

Development of a Cantonese-speaking smart companion doll, SmartLittle, for elderly with dementia: Users' view and experience

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Abstract

Background: Doll therapy is a non-pharmacological method that uses lifelike dolls to comfort people with dementia, reduce anxiety, and evoke positive emotions. A locally developed Cantonese-speaking smart companion doll, named as LittleSmart, shown to positively impact dementia-related behavioral and psychological symptoms, has been developed. This doll has been used in various elderly care settings to gather feedback from stakeholders for evaluation and further enhancements.

Method: Since 2022, SmartLittle has been trialed in over 150 elderly care units, serving over 380 persons with mild cognitive impairment and 600 with moderate to severe dementia for a period of 3 months. Workers received operational training before the program started, and feedback was collected through a questionnaire after completion.

Result: Among the participating units, 94% completed the trial period. 51 units gave written comments concerning 7 aspects of usage, including the speech speed and loudness; interactivity; battery supply and charging; ease of control; available contents and recordings for use; emotional interaction and overall appearance of the doll. Among the 83 units that have completed the feedback questionnaire after the trial programme, 84% of them will recommend the smart doll to other units for use.

Conclusion: The Cantonese-speaking smart doll provided an affordable way to alleviate the burden of caregivers in supporting dementia patients. With the input provided by stakeholders, the developer will continue to enhance the doll design to address the local needs. Overall, users agreed that the use of this smart doll can improve the quality of elderly care services.

Keywords: Dementia, companion doll, smart doll, socially assistive robot, gerontechnology

INTRODUCTION

Dementia, a progressive neurodegenerative condition, affects over 57 million people globally in 2021 (World Health Organization), with numbers expected to rise sharply in aging populations. By 2050, it is expected that this number will rise to 139 million, and 50% will be from the Asia Pacific region (Alzheimer's Disease International, 2014). The symptoms of dementia, which include cognitive decline, memory impairment, and behavioral disturbances, can cause significant psychological, emotional, and economic burdens on individuals, families, caregivers, and healthcare systems. In dementia care, non-pharmacological interventions have become more prominent due to the limited effectiveness of pharmacological treatments. The use of socially assistive technologies, like social assistive robots, has become a promising approach to enhance patient well-being and reduce caregiver strain.

Social assistive robots, commonly designed to look like animals (e.g. PARO the therapeutic seal) or infants (e.g. KABO-CHAN the companion doll), are created to provide emotional comfort, stimulate cognitive engagement, and promote social interaction. These devices utilize tactile sensors, artificial intelligence, and behavioral mimicry to create lifelike responses, which in turn create a sense of companionship for users. However, these devices have a high upfront cost, and language support may not be readily available for local use (i.e. Chinese dialect: Cantonese).

Various studies in the past have examined the therapeutic potential of these robots, with evidence showing benefits in multiple areas, including agitation reduction, mood enhancement, and enhanced social participation. Lu et al. (2021) conducted a systematic review to examine 13 randomized controlled trials involving socially assistive robots for older adults with de-

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mentia. Through meta-analysis, it was revealed that pet-type robots significantly reduced agitation and depression levels, with exposure time and session length being key influencing factors. Similarly, Nam and Park (2024) also conducted a meta-analysis of 20 trials and found that robot care interventions yielded small but significant improvements in neuropsychiatric symptoms and social health outcomes, with humanoid-type robots showing greater efficacy than other forms. Ling et al. (2022) examined whether engagement with a Cantonese-speaking smart doll for institutionalized elderly could reduce Behavioral and Psychological Symptoms of Dementia (BPSD) and improve social communication. The results indicate that a one-month interaction with the smart doll led to a statistically significant decrease in the participants' agitation.

The effectiveness of companion robot dolls appears to vary depending on dementia severity and intervention length. Individuals in the early stages of dementia, who retain partial cognitive and emotional capacities, can engage in more complex interactions such as conversation and play. In moderate stages, where memory and reasoning are more impaired, simpler forms of engagement, such as tactile stimulation and visual cues, become more relevant. Robot dolls that mimic infant behaviors or animal-like responses can evoke nurturing instincts and reduce anxiety through reminiscence and sensory stimulation. Lim and Oh (2025) demonstrated that a six-week social robot intervention yields notable cognitive gains in older adults with mild to moderate dementia, reflected by a mean increase of 3.9 points on the MMSE scale. Other studies have also shown that exposure to robot dolls in group settings can significantly reduce agitation and depressive symptoms, particularly when sessions are frequent and of sufficient duration (Lu et al., 2021; Wu et al., 2025).

