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Behavioral Responses of Nursing Home Residents to Visits From a Person with a Dog, a Robot Seal or a Toy Cat

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ABSTRACT Previous studies suggest that contact with dogs can positively affect the wellbeing of elderly people in nursing homes, but there is a lack of research investigating the causal pathways of these effects. One such pathway may relate to the behavioral responses of the elderly when interacting with a dog. The present study compared the immediate behavioral responses of nursing home residents to bi-weekly visits from a person accompanied by either a dog, a robot seal (PARO®), or a soft toy cat, using a randomized controlled design. A total of 100 nursing home residents completed the study. Each participant received a total of 12 visits, during which their behaviors, including interactions between the visitor and the accompanying animal (real or artificial), were recorded. Also, data on cognitive impairment, presence of depressive symptoms, age, time lived in the nursing home, dementia diagnoses, and gender were collected. We found that the immediate responses to, and interaction with, the visiting animal depended on the type of animal that was brought along. The dog and the interactive robot seal triggered the most interaction, in the form of physical contact ($F_{(2,103)} = 7.50$, $p < 0.001$), eye contact ($F_{(4,151)} = 6.26$, $p < 0.001$), and verbal communication ($F_{(4,195)} = 2.87$, $p < 0.05$). As well, the cognitive impairment level of the residents affected with whom they interacted. The higher the cognitive impairment level, the more interaction was directed toward the animal and less toward humans, regardless of visit type ($F_{(2,101)} = 4.10$, $p < 0.05$). The dogs and the robot seal stimulated the residents to more interaction, compared with the toy cat, but the robot seal failed to maintain the

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attention at the same level over time. The cognitive functioning of the residents correlated with the level of interaction, and this needs to be studied further.

Keywords: animal-assisted therapy, cognitive impairment, nursing home, quantitative behavior sampling, visiting dog

Visiting dogs have become increasingly common in nursing homes for the elderly, and many organizations throughout the world arrange dog visits, most commonly with the help from volunteers. The general view is that dog visits have positive effects on the residents. However, there is still no conclusive scientific evidence of either immediate or long-term effects, even though the outcomes of dog visits have already been studied from different angles (Filan and Llewellyn-Jones 2006; Virues-Ortega et al. 2012; Bernabei et al. 2013).

Until now, most studies on the effects of visiting dogs have concentrated on general effects on the mental wellbeing of the residents or on human behavioral problems shown outside the actual therapy sessions (e.g., Churchill et al. 1999; McCabe et al. 2002; Richeson 2003). Dog visits have been associated with a decrease in the feeling of loneliness in cognitively intact nursing home residents (Banks and Banks 2002; Banks and Banks 2005; Banks, Willoughby and Banks 2008) and found to reduce depressive symptoms (Le Roux and Kemp 2009; Travers et al. 2013), but other studies have not demonstrated these effects (Crowley-Robinson, Fenwick and Blackshaw 1996; Zisselman et al. 1996; Lutwack-Bloom, Wijewickrama and Smith 2005). Virues-Ortega et al. (2012), in a meta-analysis on the effects of animal-assisted therapy (AAT) on the psychological status in nursing home residents, reported only a limited effect. Reviews of the literature have reached the same conclusion and call for more research (Filan and Llewellyn-Jones 2006; Bernabei et al. 2013).

As the evidence for long-term effects is not at all clear, possibly also due to very different experimental approaches and settings, a first step is to unravel whether, and which elements in, human–dog interaction could potentially have an effect. Is it, for instance, the tactile element or the interaction in a broader sense, and is it possible to elicit the same responses if another object is used instead of a dog (Marino 2012)? To determine this, we need to analyze the behavior *during* the human–animal interaction and produce data that describe the interplay between the human and the animal and how the presence of a dog stimulates and affects the immediate response of the person. The first step is to collect data to quantify these responses, and the next step is to compare these responses with long-term effect measures. This approach will make it possible to disentangle the effective elements of the intervention and get the knowledge needed to be able to adjust and optimize future interventions (Thodberg, Berget and Lidfors 2014).

A few small-scale studies have collected behavioral data during dog visits. Fick (1993) scanned the behavior (in 40-second intervals) of residents taking part in a group therapy session with a dog present half of the time and found that the conversations (verbal social interaction) between nursing home residents increased when the dog was present. In another study, animal-assisted therapy (cats and dogs) for residents in groups led to more conversations, measured as frequency of talking, compared with other types of activities without animals (Bernstein, Friedmann and Malaspina 2000). In contrast to this, Hendy (1987) found that residents in groups who were visited by either a human alone, a human and a dog, or a dog alone all had more smiles and were more alert, measured as occurrence per minute (one-zero sampling), compared with a control treatment with no guests.

Fake animals have been used in a couple of studies in nursing home settings. Visits from either a person and a dog, a person and a robot (AIBO), or a person alone all stimulated socially interactive behavior measured as, for example, conversation (Kramer, Friedmann and Bernstein 2009). Greer et al. (2001) compared how real cats and toy cats stimulated conversation between residents in groups and found that when real cats were used, more words and meaningful verbal elements were used by the elderly.

