

## The Background to Human-Animal Interaction (HAI) Research

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Human-Animal Interaction (HAI), and specifically what is called the human-animal bond, has a long history. The long-standing social implications of our association with animals continue as well as an ever-increasing utilization of animals to help mitigate the impact of disabilities. In the last four decades there has been a growing research enterprise exploring the human health consequences of our association with animals as well as studies of the psychological and physiological mechanisms to help explain the findings. Research in the area continues and the future of HAI is both challenging and exciting.

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### HAI History

The emotional impact of the Human-Animal Bond (HAB) goes back as far as human history. A Midrash (1391-1271 BC) from about 2<sup>nd</sup> Century CE tells how Moses

followed a sheep who left the flock. His annoyance abated when he realized the animal was seeking a drink of water. He explains he wished he knew the animal was thirsty and after the sheep had its drink he carries it back to the flock because he

assumed it was exhausted. Seeing his compassion, the lord put him in charge of his people. Even God uses the attribution of being kind to animals as a sentinel for the goodness of the person. This attribution that caring for animals is an indication of a good person has been objectively documented in a variety of studies (Lockwood, 1983) and is still at the heart of the human-animal bond. The first popular medical reference to the potential therapeutic value of animal contact appears in 1860 as a small reference in the many writings of Florence Nightingale.

“A small pet animal is often an excellent companion for the sick, for long chronic cases especially. A pet bird in a cage is sometimes the only pleasure of an invalid confined for years to the same room. If he can feed and clean the animal himself, he ought always to be encouraged to do so.” (Nightingale, 1860.)

Perhaps not surprisingly, Nightingale, who revolutionized hospital medical care, found her calling to nursing after treating a wound of a neighbor’s dog. It is after that event she has a dream that clarifies her desire to serve people and leaves England for Germany to study nursing, undeniably the world’s most famous and revered nurse.

The first clearly articulated publication documenting the value of animals for children, both their development and in therapeutic settings, was the work of Boris Levinson.

“Animals have generally played a great role in human ecological adjustment. Just as credible a reason as any for the domestication of animals is their use as pets. In other words, there is as much reason to believe that man’s psychological needs were the primary cause for domestication of animals as that man needed to use animals for such material purposes as the saving of human labor or the satisfaction of a hunger for food” (Levinson, 1969)

People’s desire to be attracted to and care for animals, especially young-looking

animals, is built into the human psyche (Beck, 2014). In addition to the normative interactions, there is a growing study of animals specifically placed in settings to improve health outcomes. The first example of an animal providing a service for the person is not documented but there are examples of a blind person aided by a dog depicted in a first-century AD mural in the buried ruins of the Roman city of Herculaneum. The first school to train dogs, all German shepherds, for soldiers who were blinded by mustard gas during World War I was in Oldenburg, Germany, 1916. Dorothy Harrison Eustis brought the idea of guide dogs to the US and the first dog-human pair was in 1928. The *Seeing Eye* has been supplying trained dogs since 1929 (Ascarelli, 2010). Now there are many programs around the country that train dogs to serve those with vision impairments and many others to provide service dogs.

### *Service, Assistance, and Emotional Support Animals*

There is considerable public confusion in distinguishing between therapy animals, service animals, assistance animals, and emotional support animals. Service animals are legally defined and protected under the Americans with Disabilities Act (ADA) of 1990 to accompany people with disabilities in government, business, and non-profit facilities that serve the public. Revised in 2010, the ADA defines service animals as “dogs that are individually trained to do work or perform tasks for people with disabilities” and mandates that the tasks must be directly related to the person’s disability ([https://www.ada.gov/service\\_animals\\_2010.htm](https://www.ada.gov/service_animals_2010.htm)). Certification is not mandated, and the dog’s training may be provided by any organization or individual (including the dog’s owner). Service dogs are not required to wear a vest or special harness, or identification tag. To protect the rights of

those with disabilities, there are legal limits placed on questions that can be asked about a service dog. The only two questions legally permitted are 1) “is the dog a service animal required because of a disability” and 2) “what work or task has the dog been trained to perform”? Requesting documentation of training, certification, or demonstration of task performance are not permitted. It is important to note that ADA also recognizes miniature horses as service animals.

