Prioritising Design Features for Companion Robots Aimed at Older Adults: Stakeholder Survey Ranking Results

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Abstract. Companion robots are social robots often resembling animals with potential wellbeing benefits for older adults. However, some such devices have failed possibly through inappropriate design. Method: Questionnaires were completed by 113 participants at nine health and care events. Participants were predominantly relevant professionals. Participants approached our interaction station, interacted with eight companion robots or alternatives, then completed questionnaires; ranking aesthetic, behaviour, technology, feel and interaction features and estimating affordable price. Results: Features ranked highly were: interactive response to vocalisations and touch, huggable size, soft fur, variety of behaviours/sounds, realistic movements, eye contact with large cute eyes, being realistic, familiar, easy to use and possessing simulated warmth. Participants thought −£225 was affordable. Conclusion: We contribute priority features for stakeholders to inform future developments. Contrasting unfamiliar embodiment of some devices, stakeholders support familiar, realistic aesthetics, with implications for enhanced acceptability, adoption and more consistent wellbeing outcomes.

1 Introduction

Health and social care (H&SC) is experiencing increasing pressure and demand worldwide, partly caused by aging and dementia [1]. Assistive robotics to support H&SC has gathered research interest [2], including robots for companionship. Among these, robot "pets" are robots designed congruent with animal aesthetics and behaviours [2]. The most well researched example is Paro, the robot seal [2]. Research has shown potential wellbeing benefits for older adults, people with dementia and stakeholders in their care, including for; loneliness, depression, agitation and quality of life [2]. Other examples include NeCoRo, AIBO, iCat [2], and comparable 'smart toys,' such as the Joy for All (JfA) cats and dogs [3]. Despite encouraging results and increasing interest, a number of devices in this sector have failed, and literature still lacks agreement on how to best design such robots. The importance of design in overall platform success cannot be overstated: appropriate design promotes acceptability among end users [4], while

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inappropriate design could lead to device disuse or no expected benefits [5], proving costly to society. In this context, research previously demonstrated significant differences between older adults (as end-users) and roboticists (as developers) in perceptions towards suitable robot pet design for older people [3]. Aesthetic and behavioural features are likely to impact device acceptability and thus ultimately use [5]. Design and embodiment continues to be a research topic without definitive results. This paper helps address the situation.

2 Methods

2.1 Setting and Procedure

Nine interaction stations at: eHealth, dementia, aging, psychiatry conferences or health-professional meetings. Attendees interacted with devices (Fig. 1), then completed consent and questionnaires. A University of Plymouth Ethics Committee granted approval.

Fig. 1. Devices. From left, Paro, Miro, Pleo, JfA dog, JfA cat, Furby, Perfect Petz dog, Hedgehog.

2.2 Data Collection

Questionnaires gathered demographics, and established i) priority design features, ii) preferred animal for target audience, iii) most appealing eyes, iv) most appropriate size, v) most appropriate volume and frequency of vocalisations, vi) reason for preferred animal, vii) reason for most appealing eyes and viii) realistic price. To establish i) unique questionnaires included a specific combination of 10 features (informed by computer script to ensure comparable frequency), picked from 42 features in Table 1. The five categories were based on discordance in previous literature. The 42 features were a combination of those previously reported [6], and additional features from our previous study (reported elsewhere) on perceptions of care home residents, relatives and staff after interaction with the devices. To establish ii)-v) participants selected from a row of pictures under the question. For vi) – viii), free text boxes were used.

Table 1. Five design categories showing 42 features of interest included on questionnaires.

