Pet Dogs as Exercise Partners Stimulates Physical Activities for Owners

Rachael Purta, Jianling Fang, and Erika Poole
The Pennsylvania State University
321E IST Building
University Park, PA 16802 USA

***Abstract*—Dog walking is a significant form of social support for dog owners to participate in consistent physical activities. Technology is also a strong impetus to encourage exercising. Through the use of pedometers and an interactive user interface that promotes walking dogs, it is hoped that dog owners will be more positive and active toward exercising. The project uses the social bond between an owner and their dog as encouragement to exercise. Currently we are still conducting research on the subject, but participant response has been encouraging.**

Keywords-fitness; physcial activity; dogs; pedometer; user interaction;

I. INTRODUCTION

The need to increase physical activity in Americans has become a growing concern in many studies of health and human-computer interaction, as well as many health professionals and health researchers in the United States. While there is increasing evidence of the benefits of exercise, such as preventing osteoporosis, reduction of cancer risk, reduced risk of heart disease and diabetes, according to the results of the U.S. National Health and Nutrition Examination Survey of 2007 [1], 63% of Americans are overweight, with 26% in the obese category.

It is not surprising that, with so many human owners overweight, many dogs are considered overweight as well according to the Purina Body Conditioning Chart [2], the veterinary standard for visually assessing healthy dog weight. According to [3], the prevalence of combined overweight and obesity in domestic canine populations has been reported to range from 23% to 41% [pp. 177]. Some reasons for this prevalence of overweight dogs are lack of exercise and overfeeding, just as it is in humans. Humans have additional barriers to exercise, such as family and work commitments, lack of enjoyment of exercise, and lack of energy.

The simplicity and relative accuracy of pedometers makes them a useful tool for studying physical activity. Because most pedometers count steps based on movement, usually a slight shake, pedometers can be used to measure not only physical steps in humans but in dogs as well. A study in 2005 [4] evaluated the accuracy of pedometers with dogs, and concluded that the accuracy is satisfyingly close to that with humans, except in a few cases such as with small breeds. Our goal is to measure and display information about the dog's activity level, using pedometers, in order to motivate their owners to walk their dogs more, and thus get more exercise themselves. In this study, we hoped to find whether concern for the dog's health and their own, as well as the opportunity for friendly competition presented by our interface, would inspire owners to increase the amount of steps they and their dog take. We also evaluated whether our web interface would help dog owners to have a more positive attitude toward exercise so that they may be willing to continue the practice in the future.

Our study consists of one week of baseline data collecting in order to see the participants' current habits, and then three weeks of trial with four participants. During the study all participants and their dogs will wear a pedometer to record and send data about the participants' steps.

In the following sections, we will discuss the relevant studies to our work, then explain the design of our system, go on to explain our criteria for participants and how we conducted our studies, explain our results, and then conclude and discuss the future of our project.

II. LITERATURE REVIEW

Several previous studies have been focused on collecting and displaying data about an individual person's habits, such as the Ubifit Garden system, the Fish'n'Steps program, and the Chick Clique project.

In the Ubifit Garden system [5], the user was given a sensor device that could infer with relative accuracy if the user was bicycling, walking, running, using a stair machine, or using an elliptical trainer, and that device sent its information to a mobile phone application also given to the user. This application displayed the information in the form of flowers and butterflies in a garden – a different color flower depending on if the exercise was cardiovascular, walking, for flexibility, or resistance training, small butterflies for past goal achievements, and a large butterfly for the current week's goal achievement – and also let the user input other activities for which the sensor was not designed or could not be worn [pp. 1799-1802].

Our project, like the Ubifit Garden system, seeks to automate the information transfer process so that the user can update it as little or as much as they want. Our system uploads data automatically every hour as long as the user has the docking station plugged in and walks within fifteen feet of that station. It also, like the Ubifit project, uses a glanceable

display that allows the user to see their dog's progress at a glance.

