms of ambiguity or make-believe may support comfort and connection without causing identifiable harm. Conversely, even an interaction that produces immediate enjoyment may be ethically problematic if it undermines autonomy, damages trust, or primarily serves organizational convenience. The acceptability of robotic deception should therefore be evaluated in relation to the person's understanding and responses, the consequences of the interaction, the availability of less deceptive alternatives, and whose interests are being served [89, 90]. Meaningfulness and ethical acceptability are related, but neither can be used as a substitute for the other.

Wang et al. [88] examined this issue by synthesizing 26 empirical studies concerning the design of social robots and the ways in which they were interpreted by PLWD. Across these studies, participants attributed biological characteristics, mental capacities, social identities, or relational roles to robots. They also expressed empathy and engaged in caretaking behavior toward them. These findings indicate that interpretations of a robot emerge through the interaction of multiple design cues, including its appearance, movement, vocalization, responsiveness, and resemblance to familiar beings. However, the reviewed studies did not systematically manipulate these features and therefore do not establish a causal relationship between a particular design cue and deception. Interpretations may also remain ambivalent or fluctuate across individuals and situations. Future research should therefore examine robotic deception as a situated and relational process rather than as a fixed property of a technology. Studies should investigate how design features, caregiver introductions, institutional practices, and the person's changing interpretations jointly shape an encounter.

Transparency should similarly be approached as an ongoing process: the artificial nature and actual capabilities of the system should remain intelligible without automatically disrupting beneficial imaginative or playful engagement. Evaluation should extend beyond whether a robot elicits interaction to consider whether the experience preserves dignity and agency, avoids harmful misunderstanding, and continues to support the person's relationships with others. Addressing these questions is necessary if embodied agents are to facilitate meaningful engagement without obscuring the ethical responsibilities associated with their design and use.

4.3 Limitations

This review has several limitations. The search covered three databases, English-language publications, and the period 2014-2025. Although supplementary searches and citation tracing broadened coverage, relevant studies indexed elsewhere or published in other languages may have been missed. This restriction is especially important because understandings of meaningful activity, personhood, family involvement, and acceptable care practices are culturally situated. The integrative design enabled comparison across empirical studies, reviews, and conceptual or design-oriented publications, but it also introduced heterogeneity in purpose, method, population, and evidential strength. A single study design specific risk-of-bias instrument was not appropriate for this mixed evidence base, and no formal certainty assessment was undertaken. The synthesis should therefore be interpreted as a conceptual account of activity forms, mechanisms, and enabling conditions rather than as evidence of comparative effectiveness or causal relationships. Some reviews may overlap with included primary studies, and the proposed forms and mechanisms are interpretive and overlapping rather than validated taxonomies. Evidence directly concerning people with moderate to advanced dementia in LTC was comparatively limited. Publications involving earlier dementia stages, community settings, or adjacent HCI and design contexts were retained when they clarified transferable concepts, but these sources should not be treated as direct evidence for residents with advanced dementia. In addition, many empirical studies were small, brief, or conducted with substantial researcher involvement. Reporting of dementia stage, facilitation, adverse or ambivalent responses, staff workload, and sustained implementation was also uneven. These limitations constrain conclusions about long-term psychosocial benefit and indicate a need for longitudinal, naturalistic, and culturally diverse research that gives greater weight to the perspectives and expressions of PLWD.

5. Conclusion

This integrative review synthesized dementia-care and HCI research published between 2014 and 2025 concerning meaningful activities and psychosocial well-being in LTC. It identified six overlapping activity forms and five recurring mechanisms through which activities may acquire psychosocial value. The findings demonstrate that neither an activity category nor a technological medium is inherently meaningful. Meaningfulness emerges through the fit between an experience and the person's biography, retained and fluctuating abilities, present state, relationships, and care context.

The synthesis advances a person-centered design agenda in which meaningfulness is understood as relational and situated. For people with moderate to advanced dementia, activities should begin with retained capabilities and provide accessible opportunities to initiate, influence, continue, or refuse participation. Design must also extend beyond the resident-facing interaction to support caregivers' facilitation and the organizational conditions required for sustained use. Evaluation should distinguish observable engagement from personal meaningfulness and longer-term psychosocial benefit, while ethical reflection should consider whether technological mediation preserves dignity, agency, transparency, and human connection.