Assistance animals are more broadly defined by the United States Fair Housing Act (FHA), Section 504 of the Rehabilitation Act of 1973, as “an animal that works, provides assistance, or performs tasks” for a person with a disability ([https://www.hud.gov/sites/documents/SERVANIMALS\\_NTCFHEO2013-01.PDF](https://www.hud.gov/sites/documents/SERVANIMALS_NTCFHEO2013-01.PDF)).

Under the FHA, assistance animals are not required to be individually trained or certified and include emotional support animals. Housing providers covered by the FHA are required to make reasonable accommodations for any assistance animal required by a person with a disability.

While covered under FHA as assistance animals, emotional support animals are excluded as service animals under the ADA. Emotional support animals provide companionship and may facilitate wellbeing and/or help alleviate loneliness, depression, and anxiety but are not specifically trained to perform tasks for a person with a disability (Brennan & Nguyen, 2014). Emotional support animals are also permitted to accompany their owners in aircraft cabins under the Air Carrier Access Act (ACAA). Airlines may require documentation for emotional support animals. However, some state and local laws do permit emotional support animals, as well as therapy animals, in public places.

The United States Department of Transportation provides a very helpful chart on differences between ADA, FHA, and ACAA definitions and coverage of service/assistance animals

[https://www.transportation.gov/sites/dot.gov/files/docs/P2.SA\\_Issue%20List.SA%20Matrix.pdf](https://www.transportation.gov/sites/dot.gov/files/docs/P2.SA_Issue%20List.SA%20Matrix.pdf)

Like Human-Animal Interaction (HAI) research in general, much of the early research on service dogs was anecdotal and focused on the placement or partnering of service dogs with individuals with disabilities. A more recent placement study surveyed service dog providers on the outcomes used to evaluate service dog placements (Butterly, 2013). Interestingly, only five of seventeen invited providers chose to participate in the survey and none were found to use valid and reliable clinical or research measures. Related to placement, several studies have focused on assessment or training of potential therapy dogs, each offering some evidence of training effectiveness (Duffy & Serpell, 2012; Lucidi et al., 2005; Weiss, 2002; Yount et al., 2013).

One of the earliest studies looking at psychosocial benefits of service dogs involved observations of adults in wheel chairs with and without dogs (Eddy, Hart, & Boltz, 1988). Those with dogs engaged in more conversation with others and received more smiles than those not accompanied by dogs. These findings were replicated in a similar study with children, also reporting increased social acknowledgements when a service dog was present (Mader et al., 1989).

Other studies also investigated the benefits of service dogs for those with ambulatory disabilities. A more rigorous study published in 1996 utilized a randomized controlled design to prospectively investigate psychological and economic effects of service dogs on individuals with ambulatory disabilities in wheelchairs (Allen & Blascovich, 1996). After being partnered with a service dog, participants showed significant improvements in self-esteem, well-being, internal locus of control, and community integration. Economic benefits were also reported, including decreased paid

assistance hours and estimated cost effectiveness over an 8-year period. More recent studies provided additional support for psychosocial benefits in this population, including increased self-esteem and owner's expected improvements that were realized after obtaining a service dog (Rintala, Sachs-Ericsson, & Hart, 2002) and improved health-related quality of life (Shintani et al., 2010). In contrast, a cross-sectional study found no overall psychosocial differences in those with and without service dogs, however comparing subgroups revealed more positive affect in service dog owners with progressive conditions and those with clinical depression (Collins, et al., 2006). Similarly, although a large sample of wheelchair users with service dogs scored higher on mobility than those without service dogs, no significant differences were found in numerous other quality of life indicators (Milan, 2007). Also reporting null findings, a study of a heterogeneous group of individuals with disabilities with and without service dogs had no psychosocial differences over an 18-month period (Spörner, et al., 2017).

In the only study to compare different types of service dogs, Hall et al (2017) compared quality of life scores between those with and without service dogs for physical disabilities with those with and without hearing service dogs. Survey results revealed quality of life benefits for those with service dogs for physical disabilities with fewer benefits found for those with hearing service dogs. Compared with weight list controls, both groups of service dog owners had higher scores on health, working, learning and independence.