In the Fish'n'Steps program [6], the user wore a pedometer to collect their steps and took a picture of the pedometer at specific kiosks in order to update their data. The number of steps they took was linked to a web application containing a virtual fish in a fishtank, which grew as they took more steps. The system also provided positive and negative feedback with the fish's facial expressions depending on if the user had walked recently or not.

We drew from the Fish'n'Steps program by making the dog's data, like the fish's growth in Fish'n'Steps, act as positive feedback for the user. In the Fish'n'Steps program many users admitted to becoming interested in their fish's well-being [4:273], while in our project the dog owners should already be interested in their pet's well-being enough to motivate them to walk with the dogs, so that no users will simply drop out for lack of interest. Learning from the Fish'n'Steps program's discovery about feedback, our system does not give negative feedback but sets a weekly goal for the user and their dog to work for. It also provides a ranking system to compare the user's dog to the other dogs, which is similar to the team portion of the Fish'n'Steps program, except that the competition is between the dogs.

The Chick Clique program [7] also used pedometers but only included junior-high age girls as the participants, and gave them phones to share their step counts with the other girls in their 'clique'. The girls were to provide encouraging messages to each other in order to reach their personal step goals, and an automatic message was sent out to all girls when they did reach a goal.

Like the Chick Clique project, our project aims at creating a sense of community between the participants and an opportunity to bond further with their dog. We give the participant a message on the screen when they reach their goal, similar to the positive feedback used for the girls.

III. SYSTEM AND DESIGN

Our application is designed for dog owners to incorporate more physical activities with their dogs. The application is composed of three parts which include a pedometer, a backstage data management system, and a web application which provides feedback to the users. The pedometer is a tri-axis motion sensor from Fitbit, and a real time recorder which keeps updated information of the steps the user has walked, the distance traveled in miles, the calories burnt, and the active level for the day.

The pedometer transmits data wirelessly and will upload the user's data to the backstage system every hour when the user is within around 15 feet range of the computer if the base station is connected to the computer. If the user is out of range, the pedometer will look for its base station every minute.

After receiving the activity info, the backend system will transfer the data to the web application, which is accessible for the users through a kiosk at home. The feedback application will show how long the user's dog has travelled for the last week. According to that information, the web application will set an exercise goal for the dog for next week. Weeks in our system are from Sunday to Sunday. As the participant and their dog walk, the percent towards their goal will increase, and when they achieve their goal, our application displays a congratulations message.

Another accomplishment of our web application is the interactive ranking system. Participant's dogs are involved in exercise competition, and their data of physical activity will be passed to the rank page and are exposed to the dog owners. Rankings are based on the percent towards the participant's dog's weekly goal. Higher percentages have higher rankings. Only the top 5 percentages are shown. The results will reset on a weekly basis, also Sunday to Sunday.

IV. PARTICIPANTS AND METHODS

Four indoor healthy adult dogs and their owners were recruited to participate in our study. The dogs that we selected weigh from 30 to 80 lbs. All of the participants are caretakers for their pet dogs, and they all have access to internet to receive activity information in a timely fashion. Participants were screened for eligibility over the telephone, email, or in person. Our criteria for selection included the following: the participant was over 18 years of age, the dog was at least 1 year old, the participant was the primary caretaker of the dog, the dog was between 21 and 80 lbs, the dog could wear a harness, the participant has wireless, and the participant had no physical limitations with walking. If the participant met study criteria, he/she was given more information about the study (either in person or by following up via email or postal mail) and were invited to set an appointment for the first session.

The study involved 4 sessions: session 1 (1 hour), sessions 2-4 (5-10 minutes each), and session 5 (1 hour). In addition to the sessions with the research team, participants will wear a pedometer and dogs will wear a harness with an accelerometer for the duration of the study (4 weeks).