Based on the sparse body of existing work on immediate effects, it appears that i) visits in general are stimulating, ii) the presence of an animal in addition to a person is more stimulating than a person alone, and iii) robot animals can be as effective as real animals. However, it is also clear that larger studies, including quantitative measures of the immediate effect of animal visits, are needed in order to identify any effective elements that could explain long-term effects.

The aim of this study was to study whether nursing home residents interacted differently with a real animal/dog compared with interactive and non-interactive fake animals during bi-weekly animal-assisted visits, measured by quantitative measures of behavior. We wanted to explore whether a real animal stimulated the residents differently compared with artificial animals, and whether this could be related to the level of feedback. The animals used were a dog, a robot seal (PARO®), and a soft toy cat. The latter two were chosen because they have been developed especially for elderly care and provide different levels of feedback. Despite the fact that they resemble different animal species, they share a number of physical characteristics, such as a soft fur coat and large, dark eyes. Thus, these animal-like objects enabled us to compare different levels of feedback to the elderly person while keeping the opportunity of tactile stimulation constant, as all the chosen animals were soft to touch but provided different opportunities for interaction. Our hypothesis was that the residents would interact most with the real animal, then the interactive robotic animal, and then the non-interactive toy animal, due to the decreasing complexity of the stimulation. In a larger perspective, the results of the study will provide more knowledge about which elements in animal-assisted interventions (e.g., physical touch), could be the potential causal pathways for long-term effects, such as, for example, a reduction in symptoms of depression or an increase in general wellbeing or quality of life.

The visits were conducted in the homes of the residents, with no other residents present, in order to separate the effect of the animal from the effect of being in a group of residents. Throughout the text, all three visiting objects (dog, robot seal, and soft toy cat) will be referred to as "animals," even though two of them are not real animals.

The study was part of a larger study of the immediate and long-term effects of bi-weekly dog visits, and the results on long-term effects are presented elsewhere (Thodberg et al. 2015).

Methods

Participants

A total of 124 nursing home residents from four nursing homes in Denmark were enrolled in the study. The four institutions have residents from a broad spectrum of the elderly population, but with a high prevalence of persons suffering from dementia at different stages. Written informed consent was obtained from all participants or their relatives. The participants could withdraw from the study at any point. The study was approved by The Scientific Ethical Committee for Denmark and The Danish Data Protection Agency.

Exclusion criteria were allergic reactions or fear of dogs, but we saw neither. In two cases, the nursing homes had a section with a resident cat. Residents in these two sections were not included due to the different level of animal contact. None of the residents had pets of their own.

Design

The design of the study was a randomized complete block design. Each nursing home was a block, and after informed consent had been given, the participants were assigned randomly to one of three visit types, using a program for blocked randomization in R software (R Core Team 2013).

The Interventions

Two persons and one animal took part in all three types of visit. The animals were a dog, a robot seal, or a soft toy cat. One person, the visitor, accompanied the animal, and the other person, the observer, made direct observations and a video recording of the visit. For each participant, we scheduled two visits per week between 9 am and 4 pm on either Mondays and Wednesdays or Tuesdays and Thursdays for 6 weeks; that is, a total of 12 visits. The time of visit was chosen to suit the individual participant, and they met the same animal, the same visitor, and one of two observers in each visit. The visitor and observer visited an equal number of residents with each animal. In each nursing home, there was a total of two visitors and two observers, and the observers followed each visitor an equal number of times. All residents had their own small apartment, consisting of a small living room and bedroom, where the visits took place. Usually, they would sit in a normal chair or a wheelchair. More rarely, they would lie down during the visit. The participants were free to move around during the visit, but this rarely happened.

We used two dogs per nursing home, but the residents who received visits by a dog always met the same dog. The visitors were part of the project staff and were not the owners of the dogs.

The visits lasted 10 minutes, excluding the time spent entering and greeting as well as ending the visit and leaving the room. We aimed at making each visit as pleasant as possible, and we adjusted the communication to the cognitive level of the resident. Whichever animal the visitor brought, the visit followed a few guidelines. To ensure that the residents could touch the animals during the visit, they were within reach for at least 80% of the time, unless the resident clearly showed no interest at all or disapproved of contact with the animal. To make the dog available for touch, it was sitting or standing next to the resident. The robot seal or the cat was held in the arms of the visitor or placed, for example, on a table to be within reach. If requested by the resident, the robot seal or toy cat was placed on his/her lap. The dog was on leash.

During the first visit, the animal was introduced and the resident was encouraged to make contact. To start the conversation, the subject “animal” was chosen, unless the resident changed the subject. The visitor positioned herself close by the resident, and the observer placed herself further away to be able to monitor the situation. The observer kept in the background but joined the conversation when it felt natural.

