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Canine Science Conference – 2022 Program Summary

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Friday, October 7, 2022

11:00 am – 12:00 pm

Registration

11:00 – 12:00 am

Poster Set-Up

12:00 pm

Opening Remarks

Ana G. Jimenez, Colgate University

12:15 – 1:15 pm

(Plenary Lecture) Canine cancer registration and biobanking practices at the Vetsuisse Faculty - evolving towards state of the art

Franco Guscelli, University of Zurich

Introduced by:

Past, present and future of cancer registration (Swiss Canine Cancer Registry, SCCR) and biobanking at Vetsuisse are outlined. The SCCR stores data from three pathology laboratories covering diagnostic submissions from 1965 to present and including over 100,000 tumors from more than 190,000 dogs. They describe animal and sample characteristics, the latter coded according to the recently devised, ICD-O-3 compatible Veterinary International Classification of Oncology for Canines system (vet-ICD-O-canine-1). Multiple logistic regression models considering the influence of sex, neutering status, age, breed, body size, and year of tumor development confirmed known, and unveiled previously unrecognized, risk factors for various cancers. Since 2007 dog registration is mandatory in Switzerland allowing for calculating population-based tumor incidences, as accomplished e.g. for skin tumors (2008-2013), thus providing valuable reference data. An interdisciplinary approach has generated tools for spatiotemporal data analysis, notably taking into account structural zeros, specific societal and contextual settings, and issues related to data aggregation, spatial non-stationarity and geographic scale. Formalin-fixed, paraffin-embedded blocks matching registry data are banked for scientific studies. The major Vetsuisse tissue and liquid biobanks are currently conveying their data to a common biobanking information management system facilitating sample sharing and linking of samples of individual animals from different repositories."

1:15 – 1:30 pm

Break

Session 1: Dog Physiology, Morphology, Health & Aging

Chaired by:

1:30 – 1:45 pm

The Dog Aging Project Brain Health Study – A Nationwide Effort to Study Companion Dogs with Cognitive Dysfunction as a Model of Alzheimer's Disease

Silvan R. Urfer, Dog Aging Project, University of Washington Dept. of Lab Medicine & Pathology

Companion dogs mirror several key aspects of human aging that cannot be easily replicated in the laboratory: They are genetically heterogeneous, share the human environment and its various risk factors, receive comparable medical care, and have extensive clinical data available. Like humans, companion dogs also spontaneously develop many age-related diseases, such as Canine Cognitive Dysfunction (CCD), a neurodegenerative disease that mirrors human Alzheimer's Disease (AD): Dogs with CCD progressively lose cognitive function and normal sleep patterns, fail to recognize familiar persons, and display increased anxiety. Additionally, they develop Amyloid-beta 42 (A β 42) and at least some hyperphosphorylated Tau (pTau) pathology in their brains. As part of the larger Dog Aging Project (DAP; dogagingproject.org), the DAP Brain Health Study is studying dogs with known cognitive statuses by collecting brains from dogs euthanized for medical reasons, as well as blood and cerebrospinal fluid from live dogs. We are analyzing these samples using neuropathology and molecular assays in order to elucidate the biomedical processes occurring in dogs with CCD. This, in combination with the rich data generated by the DAP, will enable us to further characterize the parallels to AD in humans, to establish biomarkers, and to potentially test therapeutic interventions in the future.

1:45 – 2:00 pm

Characterization of Neuropsychiatric Symptoms in Dogs with Dementia

Daniel W. Fisher, University of Washington

Over 90% of people with Alzheimer's Disease (AD) experience Neuropsychiatric Symptoms (NPS), including apathy, agitation, aggression, anxiety, dysphoria, impulsivity/disinhibition, and even psychosis. In Canine Cognitive Dysfunction (CCD), a disorder with neuropathological changes similar to AD, behaviors reflective of NPS are common and challenging to manage clinically. Despite the significant burden of these NPS in humans and dogs, little is known about the molecular mechanisms. Here we present our preliminary neuropathological findings from using state-of-the-art quantification of Amyloid- β plaques and microglial activation on post mortem brain samples from a dog affected with CCD. In collaboration with the Dog Aging Project (DAP) and leveraging its rich clinical and environmental data in companion dogs, we will investigate the epidemiological factors of NPS in dogs and collect neuropathological data from a select group of dogs with and without CCD and NPS. This includes validating a novel screening and research questionnaire to track NPS in CCD, neuropathological investigations into apathy-like behavior in CCD, and proteomic investigations of post-mortem brain tissue samples of a select group of DAP participants. From these investigations, we hope to contribute to understanding more about dementia in humans and dogs so we can create future therapeutics to benefit both species.

2:00 – 2:15 pm

Development and initial validation of a dog quality of life instrument.

Geert De Meyer, MARS Petcare

The increasing attention for the dog-owner relationship combined with advances in nutrition and veterinary care have made wellbeing a focal point for dog owners, veterinarians, and dog product and service providers. While canine wellbeing can be quantified by survey-based quality of life instruments like those used in human healthcare, there are currently few instruments available that can do this reliably and at scale. Here we report the development and initial validation of a canine quality of life instrument specifically designed to quantify wellbeing in the general dog population. The instrument is based on a simple 32-question survey and includes 5 daytime domains (energetic, mobile, relaxed, happy, sociable) and 3 mealtime domains (relaxed, interested and satisfied). It captures specific health-related aspects as well as more general wellbeing aspects and, in an initial sample of 2813 dogs, already provides useful insights on canine wellbeing. We believe that data collection at scale with this instrument will help bring optimal wellbeing to the dogs we care for.

2:15 – 2:30 pm

Cellular metabolic pathways of aging in dogs: could p53 be at play?

Ana G. Jimenez, Colgate University

Larger dog breeds have shorter lives and die of cancer more readily than smaller breeds. The tumor suppressor p53 factor is a key suppressor oncogene and the p53 pathway arrests cellular proliferation and prevents DNA mutations from accumulating during cellular stress. The p53 pathway can also control cellular metabolism to prevent shifts common to cancerous phenotypes. We explored whether increases in glycolysis in larger breed dogs are associated with p53 activity in large breed puppies (N=47), small breed puppies (N= 40) and large breed senior dogs (N=36), and small breed senior dogs (N=13), a total of N=136 subjects. We used primary fibroblast cells from small and large, puppies and old dogs. Control cells and UV-treated cells were used to measure aerobic and glycolytic metabolic profiles using a Seahorse XFe96 oxygen flux analyzer. Additionally, we quantified inherent differences in p53 expression in canine primary fibroblasts, before and after UV-treatment by using immunohistochemistry. Using a three-way ANOVA (size, age, treatment), we found no differences in aerobic or glycolytic cellular metabolic profiles between control and UV-treated cells. Preliminary data of immunohistochemistry of p53 protein expression revealed differences in the interaction term between treatment*size class ($F_{1,67} = 7.258$, $p = 0.009$) in the ratio of p53 in the nucleus compared to the cytoplasm, where control values for small breed dogs showed the highest ratios comparatively.

2:30 – 2:45 pm

Behavioral and Biological Markers of Trauma in Dogs

Rosemary Strasser, University of Nebraska Omaha

Companion animals rescued from adverse environments, such as hoarding situations, dogfighting, or overcrowded commercial breeding operations, often require intensive rehabilitation before rehoming, placing a tremendous burden on shelters. Few studies have examined harm caused by adverse environments beyond what is visibly seen upon intake (e.g., scars, malnutrition, etc.). In the following presentation, I will present data from past and current studies in my laboratory that have examined behavioral and biological markers within dogs rescued from adversity environments. We have found that dogs with a history of living in adverse environments have higher cortisol levels [$F_{1,23} = 4.51$, $p = 0.045$] and altered behavior in a novel social context [more fear behavior ($p = 0.022$) and lower affiliative ($p = 0.039$) compared to other shelter dogs. Research on a novel biological marker associated with psychological distress in other animal models is also being investigated. In addition to the physical signs of trauma that may appear in dogs from adverse backgrounds, developing novel behavioral and biological markers of psychological trauma in dogs is needed both for rehabilitation purposes and to inform on animal welfare policy.