Session 1

Session 1 took approximately 1 hour and was held at the person's home. During this session, consent was obtained. Participants were asked to complete a survey inquiring about the following: demographics, DAPA (Dogs and Physical Activity Tool [8]), physical activity habits (Godin Leisure Time Exercise Questionnaire [9]), and attitudes toward physical activity (PACES Questionnaire [10]). We also conducted a semi-structured interview to learn more about daily routines with respect to the dog and physical activity. The dog was fitted with a harness containing a pedometer, which were commercially available harnesses with pockets that can fit a pedometer inside ("Butterfly Dual Pocket Cape Vest" and "Reflective Small Service Dog Vest - Zipper Pocket" ordered from http://www.workingservicedog.com). Typically used by working dogs, such as therapy dogs, police dogs, and search and rescue dogs, these harnesses come in a

variety of sizes, and have been successfully used with many dog breeds. Then the owner was given a commercially available pedometer to wear for the duration of the study. The pedometer's display was covered. We installed a small kiosk in the home containing a display with a dog picture and a dog fact of the day, and two wireless base stations. The kiosk serves two purposes: firstly, after the first week of data collection, it provides data about the dog's activities. For the first week it shows interesting facts and a dog picture to make the participant used to looking at the kiosk. Secondly, it will collect accelerometer/pedometer data from dog and owner when he or she walks within range of it. At the conclusion of session 1, we collected 1 week of baseline data on physical activity of the person and the dog and then switched their kiosk view to our application.

Session 2

We enabled the home kiosk to show data about the dog's physical activity from our application webpage, we checked for any technology malfunctions, and we administered the Godin Leisure Time exercise questionnaire.

Sessions 3-4

We checked for any technology malfunctions, and we administered the Godin Leisure Time exercise questionnaire.

Session 5

Participants were asked to complete a survey inquiring about the following: dog walking habits using the DAPA, physical activity habits, and attitudes toward physical activity. At the conclusion of the study, the research team took back the dog harness/pedometer combo, the pedometer worn by the owner, and base station, and then conducted a semi-structured interview about the usability and subjective experience using the intervention.

V. RESULTS AND ANALYSIS

At the time of the writing of this paper, data collection was ongoing. Due to the short timeframe allowed for recruiting, participants enrolled in the study at different intervals, resulting in many participants being at different stages of the study. The participant farthest in the study had just started week 3 at the writing of this paper. We collected and totaled our results so far, shown in Table 1. Recall that in the first week we had a general view for all participants, with a picture and a dog fact of the day to get them used to looking at the kiosk, and in the second week we switched the kiosk view over to our application. Our hope was that the number of steps and mileage would increase in the second week, but according to Table 1, we found out that was not the case. Factors outside our control, however, such as the weather, may have affected our participant's motivation to walk. One participant even told us that whether she walked her dog or not depended if it was raining. Two out of the four participants on the DAPA questionnaire reported that rain was a significant factor in walking their dogs, one rating the question as a 5 out of 7 (a little likely) and the other a 6 out of 7 (quite likely). Table 2 shows the number of days it rained in the first and second weeks. All weeks were quite rainy, but the first participant and their dog had more rainy days their second week than first, and the second had just as many.

This large amount of rain contributes to a second factor that may have influenced our data: our pedometers are not waterproof, and we cautioned our participants against wearing them in water. This may have made participants uncertain at best in using the pedometers on rainy days, whether they walked or not. In addition, two of the four dogs enrolled in the study tended to like swimming, and so their owners were instructed to just take the vests with the pedometers off the dogs. This is a valuable activity for both the dog and the owner that was not included in our data, which may also contribute to the lower second week.

