Therapeutic robocat for nursing home residents with dementia: Preliminary inquiry

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Abstract

Traditional pet therapy enhances individual well-being. However, there are situations where a substitute artificial companion (i.e., robotic pet) may serve as a better alternative because of insufficient available resources to care for a real pet, allergic responses to pets, or other difficulties. This pilot study, which compared the benefits of a robotic cat and a plush toy cat as interventions for elderly persons with dementia, was conducted at a special care unit of a large, not-for-profit nursing home. Various aspects of a person's engagement and affect were assessed through direct observations. Though not identical, similar trends were seen for the two cats. Interacting with the cats was linked with decreased agitation and increased pleasure and interest. The study is intended to pave the way for future research on robotherapy with nursing home residents.

Key words: intervention, dementia, technology, agitation

The potential benefits of robotic pets

Life in the nursing home, especially when complicated by the progression of dementia, is often accompanied by negative emotions that disrupt social interactions. It is a challenge to find appropriate stimuli and activities that help engage people with special needs in therapeutic activities.[1-5] A number of approaches have been developed specifically for nursing home residents with dementia. Research has shown the engaging value of simple pleasures, such as sewing, coloring, and playing with toys[6] and the positive influence on disruptive behaviors of family videotapes and music.[7,8] Pet therapy has been widely used with persons with dementia. Churchill et al.[9] showed that the presence of a dog, in comparison to the control condition when the dog was not present, enhanced socialization (e.g., increases in verbalization, smiles, looking, etc.) in residents with dementia. While traditional pet therapy has been shown to enhance individual well-being,[10] there are situations where a substitute artificial companion, such as robotic pet, may be a better match. The presence of a real pet in the nursing home environment can be associated with difficulties and limitations. Problems include insufficient nursing staff resources (i.e., there is no one who can take care of a pet on a regular basis), allergic reactions to pets among some residents, concerns about pet behaviors that could injure persons with dementia (i.e., scratching, biting, accidentally tripping people), and concerns about involuntary disruptive behaviors manifested by people with dementia that could harm a pet.

A recently developed approach, which has been named robotherapy,[11] emphasizes certain advantages to using robotic pets as artificial companions for elderly people with cognitive impairment and other physical, mental, or social problems. Specifically, the advantages are the highly imitative life-like behavior of the robotic pet, modeling of emotional states normally experienced by people, and alternative modes of communicating (e.g., tactile-kinesthetic, auditory and visual sensory, emotional, and social). A study of reactions to the robotic entertainment dog, AIBO® (Sony Corporation, Japan) showed that people tend to communicate and become emotionally connected to the robotic pet.[12] Another recent study[13] describes the beneficial effect of AIBO as

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Figure 1. The robotic cat NeCoRo.

a companion for elderly persons with dementia. The use of AIBO with four people with severe dementia resulted in increased communication patterns. Our study was conducted to examine the utility of robotherapy for elderly persons with dementia. Instead of AIBO, we used the robotic cat NeCoRo® (Omron Corporation, Japan) because of its life-like appearance and ability to adjust to the level of interactivity maintained by its human partner. For each study participant, we compared results obtained during a session with the robotic cat to those obtained during exposure to a plush toy cat. In addition, participants' responses were compared to their behavior during a baseline period prior to the exposure to the cat. We set out to answer three basic questions in this pilot study:

1. What kind of effects occur when a cognitively impaired person interacts with a robotic pet?

2. Does a robotic cat trigger more positive experiences than a plush toy cat?

3. To what degree does communication between a nursing home resident with dementia and a robotic cat depend on the resident's level of cognitive impairment?

Methods

Sample

All study participants were recruited from a large, suburban not-for-profit nursing home. Ten relatives of nursing home residents diagnosed with dementia were approached, and nine provided consent for their relatives to participate. All nine participants were female, ranging in age from 83 to 98 years, with an average age of 90 years. The mean score on the Global Deterioration Scale,[14] which assesses severity of age-related cognitive decline and Alzheimer's disease on a scale from 1 (no cognitive decline) to 7 (late dementia or very severe cognitive decline), was 5.4 (range 4-7).

Methods and procedures

The project was based on a comparison condition experimental design involving a comparison of engagement responses to two different stimuli: the robotic cat NeCoRo (Figure 1), and a plush toy cat (Figure 2). The plush toy cat was selected after an Internet-based search of more than 60 plush toy cat samples presented on different web pages, so its appearance would match as closely as possible that of the robotic cat.

