Assistive Technologies for People with Dementia: Personal Review

Kiyoshi Yasuda, Speech & Language therapist   Aug. 6. 2020

Osaka Institute of Technology / Kyoto Prefectural University of Medicine / Saiga Clinic

Chapter 11 Assisting Dog for People with Dementia

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11.1 Animal Assisting Therapy

People frequently communicate with one another using nonverbal forms of communication, such as gestures and facial expressions. Many behaviors can occur to interactions between individuals and pets. For example, typical social behaviors of people interacting with dogs include talking, non-verbal expressions, and touching that engage the dog in a social way. Dogs have long been touted to be "man's best friend," with anecdotal evidence suggesting that dogs provide numerous benefits to their owners and those they encounter throughout their lives. Among the proposed benefits are reduced levels of stress, and improved physical health (McLellan, 2012).

Human–animal interactions are becoming a focus of research in an attempt to document claims that animals make humans feel better and serve as aids to communication. Dogs have evolved with humans for more than 10,000 years and feature prominently in animal-assisted therapy (*AAT*) practice and research. Animal-assisted therapy (AAT) is gaining popularity as part of therapy programs in residential aged care facilities. Humans and pet dogs respond to quiet interaction with a lowering of blood pressure and an increase in neurochemicals associated with relaxation and bonding. These effects may be of benefit in ameliorating behavioral and psychological symptoms of dementia (BPSD). Several small studies suggest that the presence of a dog reduces aggression and agitation, as well as promoting social behavior in people with dementia. (Filan & Llewellyn-Jones, 2006).

AAT most commonly involves interaction between a client and a trained animal, facilitated by a human handler, with a therapeutic goal such as providing relaxation and pleasure, or incorporating activities into physical therapy or rehabilitation. The therapeutic possibilities of companion animals have been described by Baun and McCabe (2003) with reference to the stage of dementia and the positive effect on caregivers.

There is preliminary evidence that robotic pets may provide pleasure and interest to people with dementia. However, real pets look and feel very different to currently available robots and toys. Real pets also show genuine affection and pleasure during interactions, which, in turn, bring pleasure to the human involved. Behavioral and psychological symptoms of dementia (BPSD) are common (Patterson & Bolger, 1994), are a major source of informal caregiver ill health (Burns & Rabins, 2000) and cause significant distress to residential care staff (Wood et al., 1999).

The non-verbal communications of dogs were reportedly more friendly, non-judgmental, and conducive to sociable behaviors than those of the best-intentioned staff members. It has been suggested that animals communicate better than humans with people with dementia who may have impaired language skills, because animals rely more on body language (Perkins, Bartlett, Travers, &

Rand, 2008).

Dog-Assisted Activity and Dog-Assisted Therapy: Broadly, two methods have been used to provide dog contact: dog-assisted activity and dog-assisted therapy. Dog-assisted activity has been defined as unstructured, informal, without specific therapeutic goals or recording of outcomes, and conducted by someone without special skills or training and possibly using an uncertified animal. By contrast, dog-assisted therapy is described as structured, one-on-one or in small groups, conducted by suitably trained professionals with specifically certified animals, and requiring active participation with specific therapeutic goals and outcomes recorded (Perkins, Bartlett, Travers, & Rand, 2008).

Relation Between Dog and Human: Animals influence the interrelationship between patient with dementia and therapist on the level of psychotherapy during and after the therapy session. Thus, they are perfectly adequate to be utilized as a 'door opener', while also reducing any anxiety a patient may be experiencing. The mere presence of a companion animal increases the number of spontaneous social initiations from strangers to individuals with disabilities. An intense bond with a pet often brings about a similar increase in personal self-esteem. Targeted animal assisted therapy is then able to promote redevelopment of self-awareness, self-esteem and personal trust in dementia sufferers (Vogt, 2013).

It is difficult to create congruence between digital and analogue communication. Thus, it is possible to digitally reproduce a current emotional state, whereas gestures and facial expressions may convey quite a different impression on one's counterpart. Animals have the ability to transfer orders and words into action. It can be assumed that within limits animals can also recognize aspects of digital communication. It is however important that a vast amount of animal communication is allocated on the analogue level. Animals react sensitively to analogue stimulation while it is insignificant whether a person transmits it knowingly or not (Vogt, 2013).

11.2 ICT-Wearing Dogs for Dog's Minds (Zeagler, Valentin, Martin et al., 2013)

Dogs currently work in many ways: guide dogs serve people with visual impairments; service dogs aid people with physical disabilities; hearing dogs alert people with auditory disabilities to sounds; Search and Rescue dogs can locate people who are lost. These highly trained canines perform critical, even life-saving tasks. The main goal of the *FIDO* project is to research fundamental aspects of wearable technologies to support communication from working dogs to their handlers. The scenarios below are just a sampling of the many ways which could use wearable electronics to communicate with humans.