For care practitioners, the review organizes existing approaches while showing why their value depends on personalization, facilitation, and context. For HCI and design researchers, it connects person-centered principles with supported agency, activity-care ecosystems, multidimensional evaluation, and responsible technology use. Technology can broaden access to sensory, embodied, biographical, and social experiences, but it should remain a mediator of meaningful activity rather than a substitute for interpersonal care. This perspective moves the field beyond cataloging interventions toward designing conditions in which meaningful engagement can be co-produced and sustained in everyday dementia care.

Author Contributions

Conceptualization, Y.F., E.B., M.R. and J.H.; methodology, Y.F., E.B., M.R. and J.H.; data curation and formal analysis, Y.F.; writing—original draft preparation, Y.F.; writing—review and editing, Y.F.; funding acquisition, Y.F. All authors have read and agreed to the published version of the manuscript.

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Data Availability

The data charted for this review are reported in Table A.1 in Appendix A and were derived from the cited publications. No additional dataset is publicly available.

Conflicts of Interest

Jun Hu is a editor-in-chief for EAI Endorsed Transactions on Pervasive Health and Technology and was not involved in the editorial review or the decision to publish this article. The authors have no other conflicts of interest to declare that are relevant to the content of this article.

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Appendix A. Characteristics and Evidential Roles of the Publications Cited in the Results

Table A.1. Characteristics and evidential roles of the publications cited in the Results section

Ref.	Author(s), year	Evidence type and venue	Population and setting	Activity or intervention	Mode of mediation	Outcomes examined or role in synthesis
[5]	Wang et al., 2019	Systematic review; <i>International Psychogeriatrics</i>	Nursing-home residents with dementia; stages varied	Non-pharmacological interventions for BPSD	Varied, primarily staff-facilitated	Behavioral symptoms, activity engagement, intervention effects, and implementation demands
[17]	Treadaway et al., 2019	Design-oriented article; <i>Design for Health</i>	People with advanced dementia; care context NR	LAUGH playful sensory artifacts	Tangible and haptic artifacts	Playfulness, comfort, curiosity, and open-ended participation
[19]	Livingston et al., 2014	Systematic review of randomized trials; <i>British Journal of Psychiatry</i>	PLWD across settings; stages varied	Non-pharmacological interventions for agitation	Varied, commonly caregiver- or therapist-facilitated	Agitation and related behavioral outcomes
[20]	Strøm et al., 2016	Literature review; <i>Journal of Clinical Nursing</i>	PLWD across care settings; stages varied/NR	Sensory stimulation and simulated social or animal interaction	Auditory, visual, tactile, olfactory, and multisensory	Vitality, self-esteem, social relationships, participation, affect, and agitation
[21]	Lin et al., 2018	Empirical intervention study; <i>Journal of Nursing Research</i>	Older adults with dementia; setting and stage NR	White-noise intervention	Auditory stimulation	Agitated behavior, mental status, and activities of daily living
[22]	Deshmukh et al., 2018	Systematic review; <i>Cochrane Database of Systematic Reviews</i>	PLWD across settings; stages varied	Art therapy	Therapist-facilitated visual and creative activity	Effects of art therapy; outcome measures varied
[23]	Jakob and Collier, 2017	Design-oriented article; <i>Design for Health</i>	Dementia-care environments; later-stage and severe communication impairment discussed	Multisensory environments and tactile or thermal artifacts	Environmental, tactile, visual, auditory, olfactory, gustatory, and movement-based	Comfort, soothing, agitation, sensory accessibility, and durability of effects
[24]	Meyer and O'Keefe, 2020	Review of reviews; <i>Dementia</i>	PLWD across settings; stages varied	Reminiscence, structured/group activities, and other non-pharmacological interventions	Conversation, prompts, and group facilitation	Mood, self-esteem, connectedness, identity, social interaction, quality of life, and agitation
[25]	Creech, 2019	Literature review; <i>Frontiers in Psychology</i>	PLWD across care contexts; stages varied	Technology-supported music activities	Digital access, reminiscence, singing, appreciation, and collaborative musicking	Enrichment of care life, reminiscence, musical participation, and social engagement
[27]	Cappelen and Andersson, 2014	Design-oriented book chapter; <i>Music, Health, Technology and Design</i>	PLWD; setting and stage NR	Musicking Tangibles	Tangible music interfaces	Independence, personhood, musical engagement, cognitive stimulation, and positive emotion
[26]	Thoolen et al., 2020	Participatory-design study/chapter; <i>HCI and Design in the Context of Dementia</i>	PLWD; setting and stage NR	Sentic	Tangible interactive music system	Sensory pleasure, music-making, agency, self-expression, and participation
[44]	Houben et al., 2019	HCI design study; DIS 2019	PLWD; setting and stage NR	Everyday sounds and soundscapes	Interactive sound-based technology	Playfulness, conversation, and connection with others
[28]	Beijer et al., 2025	HCI design study; CHI 2025	People with advanced dementia; care setting NR	Mano tactile experiences	Tangible and haptic interface	Tactile experience, accessibility, and engagement
[29]	Bennett et al., 2016	HCI design/evaluation study; CHI 2016	People in a dementia-care context; stage NR	Resonant Interface Rocking Chair	Motion-activated music integrating proprioceptive, vestibular, and auditory stimulation	Imagination, sensory engagement, and embodied participation
[30]	Konrad et al., 2024	Non-controlled within-subject study; <i>Frontiers in Neurology</i>	PLWD in long-term inpatient care; stage NR	Tovertafel	Shared tabletop projection and movement sensing	Apathy, social interaction, and social activity