2:45 – 3:00 pm

An Investigation of Activity Tracking Data and Analgesic Protocols to Assess Elective Sterilization Recovery

Geert De Meyer, MARS Petcare

Although spay and neuter procedures are one of the most frequently performed operations in dogs, little is known on how recovery time might differ between analgesic protocols used. This retrospective analysis includes observational data on 735 dogs that underwent general anesthesia for elective sterilization and had activity tracking data available for seven days prior to and up to 21 days following the intervention. Recovery time was defined as the time where the daily activity reached 80% of the pre-intervention activity. Effects of analgesic drug combinations were studied by a doubly robust causal survival analysis that included propensity score weights and appropriate covariates selected from a causal directed acyclic graph. Results revealed that analgesic protocols significantly affected the recovery time ($p < 0.001$) with the differences between the best and worst options ranging from 3 to 10 days depending on dog size and sex. Our results demonstrate that causal data analysis methods applied on observational data can reveal valuable insights on veterinary care topics.

3:00 – 3:15 pm

Break

Session 2: Dog Breeds, Domestication & Genetics

Chaired by:

3:15 – 3:30 pm

The Genetic Selection of Alaskan Sled Dogs for Athletic Performance

Heather J. Huson, Cornell University

Alaskan sled dogs (ASD), bred for over a century for their athletic prowess, provide a unique opportunity to study the genetics influencing athletic performance. Originally serving as the sole means of transportation in the arctic, they were transitioned into a sporting dog used for racing by the 1930's. The sport diverged into two racing styles: sprint (<30 miles) and distance (up to 1,000 miles) with dogs being selected for speed or endurance respectively. Genotype data was used to compare runs of homozygosity (ROH) and marker based FST. Similarly, genome-wide associations studies on traits such as work ethic, mental stress tolerance, and a dog's ability to lead the team were conducted. Preliminary ROH results using 440 ASD identified genes overrepresented in the biological pathways of multiple metabolic processes, respiratory electron transport chain, locomotion, muscle contraction, and metabolite and energy precursors as being differentially selected upon between sprint and distance ASD (p -value<0.05). Trait association studies of 241 elite and poor performing ASD identified regions of the genome associated (FDR p -value< 0.05) with work ethic and mental stress tolerance in the total population and speed in the sprint dogs. Two hundred ASD are being genotyped and will be added to these analyses.

3:30 – 3:45 pm

Neuroanatomical correlates of breed differences in canine temperament

Erin E. Hecht, Harvard University

Aspects of temperament, such as aggression, anxiety, and trainability, differ significantly across dog breeds and are highly heritable. We analyzed structural MRI scans from 62 dogs of 33 different breeds in relation to scores on a well-validated measure of canine temperament, the Canine Behavioral Assessment

and Research Questionnaire (C-BARQ). Several traits showed significant relationships with gray matter variation across the dataset. Stranger-directed fear and aggression, putatively the main behaviors under selection pressure during wolf-to-dog domestication, were linked to brain networks involved in social processing and the flight-or-fight response. Additionally, expansion in cortex was significantly associated with trainability scores. Meanwhile, reductions in cortex and expansion in subcortical regions was associated with fear, aggression, and other "problem" behaviors. These results closely overlapped with regional volume changes with total brain size. This suggests that the established link between dog body size and behavior is due at least in part to disproportionate enlargement of cortical regions in larger-brained, larger-bodied dogs. These results recapitulate patterns of neurodevelopmental constraint previously documented in a cross-species context, where later-developing regions (cortex) are disproportionately enlarged in larger-brained, larger-bodied animals. We explore the relationship between these results and the known correlation of increasing reactivity with decreasing body size in dogs.

3:45 – 4:00 pm

Effects of genetics and socialization on fox behavior

Anna V. Kukekova, University of Illinois at Urbana-Champaign

The sociability of tame and conventionally bred foxes (*Vulpes vulpes*) was measured by their tendency to approach and interact with an experimenter. Three groups of foxes (11 foxes per group) were tested: 1. Tame and 2. Conventional foxes which were raised under standard farm conditions, and 3. Tame-Socialized foxes which were raised in a group that received regular human contact. The foxes' responses to the experimenter were coded for 20 behaviors and then analyzed using Kruskal-Wallis test. We observed that both Tame and Tame-Socialized foxes spent significantly greater time in proximity to the experimenter than Conventional foxes. In contrast, less than half of Conventional foxes entered a 2m-diameter circle with the experimenter and were the least active group during the test. Of the three fox groups, those that were Tame-Socialized spent the most time interacting with the experimenter, while Tame foxes showed the greatest activity and shortest latencies to approach. Furthermore, Tame foxes demonstrated more excitement during testing while Tame-Socialized foxes were the most comfortable interacting with the experimenter, a likely effect of their previous socialization experiences. Overall, we found the greatest behavioral differences when comparing Tame and Tame-Socialized to Conventional foxes, as would be expected from their genetic differences.

4:15 – 6:00 pm

Poster session and welcome social

6:45-9pm

Informal dinner/Happy hour at

Saturday, October 8, 2022

8:00 – 9:00 am

Registration

9:00 am

Opening Remarks

Ana G. Jimenez, Colgate University

9:15 – 10:15 am

(Plenary Lecture) Deepening Our Understanding of Dog-Human Bonds

Monique Udell, Oregon State University

Introduced by:

Research has suggested that pet dogs and humans can form attachment bonds. However, the broader attachment literature suggests that both the kind and quality of attachment relationship may also be relevant when considering how these relationships influence a dog's behavior. Through a series of experiments, we have identified at least two kinds of attachment bond relevant to the dog-human relationship, as well as meaningful differences in attachment style between dogs and adult owners with different parenting styles (Fisher's Exact Test, $p = 0.04$) and also in a dog's initial attachment behavior towards children and adults within the same household (Binomial tests, $p < 0.03$). In addition, the quality of these relationships was found to predict other aspects of the dog's behavior, including time spent gazing at the owner ($\chi^2 = 6.94$, $p = 0.03$) and independent problem-solving focus and persistence ($\chi^2 = 6.67$, $p = 0.04$). Our findings suggest that not all bonds are created equal when it comes to predicting the behavioral and welfare implications of these relationship. Consequently, there is a need for more research aimed at understanding the nature and quality of individual dog-human relationships, and how best to promote mutually beneficial outcomes across different settings.

10:15 – 10:30 am

Break

Session 3: Adoption, Shelter Practices & Attachment

Chaired by:

10:30 – 10:45 am

Reducing Kennel Reactivity in Shelter-Housed Dogs

Rachel J. Gilchrist, Arizona State University

Behavioral indicators of human-directed reactivity have been implicated in longer lengths of stay for shelter dogs and identifying ways to reduce human-directed reactivity would not only benefit the immediate welfare of the dog but also could decrease the amount of time the dog spends in the shelter. The purpose of this study was to evaluate the generalizability of a response-independent food intervention in reducing human-directed reactive behaviors across experimenters and non-experimenters, as well as assessing what behaviors dogs show before, during, and after the presence of people at the front of their kennels. The presence a person at a dog's kennel and the dog's behavior was collected for 59 dogs across three Arizona shelters over 14 days, during which an experimenter conducted one session per dog per day (i.e., threw a treat through the kennel ten times per day on the 10 intervention days). Preliminary

results of trial-level analyses indicate that >91% of dog engaged with the intervention, and that people spend approximately 46 minutes per day passing by a dog's kennel. A minimally-effortful intervention can successfully be used to engage human-reactive shelter dogs while in the presence of a human.