Melissa and her guide dog Roman are walking along a familiar sidewalk when Roman suddenly stops. Roman tugs a tab on his harness and the message "go around" sounds in Melissa's earbuds. Roman finds a safe route off of the sidewalk, avoiding the wet cement in their path.

Charles is engrossed in a movie when his hearing dog, Schubert, alerts. Schubert touches one of the four buttons on his vest with his nose. A message appears on Charles' head-mounted display. "Tornado siren? Oh my!"

This paper describes a pilot study of four different on-body sensors that allow dogs to give information to their handlers. They integrated electronics into dog clothing to create canine user interfaces. They tested these interfaces with three assistance-trained dogs to evaluate ease of interaction, error rate, and false positive rate.

The results of this pilot study are extremely encouraging; they demonstrated that it is possible to create wearable electronics that dogs can reliably activate to communicate with their handlers. There is a vast amount of work yet to be done. The sensors need to be smaller and more robust and require less power.

Along with the sensor placement study they need to discover the best ways to train the dogs to differentiate multiple sensors on their bodies, and to activate them on different environmental triggers. They plan to explore other sensors, such as "Touch-points", which are areas embroidered with conductive thread that could be activated with a simple nose or paw touch. They also plan to stress-test the designs with dogs at speed on an obstacle course, which could simulate a rugged outdoor environment. This technology could easily be adapted to other canine professionals, for Police work and Military Working Dogs who could communicate the location and type of Improvised Explosive Devices (IEDs). Providing dogs with the ability to communicate

clearly to humans opens a myriad of possibilities.

11.3 ICT-Wearing Dogs for Dementia Suppot (Yasuda, Kuwahara, Nakamura et al., 2012)

Traditionally, dogs also have been trained for various purposes that take advantage of their acute sense of smell, hearing, and mobility, such as police dogs, detection dogs, hunting dogs, rescue dogs, etc. Furthermore, dogs have also been used to successfully help individuals with disabilities, including visual, hearing, and physical impairments.

Guide dogs, for example, assist blind people so they can avoid various physical obstacles. A hearing dog can alert their owner to important sounds, such as doorbells, alarm clocks, ringing telephones, etc. They also work outside the home, alerting people to sounds, such as sirens, approaching cars, and to let them know if someone is calling their name. Service dogs are taught to pick up dropped items, open doors, turn on lights, and pull wheelchairs for physically handicapped owners. They can carry oxygen tanks for breath support. Some dogs also help individuals with mental disabilities, including depression and autism. Other dogs are even used to help with early detection of seizures and diabetes. These dogs are called assistance dogs.

However, except for animal assisted therapy, use of assistance dogs has not been reported for individuals with dementia. Although details are not known, several anecdotal episodes have been found on the Internet. For instance, for a individual with dementia, the utterance of the phrase "home" will help the dog navigate to the person's home from wherever they are, even if they've lost their way. A dog may teach individuals the parking spot of car.

Not limited to forgetting their way, parking spots etc., individuals with dementia also show other forgetful behaviors, such as forgetting to execute daily tasks, forgetting where items are located, etc. Additionally, various BPSD often appear. However, no comprehensive supporting ideas for these symptoms have been proposed utilizing assistance dogs.

As one of the interventions for assisting individuals with dementia, assistive technology or information communication technologies (ICT) have been utilized. IC recorders were effective as an automatic output of messages for individuals with memory impairment and dementia. The IC recorder also attempted to treat other BPSDs, such as eating few meals and getting angered easily by the sound of music. Additionally, the reminiscence photo video was a slideshow video of individual's photos with narration, background music etc. Kuwahara et al., (2009) have created remote reminiscence talking and scheduling prompter systems using video phones. For two out of four individuals, these interventions were effective for their psychological stability and schedule performances.

Yasuda et al., (2010) developed a wearable system to record one day's behavior, using a small video recorder and IC recorders. The recorded utterances were analyzed by speech recognition software on a personal computer (PC). Recently, Sakai et al. (2011) developed a free-talking system in which an anime agent on a PC monitor asked individuals' questions; other questions followed after the agent recognized the finish of an individual's reply to each question. The research described above suggests that various ICT devices and content are effective in coping with various symptoms of individuals with dementia. The best way to help individuals with dementia is to provide them with appropriate information via ICT devices.