The third and final outside factor, also related to weather, is the amount of power outages our participants had, resulting in lost data as the kiosk lost connection to the internet. We were not always able to go out to the participant's homes immediately, resulting in sometimes several days where the participants had no data at all. Later in the study we found a way to remedy this, but some data was still lost. Perhaps if this data had been recovered, the outcome would have been different, but the difference would not have been a great one. The numbers shown in Table 1 are averages of days the

Table 1 Total Participant and Dog Steps

Participant	1 week avg steps	2 week avg steps
1	16553	12641
2 (dog)	11933.2	10900.17
3	1833.25	1489
4 (dog)	1803.25	1451.25
5	7231	
6 (dog)	5369.71	
7	9568	
8 (dog)	9392	

Table 2 Total Rainy Days for Each Participant's Week

Participant	1 week rainy days	2 week rainy days
1	4	6
2 (dog)	4	6
3	5	5
4 (dog)	5	5
5	6	
6 (dog)	6	
7	5	
8 (dog)	5	

participants did have data, however, and so would only be adjusted slightly if each participant had a full week's data.

In comparing the participant's data to their dogs, we discovered that the pedometer we used tended to underestimate the dog's physical activity. One participant noted this because she knew the mileage of the routes she took her dog on, and was surprised when she returned home that the mileage shown on our kiosk did not match by about three miles. We took a closer look at our data and found that while for some participants, the step count for them and for their dogs was quite close, for others the step counts were sometimes thousands of steps apart. For all participants, however, the mileage reported from the pedometers for their dog was about halved compared to their own mileage. Tables 3 and 4 give a sample of the step and mileage counts of the participants and their dogs from a particular day.

Table 3 Step Counts and Difference between Participants and Their Dogs

Participant step count	Dog step count	Percent difference
18879	15853	16.02839133
1073	1037	3.355079217
5388	3982	26.09502598
7263	7009	3.497177475

Table 4: Mileage Counts and Difference between Participants and Their Dogs

Participant miles	Dog miles	Percent difference
11.13	4.44	60.10781671
0.42	0.24	42.85714286
2.21	0.94	57.46606335
3.21	1.65	48.59813084

As shown in the tables, some participant's step counts differed from their dogs by < 5%, while others differed by > 10% or sometimes > 20%! One reason for this, perhaps, is the participants could be wearing the pedometer at times when they are not with their dog, thus accumulating more steps than the dog. In the case of the first participant in Table 3, however, she reported only wearing the pedometer when running with her dog. Running perhaps is the key here. In [3], Dr. Chan discovered that some large dogs, when running, had underestimated step counts by > 5%. The first participant and their dog's steps are consistent with these results.

The difference in mileage between the participants and their dogs is no slight percent in Table 4, consistently underestimating each dog's mileage by > 40%. To find out why the differences are so great, perhaps we should question the formula the pedometer uses to calculate mileage. Usually mileage can be found by multiplying the stride length (in feet) by the number of steps and then dividing by 5280 (the number of feet in a mile). What, though, did the pedometer use for the stride length? When first setting up our pedometers, the height of the person or dog was asked for, and our team gave each dog a height of 3 feet. In retrospect, this might have skewed the way the pedometers calculated mileage, as a 3-foot person walks much differently than a taller person. Plus, we had a mixture of sizes of dogs, and so a consistent number given to all dogs may have contributed in skewing further the percent difference between dogs and their owners. In the future, studies with these pedometers will have to have the height and/or stride adjusted to give more accurate results. We will discuss this further later.

VI. CONCLUSION

So far there is not enough evidence to prove that our application has a positive impact on the participants. However, considering that various factors could potentially affect one's attitude towards exercise negatively, as well as the constraints of the pedometers, we think that it is possible that our application can play a positive role in motivating people to walk their dogs. Through interviews with the participants, we discovered that weather is a major contributor which decides how often the participants walk their dogs. As far as the results go, negative factors like the weather seem to have a stronger role than our application. When more results are collected, we hope to have more data to prove the benefits of our application.