10:45 – 11:00 am

The efficacy of differential reinforcement of alternative behaviour compared to counter conditioning in increasing human approach behaviour in dogs within a rescue centre.

Lynda Taylor, Bishop Burton College

Modifying fearful responses in dogs is generally based in classical counter conditioning (CCC). However, differential reinforcement of alternative behavior (DRA) also results in changes in emotional state. Nevertheless, there is limited research comparing the efficacy of the two. This research compared DRA to CCC in its ability to increase human approach behavior (HAB) in fearful dogs. Thirty dogs were assessed for HAB through positioning within the kennel run and then randomly allocated to one of three groups, CCC, DRA, or control. During the conditioning phase, food was tossed into the kennel run for the CCC group; in the DRA group, dogs were reinforced for interactions with a cone. Following 10 episodes of conditioning, HAB was reassessed. Within both groups, a significant difference was indicated between baseline and post-conditioning for total time spent at the kennel gate and run ($N=10$, $T=28$, $p=0.018$, $r=0.53$). However, in the DRA group, there was also a significant increase in time spent in the kennel run compared to the kennel rear ($N=10$, $T=35$, $z=2.38$, $r=0.53$). This suggests that DRA may be more effective than CCC in increasing HAB in the most fearful dogs.

Session 4: Applied Behavior, Behavior Assessments & Dog success

Chaired by:

11:00 – 11:15 am

Do we know what dogs want? Applying an animal welfare science lens to our field.

Mia Cobb, The University of Melbourne

Canine science has thrived over the last 15 years. It is now recognized as an interdisciplinary field advancing our understanding of canine physical health, cognition, behavior, ecology, genetics and evolution, human-animal interactions, canine senses and performance. Over this same period, the field of animal welfare science has also progressed, translating findings from physiology, neuroscience, behaviour and anatomy to enhance our understanding of the lived experiences of non-human animals, including dogs. Understanding and assuring the welfare of animals is increasingly important globally, underpinning the social license to operate for many industries reliant upon animals amidst changing societal ethics concerning animals. This presentation reviews research efforts within canine science over the last fifteen years through the lens of the Five Domains of Animal Welfare model. The results highlight canine science's emphasis on anthropocentric goals and expose important deficits, representing significant opportunities for researchers. The importance of multi-, inter-, and trans-disciplinary research approaches, including both qualitative and quantitative methods are identified. Finally, the strategic importance of centring canine welfare as a priority within our science, and how this can be accomplished, is discussed.

11:15 – 11:30 am

Leveraging Canine Cognition to Enhance Search Vigilance in Operational Scenarios

Mallory DeChant, Texas Tech University

Detection dogs are routinely asked to search in environments that have few to zero target odors to be found. Previous studies have demonstrated reduced performance and a search decrement in dogs that are repeatedly asked to search in these environments. The aim of this study was to develop a laboratory model under controlled settings that demonstrates search vigilance decrement under low target odor prevalence. Eighteen dogs were trained to detect double base smokeless powder in a three-choice automated olfactometer device. Dogs received five daily sessions of training (Baseline phase) in two different rooms/contexts (simulated "Operational" and "Training" contexts) at a target odor prevalence rate of 90%. Next, dogs progressed to the Testing phase where dogs received five daily sessions in each context. The target odor prevalence rate in the Training context remained at 90%, whereas the Operational context was decreased to 10%. All dogs demonstrated a significant decrement in search related behavior (timeouts, search latency, and lower number of odor port searched) and detection performance in the Operational room where the target odor prevalence rate was 10%. Behavioral coding revealed a relax tail, higher search score, lower search latency, and lower environmentally directed behavior was correlated with higher accuracy.

11:30 – 11:45 am

Effects of early rearing environment on working dog puppy behavior and outcome

Emily Bray, University of Arizona; Canine Companions for Independence

Previous studies have found that levels of maternal care during the first few weeks of life are associated with subsequent puppy and adolescent behavior, as well as success in a guide dog program. To further explore the role of mothering, we observed maternal interactions in service dog litters from Canine Companions ($N=59$ dams, 235 puppies). Variation in maternal style could be summarized by a single principal component and was associated with demographic factors, including birth season and breed, as well as a subset of behavioral traits measured in dams, prior to parturition. Variation in maternal style was associated with several offspring behavioral phenotypes (measured by behavioral assays and validated questionnaires), with effects observable at 8 weeks of age and enduring into adulthood. We also found a strong relationship with service dog outcome: specifically, dogs with more interactive mothers were more likely to graduate from the training program ($\beta=0.86$, 89% CI = 0.26 – 1.66). Intriguingly, we had previously found the opposite in guide dogs. Thus, optimal early-life conditions likely vary based on the specific functional roles that dogs are bred and trained for.

11:45 – 1:30 pm

Lunch

On your own – explore downtown Hamilton. Lunch suggestions can be found on our CSC2022 website!

Session 4, continued: Applied Behavior, Behavior Assessments & Dog success

Chaired by:

1:30 – 1:45 pm

Evaluating dog interactions with food-based enrichments during short periods of social isolation

Hannah Flint, Waltham Petcare Science Institute

As a social species, dogs may experience negative emotional states when isolated from human caregivers and conspecifics. This study aimed to evaluate how dogs interact with different enrichments during a short period of social isolation, as a first step towards identifying methods for improving dog emotional wellbeing. Using a cross-over design, dogs ($n=20$) at Waltham Petcare Science Institute were exposed to four different food-based enrichments

while left alone in a familiar room for 20 minutes: long-lasting chew (Chew), kibble in a treat-dispensing toy (Toy), and kibble dispensed through a remote treat-dispensing device with (Device+Voice) and without (Device) a person talking to the dog. Time spent engaging with each enrichment, and emotional valence and arousal (7-point scale collected every 5-minutes) were scored from videos. Results of linear mixed models indicated Chew was the most successful enrichment, with dogs having higher valence ($p < 0.01$ vs Device and Device+Voice) and lower arousal ($p < 0.01$ vs Device and Toy) scores during the first five minutes of isolation, and spending the most total time engaged ($p < 0.01$ vs all). Based on these findings, long-lasting chews should be further explored to assess their impact on dog emotional wellbeing during longer periods of social isolation.

1:45 – 2:00 pm

Litter size and intervention influence puppy competitive behaviour during nursing in the domestic dog (*Canis lupus familiaris*)

Quinn Rausch, University of Guelph

Early experiences with littermate competition might influence competition later in life, including development of aggressive forms of resource guarding behaviour. Objectives of this study were: 1) to identify and describe puppy competition during nursing and, 2) to identify factors associated with the performance of competitive behaviour. Nursing videos of 101 litters (N=582 puppies) were obtained from YouTube. Competitive and nursing behaviours were scored using BORIS for 60 seconds mid-nursing bout, and associated factors were assessed using mixed logistic regression. During observations, 63% of puppies displayed competitive behaviour and 94% of litters had at least one competitive puppy. Puppies from litter sizes of 7-9 had higher odds of displaying competitive behaviour compared to litter sizes of 2-4 puppies ($p = 0.006$), likely due to limited space and nipple availability. Puppies who received human or bitch intervention during nursing also had higher odds of displaying competitive behaviour ($p = 0.034$). This could either be because puppies who were struggling to get nipples had to compete, or that competitive puppies were intervened with because they were being too competitive. Results show young puppies show competitive behaviour during nursing and levels are influenced by management factors; further research is needed to explore impacts on later behaviour.