The dogs were approximately the same size and were retrievers or retriever mixes (one Golden Retriever, male, aged 5 years; two Labrador Retrievers, one male, aged 3 years, one female, aged 8 years; and one Labrador Retriever/Siberian Husky mix, male, aged 6 years). The dogs were not trained especially for this task, and none of them were neutered. Three of them were approved by a Danish organization that certifies family dogs and their owners to work as volunteers with dog-assisted interventions in nursing homes (“TrygFonden visitor dogs”; www.besoegshunde.dk). The last dog was not certified, but fulfilled the same criteria of good health and appropriate behavioral reactions. All dog owners had liability insurance for their dog. The dogs were carefully looked after throughout the study, and no situations occurred where the welfare of the dogs was at risk.

The robot seal, PARO®, is a so-called "mental commitment robot" developed in Japan (Shibata and Wada 2011) mainly for people suffering from dementia (http://www.paro robots.com). The robot is in the shape of a baby harp seal with white synthetic fur and weighs 2.8 kg. The robot is interactive and responds to sound, touch, light, and being put out of balance by movement and vocalization. It can move its neck vertically and horizontally, paddle with its front and rear flippers, and blink its eyelids. The sounds emitted are squeal-like.

The soft toy cat ("Billy the cat"; www.joyk.se) was developed for people with special needs. It has synthetic grey and white fur and weighs 0.95 kg and is not interactive.

Measures

Behavioral Observations: The behavior of the residents was recorded mainly by direct observation, and a few parameters were video-recorded (see footnote in Table 1). We registered the frequency and duration of physical contact with the visiting animal, talk directed to the animal and the visiting person, and visual contact with either the animal or the visiting person. An ethogram is given in Table 1. For direct observation, the observer used a tablet with a touch screen, where the behavioral elements were represented by specific areas within categories of "conversation/talk," "physical contact," and "eye contact." The timing of the individual behavioral elements was activated when the behavior started, and deactivated when another behavior in that category was activated, making it possible to extract exact data on frequency and duration. Visual contact with the animals was only registered in the last three of the four nursing homes. "Eye contact with the visiting person" and "looking at other things/away" were analyzed from the video recordings, but only in the last three nursing homes.

Description of the Population: Basic information for each participant was given by the staff and included: age, time lived in the nursing home, dementia diagnosis, and gender. The participants were interviewed by a project nurse before the experimental period and scored on three psychiatric scales. We used the Mini-Mental State Examination (MMSE), which gives information about the participants' cognitive state; The Gottfries-Bråne-Steen scale (GBS), which gives an evaluation of disabilities, language, psychiatric symptoms, average daily living function, and behavior of the participants (Bråne, Gottfries and Winblad 2001); and The Geriatric Depression Scale (GDS), which screens for depressive symptoms (Montorio and Izal 1996). The instruments chosen are validated for this population and cover relevant and important aspects and general issues. If the participants were unable to answer specific questions from the psychiatric scales due to impairment of vision, hearing, or due to general reluctance, the questions were taken out of the total score, as the failure to reply did not reflect the mental state of the participant.

Statistics

Variables: From the variables describing the residents' physical contact with the animals (Table 1), we calculated one composite variable, "physical contact." We initially had two versions of the variable: with or without passive physical contact. We analyzed both variables and reached the same result and therefore chose the version including passive physical contact. Conversation was analyzed as "talk in total," "talk to the visiting animal," and as "talk directed at a person." "Talk to the person about the visiting animal" was also analyzed individually. To analyze the effect of cognitive impairment on the probability of touching and talking to the animal,

Table 1. Ethogram describing the behavioral elements and the derived composite variables, and an overview of the use of statistical models: generalized linear mixed model (GLMM; probability of occurrence) and non-parametric analysis (NPA; duration).

Behavior Category	Behavioral Elements	Description	Composite Variables
Physical Contact			
	Touching with hand	Touching the animal with one or both hands	Physical contact (GLMM, NPA)
	Touching with head	Touching the animal with the head	
	Touching with hand and head	Touching the animal with the head or one or both hands	
	Passive physical contact	The resident is in physical contact with the animal, but not with the hands and head, for example, the dog is leaning against the leg of the resident.	
Conversation/Talk			
	To the visiting animal (GLMM)	Talking directly to the animal	Talk in total (GLMM, NPA)
	To the person about the visiting animal (GLMM)	Talk directed to the visitor or the observer about the visiting animal	Talk directed at a person (GLMM, NPA)
	To the person about other things	Talk directed to the visitor or the observer about other things	
Eye Contact			
	With the animal* (GLMM)	Looking directly at the animal	
	With the visiting person*v (GLMM)	Looking directly at the visiting person or the observer	
	Looking at other things/ away*v	Looking neither at the visiting animal nor any of the persons present	

*Only sampled in three nursing homes (2, 3, 4). vSampled from video recordings.

a composite variable was calculated as the sum of "physical contact" and "talk to the visiting animal" (not shown in Table 1).