In severe dementia, where verbal communication and recognition are severely compromised, the role of robot dolls shifts toward providing comfort and routine. Studies have shown that even minimal interaction, such as holding or stroking a robotic pet, can elicit emotional responses and reduce agitation (Mino et al., 2022; Molteni et al., 2022).

Another factor that influences the success of using a companion robot doll for dementia patients, particularly in Asia Pacific countries, is related to the use of language, as the majority of the end-users do not speak English. Many older adults only speak their local dialect. Moreover, the acceptance of technology among the elderly and their caregivers is also an influencing factor

for the implementation of companion robots in dementia care. While the introduction of companion smart dolls in elderly care homes aims to reduce the physical and mental workload of staff, these devices often end up creating additional tasks and responsibilities (Persson et al., 2022; Hung et al., 2019). Without adequate training and technical support, staff may fear incorrect usage or device malfunctions, leading to reluctance in integrating these robots into daily care routines.

In Hong Kong, the development of smart companion dolls started in 2018, where a Cantonese-speaking robot doll was developed (*Figure 1a*). This doll aims to provide basic interactive communication with older adults. Thereafter, the second generation of companion robot doll controlled from web-based server apps was developed to provide training for dementia subjects in hostels in 2019. According to Cheung et al. (2020), voice encouragement and cueing can help promote interaction when using these dolls (*Figure 1b*). To ease the technophobia of frontline staff and facilitate better usage of companion robot dolls in daily applications, a lending program was launched in 2022, which provides the 3rd generation of these robot dolls (*Figure 1c*) to individual hostels for use, which is named "SmartLittle". This robot doll consists of a washable skin cover and an interactive hardware core module. Operators can customize verbal cues and record messages and music to facilitate communication between end users and the robot. In order to gain an in-depth understanding of user experiences and identify critical pain points for design enhancement, a lending program was launched. This program offers pre-use training to familiar frontline workers with the operation of the smart doll, followed by a period of usage and concluded with user feedback collection. The results gathered from these trial uses were feeded back to the design team to enhance the function and acceptance of these devices.

METHODS

The Smart Companion Doll Lending Program adopts a structured methodology to introduce and evaluate the use of gerontechnology in elderly care service units, with the goal of enhancing service quality and promoting technological adoption. Participating elderly care units are selected based on their readiness and capacity to integrate technology into their operations. Each selected unit receives two to four smart companion dolls for a three-month trial period. According to the nature of different units and different seasons, we may provide dolls with different clothes (*Figure 2*). Prior to deployment, staff members from each unit attend a compre-

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Figure 1. (a) The 1st generation of the companion robot doll developed in Hong Kong in 2018; (b) The 2nd generation of the companion robot doll and its controlling user interface in 2020; (c) The 3rd generation of the companion robot doll, which is reported in this study

hensive know-how training session. This session equips them with the necessary skills to operate, maintain, and integrate the robots into their daily care routines effectively.

During the three-month implementation phase, the robots are used to enhance users' engagement through companionship, cognitive stimulation, and health-related reminders, subject to the units' operation. Units are encouraged to document their experience through photo taking and regular staff reflections. Throughout the trial, technical support is provided to ensure smooth operation, including remote assistance or replacing a robot.



Figure 2. Variety of doll clothes designed to suit different elderly care units and different seasons during the trial program reported in this study.

At the end of the trial period, each unit completes a post-usage questionnaire to evaluate the usability, effectiveness, and overall impact of the companion robot doll on staff workflow and user wellbeing. Based on the user survey conducted by Ling et al. (2022) on an earlier design of SmartLittle, five areas of evaluation criteria were incorporated. The criteria were listed in the form of 33 statements, covering design features of smart doll (A1-6), function of the smart doll during the evaluation period (C12-17), experience sharing by respondents (D18-25) and overall user experience (E26-33). The respondents evaluated the design features, functions and overall user experience of the smart doll using a 5-point Likert scale, where 1 meant "very disagree" and 7 meant "very agree". As the revised questionnaire was developed exclusively to obtain feedback from frontline operators for the enhancement of the smart doll, it has not been subjected to a formal revalidation process. In addition, unit representatives participate in a focus group discussion to share their experiences, challenges, and recommendations. This feedback, both quantitative and qualitative, is analyzed to assess the technology's acceptance, benefits, and areas for improvement.