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Table A.1. Characteristics and evidential roles of the publications cited in the Results section (continued)

Ref.	Author(s), year	Evidence type and venue	Population and setting	Activity or intervention	Mode of mediation	Outcomes examined or role in synthesis
[31]	Abraha et al., 2017	Systematic review; <i>Cochrane Database of Systematic Reviews</i>	PLWD across settings; stages varied	Simulated presence therapy	Family-recorded audio and scripted conversations	Agitation, behavioral symptoms, and quality of life
[32]	Budak et al., 2023	Scoping review; <i>Disability and Rehabilitation: Assistive Technology</i>	PLWD in LTC; stages varied/NR	Assistive technologies for psychosocial interventions, including reminiscence	Primarily screen-based ICT and shared use	Loneliness, social connection, shared interaction, and access constraints
[33]	Lazar et al., 2014	Systematic review; <i>Health Education & Behavior</i>	PLWD across settings; stages varied	Technology-mediated reminiscence	Digital, screen-based, and tangible reminiscence systems	Reminiscence-related psychosocial outcomes; measures varied
[34]	Huber et al., 2019	HCI design/evaluation study; TEI 2019	PLWD in dementia care; stage NR	Tangible objects for reminiscing	Personally or culturally familiar tangible prompts	Recognition, memory, storytelling, and social interaction
[35]	Morales-de Jesús et al., 2021	Conversational-system development/evaluation; <i>Healthcare</i>	People with early-stage Alzheimer's disease; setting NR	Personalized reminiscence dialogue	Spanish-language conversational agent using personal history and preferences	Reminiscence, self-expression, companionship, and social connection
[36]	Xygykou et al., 2024	HCI design/evaluation study; CHI 2024	People with early-stage dementia; setting NR	MindTalker	Personal photographs with large-language-model conversational mediation	Self-expression, reminiscence, companionship, connectedness, accuracy, privacy, dependency, and trust
[37]	Hassink et al., 2017	Contextual exploratory study; <i>Animals</i>	Care-farm users; participant details and dementia stage NR	Farm-animal-assisted care	Direct interaction with live farm animals	Companionship, communication, positive affect, belonging, and social interaction
[38]	Han et al., 2016	Systematic review; <i>Activities, Adaptation & Aging</i>	PLWD across settings; stages varied	Individualized leisure, social, walking, dancing, sport, and manipulative activities	Primarily human-facilitated, non-digital	Engagement, affect, sleep, physical function, and social participation
[39]	Cabrera et al., 2015	Systematic review; <i>European Geriatric Medicine</i>	PLWD living in nursing homes; stages varied	Non-pharmacological interventions	Varied, primarily staff-facilitated	Behavioral problems, passivity and apathy, positive affect, and engagement
[40]	McNaney et al., 2017	Co-design study; CHI 2017	Young people and PLWD; community context	DemYouth tools	Mobile/tablet toolkit and facilitated co-design	Intergenerational engagement, communication, and social awareness
[41]	Welsh et al., 2018	HCI design/evaluation study; CHI 2018	Young people and PLWD; setting NR	Ticket to Talk	Shared digital media as conversational prompts	Conversation and intergenerational engagement
[42]	Morrissey et al., 2017	Contextual design-led community-platform study; CHI 2017	Community stakeholders; PLWD details NR	Care and Connect	Online community commissioning platform	Dementia-friendliness, community participation, and social connection
[43]	Moyle et al., 2018	Mixed-methods pilot study; <i>Aging & Mental Health</i>	Older PLWD, family members, and health professionals; setting/stage NR	Telepresence-supported visits	Remote face-to-face video communication	Social connection and stakeholder views of telepresence
[45]	Ryan et al., 2020	Empirical study; <i>Dementia</i>	People with mild-to-moderate dementia and family carers; setting NR	Personalized reminiscence	Shared tablet with multimedia content	Communication, reminiscence, identity expression, and social connection
[46]	Abdollahi et al., 2022	Contextual pilot study; <i>IEEE Transactions on Affective Computing</i>	Older adults; dementia status, setting, Ryan socially assistive robot and stage NR		Humanoid robot with artificial emotional intelligence	Emotional assistance, engagement, and social interaction
[47]	Rampioni et al., 2021	Thematic literature analysis; <i>JMIR mHealth and uHealth</i>	Patients with dementia across studies; stages/settings varied	Embodied conversational agents	Embodied and screen-based conversational systems	Companionship, communication, facilitation, speech recognition, accuracy, privacy, and trust