For the analysis, the 12 visits were divided into 3 time periods, with each time period covering 2 weeks (4 visits). This was chosen to be able to compare the overall phases of the visit period.

Only 15% of the residents fulfilled the depression criterion (GDS score > 6), and due to this low prevalence, the GDS measure was not analyzed further.

Parametric Models: Behavioral variables were analyzed using a generalized linear mixed model (Table 1) and were entered as binomially distributed. Fixed effects were visit type, time period, the interaction between visit type and time period, gender of the resident, identity of observer, identity of visitor, and nursing home. Covariates were age and initial MMSE score of the residents. The probability of touching and talking to the animal was additionally analyzed for effects of the residents' cognitive impairment level. Fixed effects were cognitive impairment level (mild, n = 26: MMSE above 20, moderate, n = 34: MMSE between 10 and 20; severe, n = 40 MMSE below 10), visit type, the interaction between cognitive impairment level and visit type, gender of the resident, identity of observer, identity of visitor, and nursing home, and the age of the resident was a covariate. This analysis was repeated with the same model but with cognitive impairment level based on the GBS scale scores instead (mild, $n = 27$: GBS below 27; moderate, $n = 45$: GBS between 27 and 55; severe, $n = 28$: GBS above 55).

In all models, we took into consideration that the measures were repeated for each resident. The results are presented as probabilities (± *SE*).

Non-parametric Models: The duration of "physical contact," "talk directed at a person," and "talk in total" (Table 1) were analyzed non-parametrically, to test for differences between combinations of visit type and time period. We used Wilcoxon Signed Ranks tests for pairwise tests of difference over time, and the Wilcoxon Rank Sum Test for differences between visit types.

The duration of "talk directed at a person" in relation to the combination of visit type and degree of cognitive impairment was analyzed by the Kruskal-Wallis Test, and the Wilcoxon Rank Sum Test was used for post-hoc pairwise comparisons. Differences in baseline measures between nursing homes were analyzed by the Kruskal-Wallis Test. Results are presented as medians (± interquartile range).

When the criteria for normal distribution were fulfilled, the differences between nursing homes with regard to the basic information and the psychiatric scales were analyzed by the Student's *t*-test and the results presented as means (± *SD*). When data were not normally distributed, we used the Kruskal-Wallis Test, and the Wilcoxon Rank Sum Test was used for post-hoc pairwise comparisons; results are presented as medians (± interquartile range).

All data were analyzed using SAS 9.3 (Cary, NC, USA).

Results

Of the 124 enrolled participants, 24 dropped out during the experimental period either due to illness or because they did not want to receive the visits. The residents were equally distributed amongst the three visit types and did not differ from the rest of the study population. Table 2 shows demographic data and information about the populations in the four nursing homes.

Table 2. Description of the study population. The age of participants and the time lived in the nursing home are given as medians with interquartile range.

Nursing Home	Age* (Years)	Time Lived in the Nursing Home (Months)	Percentage with a Dementia Diagnosis (%)	Percentage of Women (%)	Number of Participants in Each Visit Treatment (Dog, Robot Seal, Toy Cat)	Number of Dropouts in Each Visit Treatment (Dog, Robot Seal, Toy Cat)
1 ($n = 22$)	86.5 [83; 89]	30 [13; 70]	22.7	59.1	7, 8, 7	1, 2, 1
2 ($n = 23$)**	89 [80; 93]	25 [6; 31]	26.1	65.2	8, 9, 6	2, 1, 2
3 ($n = 27$)	84 [79; 90]	21 [14; 36]	37.0	77.8	10, 9, 8	3, 2, 1
4 ($n = 28$)	81.5 [67.5; 87.5]	32 [11.5; 68]	32.1	71.4	10, 9, 9	2, 3, 3
Total ($n = 100$)	85.5 [79; 90]	24.5 [12.5; 50]	30.0	69.0	35, 35, 30	8, 8, 7

*The nursing homes differed with regard to the age of the residents ($\chi^2 = 10.1$; $df = 3$; $p < 0.05$).
**In nursing home 2 one resident dropped out before being allocated to a visit treatment.

Table 3. The values of the psychiatric measures before the six-week intervention period, shown as either medians and interquartile range or means and standard deviation.

Nursing Home	MMSE*	GBS	GDS
1 (*n* = 22)	20 [9; 23]	37.3 ± 28.5	3 [1; 5]
2 (*n* = 23)	15 [7; 21]	41.3 ± 19.1	2 [1; 5]
3 (*n* = 27)	7 [3; 17]	56.7 ± 26.3	2 [1; 5]
4 (*n* = 28)	16 [6.5; 21]	41.4 ± 20.5	1.5 [0; 3.5]
Total	14 [5.5; 21]	44.6 ± 24.6	2 [1; 5]

*The nursing homes differed with regard to the residents' MMSE score ($\chi^2 = 9.49$; $df = 3$; $p < 0.05$).
MMSE: Mini-Mental State Examination, GBS: Gottfries-Bråne-Steen scale, GDS: Geriatric Depression Scale.

