NOT JUST A SILLY VOICE: DOGS RESPOND TO MOTHERESE BUT WOLVES DO NOT

By

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Not just a silly voice: Dogs respond to motherese but wolves do not

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How social interactions between species influences the evolution of each species' social communication is an understudied topic. I explore how human communicative behavior might have influenced the evolutionary process of domestication from wolves to dogs. To do this I focus on a type of baby-talking speech pattern termed "Motherese," often used by humans when interacting with their dogs. Motherese is a vocal pattern used by human parents to comfort and amuse their children and is characterized by higher pitch, short utterances, repetition, and slower and elongated vowels. Handlers also commonly use motherese when socializing animals. Socialization is the process of desensitizing an animal that is wild by nature to human contact and activity, and is synonymous with being tamed. By looking at the effectiveness of motherese in human encounters with captive, socialized wolves we can begin to understand if domestication within dogs was influenced by the auditory communication patterns of humans. I test hypotheses generated from the prediction that wolves and dogs differ in their response to motherese. I hypothesize that the animals will show a preference towards humans using motherese speech patterns during interactions. To test my hypotheses, I compare the behavioral reactions of captive wolves, dogs, and wolf-dog hybrids using separate auditory stimuli patterns. Specifically, I test whether the animals show social responses to motherese speech patterns that differ from their responses to other patterns of vocalization. Dogs showed a strong preference for women speaking with motherese. Wolves and wolf-dog hybrids did not show a preference for one auditory stimulus over another. Animals also interacted most with the opposing sex humans,

suggesting that sex of a human handler could be important during interactions. Human behavior influenced the behavior of the domesticated dogs, but not the socialized wolves. These results support the hypothesis that domestication shaped the way humans and dogs effectively communicate with one another, and that dogs are capable of understanding human intent better than socialized wolves.

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INTRODUCTION

Inter-species communication is an understudied topic. Many mysteries still exist as to how different animals are capable of communicating through various means. This phenomenon is seen both in wild and domesticated animal interactions. Among the domesticated animals, dogs are exceptionally qualified to effectively communicate with humans (Kaminski, Call, & Fischer, 2004; Kubinyi, Virányi, & Miklósi, 2007; Miklósi, Kubinyi, Topál, & Gácsi, 2003; Udell, Dorey, & Wynne, 2008, 2010; Udell & Wynne, 2011). The ways in which humans and dogs communicate with one another can lend insight into the domestication of the dog from the wolf. I focus on how different types of human auditory stimuli are received by dogs in a social situation. I compare the reactions of the dogs to those of captive, socialized Grey wolves, and an array of wolf-dog hybrids. The animals are not instructed to perform tasks. Rather, they are presented with varying forms of auditory stimulus and allowed to interact freely with human volunteers. Studying these interactions can lead to a discovery about how early behavioral traits between both species might have influenced communication behaviors with humans in the present.

All dogs are descended from wolves. We know through genetic sequencing and fossil evidence that dogs were distinct as a sub-species by at least 15,000 years ago (Axelsson et al., 2013; Coppinger & Coppinger, 2001; Savolainen, Zhang, Luo, Lundeberg, & Leitner, 2002; Schleidt & Shalter, 2003; Thalmann et al., 2013). Some small canid fossils from Europe suggest that dogs could be as old as 36,000 years, but the identification of those fossils is debatable (Coppinger & Coppinger, 2001; Savolainen et al., 2002; Thalmann et al., 2013). Savolainene et al. (2002) used mitochondrial DNA from dogs all over the world to determine the geographic origin of the species. Their findings suggest that dogs originated somewhere within Eastern Asia,

and from multiple lineages. Thalmann et al. (2013) ran similar genetic tests and argued that dogs might have originated within Europe between 32,000 and 18,000 BP. These two viewpoints do not need to be mutually exclusive. Instead they support the theory that dogs likely evolved multiple times in the Old World before being brought to the New World.

As ancient humans traveled the globe they would have brought their canid companions with them (Coppinger & Coppinger, 2001). Often, interbreeding of *Canis* species can produce viable hybrid offspring (Coppinger & Coppinger, 2001; Iljin, 1941; Thalmann et al., 2013; Vila & Wayne, 1999; Vila et al., 2003). Thus, it is not unreasonable to suggest that dogs from separate localities could have successfully interbred. If this type of interbreeding happened frequently then separate *Canis* lineages would have become less genetically distinct through time. Today dog breeds still have similar genetic sequences with grey wolves. The amount of genetic similarity among the dog breeds and wolves can be due to a few reasons. First, dog breeds from different origins could have interbred, creating hybrids within the breeds. Natural selection is Darwin's theory that organisms evolve to their environments over generations to achieve optimum fitness (Cain, Bowman, & Hacker, 2008). These adaptations can be both behavioral and physical, and must be heritable through genetics. Through natural selection wolves became perfectly adapted for stamina hunting (Mech & Boitani, 2003; Mech, 1970; Young & Goldman, 1944). Dogs evolved to live within human society (Coppinger & Coppinger, 2001). A new niche must have become available sometime at least 15,000 years ago for dogs to have evolved such different survival strategies than wolves (Axelsson et al., 2013; Coppinger & Coppinger, 2001; Kubinyi et al., 2007).