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Table A.1. Characteristics and evidential roles of the publications cited in the Results section (continued)

Ref.	Author(s), year	Evidence type and venue	Population and setting	Activity or intervention	Mode of mediation	Outcomes examined or role in synthesis
[48]	Moyle et al., 2019	Cluster-RCT reflection article; <i>Aging & Mental Health</i>	PLWD in LTC; stage NR	PARO therapeutic companion robot	Zoomorphic social robot	Dementia symptoms, emotional engagement, implementation, and relational concerns
[49]	Bradwell et al., 2022	Stratified cluster RCT and mixed-methods study; <i>JMIR Aging</i>	Care-home residents with dementia; stage NR	Joy for All pet robots	Affordable zoomorphic companion robots	Companionship, emotional response, interaction, implementation, and acceptance
[50]	Gustafsson et al., 2015	Pilot study; <i>Journal of Gerontological Nursing</i>	PLWD in a dementia-care context; setting/stage NR	JustoCat robotic cat	Zoomorphic companion robot	Companionship, emotional response, and interaction
[51]	Moyle et al., 2016	Pilot feasibility study; <i>International Journal of Social Robotics</i>	Older PLWD; setting and stage NR	CuDDler animal robot	Zoomorphic companion robot	Engagement and emotional response
[52]	Dinesen et al., 2022	Exploratory study; <i>JMIR Rehabilitation and Assistive Technologies</i>	Persons with dementia; setting and stage NR	LOVOT social robot	Embodied social robot	Use, engagement, companionship, and social interaction
[53]	Feng et al., 2019	HCI design/field study; DIS 2019	PLWD in a Dutch nursing home; stage NR	LiveNature ambient nature experience	Ambient display, tangible water pump, and robotic sheep	Relaxation, closeness to nature, multisensory engagement, and embodied/social interaction
[54]	Raß et al., 2023	Exploratory ethnographic study; PETRA 2023	People with advanced dementia and caregivers in a protected care environment	Pepper	Humanoid robot with caregiver facilitation	Engagement, resident-caregiver interaction, and acceptance
[55]	Valentí Soler et al., 2015	Empirical intervention study; <i>Frontiers in Aging Neuroscience</i>	People with advanced dementia; setting NR	Social robots, including NAO	Humanoid robotic mediation	Social interaction and emotional or behavioral support
[57]	Sarabia et al., 2018	Contextual empirical study; <i>International Journal of Social Robotics</i>	Acute-hospital patients; dementia status and stage NR	Assistive humanoid robot	Robotic mediation	Social interaction and social isolation
[56]	Whelan et al., 2020	Multiple case study; <i>Gerontechnology</i>	PLWD; setting and stage NR	MARIO social robot	Humanoid robotic mediation	Resilience and social connection
[58]	Cruz-Sandoval et al., 2020	HRI intervention/evaluation study; HRI 2020	PLWD; setting and stage NR	EVA-facilitated therapy	Social robot as therapy facilitator	Dementia-related behavioral symptoms and therapeutic engagement
[59]	Sumioka et al., 2021	Case study; <i>Frontiers in Robotics and AI</i>	Older adults with dementia; setting and stage NR	Hiro interactive doll therapy	Minimal infant-like embodied robot	Emotional/social engagement and therapeutic interaction
[60]	Liu et al., 2021	Pilot study; <i>Frontiers in Psychology</i>	People with dementia; setting and stage NR	Bright ambient-light therapy	Environmental light mediation	Dementia symptoms, cognitive function, diurnal disturbance, and mood
[61]	Marquardt et al., 2014	Evidence-based review; <i>HERD</i>	People with dementia across built environments; stages varied	Wandering areas, outdoor access, domestic familiarity, and enhanced environments	Built-environment mediation	Comfort, orientation, movement, mood, agitation, wandering, and person-environment fit
[62]	Brankaert and Den Ouden, 2017	Contextual design/methodological article; <i>Technology Innovation Management Review</i>	Living-lab and care innovation contexts; participants/stage NR	Design-driven living-lab approach	Participatory and organizational mediation	Methodological support for developing and embedding solutions in complex care contexts
[63]	Gomes et al., 2020	Feasibility study; PETRA 2020	Older adults with advanced dementia and caregivers; setting NR	HealingSpaces	Tablet, smart lights, speakers, and projectors	Focus, engagement, relaxation, and customizable sensory stimulation