2:10 pm – 2:15 pm

Do cognitive tasks predict dogs' social behavior in a dog park?

Kyle C. M. Smith, Pennsylvania State University

Various cognitive tasks have been purported to measure dogs' social cognitive abilities. However, few studies have compared observed behavior of dogs with their performance on such cognitive tasks. I will examine the external validity of social cognitive tasks by comparing dogs' performance on these tasks to observed behavior in a dog park. During the summer of 2022, forty dogs were filmed for 30 minutes each in Tudek Dog Park, State College, Pennsylvania. From these focal follows, the proportion of time a dog spends exhibiting affiliative and stress behaviors was coded. In a follow-up visit, each dog participated in a series of cognitive tasks, including gesture-following, gazing to humans in an unsolvable task, and reaction to opening an umbrella. I will test whether communication tasks correlate positively with affiliative behaviors and whether a reactivity task correlates positively with stress behaviors. To test these statistically, I will use binomial GLMMs to predict proportions of observed behavior categories based on cognitive task performance (significance level $p < 0.05$). The findings of this study will help clarify the ways in which dogs' cognitive abilities affect their social interactions, or alternatively point to possible overinterpretation of cognitive tasks conducted in the lab.

2:15 – 2:30 pm

Break

Session 5: Social Reinforcement, Cognition & Learning Chaired by:

2:30 pm – 2:45 pm

Categorizing Dogs' Real World Visual Statistics

Madeline H. Pelgrim, Brown University

Dogs are relied upon in a variety of working roles, yet little is known about the kinds of visual information available to them, as well as how they direct their attention within their environment. The present study, inspired by comparable work in infants, aims to categorize the identity of objects available to dogs during a common event in their daily lives, a walk. Using a head-mounted eye-tracking apparatus that was custom designed for dogs, dogs walk on a pre-determined route outdoors under naturalistic conditions. Frames from walk videos are analyzed using computer vision techniques to determine the objects in dogs' view and which objects they look at. Data collection is ongoing ($n = 4$ dogs generating 49,431 frames for analysis). So far, there are few individual differences between dogs. Dogs look proportionally more to people and plants than to other objects in their environment, such as the sky which they rarely look to. The results of this project provide a foundational step towards understanding how dogs' look at and interact with their physical world, opening up avenues for future research into how they complete tasks, and learn and make decisions, both independently and with a human social partner.

2:45 pm – 3:00 pm

Evaluations of prosociality and competence in domestic dogs (*Canis lupus familiaris*)

Zachary Silver, Yale University

Humans evaluate other agents' behavior on a variety of dimensions including prosociality and competence. Seeking out prosocial, competent agents while avoiding antisocial, incompetent agents enables the selection of suitable social partners and facilitates effective cooperation. While these evaluations are well-documented in the human species, less is known about social evaluation in non-human animals. Dogs represent an optimal species to examine whether social evaluation is unique to the human species given their domestication history and social experience with humans. Here, we explore dogs' ability to evaluate humans on the basis of prosociality and competence. Using third-party social evaluation paradigms, we find that trained (binomial: 88%, $p < .01$) but not untrained dogs (binomial: 50%, n.s) prefer prosocial over antisocial humans. In the domain of competence, however, we find that neither trained ($t = 0.44$, $df = 18$, n.s) nor untrained dogs ($t = 0.08$, $df = 39$, n.s) preferentially recruit competent over incompetent humans. These results suggest that with sufficient experience acquired via training, dogs can show human-like evaluations of prosociality. However, training does not appear to bolster dogs' evaluations of competence. Taken together, our findings provide a preliminary framework for how dogs make social judgments about novel human agents.

3:00 – 3:15 pm

Do Dogs Care About People?

Clive Wynne, Arizona State University

Two experiments explored how dogs value their humans. In the first, dog owners (N=60) entered a box and cried out in Distress or Read calmly while their dog was nearby. In a Control condition, a treat was dropped into the box. 20 dogs rescued their owner in the Distress test, 16 in the Reading test and 19

retrieved treats in the Control task. After accounting for ability to open the box to obtain food, dogs released their owner more often in the Distress condition than the Reading condition ($X^2(1, N=60) = 36.35, p < .0001$). In a second experiment dogs ($N=60$) were pre-trained to open the box. 44 dogs opened in the Distress test, 43 in the Reading test and 42 in an additional Silent condition. These differences were not significant ($X^2(2, N=60) = 2.60, p = .27$), however there were significant differences in latency to open the box ($X^2(2, N=60) = 0.98, p < .0001$) with dogs opening slower in the Silent test than the Distress ($z = 2.94, p < .01$, or Reading tests ($z = 4.65, p < .001$). Opening latencies did not significantly differ between the Distress and Reading tests, ($z = -1.74, p = .20$). These results will be discussed in the context of inter-species prosocial behavior.

3:15 – 3:30 pm

Do Dogs Rely on Their Experience With a Cue to Predict How Others Would Respond to It?

Dana Ravid, City University of New York

Theory of Mind (ToM), the ability to impute mental states to others, has been studied extensively in animals, but findings are still controversial. Dogs were shown to behave in accordance with what humans see or know, e.g., beg for food from a seeing vs. an unseeing person. However, it is unclear whether they do so by actually attributing mental states such as knowledge or by relying on how they previously saw humans behave in similar circumstances. To address this question, we tested whether pet dogs relied on their own experience with an auditory cue to predict how humans would respond to it, without ever having observed them do so. For this, eight dogs learned to use a sound to find a treat. Then they were tested whether they would predict that an experimenter would use the cue in a similar manner. So far, five dogs completed the test and showed that they did not rely on the auditory cue to make their predictions. This study has implications for our understanding of dogs' cognition and dog-human interactions. Additionally, the method implemented here may be used to study ToM-related behaviors with other species including human.

3:30 – 4:00 pm

Break

4:00 – 5:00 pm

(Plenary Lecture) The Dog Aging Project

Daniel Promislow, University of Washington School of Medicine

Introduced by:

Dogs offer a powerful model to understand natural variation in aging. Breeds vary tremendously in lifespan and risk of specific diseases. They share our own environment, yet experience the process of aging so much more quickly than we do. The Dog Aging Project (DAP) was created to discover the biological and environmental factors that influence aging in dogs, and to seek ways to maximize healthy lifespan. The DAP is a long-term longitudinal study of aging, funded by the National Institute on Aging, and run by a nationwide team of scientists, veterinarians, trainees and professional staff. Since its launch in 2019, more than 40,000 people and their companion dogs have joined, and recruitment continues. Data include owner-reported surveys, environmental information, and from a subset of dogs, clinical chemistry, whole genome sequencing, and profiles of the epigenome, metabolome, microbiome and flow cytometry. As an Open Data project, data and residual samples are publicly available. Moreover, the DAP has created a foundation upon which others are invited to propose and create ancillary research projects. This presentation will discuss our published results from analysis of survey data, as well as new and unpublished findings from biological samples.

5:45 – 8:30 pm

Catered dinner

Sunday, October 9, 2022

8:00 – 9:00 am

Registration

9:00 am

Opening Remarks

Ana G. Jimenez, Colgate University

9:15 – 10:15 am

(Plenary Lecture) Everyone is your friend! Learning about the genetics that influence canine hypersociability

Bridgett vonHoldt, Princeton University

Introduced by:

Research has suggested that pet dogs and humans can form attachment bonds. However, the broader attachment literature suggests that both the kind and quality of attachment relationship may also be relevant when considering how these relationships influence a dog's behavior. Through a series of experiments, we have identified at least two kinds of attachment bond relevant to the dog-human relationship, as well as meaningful differences in attachment style between dogs and adult owners with different parenting styles (Fisher's Exact Test, $p = 0.04$) and also in a dog's initial attachment behavior towards children and adults within the same household (Binomial tests, $p < 0.03$). In addition, the quality of these relationships was found to predict other aspects of the dog's behavior, including time spent gazing at the owner ($\chi^2 = 6.94, p = 0.03$) and independent problem-solving focus and persistence ($\chi^2 = 6.67, p = 0.04$). Our findings suggest that not all bonds are created equal when it comes to predicting the behavioral and welfare implications of these relationship. Consequently, there is a need for more research aimed at understanding the nature and quality of individual dog-human relationships, and how best to promote mutually beneficial outcomes across different settings.