However, individuals with dementia often forget to possess their ICT devices, so they cannot hear the messages from the devices outside of their home. Also, they often dislike or refuse to wear the devices. Furthermore, due to lack of motivation, or lack of the psychological interaction with the devices, some individuals do not perform the daily tasks instructed by the devices.

A lot of pet robots have also been created as images of pet animals. Some individuals even treat these artificial machines as actual pets. Engineers are also developing various assistance robots, such as communication robots and care giving robot. Although a robot can move, they are slow in going up stairs or walking on rugged roads or fields. These robots also need complicated software and are too expensive to be used in a normal home. In addition, engineers are also studying smart homes. However, such smart homes are also too expensive to build. This system also does not work outside of the home.

Consequently, we came up with an idea that if dogs were mounted with ICT devices, such as sensors, computers, other electronic appliances, then various tasks would become possible. This ICT- augmented- assistance dog can help individuals with dementia relax, initiate actions, and more easily execute daily tasks, which the traditional assistance dogs or ICT devices cannot

realize, respectively. Related ideas have not been found, except one in the military literature, in which camera and radio transmitter systems were built in the armored vest of a scouting dog.

In regard to using assistance dogs in this manner, we can hire professional trainers to breed and train dogs, and then adapt the trained dogs to individuals with dementia.

What we are proposing now may be called the Human-Computer-Animal Interface (HCAI), incorporating various fields, such medical, welfare, engineering, and dog training. We would like to describe the details of this idea. Anticipated effects on the quality of living of individuals with dementia are also discussed.

Comparison of Functional Abilities Between Dogs and ICT Devices: If the abilities of a dog and ICT devices were integrated, a more efficient and unprecedented assistance system can be created, while eliminating their demerits simultaneously.

Devices for Mounting: The owing devices may be efficient when they are mounted on to dogs. Non-electronic devices, such as medicine, pencils, memo pads, etc., are also needed. They are classified into the following five categories: Sensors (sound, smelling, lighting, temperatureetc.), Media for recording and sending information (USB, blue tooth, mobile Wi-Fi etc.), Electronic appliances (IC recorder, video recorder etc. wide angle camera, GPS, batteries, etc.), Computers (smart phones, tablet PC, etc.), Non-electronic devices (medicine, diary, glasses, bait for dog, etc.).

These devices are stored in special bags on the back and sides of the dog's trunk. Devices to be mounted on to a dog should be selected for an owner's specific needs, a dog's capability, and to meet specific circumstances. Dogs may be trained to sleep near remote charger systems so that devices can charge while dogs are sleeping.

Various Supporting Plans: Various kinds of support will be possible using assistance dogs who are mounted with the above devices. We, therefore, classified support plans into the following categories. Additionally, most individuals with dementia cannot manipulate these devices, so the booting of the devices needs to be automatic. Therefore, volunteers or caregivers should set the time schedule for booting.

Healing and relaxation support: A dog by itself can provide healing and relaxation to individuals with dementia (owner) through their fur, gestures, and expressions. Furthermore, dogs mounted with the above devices should be trained to go to owners when an alarm sounds from the IC recorder, or when other devices emit sounds at a set time. Dogs will then be trained to show owners content, such as music, photos, or reminiscence videos.

Scheduling support: By mounting IC recorders and other voice output devices, recorded messages or video instructions can be played to prompt an individual's daily activities, such as taking medication, eating breakfast, and so forth. When an alarm or word is emitted, the trained dogs go to their owners and show the messages or video instruction through the devices. Preceding these presentations, automatic outputs of music are also desirable to raise motivation to accomplish given tasks. Medicine and water prepared in the bag are conveyed by the dog when an alarm sounds along with the message output to "take medicine". The dog will be trained to deliver a note pad and pencil when alarm and message "take memo" are emitted.

Communication support: Individuals with dementia ask the same questions repeatedly, such as "What day is it today?", "Shall I go to the hospital today?" In order to deal with these questions, dogs will go to owners when an alarm or word is emitted intermittently and to give information regarding what an individual wants to know before they ask.

In order to help individuals with dementia converse with remote caregivers and volunteers, small computers and cameras with Internet connections need to be mounted on to dogs. When an alarm or word is emitted by the remote volunteer, the trained dog will go to owners to start a remote conversation with the volunteer. When there are no volunteers to talk to, the free-talking system with the anime agent can be used. This system starts on set times, or an individual's verbal agreement to talk in response to an automatic recommendation is given by the dog, such as "Do you want to talk with the agent?"

Recording support: When an alarm is emitted regularly, the dog goes to their owner and asks what the owner has just talked about, eaten, or what task has been done. The individual's replies are recorded, which will be automatically analyzed by speech recognition software. Later, a caregiver who is living away from the patient's home can check the recorded content via the

Internet.

