Effects of Robotic Dogs as Catalysts for Social Interactions: A Preliminary Study

Hsiao-Chen You, National Taichung University of Science and Technology, Taiwan
Ying-Yu Huang, AJ Mobi Integrated Marketing Co., Ltd, Taiwan
Yi-Shin Deng, National Taiwan University, Taiwan

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Abstract
As robotics technologies are advancing at an ever increasing rate, robotic pets have emerged in the market offering companionship and socialization to users, including robot-assisted activity. However, the effects of robotic analogues of living dogs as social catalysts remain unclear. Can robotic dogs act as catalysts for human social interactions like real dogs? How do social behaviors differ toward a person with a robotic dog versus one with real dog? To address these issues, we conducted two experiments, first, to investigate whether or not pet dogs can serve as a social catalyst to facilitate interpersonal interaction in our current society; and secondly, to explore whether or not the effect of promoting interpersonal social behaviors can be achieved when robotic dogs replace real pets. The results revealed that pet dogs indeed could serve as social catalysts that promoted interpersonal interactions and increased the frequency and the duration of social behavior of participants. The best results were seen especially among close friends. However, the catalysis effect of robotic dogs was not significant in this study. Instead, the effect of different venues on the social interaction was more significant. Our analysis suggests that if such effects of robotic pets exist, they may be small compared to other factors in social human-robot interaction.

Keywords: Robotic Pet, Social Interaction, Human-robot interaction, Social catalyst

Introduction

Scientific studies have revealed numerous benefits of being a dog owner on human physical and mental health. Additionally, in an observation study, Messent (1983) discovered that dog owners experienced a significantly higher frequency of social interactions than those who walking the same route without dogs, and suggested that the presence of a dog could act as an "ice-breaker" and provide a neutral opening for conversation. McNicholas and Collis (2000) further validated that dogs have a robust catalysis effect to enhance social interaction between people, and believed this effect could strengthen social networks and social provisions, and in turn elevate psychological wellbeing of dog owners. As robotics technologies are advancing at an ever increasing rate, robotic pets have emerged in the market offering companionship and socialization to users, including robot-assisted activity. However, the catalysis effect of robotic analogues of living dogs remains unclear. Can robotic dogs act as catalysts for human social interactions like real dogs? How do social behaviors differ toward a person with a robotic dog versus one with real dog? To address these issues, we conducted two experiments, first, to investigate whether or not pet dogs can serve as a social catalyst to facilitate interpersonal interaction in Taiwan current society like previous studies; and secondly, to explore whether or not the effect of promoting interpersonal social behaviors can be achieved when robotic dogs replace real pets.

Related Studies

The work of McNicholas and Collis (2000) sought to refine and extend the study done by of Messent (1983) reveals that the existence of dogs indeed achieves a social catalyst effect, and the effect is especially evident in strangers and acquaintances. However, despite the substantially increased interaction frequency due to the existence of dogs, the interaction time is not affected by the existence of dogs, while gender of interactor and dog size do not affect dogs' effect as social catalysts. Even if dogs and experimenters' lack an attractive appearance, they can still achieve a social catalyst effect. On the other hand, the appearance of experimenters has an impact on interaction frequency. According to the results, using dogs as social catalysts and the casual exchanges can enhance social networking, which explains pet owners' health advantage.

To compare the ability of a living dog and a robotic dog (AIBO) to treat loneliness in elderly patients living in long-term care facilities, Banks, Willoughby and Banks (2008) conducted an experiment under three conditions: not receiving animal-assisted therapy (AAT), receiving AAT with a living dog, and receiving AAT with AIBO. The result showed that both the Dog and AIBO groups had statistically significant improvements in their levels of loneliness, compared with the control group (not receiving AAT). Interestingly, some of the residents and staff initially were unwilling to interact with robotic dog; however, with exposure, this resistance degenerated. Acceptance of robotic pets suggests their use in nursing homes is feasible. Robotic dogs could be an option, especially for those needing AAT in circumstances where the qualified living animals cannot be obtained.

In order to measure the social interaction, the Rochester Interaction Record (RIR) developed by Wheeler & Nezlek (1977). A standard set of questions requests the participant provide data about the social interaction, such as the duration of

interaction, the number and gender of the other people in the interaction, and ratings of dimensions on intimacy, satisfaction, and extent of influence. The stability and validity of RIP scale was examined (Reis and Wheeler, 1991), and it is now a widely used instrument to measure the nature and extent of engagement in social interaction that lasts at least 10 minutes.