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Table A.1. Characteristics and evidential roles of the publications cited in the Results section (continued)

Ref.	Author(s), year	Evidence type and venue	Population and setting	Activity or intervention	Mode of mediation	Outcomes examined or role in synthesis
[64]	Thoolen et al., 2020	HCI design/exploratory study; DIS 2020	Residential dementia care; participant details and stage NR	AmbientEcho	Simulated window, digital frame, ambient light, music, and identity-tagged objects	Personalized media engagement, identity resonance, and ambient experience
[65]	Moyle et al., 2018	Mixed-methods pilot study; <i>The Gerontologist</i>	People with dementia; setting and stage NR	Virtual Reality Forest	Immersive and movement-responsive environmental mediation	Engagement, environmental experience, and embodied participation
[66]	Matsangidou et al., 2022	Participatory-design study; UMAP 2022 Adjunct	Dementia in-patients; stage NR	VR "out-world" experience	Immersive mediation	Escape from institutional constraints, relaxation, and personally meaningful experience
[67]	Feng et al., 2018	HCI design/evaluation study; Chinese CHI 2018	Seniors with dementia in LTC; stage NR	Interactive farm/nature experience	AR display, tangible pump, and robotic animal	Multisensory engagement, relaxation, nature experience, and active participation
[68]	Van Santen et al., 2018	Systematic literature review; <i>Journal of Alzheimer's Disease</i>	People with dementia across studies; stages/settings varied	Exergaming	Game-based and embodied mediation	Cognitive, physical, motivational, and social outcomes, including accessibility limitations
[69]	Swinnen et al., 2021	Pilot randomized controlled trial; <i>Alzheimer's Research & Therapy</i>	Residents with major neurocognitive disorder in LTC; stage NR	Exergaming	Game-based and embodied mediation	Physical and cognitive function, motivation, mood, and participation
[70]	Gunst et al., 2022	Contextual single-blinded intervention study; <i>Aging Clinical and Experimental Research</i>	Nursing-home residents; dementia stage NR	Exergaming	Game-based and embodied mediation	Well-being
[71]	Feng et al., 2020	Empirical effects study; <i>Sensors</i>	People with dementia; setting and stage NR	AR display combined with a social robot	Blended-reality and robotic mediation	Contextual interaction and effects of interactivity and system responsiveness
[72]	Lee et al., 2020	Contextual HCI design study; HCII 2020	Older adults; dementia status, setting, and stage NR	Embodied creative interaction	Embodied and creative mediation	Creative social engagement
[73]	Desai et al., 2020	Conceptual/design article; HCII 2020	People with dementia; setting and stage NR	Blended-reality environments	Immersive and embodied mediation	Familiar, meaningful, and sensory-rich experience; empirical outcomes NR
[74]	Desai et al., 2022	Design-oriented book chapter; <i>Designing Interactions for Music and Sound</i>	People with dementia; setting and stage NR	Sound-based mixed-reality prompts	Immersive and blended mediation	Familiarity and personally meaningful experience
[75]	Unbehaun et al., 2019	Development/design article; DIS 2019 Companion	People with dementia; setting and stage NR	ICT-based training system	Screen- and game-based mediation	Training and participation; supports analysis of screen-interface demands
[76]	Aruanno and Garzotto, 2019	Design-oriented mixed-reality study; <i>Multimedia Tools and Applications</i>	People with Alzheimer's disease; setting and stage NR	MemHolo mixed-reality experiences	Immersive mediation	Cognitive stimulation and personally meaningful experience; specific psychosocial outcomes NR

Note. NR = not reported; PLWD = persons living with dementia; LTC = long-term care; HCI = human-computer interaction; BPSD = behavioral and psychological symptoms of dementia.