RESULTS

From 2022 to 2025, a total of 153 service units from all the 18 districts of Hong Kong participated in the lending program of SmartLittle. Among them, 8 units have borrowed companion robot dolls for more than one time. Of the 153 units, 68 are elderly hostels, 73 are District Elderly Community Center and the remaining 12 belong to Residential Care Homes for People with Disabilities, Carer-centric Service Centers and Palliative support service.

All participating units received the know-how training prior to the commencement of the lending program. Among them 54% returned the post-usage questionnaire and 47% of the participating units have their staff attended the focus group session. These units have given valuable input to the performance of the companion robot doll.

According to the post-usage questionnaire feedback, a clear positive tilt was shown across all 11 items: one-sample Cohen's d (vs. neutral = 3) ranges from 0.50 to 1.17, indicating medium to large practical effects. The strongest magnitudes appear for Appropriate design ($d = 1.15$), Easy to clean ($d = 1.17$), Battery is easy to replace ($d = 0.99$), Supports general caregiver duties ($d = 0.95$), and Helps manage emotions ($d = 0.88$). Two items, in-

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Figure 3. Doll clothes designed by staff together with elderly people during the trial.

cluding Moderate volume and Functions meet the needs of the elderly show comparatively smaller (but still positive) effects due to higher neutrality. Figure 4 shows a summary of the results on the evaluation of product features and usability. In addition to the rated results collected through the questionnaire, written comments were also collected. Verbal comments gathered during focus group meetings were transcribed and summarized in Table 1.

DISCUSSION

Previous studies have shown that both companion dolls and doll therapy can help reduce behavioral and psychological symptoms in older adults with dementia (Abbott et al., 2019; Márquez-Sánchez et al., 2020). Rashid et al. (2023) further demonstrated through a systematic review and meta-analysis that therapeutic robots such as Paro which mimic real sounds, facial expressions, and body gestures during physical interaction can significantly improve these symptoms. By incorporating real human voices into robot dolls, Sumioka et al. (2021) demonstrated that it can enhance the human-likeness of the robot and promote more interactive engagement. In this work, SmartLittle was developed with a customizable recording feature that allows messages in multiple languages or dialects. This capability was well received in the local context, where Cantonese is the primary language for many users.

Direct input from elderly individuals with dementia is important for the development of SmartLittle but challenging to obtain. Instead, we utilized a lending program targeting their caregivers and related service unit administrators. The program enabled the trial use of SmartLittle without any cost implications, and feedback was solicited through focus groups and post-usage questionnaires to continually improve the product. Nearly all the units that participated finished the three-month trial and provided feedback.

In terms of the appropriateness of the design, 63% of respondents rated satisfactory or above (it is calculated as the overall average all items in Figure 4). Some respondents noted that the robot's functions do not fully meet the specific needs of the elderly, and its sound level is inadequate for noisy environments. Regarding func-

tionality, the current version of SmartLittle lacks AI chat features and instead relies on pre-recording messages and songs for stimulation and entertainment, which limited interactivity. Given the varying stages of dementia among users, it is understandable that the current design cannot fulfill the needs of all dementia users.

For daily use of the smart companion doll, it was noted that 27% of the respondents indicated that the high price hindered its adoption. Another 23% respondents felt that the design was not well-localized enough, and 14% respondents still questioned the therapeutic effectiveness of using companion robot dolls.

Successfully implementation of companion robotic dolls in elderly care service units often depends on the acceptance of the caring team over the individual with dementia. Persson et al. (2022) observed that the use of robotic dolls sometimes increased the workload of caregivers without gaining efficiency in daily care. Caregivers' concern typically relates to limited technical know-how, fear of device malfunctions, and hygiene issues. To address this, training and support services were provided prior to and during the lending program, which over 80% of units rated satisfactory or above. Overall, 77% agreed the trial positively impacted care quality.