Danger detection support: Certain abnormal changes in the environment, such as smells, heat, smoke, etc. can be noticed by an assistance dog. The dog will be trained to go to the owner. As for the observation of owner's safety, alarms are emitted at regular intervals. At each time, the dog will search for their owner, and will require owners to touch a monitor on the dog. This touching is transmitted to a caregiver as a safety signal. If no signals were sent, caregivers will confirm the owner's safety through the camera on the dog's head.

Individuals with dementia so often become confused in the evening and want to return to their "home". When an owner steps on a mat near the exit of their home, an alarm sound is emitted. The dog will then rush to this spot, showing previously prepared messages from a caregiver to the owner.

Searching support: Caregiver or volunteer paints some smelling on objects by such as aroma. When owner lost the object, same smelling is sniffed to the dog. The dog will search it and may bring it back. If possible, the word "key" makes the dog search key on the base of previous combination of "key" and its smell.

Group activity support: Dog can accomplish role as pet dog also in the institution. Furthermore, each institutionalized individual is attached with electronic tags, on which special messages for each individual are recorded. When the dog with a tag reader approaches to an individual, the special messages are emitted to the individual like "Hollow, Mr. Yasuda, how about your ache on the back?" When group conversations, such as reminiscence discussions, are held in institutions, the anime agent of the free-talking system can play the role of chairperson through the dog.

Discussion: Wearing ICT devices may be somewhat burdensome for assistance dogs. However, other assistance dogs have been trained to pull wheelchairs, oxygen tanks, etc. Dogs have a natural tendency to share their enjoyment with their owners. By wearing ICT devices, they can assist their owners with dementia, increase their owner's security, communication, and convenience. They also give the owners healing through their fur, expressions, and movements, which ICT devices alone cannot provide. In this way, dogs may be eager to assist their owners and family members living under afflictive situations caused by dementia.

Traditionally, to train assistance dogs required professional trainers, several years, and large expenses. If devices were appropriately mounted on the dogs, and if tasks to be executed by the dogs were selected for owners, selected dogs can become "semi" assistant dogs for individuals with dementia in shorter training periods. The regular routine and responsibility of caring dog are thought to be beneficial for individuals with dementia.

Concurrently, the number of dog lovers is also increasing. Therefore, we consider assistance dogs wearing ICT devices to be a reasonable intervention of assisting individuals with dementia. This idea will be published on a website. Further appropriate support plans will be desirable to be developed by many professional trainers, engineers, amateurs, and those in the healthcare field. We expect trials and results will be also published on the website (http://hojoken.grupo.jp/) to accelerate development of smarter interventions and implementation of Human-Computer-Animal Interface (HCAI).

Experiments for Assisting dog (Oshima, Yasuda, Machishima et al., 2015): Today, even health professionals use their smartphones to alert them about important tasks. However, these applications have limited use for people with dementia. First of all, most of them forget where their smartphones are located. Second, due to a lack of personal interaction, some people are reluctant to perform the daily tasks instructed by the devices. It is also difficult for a robot at present to chase after a person and run upstairs (Oshima, Yasuda, Machishima et al., (2015).

To overcome these shortcomings, we had the idea of mounting an ICT device on a dog. Now people with dementia would not have to remember to carry their phones. With a little training, a dog can be taught to rush to its owner when the smartphone on its back e m i t s an alarm. Dogs can run to their owners even up a flight of stairs. People with dementia might be more willing to perform tasks if their dogs brought the smartphones.

Methods: T h e y compared the effectiveness of a smart- phone attached to a dog's back to a stationary smartphone. They

built an application for an android smartphone, the FleaPhone CP-D02. The display of the application consists of three parts: setting the alarm, inputting a message, and a completion button.

The subject in this experiment is a healthy person in her 50s. She has a five-year old female toy poodle that is kept indoors. The dog wore the smartphone on its back. It took one week for the dog to become accustomed to having the smartphone tied to its back. The subject trained the dog to run to her when the smartphone emitted a specific sound. This training took only three days.

The study was conducted for five days over the course of one week. Each study day lasted from 9 a.m. to 9 p.m. These 12 hours were divided into four parts. In each part, each smartphone emitted an alarm at a random time. The subject had a maximum of eight chances of hearing the alarm. The subject did not know when the alarms would sound. The subject was required to turn off the alarm and to perform an allotted task.

The Kraepelin test was used as a task. This test requires an individual to perform calculations as fast and accurately as possible. The test is a boring task and involves mental stress similar to that experienced by people with dementia who have to take medication.