The scores of the psychiatric scales are shown in Table 3. The participants in the three treatment groups did not differ significantly on any of the psychiatric scores.

Physical Contact

The odds of having physical contact with the animal depended on the visit type ($F_{(2,103)} = 7.50$, $p < 0.001$). The residents who had visits from a person and a dog or a robot seal were more likely to have physical contact with the animal, compared with residents receiving visits from a soft toy cat ($p < 0.001$ and $p = 0.01$, respectively; Figure 1). The probability of touching the animals decreased over the intervention periods (time period 1: 0.56 ± 0.04, time period 2: 0.51 ± 0.05, and time period 3: 0.49 ± 0.05; $F_{(2, 199)} = 3.18$, $p < 0.05$) and was also affected by nursing home ($F_{(3, 103)} = 2.69$, $p = 0.05$) and negatively affected by increased MMSE score ($F_{(1, 103)} = 7.92$, $p < 0.01$).

The duration of physical contact with the animal was longer for dog and robot seal visits, compared with the cat visits for all time periods (dog vs. toy cat, time period 1: $z = -2.6$, $p < 0.01$; time period 2: $z = -3.5$, $p < 0.001$; time period 3: $z = -3.1$, $p < 0.01$; robot seal vs. toy cat, time period 1: $z = -2.1$, $p < 0.05$; time period 2: $z = -2.2$, $p < 0.05$; time period 3: $z = -2.3$, $p < 0.05$; Table 4). During toy cat visits the residents touched the cat for longer in time period 1 compared with time period *2* (S = –101.5, $p < 0.0001$).

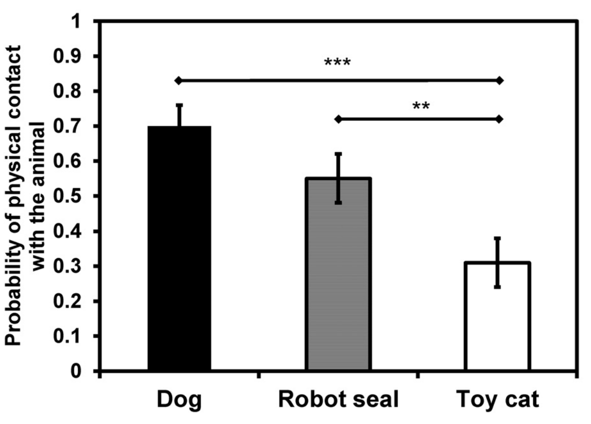


Figure 1. Relationship between the probability of having physical contact with the animal and the visit type. **$p < 0.01$; ***$p < 0.001$.

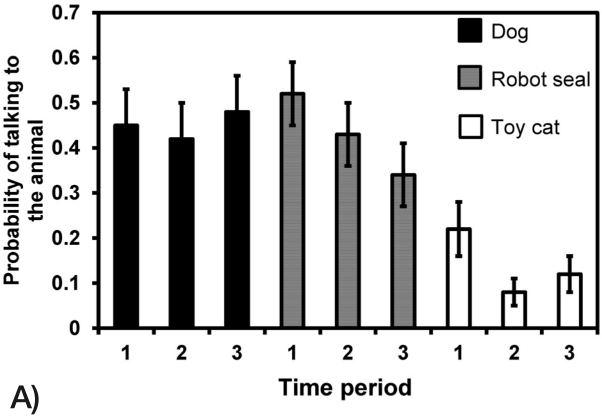
Table 4. Duration in seconds (median ± interquartile range). Differences between visit types within time period are indicated by different letters (x and y), and differences within visit types across time periods are shown by different letters (a and b). See text for more details.

Visit Type and Time Period	Dog			Robot Seal			Toy Cat		
	1 *n* = 36	**2** *n* = 35	**3** *n* = 34	**1** *n* = 41	**2** *n* = 36	**3** *n* = 34	**1** *n* = 34	**2** *n* = 32	**3** *n* = 30
Duration of Physical Contact	92 [7; 192]	56 [7; 224]	93 [1; 213]	67 [3; 148]	18 [0; 367]	28 [0; 309]	7 [0; 52] a	0 [0; 14] b	0 [0; 48] ab
	x	x	x	x	x	x	y	y	y
Duration of Talk Directed at a Person	183 [39; 354]	217 [53; 356]	164 [41; 265]	279 [138; 437] a	252 [102; 407] b	206 [123; 403] b	321 [188; 434] a	361 [156; 420] a	297 [128; 338] b
	x	x	x	xy	xy	xy	y	y	xy
Duration of Talk in Total	250 [77; 427]	252 [56; 458]	263 [41; 428]	377 [250; 483]	385 [196; 488]	307 [162; 474]	325 [187; 434]	361 [156; 420]	298 [128; 338]
				a	ab	b	a	a	b