More recent studies have investigated the impact of service dogs on children with developmental disabilities with mixed results. Burrows and colleagues published several qualitative studies of families with children with autism and service dogs (2008 a, b). They identified service dog themes of safety, increased

freedom, public outings, and family activities, and improved social recognition and status. In assessing the home environments of autism service dogs, they also focused on dog welfare, identifying potential stressors that may impact the behavior and welfare of service dogs and parental satisfaction (Burrows et al, 2008c). Assessing physiological stress during the introduction of a therapy dog into families with children with autism, other investigators found cortisol awakening response, but not average diurnal cortisol levels, diminished in children with ASD in the presence of service dogs, supporting potential behavioral benefits of service dogs in children with autism (Viau, et al, 2010).

Studies have also identified negative aspects or challenges posed by acquiring service dogs, including the effort and cost involved in caring for service dogs and encountering people not familiar with service dogs (Rintala, Sachs-Ericsson, & Hart, 2002), public access issues, training time, and time consumed by increased social interactions (Burrows et al., 2008a, 2008b).

As concluded in a 2012 systematic review on service dogs for people with disabilities (Winkle, 2012), methodological limitations are evident in most of the published studies with small sample sizes, convenience samples, inadequate psychometrics on outcome measures, and inadequate controls on potential confounding variables. These research shortcomings limit conclusions about the benefits of service dogs.

### *Animal-Assisted Interventions (AAI)*

For many years, people employed animals, mostly dogs and horses, in what eventually became known as AAI, sometimes referred to as animal-assisted activity (AAA), animal-assisted therapy (AAT) or animal-facilitated therapy (AFT), which recognized that the interaction with animals was not a goal directed, stand-alone

therapy but facilitated or assisted the more established therapeutic intervention that was taking place. These new roles for pets helped justify the strong bonds people had for their pets (Katcher & Beck, 1983) and provided a novel activity for owner participation with their pets. As mainstream media began to publicize visiting pet owners in community settings, more pet owners became interested in participating in this volunteer activity and the need for organizations to serve interested volunteers and provide regulation became apparent. Therapy Dogs International (TDI) was the first such national organization in the United States, founded in New Jersey in 1976 as a volunteer organization for testing and registering therapy dogs to visit nursing home, hospital, and other settings ([www.tdi-dog.org](http://www.tdi-dog.org)).

Incorporated in 1981, The Delta Society became a major certifier of therapy dogs and through its National Service Dog Center, provided advocacy and education related to service dogs for people with a variety of disabilities. The Pet Partners therapy animal program ([www.petpartners.org](http://www.petpartners.org)) was established in 1990 as was Therapy Dogs Incorporated, now Alliance of Therapy Dogs. ([www.therapydogs.com](http://www.therapydogs.com)). In 2012, the Delta Society changed its name to *Pet Partners*, in the belief it would better express its mission as a nonprofit organization that evaluates and registers animals and their volunteer handlers to provide animal-assisted interventions in a variety of healthcare, educational, and other settings ([www.petpartners.org](http://www.petpartners.org)). All three animal therapy registration programs require an initial evaluation of animal health and temperament, followed by annual health assessments from a licensed veterinarian. Unlike the other two organizations, Pet Partners does not limit registration to dogs, but also registers other species meeting the organization's requirements, including cats, llamas, horses, goats, birds, and rabbits. Pet Partners also requires biennial re-evaluation

for registration renewal to monitor continuing appropriateness of animal and owner for animal interaction work and offers a number of online educational modules, including canine body language and infection prevention and control.

The professionalization of HAI continues to evolve. Recognizing the lack of guidance for incorporating animals into healthcare and other settings, the Delta Society published standards of practice for animal-assisted activities and animal-assisted therapy (Delta Society, 1996). In 2001, Aubrey Fine published the first edition of *The Handbook on Animal-Assisted Therapy*, now in its fourth edition. More recently, an evidence-based manual was developed to assist healthcare professionals and others to start and maintain AAI programs in healthcare settings (Barker, Vokes, & Barker, in press).

Pet Partners remains a leader in the field advocating for therapy animals, developing and providing continuing training and education for therapy animal teams, funding service animals for individuals with disabilities, and supporting HAI research. In addition to publishing a curriculum and continuing education materials, Pet Partners once again offered a conference in 2017 to bridge human-animal interaction research and practice.

As AAI became more popular, other programs arose in response to specific needs. Intermountain therapy dogs was established in 1999 as the first literacy program to involve therapy dogs as reading mentors for children ([www.therapyanimals.org](http://www.therapyanimals.org)). Similar programs have subsequently arisen around the country.