The design of the robotic cat, NeCoRo, is based upon the concept of an emotional communication robot[15,16] (Figure 3). Enhanced artificial intelligence and built-in sensors allow for a variety of responses during interactions, which can be either verbal (meow, purr, or hiss) or nonverbal (stretching paws, wagging tail, opening and closing eyes, turning head and spreading ears, and sitting or lying down). Both cats were covered with soft synthetic gray fur of different shades. The plush cat was lighter and softer than the robotic cat.

All nine residents received two interactive sessions—one with the robotic cat and one with the plush cat, with a duration of 10 minutes each. Only one session per day was conducted for each resident. To control for any effects due to order of presentation, the presentation order of the cats was randomized. Six participants were given the robotic cat during the first session, and the other three participants spent the first session with the plush cat. All sessions were conducted by research assistants with at least one year of experience in working with cognitively impaired nursing home residents. The research assistants had been trained to perform all of the study assessments. For the purposes of this project, we developed a protocol for presenting these cats to a person with dementia, and this protocol was used with each study participant. At the beginning of each session, the research assistant introduced the cat to the participant by saying, "Hello Ms. X. This is a robotic cat (or, a plush cat). You can play with him any way you like—you can talk to him and you can touch him." If there was no response by the participant, the research assistant would model an interaction for the resident.

Assessments

Direct observations of behavior were recorded at baseline (i.e., during the five minutes immediately prior to the intervention) and during each session. Observations were recorded on three assessments:

Figure 2. Plush toy cat.

1. Agitated behaviors were assessed on the Agitated Behaviors Mapping Instrument (ABMI).[17] Inter-rater agreement was checked

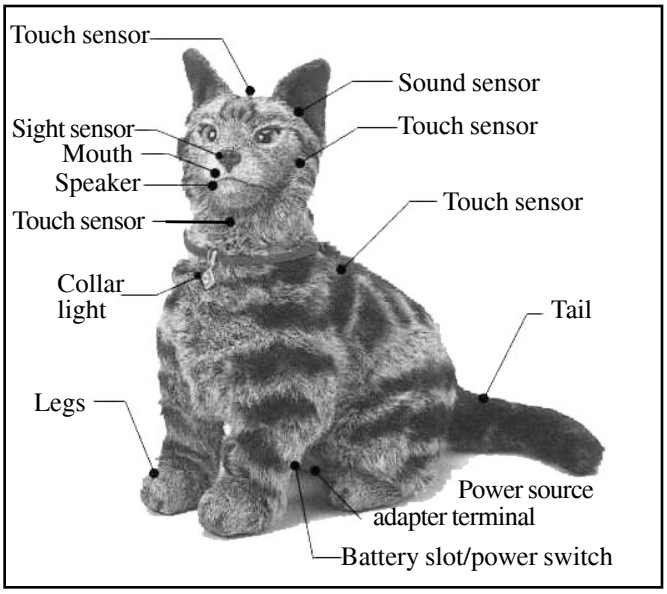

Figure 3. NeCoRo robotic cat.

for this assessment for a separate study and averaged 95.2 percent.

2. Affect included the measurement of pleasure, interest, sadness, anxiety, and anger via Lawton's Modified Behavior Stream.[18] Both the ABMI and the affect measurements were recorded directly onto a hand-held Palm Pilot m100 computer (PalmOne, Milpitas, California). Inter-rater agreement evaluations for this measure were conducted for another study and averaged 85 percent.

3. Residents' engagement with the stimuli was assessed along the dimensions of attention, attitude, intensity of manipulation with the stimuli, and duration of engagement. The first three constructs were measured on a 5-point scale, where the highest score of 5 characterized a positive outcome (i.e., very attentive, very positive, very strong). Duration of the actual engagement of the study participant with the robotic cat or plush cat was measured in minutes. The quality of engagement was recorded and included such items as the type of activity (e.g., holding an object or manipulating the object) and the target of the resident's speech while engaged with the stimulus. This measure was developed for a study on agitated behavior by the second author. Two research assistants independently rated 11 observations with the cats. Pearson correlations were r = .76, p = .008 for duration; r = .63, p = .018 for attitude; r = .67, p = .012 for attention; and r = .66, p = .014 for intensity.

Results

The research assistants did not observe any safety concerns for the participants during the sessions with the robotic cat or with the plush cat. Sometimes they were concerned for the safety of the robotic cat if the resident were to drop it.