To examine whether robotic pet ownership may increase human contact, two phases of investigation are required. First, it is important to understanding cultural differences. Even with prior experimental evidence on dogs as effective social catalysts, the catalysis effects may not manifest strongly in our society. It is necessary to validate that dogs and their robotic analogues can be regarded as social catalysts for dog owners in Taiwan, where this study takes place. Secondly, any such enhancements to social contact with different robotic analogues of living dogs must be investigated to offer an explanation for the social advantages reported amongst robots users.

Study 1

Study 1 aims to investigate whether or not dogs can serve as social catalysts to facilitate interpersonal interaction in Taiwanese current society; and to explore whether or not the effect of promoting interpersonal social behaviors can be achieved when a robotic dog replaces a real dog. The dog selected for the experiment was a red poodle with a stable temperament, no tendency to bark without cause, owned by one of the paper authors. Throughout the experiment, the dog was leashed to the experimenter's side. The robotic dog used here is a commercially available electronic dog, operated by clapping and by tapping on different body parts of the dog, different actions can be performed, with different accompanying sounds. The motor responses could not be changed manually. In the experiment, the experimenter chose to either hold the dog or place it on the side.

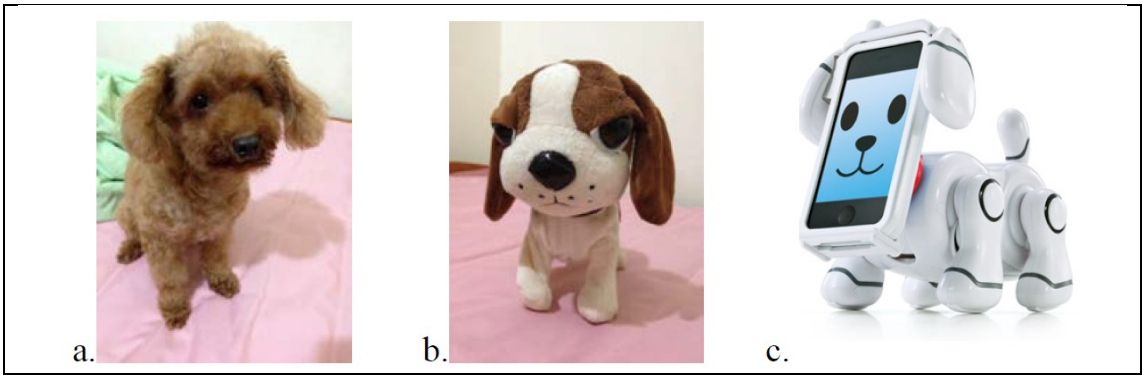

Figure1: Dogs used in this study: (a) red poodle, (b) electronic toy dog, and (c) robot dog (SmartPet)

Four experimenters, 3 female and 1 male, were recruited from graduate school at the National Taichung University of Science and Technology (NTUST) to act as participant observer and recorder. Each of experimenters was accompanied by the dog (red poodle) for 5 days (from Monday to Friday) commuting from home to school, taking public transportation, attending lectures, doing grocery shopping, etc. (the Dog condition). The same routines were followed with a fluffy electronic dog (the Robot

condition) and without dog (the No Dog condition), also for 5 days separately. The three conditioned experiment took each experimenter 15 days to complete. The interactee were people who have interacted with the experimenters during the experimental period. They has no knowledge of the content of the experiment.

During the experiment, the experimenter was responsible for interacting naturally with people encountered (interactee) and using notes to briefly record information of each interaction for later analysis and avoid omissions. The measures of social interactions in the three conditions were: (1) number of interactions, (2) Duration of interactions, (3) gender of interactee, and (4) type of the interactee (friend, acquaintance, or stranger). A Revised Rochester Interaction Record was used in study 1 for this purpose (Figure2). Prior to the experiment, preliminary work was conducted to ensure that the four experimenters could reliably use the Revised Rochester Interaction Record.