In addition to the American programs, other countries have also seen the establishment of therapy animal programs, primarily restricted to dogs. Therapy Dogs International is active in Canada as well as the United States with some presence in other countries. Irish Therapy Dogs, based in Dublin, is active country-wide with regional

coordinators and a network of volunteers providing therapy dog visits to hospitals, assisted living facilities, day care centers (for seniors), and schools. Australia, Japan, Singapore, and Switzerland also have national organizations. Many countries have regional or local therapy dog programs including Africa, Canada, Great Britain, Italy, Korea, New Zealand, The Netherlands, and Poland.

In 1990, the International Association of Human-Animal Interaction Organizations (IAHAIO) was founded by representatives of human-animal interaction associations in seven countries to provide leadership in the human-animal interaction field and serve as an umbrella for associations and institutions in the field ([www.IAHAIO.org](http://www.IAHAIO.org)). The founding sponsor was Mars Inc. and the first president was Professor Sam Ahmedzai. IAHAIO currently has 61 full and 32 affiliate members representing Europe, North America, South America, Pacific Rim, and Southern Asia. Over the years, IAHAIO has published several white papers to provide guidance in the field, including a 2014 paper on guidelines for animal-assisted interventions and animal wellness, and sponsored conferences every few years (IAHAIO, 2014). The white paper on AAI also provides researchers and practitioners with a set of clearly defined terms that previously suffered extreme variability of use in the literature and in practice. Clarifying the basic language of the field allows for more efficient exchange of information and ideas.

### **History of HAI Research & Scholarship**

AAI preceded any theory or objective documentation of effectiveness but continued as there was little harm and some obvious good. To finally bring focus and research to this new empirically useful endeavor was a group convened by veterinarian Leo Bustad and psychiatrist

Michael McCulloch. In 1977 they started the Delta Unit of the Latham Foundation, soon to become the Delta Foundation, formed in Washington State as Leo Bustad was the president and Dean of the Washington State University College of Veterinary Medicine. The original board was comprised of Leo K. Bustad, Michael J. McCulloch, William ‘Bill’ McCulloch, R.K. Anderson, Stanley L. Diesch, Joe Quigley, and Alton Hopkins. Michael McCulloch suggested the Delta name and logo to acknowledge the three interconnecting points of focus; people, animals, and nature. In 1981, Bill McCulloch initiated the American Veterinary Medical Association’s Human-Animal Bond Task Force, bringing increased veterinary attention to the area and providing a forum for dialog and advocacy.

By 1981 the Delta Society was incorporated with an active board of directors and began to attract pet industry funds that were made available for research directed at documenting and validating the value of human-animal interactions to improve human health. At that time Dr. Bustad said to the board, “All the world’s researchers interested in the human–animal bond could fit into one small office.” (Beck & Rowan, 2008). Delta Society sponsored and published research on human-animal interaction (HAI) in the late 1980s, providing a professional organization for HAI researchers and practitioners to come together and share experiences and knowledge.

Recognizing the need to publish scholarly articles in the human-animal bond field, many of the original Delta Society board members founded the journal *Anthrozoös* and served on the initial editorial board with Andrew Rowan as editor. Soon after, the International Society for Anthrozoology was founded in 1991 by John Bradshaw, Ivan Burger, Erika Friedmann, Benjamin Hart, Lynette Hart, James Serpell, and Dennis Turner to promote academic, scientific, and scholarly

research and collaboration in the field.

The mission to conduct research into the basic theory, development, and validation of animal intervention fell to professional groups and universities. In the US, the University of Pennsylvania, School of Veterinary Medicine received a major grant in 1977 from the Geraldine R. Dodge Foundation to develop the first center to study both human and animal health as they interact together—the *Center on Interaction of Animals and Society*. In 1981 the University of Minnesota’s *Center to Study Human-Animal Relationships and Environments* (CENSHARE) began and Purdue University’s *Center for Applied Ethology and Human-Animal Interactions* (now *Center for the Human-Animal Bond*) in 1982. Now more than 75% of all US veterinary schools and a few non-veterinary schools, including medicine, psychology, and social work, have some commitment to the study of humans and animals specifically interacting in ways that positively impact human and animal health (Beck & Martin, 2008).