Conversation/Talk

The probability of talking directly to the animal was affected by an interaction between visit type and time period ($F_{(4,195)} = 2.87$, $p < 0.05$), and was higher in visits with either a dog or robot seal, compared with a toy cat, regardless of the time period (time period 1: dog vs. toy cat, $p < 0.05$, robot seal vs. toy cat, $p < 0.05$; time period 2: dog vs. toy cat, $p < 0.0001$, robot seal vs. toy cat, $p < 0.0001$; time period 3: dog vs. toy cat, $p < 0.001$, robot seal vs. toy cat, $p < 0.01$; Figure 2a). The probability of talking to the dog was constant over the intervention period, whereas a decrease in the probability was found for both visits with the robot seal and the toy cat (robot seal: time period 1 vs. 3, $p < 0.01$; toy cat: time period 1 vs. 2, $p < 0.05$; time period 1 vs. 3, $p < 0.05$; Figure 2a). Talk directed at the animal was positively affected by the nursing home ($F_{(3,102)} = 5.62$, $p = 0.01$) and the observer ($F_{(3,105)} = 3.43$; $p < 0.05$), and female residents talked to the animals more than male residents ($F_{(1,102)} = 4.34$, $p < 0.05$). The residents were more likely to talk directly to the animal the older they were ($F_{(1,102)} = 8.48$, $p < 0.01$). The time spent talking to the visiting person depended on both visit type and time period, and it was longer when the accompanying animal was a toy cat, compared with a dog in both time period 1 and 2 (time period 1: $z = 2.1$, $p < 0.05$; time period 2: $z = 2.0$, $p < 0.05$). The duration did not change over time for dog visits, but for both robot seal and toy cat visits, the duration fell over time (robot seal, time period 1 vs. time period 2, S = –125, $p < 0.05$, time period 1 vs. time period 3, S = –140, $p = 0.01$; toy cat, time period 1 vs. time period 3, S = –105, $p < 0.05$, time period 2 vs. time period 3, S = –137.5, $p < 0.01$; Table 4).

The odds that the resident would talk about the visiting animal was affected by an interaction between visit type and time period ($F_{(4,195)} = 4.10$, $p < 0.01$) and was found to be highest for the visits with a dog or a robot seal, compared with the toy cat visit, regardless of time period (time period 1: robot seal vs. toy cat, $p < 0.05$; time period 2: dog vs. toy cat, $p < 0.0001$, robot seal vs. toy cat, $p < 0.01$; time period 3: dog vs. toy cat, $p < 0.0001$, robot seal vs. toy cat, $p < 0.01$; Figure 2b). However, again we found a decrease over time for both the robot seal and the toy cat (robot seal: time period 1 vs. 2, $p < 0.01$, time period 1 vs. 3, $p < 0.01$; toy cat: time period 1 vs. 2, $p < 0.0001$, time period 1 vs. 3, $p < 0.0001$; Figure 2b).



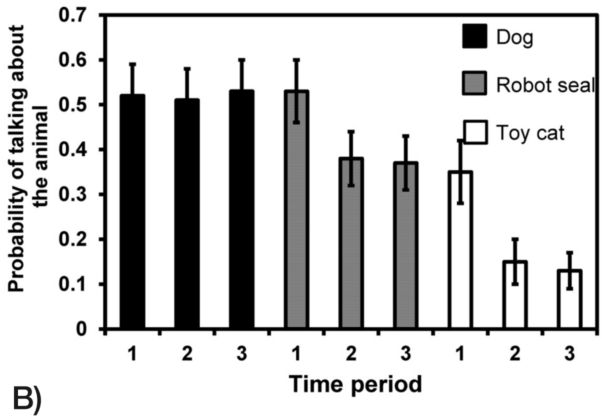


Figure 2. Relationship between the probability of talking to A) or talking about B) the animal and visit type over time. The probability of each was affected by an interaction between visit type and time period ($p < 0.05$ and $p < 0.01$, respectively).

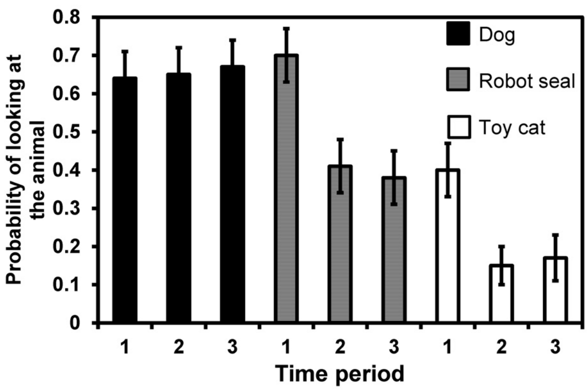


Figure 3. Relationship between the probability of looking at the animal and visit type over time. The probability was affected by an interaction between visit type and time period ($p < 0.001$).