10:15 – 10:30 am

Break

Session 5, continued: Social Reinforcement, Cognition & Learning

Chaired by:

10:30 – 10:45 am

Does Mikey Like it? Investigating dog preference based on behavior and owner perception

Anamarie Johnson, Arizona State University

Most studies on dog food and treat preferences focus on how the owner feels about the food (using self-reported surveys) or how the dog interacts with the food. Dog behavior is often investigated by analysis of intake ratios, approach latencies, and choice in simple comparison presentations. The aim of this study was to examine dog behavior and engagement in a home-environment with eight different dental chews using direct behavioral analysis and to investigate any relationship between coded dog behavior and owner survey responses regarding preference among the chew types. Eighty-eight participants recorded their dogs engaging with each dental chew. These videos were then analyzed for appetitive behaviors. Regression analysis compared how appetitive behavior predicted owner preference and owner-reported dog preference based on the survey questions. Overall, appetitive behavior did not differ significantly across the eight chews, but large dogs showed significantly more appetitive behavior than small or medium dogs. Owner happiness and indifference to the dental chew correlated significantly with owner reported dog happiness and disappointment with the chew ($r(702) = .61, p < .001$; $r(702) = .53, p < .001$). Appetitive behavior accounted for little variance in owner preference but accounted for about 18% of variance in owner-reported dog chew preference.

10:45 – 11:00 am

What is Written on a Dog's Face? Implications of Phenotype Diversity in Human-directed Canine Communication

Courtney L. Sexton, The George Washington University

Dogs have acquired behavioral and anatomical traits that engender successful social interaction with humans. In particular, dogs make eye contact and use a variety of facial cues to effectively communicate with human companions. Through behavioral and physical phenotype analyses of domesticated dogs living in human households, this project evaluates the potential impact of superficial facial markings on the production of human-directed facial expressions. DogFACS was used to capture expression rates, and facial patterns and coloration were coded according to an original schematic. Preliminary results suggest minimal correlation between expression rate and facial complexity score. Interestingly, per study surveys, human companions poorly characterize dogs' rates of facial expressivity, with most scoring dogs higher than observed at test. Also of note are within-subject rates of expression vs. attention. Many dogs scoring lower on expression maintained prolonged eye contact with the human companion. Understanding how and to what degree interaction with humans impacts the development of novel modes of communication in dogs could provide valuable insight into what shaped early human culture. Likewise, by gaining a fuller understanding of how dogs communicate with humans, we can be better equipped to support them in the critical roles they fill within our society.

Session 6: Dog Breeds, Domestication & Genetics
Chaired by:

11:00 – 11:15 am

Functional Impacts of High-Effect Mutations Associated with dog Hyper-Sociability

Dhriti Tandon, Princeton University

A significant amount of variation in human-directed dog sociability can be traced to a polymorphic transposable elemental (TE) insertion that lies within the General Transcription Factor 2-I (GTF2I) gene. However, not much is known about the molecular impacts of this polymorphism. TEs can cause changes in chromatin looping that lead to altered cis- regulatory contacts. Chromatin conformation capture data showed that dogs containing the TE formed a loop with the gene Elastin (ELN) that incidentally plays a key role in the penetrance of phenotypes such as enhanced social behavior and cranio-facial abnormalities in humans with Williams Syndrome. This loop was absent for dogs lacking the TE. Subsequently, we found a significant difference in expression of LAT2. This gene is located between GTF2I and ELN, which make the two ends of the chromatin loop, and is involved in the glutamate-glutamine cycle of the brain. We also found a modest change in expression of ELN ($p=0.19$). Co-expression analyses reveals that genes functionally related to ELN and LAT2 differ in expression between samples containing and lacking the TE. Hence, the TE insertion site located within GTF2I could have the propensity to alter three-dimensional chromatin looping and subsequently changes in gene expression.

11:15– 11:30 am

Do dogs have elements of Williams-Beuren Syndrome? Transposons, behavior & training success in a population of assistance dogs

Gitanjali E. Gnanadesikan, University of Arizona

Williams-Beuren Syndrome is a neurodevelopmental disorder in humans—caused by the deletion of 28 genes—involving hyper-sociability and cognitive deficits. In canines, the homologous region shows a strong signature of selection in dog-wolf comparisons. Within this region, four loci with structural variants derived from transposons have been associated with social behavior in dogs and wolves. We conducted a cohort study of 1,001 dogs from a population of assistance dogs (Canine Companions), including both successful graduates and those released from the training program for behavioral reasons. Phenotypic data included puppy-raiser questionnaires (C-BARQ), trainer questionnaires, and cognitive and behavioral tests (DCDB). Bayesian mixed models revealed strong associations (CI95% excluded 0) between genotypes at two loci and certain phenotypic measures, including separation-related problems, response to a threatening stranger, response to an unfamiliar dog, and performance on a novel communicative gesture task. Furthermore, we found moderate differences in the genotypes of dogs who graduated versus those who did not; insertions in GTF2I showed the strongest association ($\beta = 0.24, CI95\% = -0.13 - 0.64$), indicating a 28% increased chance of success with one insertion. Our results provide insight into the role of these loci in dog sociability and may inform breeding and training practices.

11:30– 11:45 am

Hand-reared wolves showing attachment behaviours toward a human caregiver demonstrate that this capability did not evolve uniquely in dogs

Christina Hansen Wheat, Lund University

Domesticated animals are assumed to display increased human-directed sociability compared to their wild ancestors. Dogs have a remarkable ability to form social relationships with humans, including attachment, a bond based on emotional dependency. The ability to form attachment with humans is specifically suggested to have evolved post-domestication in dogs, but attempts to quantify attachment in wolves have also been performed. However, while these rare wolf studies highlight the potential for wolves to express human-directed attachment, the varied methods and contrasting results emphasize the need for further testing. We used the standardized Strange Situation Test to investigate attachment behaviour in wolves and dogs hand-reared and socialized under identical conditions. We found that 23-week-old wolves and dogs equally discriminated between a stranger and a familiar person, expressing similar attachment behaviours toward the familiar person. Additionally, only wolves expressed significantly elevated stress behaviour, but the presence of the familiar person buffered this stress response. Together, our results suggest that wolves can show attachment behaviours toward humans comparable to those of dogs. Importantly, our findings demonstrate that the capability to form attachment with humans exists in relatives of the ancestor of dogs, thereby refuting claims that this phenotype evolved after dog domestication was initiated.