Analysis of agitation

Paired sample t-tests were used to determine how interactions with the robotic cat and the plush cat influenced various kinds of problem behaviors (i.e., verbal, physical, and overall agitation). Separate t-tests were performed for robotic cat data and plush cat data, with the independent variable in all analyses being time (baseline vs. intervention). The results showed that the level of physical agitation and overall agitation decreased significantly when the residents were interacting with the plush cat ($t_{(8)} = 2.5$, $p = 0.036$ and $t_{(8)} = 2.4$, $p = 0.046$, respectively). Interactions with the robotic cat also lowered the level of agitation, but no test statistics were significant ($t_{(8)} = 2.0$, $p = 0.078$ for overall agitation). Comparison of agitation at baseline for both stimuli did not reveal any significant results.

Analysis of affect

Sessions with the robotic cat yielded a significant increase in pleasure ($t_{(8)} = 3.6$, $p = 0.007$) and interest ($t_{(8)} = 2.7$, $p = 0.028$). While pleasure and interest increased with the plush cat, the test statistics were not significant ($t_{(8)} = -1.8$, $p = 0.111$ for pleasure and $t_{(8)} = -2.3$, $p = 0.052$ for interest). Analyses pertaining to anger and anxiety failed to yield significant results for either the robotic cat or plush cat (Table 1).

Analysis of engagement

Analysis via paired t-test did not reveal statistically significant differences in the engagement parameters. The intensity of manipulations with the robotic cat was higher than with the plush cat ($t_{(8)} = 2$, $p = 0.081$), although this difference did not reach statistical significance. On the other hand, only 22 percent of the participants held the robotic cat during their sessions, whereas 78 percent of the residents held the plush cat.

Analysis of relationships of engagement with cognitive functioning and age

Pearson correlations were calculated to determine relationships of the engagement parameters with age and

Table 1. Comparison of effects produced by the interactions between a resident and a stimulus such as the robotic cat and a plush toy cat

Individual parameter	Outcome measure	Stimulus	Time measure	Mean of target behavior (N = 9)	t-test	
					t value (df = 8)	Probability sig. (2-tailed)
Agitation	Verbal agitation	Robotic cat	Baseline	4.2	1.10	.299
			Treatment	2.9		
		Plush toy cat	Baseline	2.4	.68	.516
			Treatment	1.9		
	Physical agitation	Robotic cat	Baseline	7.1	1.93	.090
			Treatment	3.3		
		Plush toy cat	Baseline	5.9	2.52	.036
			Treatment	2.6		
	Combined agitation	Robotic cat	Baseline	11.3	2.02	.078
			Treatment	6.2		
		Plush toy cat	Baseline	8.3	2.36	.046
			Treatment	4.4		
Affect	Pleasure	Robotic cat	Baseline	1.2	3.59	.007
			Treatment	2.3		
		Plush toy cat	Baseline	1.3	1.79	.111
			Treatment	2.1		
	Anger	Robotic cat	Baseline	1.0	1.00	.347
			Treatment	1.2		
		Plush toy cat	Baseline	1.0*		
			Treatment	1.0		
	Anxiety	Robotic cat	Baseline	1.2	1.00	.347
			Treatment	1.1		
		Plush toy cat	Baseline	1.0	1.00	.347
			Treatment	1.2		
	Interest	Robotic cat	Baseline	2.7	2.68	.028
			Treatment	3.7		
		Plush toy cat	Baseline	2.6	2.28	.052
			Treatment	3.4		

* The t-test cannot be computed because the standard error of the difference is 0.

Table 2. Correlations of cognitive functioning and age with four observational measurements: Robotic cat vs. plush toy cat					
		Duration of engagement	**Intensity of manipulation**	**Attention to stimulus**	**Attitude toward stimulus**
Level of cognitive impairment (GDS)*	Robotic cat	r = -0.67 p = 0.05	r = -0.27 p = 0.48	r = -0.41 p = 0.28	r = -0.59 p = 0.10
	Plush toy cat	r = -0.48 p = 0.23	r = -0.73 p = 0.03	r = -0.65 p = 0.06	r = -0.45 p = 0.22
Age	Robotic cat	r = -0.38 p = 0.32	r = -0.45 p = 0.23	r = -0.61 p = 0.08	r = -0.37 p = 0.33
	Plush toy cat	r = -0.51 p = 0.20	r = 0.05 p = 0.90	r = 0.02 p = 0.97	r = 0.11 p = 0.78
* Higher score on Global Deterioration Scale (GDS) indicated greater cognitive impairment.					