Dog / No Dog / Robot (Please circle)
Experiment dates:___ /___ to ___ /___ Experimenter & recorder:
Date:_____ / _____ No. of interactee:_____
Duration: Non-verbal exchange / Less than 1 minute / 1-3 minutes / More than 3 minutes
Gender of interactee: Male / Female
Type of the interactee: Friend / Acquaintance / Stranger

Figure2: Revised Rochester Interaction Record used in study 1

In the total of the 60 days of the experiment, 4832 encounters were observed, 1874 when the experimenters were accompanied by a real dog, 1501 when they were accompanied by a robotic dog, and 1457 when they were not (Table1). Formal statistical analysis confirmed the difference between the Dog and No Dog groups in the overall frequency of interactions. However, contrary to the finding of McNicholas and Collis (2000), presence of the dog in study 1 was associated with relatively few additional encounters with strangers and friends, but significantly increasing encounters with acquaintances. This is illustrated in Table2.

Table1: Frequency of interactions by condition and different experimenter

	Dog	Robotic Dog	No Dog	Total
Experimenter A (F)	216	233	164	613
Experimenter B(M)	678	537	471	1686
Experimenter C (F)	707	583	612	1902
Experimenter D (F)	273	148	210	631
Total	1874	1501	1457	4832

Table2: Frequency of interactions by condition and category of interactee

	Dog	Robotic Dog	No Dog	Total
Stranger	175	159	126	460
Friend	553	483	476	1512
Acquaintance	1146	859	855	2860
Total	1874	1501	1457	4832

		Significance in catalysis effect	Best condition
Number of interactions		Yes	Accompanied by a real dog
Gender of interactee	Male	No	
	Female	No	
Category of interactee	Stranger	No	
	Friend	No	
	Acquaintance	Yes	Accompanied by a real dog
Duration of interactions		Yes	Accompanied by a real dog

Table 3: Significance of catalyst effect of variables and post hoc comparison

Table 3 shows the three conditions in Experiment 1 (accompanied by a Dog, accompanied by a Robotic Dog, and No Dog), their extent of effect on the dependent variables (number of interactions, gender of interactee, category of interactee, duration of interaction), and the what the best condition was when the controled variables had the most significant effect on the dependent variables. According to the data obtained in Experiment 1, statistical analysis was carried out. Findings show that the presense of dogs had a significant effect on the increasing of number of social interactions, especial engagments among acquaintances, and the increasing in duration. Hence, the post hoc comparison shows that when accompanied by a real dog, the social catalyst effect was superior to that of the "No Dog" and "Robotic dog" conditions.

Study 2

In previous study, our first attempt to find support for robotic dog's catalysis effect was failed by using a simple, electronic dog toy to replace the real dog. A second study was conducted with two different robotic dogs and in three locations to investigate whether the catalysis effect of robotic dogs exists, and whether the effect was influenced by the function and appearance of robots. Besides the fluffy electronic dog used in study1, another intelligent robotic dog, "SmartPet", was selected for the experiment. A smart mobile device can be attached to the plastic body of the "Smart Pet" to become its face. After downloading the SmartPet app, it becomes a robotic dog with a variety of expressions and interactive features.

In study 2, the experimenter and the observer were not the same person. The experimenter who acted as the dog handler and participant observer throughout the experimental period. The observer kept a discreet distance from the experimenter to calculate the duration of each interaction and monitor accuracy of recording. A Revised Rochester Interaction Record was used in study 2 for these purpose (Figure 3). Both of the researchers were female graduate students, in their mid-twenty, of average height and build. During the experiment, the experimenter was responsible for interacting naturally with people encountered (interactee) and using notes to briefly record information of each interaction for later analysis and avoid omissions. For each encounter, the experimenter needed to fill out the interaction record used by the experimenter (Figure 4). After each experiment, the experimenter compared her record with the observer's record to verify if there were omissions. Furthermore, the camcorder and voice recording files were checked for consistency.

Data were collected in three location: on campus, at bus stop, and at a coffee shop, each location twice. Eighteen trials, each lasting for 30 minutes, were conducted for each of the three contions: Experimenter along ("No Dog"); Experimenter with electronic toy dog ("Electronic Dog"); Experimenter with intelligent robotic dogs ("Robotic Dog"). All trails were held at comparable times on Tuseday for each location. The procedure was for the experimenter to sit for 30 minutes at one of three previously selected locations as it waiting. The number of people who interacted with her was recorded for each trail in each condition.