11:45– 12:00 pm

Development of object play in wolf pups (*Canis lupus*) with comparisons to dogs (*Canis lupus familiaris*)

Karen M. Davis, SUNY Potsdam and University of Tennessee

There is a lack of studies exploring the development of object play of wolf and dog pups. Comparisons of wolves vs. dogs can aid in teasing out the influences of domestication on type, extent and possible functional significance of differences. We report the development of object play from 2 to 9 weeks of age in 2 litters of wolf pups (*Canis lupus*) hand-reared at Wolf Park in Battle Ground, IN. Both litters were video-recorded in their home enclosures at the week and half week marks. Each litter was given a separate set of the same five commercial dog toys with differing sensory and functional qualities. The first ten minutes of activity from each session were analyzed using the Noldus Observer XT program and a previously developed ethogram of object related behaviors. The results were analyzed using repeated measures LMMs. Percent of time spent playing with toys, ($F(6,20)=5.53$, $p=0.002$), behavioral count ($F(6,22)=9.13$, $p<0.0001$), and behavioral diversity ($F(6,22)=10.10$, $p=0.0001$) all increased significantly with age for wolf pups. Findings showed both similarities and differences with dog breeds previously studied using the same toys. These findings expand our grasp of infant wolf behavior and the comparative development of object play in canines.

POSTER ABSTRACTS

1. Dog Relinquishment to a UK Rehoming Organization During the Covid-19 Pandemic

Karen E. Griffin, Utrecht University & The Dog Rehoming Project

Suggested increases in adoption rates at the start of the Covid-19 pandemic have reportedly led to relinquishments as lockdown restrictions eased. However, there has been a lack of scientific investigation into these claims, and a lack of understanding of the impact of the pandemic relinquished dog demographics. Three years of dog intake data (2019-2021) from a UK rehoming organization were analyzed. The total number of dogs relinquished during this period was 922. There was a significant relationship between year and dog friendliness ($p < 0.001$); dogs relinquished more recently were more likely to be labeled as dog unfriendly. There was no effect of year relinquished on dog sex ($p > 0.05$), or between year relinquished and dog size ($p > 0.05$). Owners may be more unable or unwilling to cope with dogs who do not readily tolerate other dogs as lockdown restrictions eased. Consistency of sex suggests that this factor did not impact relinquishment, with males remaining higher throughout. No changes in relinquished dogs' sizes suggests that people's reasons for relinquishment are not altered by how big the dog is. With continued lifestyle changes impacting owners, rehoming organizations need to be aware of the impact of the pandemic on prevalence and tolerance of dog-related behavioral challenges.

2. The Development of a Theoretical Model and Tool for Assessing Shelter Dog QoL Pre- and Post-adoption

Dr. Karen E. Griffin, Utrecht University & The Dog Rehoming Project

Shelters intend for dogs pre- and post-adoption to have the best quality of life (QoL). However, there is minimal research into dogs' QoL in either period. This study aimed to: 1) develop a theoretical model of dogs' needs by adapting Maslow's Hierarchy of Needs, and 2) develop a practical tool to assess dogs' QoL based on the theoretical model. Dogs' QoL was qualified as a function of how well their needs are met. Thirty-seven specific needs were identified from scientific literature, and 15 need groups (e.g. access to food) were created. These were organized into levels to create a hierarchy, as analogous to Maslow's as possible. Both hierarchies were sent to an expert panel (e.g. canine welfare scientists) to assess the adapted version's face validity (compared to the original). Using a modified Delphi method, face validity was established using feedback rounds from the expert panel to reach as close to a consensus as possible. Once face validity was established, a QoL questionnaire-style assessment tool was developed based on it. The tool was designed for usage by a wide audience to assess QoL pre- and post-adoption; it is now ready for use in the larger project this study is part of.

3. Investigation into what training methods dog owners use and why

Anamarie Johnson, Arizona State University

While there has been recent attention in the scientific community on the ethical and welfare implications of different dog training methods, less research has investigated what methods and training tools United States dog owners are using and why. We conducted two surveys with nearly 800 Arizona State University undergraduate students to gain a more realistic look into how dog owners in the United States train their dogs and where they are receiving their training information. The implementation of two surveys allowed validation of the first study in seeing similar trends across two populations. Only 5% of respondents reported utilizing a trainer when they had concerns regarding their dog's behavior; 50% would ask a friend or family member or seek advice online. Few reported taking their dog to any training classes; 70% reported either training the dog themselves or not implementing any formal training with their dog. For problem behaviors, 57% of respondents noted that they would use auditory or physical corrections. Overall, 54% of respondents felt that rewards-based training was most effective.

4. Holistic modalities to treat separation-related disorders - a novel approach to address the root cause of anxiety, fear, and frustration

Melanie Uhde, Canine Decoded

The diagnosis of separation-related disorder (SRD), a term encompassing a variety of behavioral issues in dogs, has significantly increased in the U.S. since 2019. Symptoms range from whining and barking to destructive behaviors that can cause harm to the dog. Severe SRD can persist for months, and the lack of effective solutions increases the risk of owners surrendering their dogs to the shelter due to uncontrollable behaviors. A recent study has shown a link between frustration or fearfulness in dogs and non-separation-related contexts, suggesting the need for behavior modification protocols addressing the root cause, not just the symptoms of SRD. We investigated the effect of protocols addressing the neurochemical imbalances associated with general anxiety, fear, and frustration on behaviors typically linked to SRD. In a longitudinal study with three different dog breeds that presented with varying symptoms, SRD-linked behaviors showed significant improvement between 3-4 weeks. Finally, new behaviors indicative of increasing independence and healthy detachment from the owner developed throughout the study in all dogs. Our results emphasize that separation-related behaviors require a holistic approach to balance neuro pathways that are not only triggering SRD symptoms but general anxiety, fear, and frustration, providing a platform for new rehabilitation strategies.

5. Factors Influencing Lifespan in Turkish Companion Dogs

Silvan R. Urfer, University of Washington Department of Laboratory Medicine and Pathology

The number of publications on companion dog lifespan has been steadily increasing; however, all of these studies thus far have been conducted in developed economies. Here we report lifespan data in $n=1,312$ Turkish companion dogs from an online owner survey evaluated through Kaplan-Meier analysis and Cox regression. Median survival time (MST) was 13 years. The most common causes of death were cancer ($N=45$), traffic accidents ($N=41$), and viral infections ($N=32$). Desexing ($\chi^2=31.6$, $P=2E-8$), being a mixed breed ($\chi^2=6.4$, $P=0.01$), and regular preventative care ($\chi^2=5.3$, $P=0.02$) significantly increased lifespan. Roaming freely significantly decreased lifespan ($\chi^2=19.5$, $P=1E-5$). Dogs living in duplexes and single-family homes lived longer than dogs living in apartments and houses on acreage ($\chi^2=10.5$, $P=0.01$). Owner income or education level did not correlate with lifespan. In a Cox model, only desexing ($HR=0.478$, $P=0.0006$), living in a house on acreage ($HR=2.30$, $P=0.0064$) and being allowed to roam freely ($HR=1.59$, $P=0.041$) remained significant. To our knowledge, this is the first study of companion dog lifespan in an emerging economy. While many of our findings correlate with those from developed economies, our sample also allows us to study factors not commonly encountered in developed economies, such as being allowed to roam freely.

6. How do dogs of different body masses, ages, and coats regulate body temperature before and after exercise across different seasons?

Kailey D. Paul, Colgate University

Essential physiological mechanisms in domestic dogs, such as internal temperature regulation, remain poorly understood. Here, we looked at temperature regulation in dogs of different sizes, ages, coat types, and head morphologies across three different seasons in 61 dogs. We used tympanic membrane temperatures and thermal imaging to observe temperature regulation in pet dogs before and after an exercise trial. Using network analysis, we found that body mass was a central feature for spring and summer trials, but not in winter. Similarly, leg length, snout length, and paw width were central predictors in two of three seasons. Mediation analysis demonstrated that nose and snout length act as significant mediators of the effects of body mass on mouth temperatures in the spring. For the summer trials, nose length and paw width significantly mediated the effect of body mass on mouth temperatures. A cross-seasonal examination of repeated measurements showed that mouth temperature heat dissipation rates decreased with increasing temperature and humidity. Overall, we found that Tear and heat dissipation rates are positively correlated with body mass in dogs, thus, negatively correlated with mass-specific metabolism. This finding suggests that small dogs allocate a bigger proportion of their metabolism to "inefficiencies" of heat production to offset greater heat loss.