Category	Features of interest for each design category
Feel	Soft pettable fur; Huggable (right size to cuddle); Portable (ease to take with you); Solid/robust (can withstand rough handling); Realistic animal weight; Simulated warm feeling; Hard/plastic shell (eg. Pleo or Miro); Simulated breathing; Simulated heartbeat
Behaviour	Animal-appropriate responses/sounds (eg. Dog barking); Variety of behaviours and sounds; Active; Looks at user (animal provides eye contact/attention); Can talk to user (human speech); Vocalisations not too loud; Playful; Facial movements/expressions; Waggy tail; Animal appropriate behaviours
Aesthetics	Looks like a real life pet; Young or innocent looking; Nice/not scary; Cartoonish appearance; Flash/draws attention; Mythical animal; Cute eyes; Familiar animal (eg. Dog/cat); Unfamiliar animal; Cute; Customisable look/animal for each user
Technology	Mechanical parts are noiseless; Realistic movements (fluent/natural); Adaptable (shut functions on/off); Autonomous system; Easy to use; Fur is detachable (to be washed); Long battery life; Cleanable
Interaction type	Interactive: Obeys some commands (eg. Sit/paw); Interactive: Looks at me or vocalises when I am near; Interactive: Looks at me or vocalises when I stroke or touch it; Interactive: Looks at me or vocalises when I talk to it

2.3 Data Analysis

To explore i) priority design features, establishing an exact ranking of all items is computationally and prohibitively expensive. For approximate ranking, we used a variant of the Condorcet method [7]: for each feature, we counted how often it is ranked higher than other features across all questionnaires. For data on ii) preferred animal, iii) most appealing eyes, iv) most appropriate size, v) vocalisations and viii) price, we report descriptive statistics, supplemented by summary free text for vi) and vii).

3 Results

3.1 Participants

In total, 113 questionnaires were completed, mainly by H&SC professionals within gerontology, dementia, psychiatry and nursing (n = 68), although others participated (9 researchers, 5 informal carers, 24 other, 7 missing). Participants included 87 females, 17 males (9 missing), average age was 48.1 (range = 18–75, SD = 14.2).

3.2 Priority Design Features

The most important features were interactivity (in response to talking to or touching the robot), being the right size to hug, having soft fur, a variety of behaviours/sounds, realistic movement and providing eye contact (Table 2).

Table 2. i) Priority features in order of approximate ranking

Ranking (Scores)	42 Features listed in order of importance
Highly rated 1–15 (190–130)	Interactive: Looks at me or vocalises when I talk to it; Huggable (right size to cuddle); Soft pettable fur; Variety of behaviours/sounds; Realistic movements (fluent/natural); Interactive: Looks at me or vocalises when I stroke or touch it; Looks at user (provides eye contact/attention); Easy to use; Looks like a real life pet; Simulated warm feeling; Nice/not scary; Animal appropriate sounds; Familiar animal; Facial movements/expressions; Cleanable
Middle ranking 16–29 (127–82)	Active; Autonomous system (works on its own); Interactive: Looks at me or vocalises when I am near; Long battery life; Animal appropriate behaviours; Cute; Cute eyes; Waggy tail; Portable (easy to take with you); Vocalisations not too loud; Playful; Adaptable (switch functions on/off); Solid/robust (can withstand rough handling); Young/innocent looking
Low rated 30–42 (41–23)	Interactive: Obeys some commands (eg. Sit/paw); Simulated breathing; Simulated heart beat; Fur detachable (to be washed); Realistic animal weight; Customisable look/animal for each user; Can talk to user (human speech); Mechanical parts are noiseless; Flashy/Draws attention; Unfamiliar animal; Mythical animal; Cartoonish appearance; Hard/plastic shell

The preferred device was JfA cat, followed by JfA dog, then Paro (Fig. 2). The least preferred options were Miro, knitted Hedgehog and Furby. Frequent preference reasons were being realistic, soft, cuddly, lifelike and familiar. JfA cat reportedly had most appropriate vocalisations while Paro had most appealing eyes, (being large, cute, having eyelashes). Stakeholders felt JfA cat (~39 cm – 26 cm) was most appropriately sized (Fig. 2). (Some missing values: 15 to preference, 23 to eyes, 36 to size, 27 to vocalisations).