No Dog / Simple Robot Dog / Smart Robot Dog (Please circle)
Date:_____ / _____ Venue: Campus / Bus stop / Coffee shop
Gender of interactee: Male / Female No. of interactee: _____
Duration: Non-verbal exchange / Less than 1 minute / 1-3 minutes / More than 3 minutes

Figure 3: Revised Rochester Interaction Record used by observer in study 2

No Dog / Simple Robot Dog / Smart Robot Dog (Please circle)	
Date:_____ / _____ Venue: Campus / Bus stop / Coffee shop	
Gender of interactee: Male / Female	No. of interactee: _____
Intimacy of Interaction:	Intimate 7 / 6 / 5 / 4 / 3 / 2 / 1 Not intimate
Satisfaction of Interaction:	Satisfied 7 / 6 / 5 / 4 / 3 / 2 / 1 Dissatisfied

Figure 4: Revised Rochester Interaction Record used by experimenter in study 2

Table 4: Frequency of interactions by condition and different venue

	Electronic Dog	Robotic Dog	No Dog	Total
Campus	24	16	40	80
Bus stop	34	28	13	75
Coffee shop	17	9	7	33
Total	75	53	60	188

Table 5: Statistical significance of the robotic dog's presence and venue on social interaction and post hoc comparison in study2

Dependent Variables		Statistical Significance		Best condition
		Presence of Robotic dog	Venue	
Number of Interactions		No	Yes	Campus, Bus stop
Gender of Interactee	Male	No	Yes	Campus, Bus stop
	Female	No	No	
Duration of Interactions		No	Yes	Campus, Bus stop
Intimacy Level of Interaction		No	Yes	Campus
Satisfaction Level of Interaction		No	Yes	Campus

In the total of the 18 trials, 188 encounters were observed, 75 when the experimenter was accompanied by an electronic dog, 53 when she was accompanied by a robotic dog, and 60 when she was not (Table 4). According to the data obtained in study 2, statistical analysis was carried out. Results show that the presence of robotic dogs had no effect on social interaction. Instead, the venue for interactions had a significant effect on the overall social interaction, male, duration of interaction, and level of interaction

intimacy and satisfaction. The post hoc comparison shows that under the condition of "campus" and "bus stop", the overall number of Interactions, number of Interactions from male Interactee, and duration of interaction were the best. As for the degree of interaction intimacy and interaction satisfaction, only "campus" had the best result. This is illustrated in Table 5.

Conclusion

The statistical analysis of experimental data from study 1 shows that presence of dog did have a significant effect on overall social interaction and duration of interaction. Through the post hoc comparison, it was found that the best condition was when accompanied by a real dog, thus indicating dogs indeed contribute to increased frequency of interaction and interaction time, especially among acquaintance s with a more significant mediating effect. Disappointingly, the robotic analogue of living dogs did not produce a significant effect on social interaction in this study. The Results of study 2 also revealed that the robotic dogs showed no significant effect on overall social interaction. Additionally, different design factors of robotic dog had no effect on the results. On the contrary, the location where interpersonal interaction took place had a significant effect on the frequency of social interaction, the duration and quality of social interaction. This study shows that the existence of robotic dogs has no significant effect on the social interaction of citizens, and the robotic dog with different design factors also have no effect on the results. Our analysis suggests that if such effects of robotic pets do exist, they may be small compared to other factors in social human-robot interaction.

According to the experimental observation in this study, the robotic dog elicited people's curiosity and prompt people to look at the robotic dog, but few people actually further started a conversation. When people looked at the experimenter and robotic dog, since the experimenter would be preoccupied with her task (interacting with robot, or taking note), the experimenter would not be able to detect people's interest in the robotic dog or initiating a conversation, thus reducing the experimenter's chance of interacting with others. Additionally, compared to external stimulation, most people focused on the electronic product they carried, but tended to miss the chance to contact more people for more social interaction. On the other hand, when the experiment was conducted at the coffee shop, the lack of customers also led to small chance for social interaction. In conclusion, it was found in this study that in terms of social interaction behaviors displayed by our citizens and the interactive quality of robots nowadays, living dogs, compared to non-living robotic dogs, are more suitable as catalysts of interpersonal interaction that trigger social interaction among people.

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Contact email: hcyous@gmail.com