VII. DISCUSSION

There has been a lot of uncertainty going on during our research. Unexpected obstacles such as frequent power outages slowed the pace of our study. In terms of future improvements, we will consider to put the pedometer in a waterproof bag, so the participants do not necessarily worry about breaking the pedometer while doing water-based exercise. Another problem we found was that the pedometer does not calculate the dog's stride length correctly, so the miles that the dog walked were substantially less than the miles of the participant. However, we believe that dogs' steps were recorded accurately because some participants were very close to their dogs' step numbers. In the future, we will need to either customize the stride length for each dog by manually measuring it or adjust the height in the pedometer's records. In terms of adjusting the height, we have a few options: first, we can give them the same height as their owners; or second, we can leave the height blank and use the stride length discussed earlier.

Despite the difficulties, most participants were excited about our project. One of our participants said that she always wanted her dog to be at the top of the rankings, and she was happy to see her progress being visualized and presented to other participants. Another participant was enthusiastic to see the progress of her dog reaching over one hundred percent, and encouraged her dog to walk more. All of the participants were very cooperative with our team, informing us about issues with their kiosks and reporting any problems they found.

In the future of our study, we will implement the changes discussed above and expand our number of participants to get more feedback on our application. Our team in the near future will ask the participants for suggestions about improving our system. We may add extra features such as daily dog activity trackers in the form of graphs and a picture of the dog on the display.

REFERENCES

[1] H. National, S. Nutrition Examination, and S. National Center for Health, *National Health and Nutrition Examination Survey III data collection forms*. Hyattsville, Md.: U.S. Dept. of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Health Statistics, 1990.

[2] (July 08). *Body Condition Chart*. Available: http://www.purina.com/cat/weight-control/bodycondition.aspx

[3] E. M. Lund, P. J. Armstrong, C. A. Kirk, and J. S. Klausner, "Prevalence and Risk Factors for Obesity in Adult Dogs from Private US Veterinary Practices," *INTERNATIONAL JOURNAL OF APPLIED RESEARCH IN VETERINARY MEDICINE,* vol. 4, pp. 177-186, 2006.

[4] C. B. Chan, M. Spierenburg, S. L. Ihle, and C. Tudor-Locke, "Use of pedometers to measure physical activity in dogs," *Journal of the American Veterinary Medical Association,* vol. 226, pp. 2010-5, 2005.

[5] S. Consolvo, T. Toscos, M. Y. Chen, B. Harrison, P. Klasnja, A. LaMarea, L. LeGrand, I. Smith, J. A. Landay, D. W. McDonald, J. Froehlich, R. Libby, and C. H. I. th Annual Chi Conference on Human Factors in Computing Systems, "Activity sensing in the wild: A field trial of UbiFit Garden," *Conf Hum Fact Comput Syst Proc Conference on Human Factors in Computing Systems - Proceedings,* pp. 1797-1806, 2008.

[6] J. J. Lin, L. Mamykina, S. Lindtner, G. Delajoux, and H. B. Strub, "Fish'n'Steps: Encouraging Physical Activity with an Interactive Computer Game," *Lecture notes in computer science.,* pp. 261-278, 2006.

[7] T. Toscos, A. Faber, K. Connelly, and A. M. Upoma, "Encouraging physical activity in teens Can technology help reduce barriers to physical activity in adolescent girls?," in *Pervasive Computing Technologies for Healthcare, 2008. PervasiveHealth 2008. Second International Conference on*, 2008, pp. 218-221.

[8] H. E. Cutt, B. Giles-Corti, M. W. Knuiman, and T. J. Pikora, "Physical activity behavior of dog owners: development and reliability of the Dogs and Physical Activity (DAPA) tool," *Journal of physical activity & health,* vol. 5, pp. 73-89, 2008.

[9] G. Godin, Shephard, R. J., "Godin Leisure-Time Exercise Questionnaire," *Medicine and science in sports and exercise.,* vol. 29, p. S36, 1997.

[10] R. W. Motl, R. K. Dishman, R. Saunders, M. Dowda, G. Felton, and R. R. Pate, "Measuring enjoyment of physical activity in adolescent girls," *American journal of preventive medicine,* vol. 21, pp. 110-7, 2001.