7. Thermal relations in sled dogs after exercise and across seasons

Geddy Rerko, Colgate University

Canine athletes, like sporting dogs, have a higher cardiovascular and thermoregulatory demand that requires them to have a greater internal temperature regulation. Here, we measured internal body temperature (Tear) and heat dissipation rates using thermal imaging in sled dogs (N=17) before and after exercise. Using linear regressions, we found that nose temperature scaled negatively with body mass in control measurements ($y = -0.2357x + 32.9339$, $R = 0.4882$, $p = 0.0468$), suggesting smaller sled dogs have warmer noses, which may challenge heat dissipation. Mouth temperature scaled positively with body mass during 15 and 30 mins of recovery from exercise (15: $y = 0.2856x + 22.7665$, $R = 0.6864$, $p = 0.0023$; 30: $y = 0.2179x + 25.2454$, $R = 0.4733$, $p = 0.0550$), likely due to the fact that larger dogs have more muscle mass, thus more potential for heat production. There was a significantly negative correlation between nose length and mouth and eye temperature right after exercise (mouth: $y = -2.2502x + 43.1896$, $R = 0.6161$, $p = 0.0110$; eye: $y = -1.7461x + 39.0360$, $R = 0.6398$, $p = 0.0076$), so that larger noses lead to decreases in mouth and eye temperature probably due to nasal turbinates.

8. Designing a System to Test Referential Understanding in Canine Keyboard Use

Heidi Lyn, University of South Alabama

There are hundreds of viral videos about dogs using keyboards to “talk” to their owners, but there is little empirical evidence to show that their key presses have any shared meaning. This was also true of apes until work showing that bonobos and chimpanzees can use a keyboard and understand English at the level of a two-and-a-half year old child (for reviews, see Lyn, 2012, 2017; Lyn & Christopher, 2020). By using techniques and data collection procedures that parallel that of the apes, I have begun a long-term research project to investigate the referential abilities of dogs with the eventual hope of comparing the dogs’ behavior directly to that of the apes. The keyboard will utilize customized housing and software to display English words and pictures of referents when the keys are pressed. Most importantly, all keyboard use will automatically be logged and time-stamped and regular video-taped data sessions of several hours will be gathered. There will also be regular experimental testing of the dog’s symbolic understanding of the symbols and English words and the development of their understanding over time. Designs. Methodologies, and experimental plans will be presented along with any initial results.

9. Re-engagement after disrupted play; evidence for shared intentionality in pet dogs

Molly Byrne, Boston College

Joint intentionality, the mutual understanding of shared goals or actions to partake in a common task, is considered an essential building block of theory of mind in humans. Domesticated dogs are unusually adept at comprehending human social cues and cooperating with humans, making it possible that they possess behavioral signatures of joint intentionality in interactions with humans. Horschler and colleagues (2022) examined joint intentionality in a service dog population, finding that dogs preferentially re-engaged a person with whom they had formed a joint activity instead of a passive bystander. In the current study we aimed to replicate these results in pet dogs. One familiar person played with the dog, and then abruptly stopped. We examined if dogs would preferentially re-engage the player instead of a familiar bystander who was also present. Consistent with the findings of Horschler and colleagues (2022), dogs preferentially gazed toward the player rather than the familiar bystander ($t(57) = 5.228$, $p < .001$). However, no difference was observed in vocalization, toy-offering, or physical contact behaviors. These findings provide preliminary evidence for behavioral signatures of joint intentionality in pet dogs, but future work is needed to understand whether this phenomenon extends to other contexts.

10. Situational Context Influences Humans’ Valence and Arousal Ratings of Dog Emotions

Holly G. Molinaro, Arizona State University

We examined the effect that context has on people’s perception of dog emotions. A dog was filmed in assumed positive (praise, play, treat) and negative situations (cat, novel object, reprimand). Videos were edited in Adobe After Effects software to remove the background. Videos with and without background were presented in an online survey to ASU undergraduates (N = 382), with videos without background being shown first. Participants rated valence and arousal of the dog in each video from 1-10. Valence responses were higher when the background was present ($F_{1,381} = 6.60$, $p < .01$), and were higher to positive situations ($F_{1,381} = 286.50$, $p < .01$). The interaction was also significant ($F_{1,381} = 497.32$, $p < .01$). Arousal did not differ based on whether the background was present or not, but was higher in positive situations ($F_{1,380} = 135.07$, $p < .01$). The interaction was significant as well ($F_{1,380} = 150.11$, $p < .01$). Context in the positive situations made the dog seem to have higher valence but lower arousal. Context in the negative situation made the dog seem to have lower valence but higher arousal. These findings showed that people use contextual information to interpret dogs’ emotions and are extremely impactful for human-animal interactions.

11. Dogs as Observational Causal Learners

Julia Espinosa, Harvard University

Dogs are thought to have poor causal inference abilities, though empirical research in this area is limited. To address this gap, we adapted a task to test dogs’ use of temporal priority and make inferences about causal structures, beyond reinforcement-based association learning. In condition 1, dogs (N=24) watched an event sequence with two levers on a puzzle box, each temporally and spatially equidistant from a treat: one lever pressed before a treat appeared from the box (causal) and the other after the treat appeared (non-causal). Dogs were significantly more likely to investigate the causal lever first (vs. non-causal) on their first exploration of the box, ($M = .75/1.0$, $S.E. = .09$), $t(23) = 2.77$, $p = .01$. We controlled for alternative explanations with a second, causally ambiguous event sequence where both levers were pressed before the treat appeared. We found that, in contrast to condition 1, dogs (N=18) investigated the levers equally on their first exploration of the box. Together, these results suggest that dogs, like infants and non-human primates, may be sensitive to observed information about temporal event sequences and may be capable of using it to infer causal links between events.

12. A canine model for transposon expression and inflammaging

Lucinda Fitzgibbons, University of Washington

LINE1 (L1) retrotransposons have been implicated as drivers of sterile inflammation in aged mice. Parallel trends have been observed in humans, but translation findings from mouse models are impeded by limited genetic diversity. Dogs have larger genetic and lifespan diversity than mouse models, making them a perfect candidate for studies attempting to identify molecular markers of aging. Additionally, dogs live in the same environment as humans, which partially addresses environmental factors shared by the two species. Here we explored the relationship between L1 expression and inflammation in dogs based on several metrics, including lifespan and size. Tissue samples were assessed by qRT-qPCR for L1 expression, as well as downstream factors linked to inflammation, including cGAS, INFB/ α . Initial results indicate correlation between animal age and L1 elements, in addition to interferons and animal size. The differences in interferon expression in older versus younger dogs appeared much less significant than expected, though a higher proportion of each sample group is needed to ensure sufficient statistical rigor. We also observed significant expression differences between breeds. Combined with the correlation with lifespan, these findings suggest that the canine model system may provide a unique approach to identifying evolutionary changes in L1 and inflammatory regulation..

13. Analysis of the gut prokaryotic microbiome of working sled dogs

Ken Belanger, Colgate University

The microbiome includes the genetic material of all of the microorganisms living within a particular environment. Thousands of species of bacteria and archaea contribute to the microbiome of mammals, including dogs, and the composition of the microbiome can have significant impacts on the health and well-being of the host. However, the factors that affect the microbiome composition of host organisms are complex and understudied. In this study, we investigate whether

several variables, including exercise, diet, and medical interventions, correlate with changes in the dog gut microbiome, using two groups of working sled dogs as models. Fecal samples were collected on multiple dates and dog owners completed detailed surveys of demographic, health, and behavioral data for each dog at each timepoint. DNA was extracted from each fecal sample and is being analyzed for bacteria and archaea composition using 16S rRNA amplicon sequencing. Resulting sequences will be compared using measures of community composition, including alpha- and beta-diversity, as well as comparative analyses and potential functional predictions. These data should provide further insights into dog microbiome composition and factors that can influence changes in the mammalian gut microbiome.