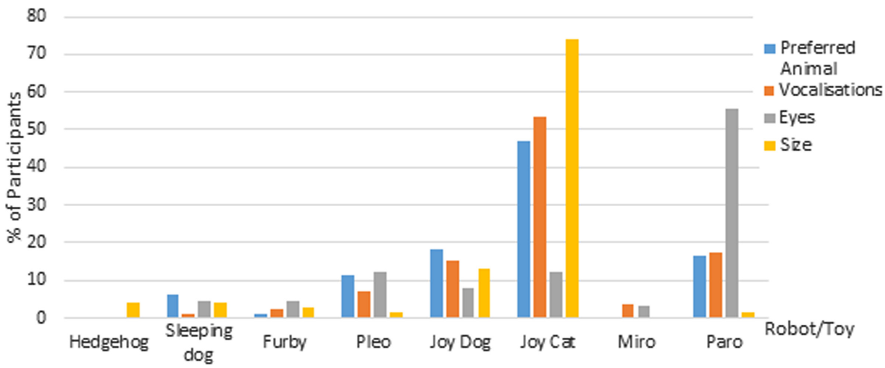

Fig. 2. Percentage of responders selecting each animal for ii), iii), iv), v)

3.3 Price

For viii) reasonable price, an example range was provided from £10−£5000 for devices on display. For participants who responded with a range (e.g. £100−£150), we took the highest figure as the maximum they consider appropriate. The average price participants felt was appropriate was £226.30 (SD = 245.80, range = £25−£1000).

4 Discussion and Conclusion

Although participants were generally H&SC professionals, the questionnaire features were derived from prior work with end-users, care staff and family members, and combined with those reported by [6]. Thus, these results provide collective insights from key stakeholders in the real-world adoption of companion robots, having implications for future developments, particularly considering importance of user-centred design [3]. Supporting [6], our relatively large sample confirmed the desire for soft fur for companion robot shells, although care must be taken in cleaning [8]. Results also strongly support familiar-realistic animal embodiment. Our stakeholders scored ‘looks like a real life pet’ and ‘familiar animal’ within the top 15 most important features, and top three specific to aesthetics. In contrast, ‘unfamiliar animal,’ ‘mythical’ and ‘cartoonish’ all received low priority. Participants also selected devices with familiar embodiment as preferable with older adults in mind (JfA cat/dog), and reported realistic, life-like and familiar as free-text reasons. The continued support for familiar animal embodiment has implications for robot design and selection of devices for real-world implementation, and perhaps explains some variation in response to unfamiliar Paro [1]. Research into these alternate devices may demonstrate more consistent wellbeing outcomes than Paro [1], should a familiar design be more acceptable to intended users.

Our stakeholders suggested a suitable price far below the £5000 for Paro, at −£226. This result has implications for developers. This study allowed for prioritisation of features to assist in keeping devices affordable. The most important factor was reported as variety of behaviours/sounds. Eye contact also ranked well. Paro’s eyes were seen as most appealing, for being large, having eyelashes, blinking and making eye contact.

A further contribution of this paper is prioritisation of interaction type. Previous work [3], demonstrated sophisticated interactivity of Paro was undervalued by older adults. Our stakeholders felt it most important devices respond to user’s vocalisations, followed by touch. Alternative interaction methods could potentially be neglected in favour of affordability. In contrast to previous work [3], where older adults valued inclusion of human speech from companion robots, it was not perceived as important to stakeholders here. This may reflect a difference between stakeholder categories of end-user and professional. Older adults may perceive an unmet need undervalued by professionals; for more verbal interaction. Regarding size, stakeholders previously reported to us Paro was too large for older resident’s laps. These results suggest the most appropriate size is best reflected in JfA cat, which is considerably smaller and lighter. Questionnaires also explored life-simulation features, with simulated warmth as stakeholder’s priority in this area. These results have important implications, considering aesthetic and behavioural robot design can impact acceptability and use [4, 5], and the health and wellbeing potentials such devices possess [2]. Limitations include reliance on immediate perceptions of stakeholders, without longer, real-world observations.

Conclusions. Our study provides prioritisation of features, whilst adhering to reported affordability of –£226 for future designs, which could include; interaction in response to vocalisations/touch, huggable size, soft fur, variety of behaviours/sounds, realistic movements, providing eye contact, large/cute eyes, being realistic, familiar, easy to use and possessing simulated warmth.

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