Over the years there were numerous international conferences and significant books from these conferences (Anderson, 1975, Fogle, 1981; Katcher & Beck 1983) that established the field in many countries and centers of education (Hines, 2003). Early investigators in HAI relied on basic observational techniques including: chart review, qualitative explorations, small sample size surveys and measures uniquely developed for purpose. Much has been written about the methodological concerns related to these early approaches and the need for greater methodological rigor in HAI research (e.g., Kazdin, 2015). It is important to recognize that this early work, however flawed it may seem by current standards, provides a key component of the process of scientific enquiry. It laid the groundwork by highlighting critical variables, provided an indication of design and measurement sensitivity to the effects of HAI, highlighted

the importance of standardized measures and detailed protocols and ultimately it provided a foundation from which current researchers can launch more sophisticated investigations, armed with the knowledge provided by this early work (Griffin, et al., 2011).

The first medical article, published in a peer-reviewed health journal was Erika Friedmann’s small sample study documenting that animal ownership increased one-year survival after a heart attack (myocardial infarction) or angina pectoris (Friedmann et al, 1980). While small, it was the first study with clear outcome measures of success (survival, an unambiguous outcome). Animal ownership was elevated to a “risk factor” worthy of inclusion in an epidemiological study. There was a long history when animal contact was studied as a negative risk factor, e.g., bites and zoonoses, but only more recently was the contact viewed as an active positive risk factor for improved human health.

In 1987 The National Institutes of Health (NIH) convened one of their many respected Technology Assessment Conferences on the subject and it was official, health benefits to animal ownership were worthy of study; “There are many promising areas of research related to potential health benefits of companion animals that would not only advance our comprehension of how to best utilize animals therapeutically but also would provide insight into the very nature of the link between people and animals in the general population.” (NIH 1988). The subsequent years saw little new funding for HAI or AAT but at least the relationship with animals was now an official area of study. The conclusion from this event was:

*All future studies of human health should consider the presence or absence of a pet in the home and, perhaps, the nature of this relationship with the pet, as a*

*significant variable. No future study of human health should be considered as comprehensive if the animals with which they share their lives are not included.” (Beck & Glickman, 1987; NIH 1988)*

There was little federal money (Rowan & Beck, 1994) for HAI studies and most funding came from non-government organizations (NGOs) and commercial sources. Mars Inc and its subsidiary the WALTHAM Centre for Pet Nutrition have been funding HAI research for more than 40 years, with their first HAI publication dating to 1975 (Mugford & M<sup>o</sup>Comisky, 1975). They funded workshops and fellowships in the 80s and have provided a small grants program via the WALTHAM Foundation (Mars, Inc) since 2001. In 2009, the Child Development and Behavior Branch (CDBB) of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD) offered grants in the area; the program was co-funded through a Public-Private Partnership between NICHD and the WALTHAM Centre for Pet Nutrition (Esposito, McCune, Griffin, & Maholmes, 2011; McCune, Kruger, Griffin, Esposito, Freund, Hurley, & Bures, 2014). Beginning in 2010 the HABRI Foundation (funded from commercial sources) began a small grants program directed toward animal-assisted interventions for specific health benefits to people of all ages. In 2008 the Human-Animal Interaction Section of Division 17 (Society of Counseling Psychology) was created by the American Psychological Association (APA). This led to the creation of the HAI Bulletin which is an online, open-access publication, but as of this writing is not yet classified as an APA journal. And now there is a special section devoted to HAI research in the *Journal of Applied Developmental Science* as of 2016. All of this scholarly activity further demonstrates the growing recognition of HAI research as a legitimate field of

scientific research and an expanding infrastructure to support growth in the field. Today, there are at least 20 U.S. academic centers committed to the study of human-animal interaction.

### *Summary of HAI Research*

As AAI became more prevalent, the need to evaluate their efficacy became apparent and contributed to the HAI research movement. As with most new fields, HAI research initially involved anecdotal reports, case reports, and small pilot studies and over the years evolved to include more rigorous interdisciplinary studies on physiological and psychological outcomes in clinical and community settings. Beginning with Friedmann et al.’s (1980) seminal study on pet owner survival after an acute coronary syndrome, other research provided further evidence of benefits to cardiovascular risk factors, culminating in a 2013 American Heart Association Scientific Statement, concluding that pet ownership, particularly dog ownership, is likely associated with decreased cardiovascular disease risk and may play a causal role in reducing that risk (AHA, 2013). See the AHA statement for an excellent review of these studies.