14. Characterizing the transcriptional landscape of canine splenic hemangiosarcoma at high resolution and exploring CAV1 as a biomarker

Chitvan Mittal, Cornell University

Canine hemangiosarcoma (HSA) is an aggressive endothelial cancer that shares similarities with human angiosarcoma. Each year, ~2 million dogs die in the US due to lack of diagnostic and therapeutic strategies, which warrants characterization of molecular underpinnings in canine HSA. To better characterize these factors, we utilize high-resolution genomics and biochemical approaches to get a comprehensive perspective of this disease. Our results previously demonstrated that dysregulations in the extracellular matrix are strongly associated with metastasis and oncogenesis during HSA. To characterize HSA specific signatures, we also included spleens with benign nodular hyperplasia (NH). Using the ChRO-seq technology, we demonstrate distinct molecular subtypes within HSA datasets. In contrast, healthy and NH spleens showed similar profiles. Furthermore, while both sexes are susceptible to HSA, breeds such as German Shepherd and Golden Retriever show higher predispositions towards HSA, suggesting both genetic and epigenetic components contributing to HSA development. Next, we explored biomarkers to diagnose metastatic HSA from benign cases. Differential gene expression analyses revealed caveolin-1 (CAV1) being significantly upregulated specifically in HSA spleens. Immunohistochemistry and H&E staining confirm that CAV1 is expressed at higher levels in HSA tissue. Our results suggest CAV1 might serve as a biomarker in diagnosing HSA from non-HSA samples.

15. Optimizing Turtle-Detection Dog Surveys

Kris Hoffmann, St. Lawrence University

Terrestrial and semi-terrestrial turtles are the reptiles most commonly studied using conservation detection dogs. Most handlers are consultants that are not tasked with publishing methodologies, though networks exist to share information among handlers. Here we share insights from surveying wood turtles and box turtles in Rhode Island using a Labrador retriever. The dog searched within 25 m of each bank along 1 km stretches of river. Eight transects were throughout the state and searched one to three times each. The dog alerted to at least 13 of 21 observed wood turtles and 8 of 9 box turtles before they were seen by people ($n = 2$) and contributed to the detection of the remaining turtles. Methods to optimize future canine searches include handlers conducting dogless scouting walks along the transects, avoiding areas that will not be productive to search (e.g. non-habitat and areas where the dog must swim), and freedom to include open areas adjacent to the transect where scent might move freely. Gear for the dog should include chest and paw protection. We encourage the development of protection for ear tips, the dorsal surface of the muzzle, and against ticks. We recommend generating dog specific protocols and schedules.

16. Identification of optimal training aids for chronic wasting disease detection

Amritha Mallikarjun, Penn Vet Working Dog Center, University of Pennsylvania

Chronic wasting disease (CWD) is a fatal transmissible spongiform encephalopathy that affects cervid species, including mule deer, white-tailed deer and elk (*Odocoileus hemionus*, *Odocoileus virginianus*, and *Cervus canadensis*). Dogs can be trained to differentiate between CWD-positive and CWD-negative fecal samples; this suggests that environmental detection dogs could be trained and deployed for surveillance to identify areas containing CWD-positive fecal matter. Training detection dogs requires the use of many samples to develop high sensitivity and specificity, and dogs should be trained in environments similar to their target search environment. Since CWD-positive fecal samples can contaminate soil and spread CWD to additional cervids, it is beneficial to develop an alternate training aid that will not spread disease and will safely allow dogs to learn to detect the odor of CWD-positive fecal matter in locations similar to their target search area.

17. Domestic dogs as a model organism for studying brain asymmetries

Sophie A. Barton, Harvard University

Humans and other primates show many examples of left/right asymmetries in gray matter, white matter, and brain activity. These asymmetries appear to correspond to complex behavioral adaptations like tool use and communication. Yet it has also been proposed that brain asymmetries are simply an emergent feature of species with large brains, like primates. Consequently, it is unclear if neuroanatomical asymmetries are adaptive traits that directly support complex behaviors. Domestic dogs offer a unique opportunity to better understand the function and evolution of brain asymmetries. Different breeds have varying brain sizes and behaviors. Furthermore, some dog behaviors are lateralized, which might indicate the existence of yet undiscovered brain asymmetries. We evaluated whether dogs show asymmetries in gray matter volume. To that end, we opportunistically collected T1-weighted MRI images of 62 dogs from 33 breeds. Using source-based morphometry, we found that dogs do exhibit cortical and subcortical asymmetries in gray matter volume across multiple clusters that are significant at $p < 0.5$ after family-wise correction for multiple comparisons. Some of these asymmetries are present in brain networks associated with reward, movement, and social interaction. These results improve our understanding of canine neuroscience and present dogs as a suitable model for studying brain asymmetries.

18. Measuring Humans' Trust in Dogs with the Multi-Dimensional Measure of Trust (MDMT)

Anwyn Gatesy-Davis, Brown University

Humans rely on domestic dogs for tasks ranging from emotional support to life-saving measures. Trust is a key element in successful partnerships, yet we have a limited understanding of how humans trust dogs. Prior work has explored humans' trust in other humans as well as in robots. In this study, we adapt the Multi-Dimensional Measure of Trust (MDMT) to investigate humans' trust in dogs. Participants were presented with 4 brief vignettes about dogs with real-world jobs. Participants completed the MDMT after reading each vignette (baseline), and a second time after reading a modification to the vignette (manipulation). Participants' trust in the dogs was manipulated in 2 directions (increase/decrease) along the 4 trust dimensions (reliable, competent, ethical, benevolent) captured by the MDMT. Results from this study allow for the comparison between humans' trust in dog agents and that of human and robot agents in the literature. Additionally, the 4 trust dimensions measured by the MDMT facilitate a fine-grain analysis of human-dog trust. Findings related to humans' trust in dogs have the potential to inform the training and use of working dogs as well as contribute to the ever-growing body of literature on human-animal relationships.

19. Comparative Analysis of Attachment Behaviors in Dogs and Selectively Bred Russian Silver Foxes (*Vulpes vulpes*)

Katie Sierra, Harvard University

The Russian Fox Domestication Experiment is one of the most influential experiments of the past century. Starting in 1959, geneticist Dmitry Belyaev began selectively breeding a group of silver foxes (*Vulpes vulpes*) for tameness to see if they could be used as a model for dog domestication. After several generations, a strain with docile demeanors resulted. There have been many subsequent comparative genetic and behavioral analyses across tame, conventional, and aggressive fox strains, with the assumption that tame fox and dog behavioral phenotypes were similar. However, direct comparisons of their behavioral responses toward humans are lacking. This present study compared the behaviors of 14 tame foxes and 16 dogs, with an emphasis on attachment, by having subjects complete the Ainsworth Strange Situation Test. A mixed effects negative binomial model was constructed to determine if an animal's species

plays a major role in the number of human-oriented interactions they initiate between experimental phases. Dogs had significantly more interactions with their owners than foxes ($p < 0.05$). For decades, Belyaev's foxes have been described as dog-like. However, this study suggests that these cohorts aren't as analogous to one another as previously suggested. These results also suggest that selection for tameness doesn't necessarily result in attachment, and that the story of dog domestication involves more than simply selecting for prosocial behavior.