Results: The responses of the subject to the questionnaire revealed that when the dog responded to the alarm and came to her, she was impressed. In the case of the living room smartphone, when she was cooking, she did not hear the alarm. In the case of the dog-mounted phone, the dog was taking a nap in the early evening and did not wake up by the alarm.

Discussion: It is clear that the subject was quicker to turn off the alarm on Set-A, because the dog was trained to run to her when the alarm emitted. Contrary to our expectations, it took only three days to train the dog. A person with dementia would be more willing to perform tasks if his/her dog brought over the smartphone. In our experiment, we assumed that the Kraepelin test would be boring. Surprisingly, the subject, a healthy person, enjoyed the test on either Set-A or -B; she described it as a brain-training exercise.

Therefore, Individuals with dementia will be more willing to perform daily tasks if influenced through their dogs. This result suggested that other applications for the people with dementia also become the more useful things of their daily lives by the dogs who mount the smartphones.

How a Dog Can Prevent a Person from Opening Door (Oshima, Yasuda, Machishima et al., 2015): In some homes and institutions, caregivers must watch over those people with dementia. That is because these people often try to open a door to go outside. If a dog can be trained to play with the patient until the caregiver shows up, then the dog may prevent that person from going through the door.

A vibration sensor *(REX-SEEK1-X)*, and a smartphone were used. Aa single tag was hung on a selected door. An application linked to the Bluetooth-compatible tag causes a smartphone to sound an alarm when the door is vibrated. In an extended application, the smartphone can be made to play predetermined messages to the person with dementia. For example, the smartphone says, "Don't go away!" "Play with me." or "Shall we go over there?"

A few things are needed to train a dog for this application. The dog's treat is placed in the box in advance. When the alarm sounds, the dog becomes accustomed to finding the treat in front of the door. Then, the owner reduces the size of the treat. At last, the dog will run to the door whenever the alarm goes off, even if there is no treat.

The smartphone- equipped dog runs up to the person when the alarm goes off. The dog might twirl around or bark. The person with dementia will notice the dog and forget about the door. A caregiver also notices the dog making a commotion and rushes over to the scene. Moreover, we expect that the person with dementia hears the messages from the smartphone and may come back by him/herself.

People with Dementia Talking through a Smartphone on a Dog (Oshima, Yasuda et al., 2015): An experiment was conducted in which one of authors spoke with a person with dementia at a facility through Skype on the smartphone that was

on the dog in order to see if a person with dementia would respond to a human voice that seemingly came from a dog. The facility has two dogs, both female Pomeranians. One of them cooperated with the experiment. She is young and easily attaches to a person. She was equipped with a harness that had a smartphone in one pocket.

Eight people with dementia sat in a half- circle and ate ice cream, while hearing someone talking to them through the smartphone on the dog. They were not told that someone would try to talk to them through a smartphone. Some of them responded to the voice through the smartphone. A few samples of conversations are shown; "D" is the author speaking via the dog, "U" is one of the users.

D: What are you going to eat? U2: We are going to eat this, here. (She showed a cup of ice to the dog.).

D: I would like to eat ice shavings with you. U3: Do you want to eat with me? D: Yeah. U3: I want to eat alone.

Most of the users with mild dementia responded to the dog "speaking." However, the user with medium dementia hardly uttered a word. Even when a human unexpectedly talks to someone with medium dementia, he or she does not always react at once. Furthermore, it is not easy for one with medium dementia to comprehend every situation, especially if that situation is something unexpected such as a talking dog. They might be a little confused or avoid confronting the situation because their cognitive functioning has been reduced.

The day will soon come when a smartphone will be able to hold a conversation autonomously. When a dog carries the phone, these people may have an enjoyable conversation. In general, we talk to a dog and infer its feelings from its responses and actions. A voice from a smartphone will support this conversation. The smartphone will encourage new relationships between people and dogs who work for those with dementia every day. One problem revealed in this study was that it is not easy to hear a smartphone outdoors.

The symptoms of dementia are varied and increase with time. Some devices can compensate for the disabilities. However, these devices must be kept on hand according to the person's stage or symptoms of dementia. The smartphone offers a lot of possibilities to provide support through only one device. However, some people with dementia forget to carry their smartphone. Also, many of them do not like to perform the tasks instructed by their device.

Even if she did not have it, a dog can be trained to bring the smartphone to its owner whenever alarm sound. An owner is happier when the smartphone on the dog gave the alarm. A dog can overcome the problems of non-possession of the smartphone and disinclination of doing daily tasks. Dogs usually follow their owners. These people can be encouraged to remember to input the necessary information into an application on the smartphone carried on the dog.

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