In addition to cardiovascular disease risk, researchers examined the potential benefits of HAI for those with dementia (Edwards & Beck, 2002; 2013; Tournier, Vives, & Postal, 2017), psychiatric symptoms/disorders (Barker & Dawson, 1998; Barker, Pandurangi, & Best, 2003; Nurenberg et al., 2015), in physical activity (Curl, Bibbo, & Johnson, 2016; Johnson, Beck, & McCune, 2011; Johnson & Meadows, 2010; Owen et al., 2010; Zeltzman & Johnson, 2011), childhood illnesses (Barker et al., 2016; Tsai, Friedmann & Thomas, 2010; Hesselmar et al., 1999; Meer et al., 2005) and other health areas. Populations studied ranged from infancy to seniors, pre-school to college and

the workplace, community living to nursing homes and hospitals.

With the rapid and steady increase in the number of people over age 65, HAI programs for older adults emerged and are expected to proliferate as are residential facilities promoting pet ownership. The health and well-being benefits of HAI among older adults have been established in relation to physical activity through dog-walking (Curl, Bibbo, & Johnson, 2016; Johnson & Meadows, 2010; Thorpe, et. al., 2006), loneliness reduction (Banks & Banks, 2005; Stanley, Conwell, Bowen, & Van Orden, 2015), and social interaction (Krause-Parello, 2012). In addition, there is increasing recognition of the importance of allowing, even promoting pet ownership in retirement facilities, wherein previously pets were forbidden (Johnson & Bibbo, 2014). AAI are now important components of programming in such facilities (Holt et al., 2016).

Research is expanding into HAI among other populations and situations including prison inmates working in dog training programs, the role of pets in families of children with Autism Spectrum Disorder (Carlisle, 2014; O’Haire, 2017), dog presence with abused children during forensic interviews and court proceedings (Dietz, Davis, & Pennings, 2012), pet presence in the workplace (Barker, Knisely, Barker, Cobb, & Schubert, 2012), and service dog training (Yount, Olmert, & Lee, 2012). Horses are increasingly regarded as companion animals, and as such are being included in AAI, including therapeutic horseback riding among military veterans with Post-Traumatic Stress Disorder (Johnson et al., 2017), and to increase behavioral as well as physical functioning among children with ASD (Gabriels et al., 2015; Lanning, et al., 2014).

Another area that is receiving attention is the grief associated with loss of a companion animal (King & Werner, 2011; Durkin, 2009; Tzivian, Friger, & Kushnir,

2015). Veterinary medical schools, community veterinary medical practice, and some community mental health practitioners and HAI Centers recognize this phenomenon, and many have programs involving licensed mental health professionals to support animal owners through this difficult experience (Larkin, 2016). However, outcomes of such programs have not been studied and this may be a fruitful area of future inquiry.

While it is not possible to review the vast number of published studies, readers are directed to several review articles and meta-analyses for more complete research summaries. The first published literature summary was an annotated bibliography of the human-animal bond (Allen, 1985). Subsequent literature reviews have focused broadly on AAI (Nimer & Lundahl, 2007; Kamioka et al, 2014, Borrego et al, 2014), and HAI (Barker & Wolen, 2008; Hosey & Melfi, 2014) while others have a more narrow focus: children reading to dogs (Hall, Gee, & Mills, 2016), AAI in internal and rehabilitation medicine (Munoz et al., 2011), assistance and therapy dogs for children with autism spectrum disorders (Berry et al., 2013; Davis et al., 2015), dog ownership and physical activity (Christian et al., 2013), dog-assisted therapy for long-term care residents (Cipriani et al., 2013), animal-assisted interventions in children’s hospitals (Chur-Hanson et al., 2014), companion animals and loneliness (Gilbey & Tani, 2015), AAI for trauma (O’Haire et al., 2015), companion animals and child/adolescent development (Purewal et al., 2017), and a meta-analysis of animal-assisted activities and depression (Souter & Miller, 2007) and psychiatric disorders (Virus-Ortega, et al., 2012).