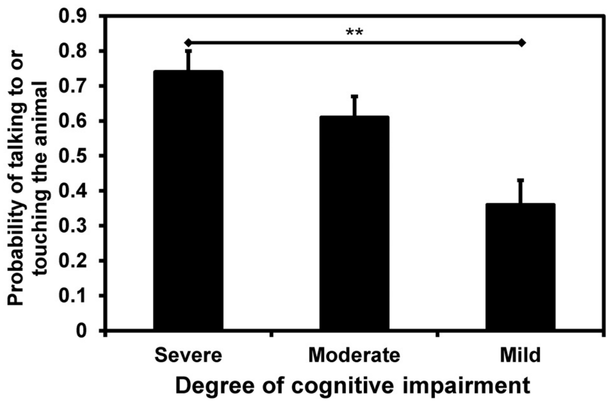


Figure 4. Relationship between the probability of talking to or touching the animal and the degree of cognitive impairment of the residents. **$p < 0.01$.

The likelihood of the residents to talk about the visiting animal increased with age ($F_{(1,105)} = 4.48$, $p < 0.05$); female residents talked to the animals more than male residents ($F_{(1,105)} = 6.22$, $p < 0.05$), as did those with a high MMSE score ($F_{(1,105)} = 5.20$, $p < 0.05$).

Total time spent talking did not differ between visit types in any of the time periods, but decreased through the time periods for both robot seal (time period 1 vs. 3: S = –157.5, $p < 0.01$) and toy cat visits (time period 1 vs. 3: S = –104.5, $p < 0.05$, time period 2 vs. 3: S = –134.5, $p < 0.01$; Table 4).

Eye Contact

The odds of looking at the visiting animal were affected by an interaction between visit type and time period ($F_{(4,151)} = 6.26$, $p < 0.001$; Figure 3). The probability of looking at the dog did not change over time, but for visits with either the robot seal or the toy cat, the probability fell during the intervention period (robot seal: time period 1 vs. 2, $p < 0.0001$; time period 1 vs. 3, $p < 0.0001$; toy cat: time period 1 vs. 2, $p < 0.0001$; time period 1 vs. 3, $p < 0.001$). In time period 1, the probability of looking at the dog and the robot seal was higher compared with looking at the toy cat (dog: $p < 0.05$ and robot seal: $p = 0.01$), and in time periods 2 and 3, the residents with dog visits were more likely to look at the animal than in visits with the robot seal and toy cat (time period 2: $p < 0.05$ and $p < 0.0001$; time period 3: $p < 0.01$ and $p < 0.0001$, respectively). Eye contact with the animal was positively affected by the age of the resident ($F_{(1,81)} = 4.87$, $p < 0.05$) and also by the observer ($F_{(3,83)} = 9.17$, $p < 0.0001$).

The probability of looking at a person decreased during the intervention period (period 1: 0.96 ± 0.02, period 2: 0.95 ± 0.02, and period 3: 0.90 ± 0.03; $F_{(2,148)} = 5.13$, $p < 0.01$) but was not affected by visit type.

Dependency on Cognitive Function

The level of cognitive impairment measured by the MMSE affected the probability of touching and talking to the animal, regardless of visit type ($F_{(2,101)} = 4.10$, $p < 0.05$; Figure 4). The residents with severe cognitive impairment were more likely to touch and talk to the animal than those with a mild impairment level ($p < 0.01$). On the contrary, residents with a high function level talked for longer to the visiting person compared with more severely impaired residents, but no interaction with the visit type was found (mild: 384 [226; 487], moderate: 270 [180; 359], severe: 136 [10; 293]; $n = 111$, $\chi^2 = 27.7$, $p < 0.0001$). We found the same results when we used the GBS scale as a fixed effect in the analysis of the probability of touching and talking to the animal (mild: 0.40 ± 0.07, moderate: 0.61 ± 0.06, severe: 67 ± 0.07; $F_{(2,102)} = 362$, $p < 0.05$). When using this classification of cognitive function, we also found shorter duration of conversations with the visiting person, the more severe the cognitive impairment level (mild: 374 [223; 487], moderate: 224 [123; 327], severe: 198 [95; 333]; $n = 111$, $\chi^2 = 12.7$, $p < 0.01$).

Discussion

We found that the immediate response to, and interaction with, the visiting animal depended on the type of animal that was brought along to the visit. The dog and the interactive robot seal triggered the most interaction in the form of physical touch, eye contact, and verbal communication. Furthermore, the cognitive impairment level of the residents affected with whom they interacted. The higher the cognitive impairment level, the more interaction was directed toward the animal and less toward humans, regardless of visit type.

To our knowledge, this is the first attempt to investigate the immediate behavioral reactions of elderly people to different animals (which offer different levels of feedback) in a randomized and controlled, large-scale study. Collecting systematic behavioral data during ongoing visits have, until now, only been applied in smaller investigations (Hendy 1987; Fick 1993; Bernstein, Friedmann and Malaspina 2000; Greer et al. 2001; Kramer, Friedmann and Bernstein 2009). Our approach and design enabled us to compare the immediate responses of the residents as a function of both the opportunity of feedback from the animal and whether the animal was real or not. This was possibly because we had an overlap between these two factors, as one of the non-animals was a robot and could actually interact with the participant to a certain extent. The methodology used in this study could be used in a range of other settings where human–animal interactions are an integrated part of the intervention.