level of cognitive impairment (Table 2). Analyses revealed a link between level of cognitive impairment and some of the engagement parameters. For the robotic cat, the level of cognitive functioning was significantly related to the duration of engagement; people with higher cognitive functioning tended to spend more time with the robotic cat ($r = 0.67$, $p = 0.05$). However, for the plush cat, cognitive functioning was significantly associated with the intensity of manipulation and attention to stimulus; people with higher levels of cognitive functioning tended to manipulate the plush cat more intensely ($r = 0.73$, $p = 0.03$) and paid greater attention to it ($r = 0.65$, $p = 0.06$). Although only three correlations between the level of cognitive functioning and engagement parameters were significant, all correlations were in the direction of reduced engagement with both the robotic cat and plush cat for persons with higher cognitive impairment. Of the eight correlations performed with age, only one reached statistical significance, indicating that older participants paid less attention to the robotic cat than did comparatively younger participants (Table 2).

Discussion

This is the first study to report what happens when cognitively impaired nursing home residents interact with a robotic cat and with a plush cat. We found that both types of cat held the participants' interest, with the robotic cat also producing significant increases of pleasure. We also found that the cats hold promise as an intervention for agitated behaviors. The amount of physically disruptive behaviors and overall agitation decreased significantly when residents interacted with the plush cat. In addition, a trend toward decreased overall agitation was seen during interactions with the robotic cat. Although not exactly the same, we found similar results with respect to agitation and affect for both cats. One could conclude that there is no difference in using either a plush cat or a robotic cat with nursing home residents with dementia. Clearly, when there are monetary concerns, the plush cat would be preferable. However, we encourage others to follow up our robotic cat research with cognitively impaired nursing home residents. This pilot study is only a first step in investigating the potential of robotherapy.

Our results demonstrate that people with severe dementia can be engaged in interactions with a robotic cat as well as a plush cat. The level of intensity of manipulation of the plush cat and the amount of attention paid to the cat were strongly associated with the level of cognitive deterioration; that is, the more impaired the resident, the less the plush cat is manipulated and the less attention is paid to it. Thus, even though the plush cat lacks any interactive behaviors, residents paid attention to it. While analysis revealed that study participants with higher levels of cognitive impairment tended to be engaged with the robotic cat for a shorter duration than those with higher levels of cognitive functioning, the important point is that cognitively impaired residents were, in fact, engaged with the robotic cat.

While this study was limited by its small sample size, gender homogeneity (only females were included in the group), and short-term sessions, its intent was to pave the way for future studies of robotherapy of nursing home residents with dementia. From this pilot project, we are able to formulate research questions for other studies.

Future research could extend our work by including a larger sample with people of different genders and ethnicity, by experimenting with different introductions to the stimuli, by controlling for the amount of contact with a research assistant, and by examining the impact of repeated exposures of "smart" robotic creatures vs. non-interactive creatures on people with different levels of cognitive functioning.

Future studies should also explore the mechanism responsible for the effects found in this pilot. The studies concerning AIBO included one study based on spontaneous postings in online AIBO discussion groups. This study documented a general tendency to communicate and develop an emotional connection with a robotic pet. The findings suggest a universal human willingness to develop attachments, even when the person knows that the object is inanimate. A second study described case studies of four people with dementia who communicated with AIBO. Results from this second study suggest that people with dementia are also able to communicate with a robotic pet.

This study used a quantitative observational methodology to show that the interaction with a robocat can produce positive and emotional effects in this population. Our study suggests that people with dementia can be engaged with robotic cats and with plush cats. The meaning of this engagement needs to be further explored. It is unclear to what extent the participants were aware that the cats were inanimate objects rather than real cats. It is possible that the cats provided a response to nursing home residents' need for social contacts. Similar to the universal need for attachment, which was underscored by Harlow's[19] studies of the cloth vs. wire mesh surrogate monkey mothers, the soft touch provided by both stimuli in our study may have provided an opportunity to elicit sensations of attachment. It is possible that in later stages of dementia, the differentiation between stimuli is weaker, and the softer stimulus will be more effective. In earlier stages of dementia, a robotic cat may seem more animate and communicative and may therefore produce greater attachment. These hypotheses can provide a basis for future research exploring the potential benefits of robotherapy for people with dementia.

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