#### *Physiological Outcomes of HAI*

While some of the first attention to physiological outcomes were included in early HAI studies of cardiovascular risk

factors, particularly blood pressure and heart rate, several key studies generated interest in incorporating other physiological measures into HAI studies. One of the first studies published exploring cortisol's sensitivity to AAI reported that 1) changes in serum cortisol were mirrored in changes in salivary cortisol after an approximate 30-minute delay, and 2) the optimal time to capture significant changes in serum and salivary cortisol after an AAI was 30 – 45 minutes post intervention (Barker et al., 2005). Odendaal's (2000) study of the effect of interacting with one's pet on oxytocin brought attention to oxytocin as an indication of affiliation and bonding with one's pet, spurring subsequent discussion and further exploration of oxytocin as an underlying mechanism of HAI effects (Beetz et al., 2012).

### *Technology in HAI Research*

The technology involved in the investigation of the Human-Animal Bond has become much more sophisticated over time and allows us to glimpse a wider variety of characteristics of the interaction between humans and animals. For example, the advent of more sophisticated video and sound recording equipment and storage devices allows HAI researchers to record subtle aspects of individual interactions, including gaze direction and duration, respiration, details of touch and many other variables, for immediate evaluation and for posterity. Behavioral researchers continue to develop and fine tune ethograms for detailed evaluation of specific behaviors recorded via video recording of HAI and still others are gleaned information on a variety of other aspects of these interactions. For example, the Observation of Human-Animal Interaction for Research (OHAIRE) is a timed interval coding system designed to objectively capture social communication, emotional displays, problem behavior, and interaction with

animals versus control objects (<https://vet.purdue.edu/chab/ohaire/ohaire-coding-system.php>). Eye tracking technology allows researchers to capture natural behavior in real time and eye tracking devices are available for use in humans, primates and dogs (<https://www.tobiipro.com/fields-of-use/psychology-and-neuroscience/primate-canine/>).

Wearable technology is expanding possibilities of investigation every day. For example, a wearable device that combines a GPS tracking unit with an accelerometer, and a video camera (also equipped with blue tooth) has been used to monitor outdoor cats to better understand territoriality and even help to improve human-pet interaction (Yonezawa, Miyaki, & Rekimoto, 2009). Similar technology has been used in humans as well: accelerometer data to determine active versus sedentary behavior in older adult dog owners versus non-dog owners (Dall et al., 2017). Physiological variables (e.g., heart rate, heart rate variability, skin conductance) are now easily recorded during HAI via wearable measurement devices (e.g., the Polar ProTrainer heart rate monitor). The measurement of important biomarkers associated with stress (e.g., cortisol) and bonding (e.g., oxytocin) are now easily measured in saliva (e.g., Miller et al., 2013; MacLean et al., 2018). All of this advanced technology allows researchers to gain a greater understanding of a nuanced interplay between the species that is as old as human history. Another technological advance that has entered AAT is robot-assisted therapy (RAA) for both young people and older adults (Melson et al., 2009; Bemelmans et al., 2012; Okubo et al., 2005).

Both Sony's AIBO dog and Intelligent System Company's Paro seal have been used because of they embody attributes of living animals and allow people to project their own attributions of meaningful and pleasant interaction. The most common population for robotic animals have been for the elderly

(Bememans et al., 2012; Birks et al., 2016; Petersen et al., 2017).

### *Welfare of Animals involved in AAI*

Investigators are beginning to study the effects of AAT on the animals involved with these activities. For example, biophysiological and behavioral indicators of stress have been studied in therapy dogs (Ng, Pierce, Otto, Buechner-Maxwell, & Siracusa, & Were, 2014) and horses working in therapeutic riding stables (Johnson et al., 2017). There is great likelihood that this work will be extended to other animals doing a myriad of work in either AAA or AAT. It is unrealistic to assume that all animals doing this work necessarily benefit from the activity, particularly given the wide range of settings, populations, and activities involved. Discussion has ensued (Glenk, 2017), but more research is needed in this area.

### **Conclusion**

As evidenced by the rich history and wide range of research topics summarized in this Introduction, the future of HAI research is bright. Clearly, conceptual and methodological challenges remain (Beck & Katcher, 2003; Esposito et al., 2011; Beetz, 2014; Kazdin, 2017; Serpell et al. 2017), but the rapid expansion of both therapeutic and scientific activities aimed at addressing these challenges point to a productive future for HAI research.

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