In addition to the rated results through the questionnaire, respondents highlighted the customizable recording feature as a major strength. However, respondents also reported that there are insufficient pre-programmed games and contents that are available to use. This affected the interactivity between the user and the robot. Some users anticipated that the next generation of the robot doll will feature AI-driven response capabilities. Given the rapid progress of artificial intelligence, in the upcoming version of SmartLittle, it will offer conversational functions covering basic interactions and even providing entertainment such as music and song playback. It is important to note that SmartLittle was originally designed as a budget-friendly assistive device for older adults with dementia, not as a comprehensive companion for the entire elderly population. In terms of operation control, some users reported that the current method for changing game modes—such as pressing a small button on the back of the doll or turning the doll upside down—is inconvenient and can be confusing. A mobile app has since been introduced to improve usability. Despite these challenges, 84% of units indicated they would recommend SmartLittle to others.

The effectiveness of using SmartLittle to support the caring for individuals with has not been fully

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Question	Totally Disagree	Disagree	Neutral	Agree	Totally Agree	Cohen's <i>d</i>	Magnitude (Cohen)
Appropriate design	0.0%	5.9%	17.6%	51.8%	22.4%	1.148	Large
Easy to operate	1.2%	12.0%	13.3%	47.0%	25.3%	0.852	Large
Battery is easy to replace	20.3%	4.7%	17.4%	46.5%	25.6%	0.988	Large
Moderate volume	3.5%	12.9%	23.5%	43.5%	15.3%	0.535	Medium
Custom recoding function meets organizational needs	2.4%	10.7%	17.9%	48.8%	10.7%	0.758	Medium
Easy to clean	0.0%	6.0%	15.5%	51.2%	22.6%	1.173	Large
Rich content in preset game	2.3%	3.5%	38.4%	43.0%	9.3%	0.68	Medium
Functions meet the needs of the elderly	1.4%	10.8%	39.2%	39.2%	8.1%	0.5	Medium
Supports general caregiver duties	0.0%	9.5%	14.9%	55.4%	13.5%	0.954	Large
Helps manage emotions	0.0%	6.7%	28.0%	46.7%	13.3%	0.88	Large
Reduces symptoms	2.7%	5.4%	28.4%	44.6%	9.5%	0.667	Medium

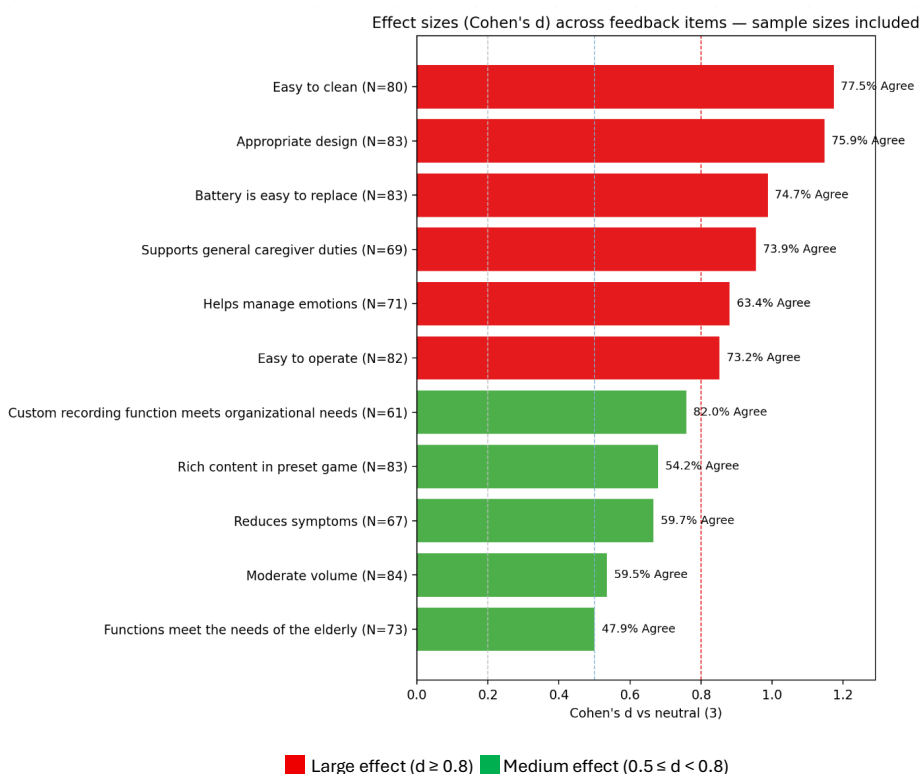


Figure 4 .Summary of Rated Result on Product Features and Usability

addressed in this work. Depending on the level of dementia and the duration of intervention, the impact of using this newly developed Cantonese speaking smart companion doll needs further investigation. Through the current trial program, the concerns on technical know-how and the initial cost of smart robot doll for frontline use have been relieved. The feedback collected has helped to identify key areas for enhancement. These included improving audio output, increasing interactivity, expanding localized content,

supporting multiple languages, and incorporating AI for more humanoid interaction. Wu et al. (2025) emphasize that the robot's physical design, whether animal-like, human-like, or abstract, plays a critical role in its acceptance and effectiveness, particularly in advanced stages of dementia. In this work, we also noted that some users have expressed their preference for a robot with a human-like appearance. A number of them have informed us that they have added their own clothing and decorations to the dolls