The dog and the robot seal triggered more physical contact, verbal communication, and eye contact compared with the toy cat. This finding suggests that the ability of the animal (or the object) to interact and give feedback affects the response, even though the interest for the robot seal decreased during the intervention period. To our knowledge, only one small study has compared the responses to real and toy animals in a similar population. Greer et al. (2001) compared verbal communication in six women with moderate dementia, who received group therapy with either toy cats or real cats. As in this study, they found that the toy animal stimulated the participants less compared with the real animal, measured as number of words spoken, and ascribed this to the obvious fact that real cats were more active and stimulating than the toy cats. We measured verbal communication in duration and found less talk directed at the toy cat compared with the other animals, but no difference between visit types in the total duration of talking.

The effect of the robot seal was comparable to the effect of the dogs, especially in the beginning of the intervention period. However, compared with the dog, talking to and about the robot seal and looking at it decreased over time, whereas the same variables in dog visits were constant over time. These results indicate that, over time, the robot seal did not maintain the attention of the participants at the same level as the dog. This could be because it is less spontaneous and has a limited behavioral repertoire; therefore, its novelty value declines over time.

Studies on the use of robot technology in nursing homes are still incipient (Mordoch et al. 2013; Robinson et al. 2013), but a few small, mainly qualitative, studies (without control groups) indicate that contact with a "socially assistive" robot could have effects on social behavior, mood, and physiological measures (Wada et al. 2005; Wada and Shibata 2006; reviews in Bemelmans et al. 2012; Mordoch et al. 2013). Kramer et al. (2009) also used a robot as a comparison with a dog during visits in nursing homes. They compared the response to three visits with a person alone, a person with a real dog, and a person with a robotic dog (AIBO) in 18 women diagnosed with dementia. The participants touched and looked at the dog and the AIBO with the same frequency, but spent more time looking at the AIBO compared with the dog. Our results substantiate these results and show that robots can stimulate communication. However, the large variation in the responses found in our study indicates that whereas some residents were very fascinated by the robot, others did not find it interesting; the interest in the dog was more equally distributed and long-lasting.

We found that the higher the cognitive impairment level, the more the residents interacted with the visiting animal, regardless of which animal was brought to the visit. In contrast, time spent talking to the visiting person was higher for the more well-functioning participants. The present study was not designed to make a balanced comparison of this effect, and the results are based on post-hoc analyses. However, the finding demonstrates a clear trend, and presumably illustrates that persons with advanced stages of, for example, dementia have problems with inter-human communication. It has previously been proposed that communication with animals is easier and perhaps more comfortable for this population (e.g., Kaiser et al. 2002), which could be because communication with animals does not rely on verbal skills and gives the elderly an opportunity to obtain tactile stimulation (Bernstein, Friedmann and Malaspina 2000). The present study supports using dog- or robot-assisted visits in nursing homes. It appears to be a good way to activate and stimulate communication of a large cross-section of nursing home residents with varying cognitive impairments.

In our results, for example, in the probability of having physical contact with the animals, we found effects of the observer and the specific nursing home. Even though our observers were all experienced and underwent training prior to the study, there were small differences in how they observed, and it is also understandable that conditions in the different nursing homes can affect the results. To be able to handle this in our study design, all observers observed an equal number of the three visit types and included several nursing homes that each had all three visit types represented.

One limitation of the study could be that the dogs were accompanied by people who did not own the dogs, which could have made the dogs less confident during the visits and therefore affected the results. The use of these people, however, ensured standardization of the visits. Our choice of using only large dogs was also a way to standardize sessions. Small dogs might have been optimal for some residents, but including different dog sizes would have required a larger sample size and that was not within the scope of the present study.

Overall, the responses to the dog and the robot seal were quite similar, apart from the finding that the residents more quickly lost interest in the robot seal over time. One explanation for this could be that we intentionally, and as part of the protocol, presented all animals similarly to the residents; the visitor sat beside the residents having a quiet conversation, but did not encourage interaction with the animal apart from talking and cuddling. It could be argued that we did not use the dogs to their full potential, as we could have engaged the residents in several activities with the dog, such as brushing, playing, training, and walking. The effects of more active dog visits remain to be investigated. Another part of the study looked at how the different visits affected the development in cognitive status, symptoms of depression, and body weight of the residents, but no effects were found that could be attributed to the type of experimental visit (Thodberg et al. 2015). It is possible that more complex and active interactions during dog visits could give a stronger response and longer lasting effects than the ones found in the present study. More scientific knowledge is needed to optimize the use of visiting dogs in nursing homes, so that all residents, regardless of mental health, will get optimal interventions adapted to their needs.

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