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Table 1. Summary of feedback from users

Strengths

1. **Appealing Design:** The robot has a cute appearance that is generally liked by elderly users. It easily attracts attention and fosters positive feelings, enhancing social interaction and emotional well-being.
 2. **Companionship and Stimulation:** It provides companionship for elderly individuals with mid-to-late stage cognitive impairment, encouraging communication, reducing behavioral issues, and improving the atmosphere in care centers.
 3. **Variety of Content:** Built-in games (e.g., Cantonese opera, nursery rhymes, exercise routines) are popular and cater to the interests of elderly users.
 4. **Customizable Recordings:** Some organizations find customizable recording feature helpful for personalization, though the operation still needs improvement.
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Key Issues and Challenges

1. **Voice and Speech Speed**
 - Voice is too soft or muffled by the doll, making it hard for elderly users to hear clearly.
 - Speech is too fast and pitch too high, making it difficult to understand.
 - Volume cannot be adjusted; some users find it too loud or too soft.
 2. **Lack of Interactivity**
 - The robot only asks questions one-way, lacks real-time responses, and has low interactivity, leading to user boredom.
 - It cannot respond appropriately based on user input, lacking flexibility.
 3. **Inconvenient Operation**
 - Switching modes require flipping or laying the doll flat, which is confusing or difficult for elderly users and may cause misunderstandings (e.g., perceived as "abusing" the doll).
 - Button placement is not ideal, causing resistance from some users.
 - Custom recording steps are complex, making it hard for staff to operate.
 4. **Power and Battery Life**
 - High power consumption requires frequent battery changes; poor battery contact is common.
 - Suggest switching to USB charging or improving battery life.
 5. **Content and Features**
 - Limited game and topic content; recommend adding more localized and familiar themes (e.g., Cantonese opera, classic songs).
 - Lack supports multiple languages or dialects.
 - No AI response capability, limiting its ability to truly provide companionship.
 6. **Material and Cleaning**
 - Plush fabric is hard to clean; suggest switching to plastic or soft rubber materials.
 - Electronic components are prone to falling out; they need better securing.
 7. **Usage Arrangement**
 - Trial period is too short; recommend extending it to six months or one year to allow more time for user adaptation.
 - More detailed user manuals and on-site training are needed.
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Recommendations

1. **Improve Audio System:** Add adjustable volume and speech speed, voice gender options, and longer pauses.
 2. **Enhance Interactivity:** Include AI responses, real-time interaction, and remote communication features.
 3. **Optimize Operation:** Use buttons or remote controls instead of physical manipulation to improve usability for both elderly users and staff.
 4. **Improve Power Design:** Switch to USB charging, enhance battery life, and reduce contact issues.
 5. **Expand Content:** Add more localized games, topics, and music; support multiple languages.
 6. **Refine Appearance and Materials:** Improve realism, allow interchangeable clothing/accessories, and make cleaning easier.
 7. **Extend Trial and Support:** Lengthen trial period and provide detailed operation guides and technical support.
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to make it more lively (Figure 3). This suggested that design flexibility for personalization could further boost user-doll engagement.

CONCLUSION

SmartLittle received positive feedback from both caregivers and service unit staff for its appearance and companionship features. The know-how training provided before the lending program played a key role in increasing acceptance and facilitating daily use. It is important to note that the primary aim of this work was to collect

user feedback to guide future enhancements of SmartLittle. Therefore, the findings should not be generalized to all smart doll designs. Also, this study did not take into account the cognitive abilities of end users, nor did it observe how long they engaged with the robot. As such, the effectiveness of SmartLittle in dementia care should not be overstated. Future technological and design upgrades, including the incorporation of AI power conversation, are planned to enhance user experience and deliver greater practical benefits.

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