Last, any dog could have interbred with other species in the genus *Canis*, like wolves and coyotes. Dog genetics can be compared to a blender mixing all of these species and subspecies

genetic lineages over at least 15,000 years. This complexity makes dog genetics incredibly intricate. Instead of focusing on the genetic characteristics of the first dogs we could focus on their behavior. All dogs share some behavioral traits (Coppinger & Coppinger, 2001; Fox, 1971; Kubinyi et al., 2007; Udell & Wynne, 2008), specifically those that allow them to successfully live within human society. Dog evolution begins with natural selection on a specific behavior, that behavior then influenced the physical and genetic properties of the species (Coppinger & Coppinger, 2001; Kubinyi et al., 2007).

At the same time that dogs were evolving humans were shifting from hunter-gatherer lifestyles to agricultural settlements (Axelsson et al., 2013; Coppinger & Coppinger, 2001). With any permanent human settlement there must also be a permanent location for all of the waste. Human waste locations would have contained food inedible for humans, but perfectly fine for something with a stronger stomach, like a wolf. Trash heaps are the perfect locations for a scavenger to thrive (Coppinger & Coppinger, 2001; Schleidt & Shalter, 2003). Before permanent settlements there would have not been consistent locations for scavengers to utilize. Once humans settled down trash locations provided constant food sources. Wolves that were too weak to live within a pack would have benefit greatly from these trash piles. The only issue with feeding at these locations would have been the proximity to humans. Wolves are notoriously nervous eaters (Coppinger & Coppinger, 2001; Mech & Boitani, 2003; Mech, 1970; Young & Goldman, 1944) and often abandon food when a human approaches. Food scraps are much lower in nutrients than wild game. Wolves surviving on scraps would have needed to eat more to maintain their metabolisms (Axelsson et al., 2013; Coppinger & Coppinger, 2001). In order for scavenging wolves to get enough food they needed to have a high tolerance for human proximity (Coppinger & Coppinger, 2001; Karlsson, Eriksson, & Liberg, 2007; Kubinyi et al., 2007).

Coppinger argues that the first evolved behavioral trait within early dogs would have been a higher fear threshold for humans. This does not mean fear is gone entirely, only that wolves at trash heaps habituated to human presence. This type of behavior is still seen in unsocialized dogs living in modern landfills (Axelsson et al., 2013; Coppinger & Coppinger, 2001). The animals are still wary of humans but a human in the distance does not cause them to leave their food.

Wolves that lived at the trash piles would have interbred with one another. The trait for higher human tolerance would have become universal in the permanent residents of the waste locations. Over time the resident dog population also evolved different dietary needs and body proportions than wolves, due to the novel food source. Humans have a lot of starch in their natural diets. The scavenging animals evolved a higher tolerance for starch than wild wolves (Axelsson et al., 2013) in response to what they were eating. In fact, Axelsson et al. (2013) found that dogs have developed gene sequences linked to starch digestion, which are not present in wolves. Major change in diet can also result in altered physical appearance. To accommodate for the loss of nutrients the bodies of the animals became smaller through the generations, until they became fixed at the optimum size. Therefore, natural selection for the early dogs also acted upon smaller animals able to handle larger amounts of starch.

Brain size is in part reliant on body size (Willemet, 2013). With the decrease in body size, brain size decreased accordingly. Animals living at the dumps naturally evolved to be less intelligent than wolves (Coppinger & Coppinger, 2001; Fox, 1971; Kubinyi et al., 2007; Mech & Boitani, 2003; Young & Goldman, 1944). With time, wolves that began scavenging at trash heaps evolved to a physically different organism, more closely resembling modern dogs. Natural selection was the driving force for this initial speciation. Humans facilitated this evolutionary process by creating a new feeding niche. But the niche alone was not enough. The ability of

some wolves to tolerate human presence was the original behavior that led to the evolution of dogs. All offspring of these animals would have possessed the same trait.

Once natural selection shaped the primitive dog humans could intervene using artificial selection. The dog genome is very adaptable (Axelsson et al., 2013; Iljin, 1941; Savolainen et al., 2002; Thalmann et al., 2013; Vila & Wayne, 1999; Vila et al., 2003) and is one reason for the variety of dog breeds around today. Natural selection was the first step in dog evolution, which was then followed by human artificial selection

Dogs and Humans

Positive relationships with humans increase the fitness of a dog dramatically. Fitness of an individual is measured by both its individual survival and the survival of its offspring (Cain et al., 2008). Any dog with a devoted owner lives the life of luxury, never having to search for food or social companions. Breeders ensure the spread of favored genetic material, providing optimum reproductive fitness. Everything needed for a dog's survival is provided. Even stray dogs revert back to their scavenging ways and live off of the human waste found all over the world (Coppinger & Coppinger, 2001). Dogs are so successful, in fact, that there is a challenging overpopulation problem in the United States (J. Frank, 2004) and most of the world. What is it about dogs that make them so likeable?

Animals in the *Canis* genus are behaviorally pliable animals (Coppinger & Coppinger, 2001; Fox, 1971; Kubinyi et al., 2007; Mech & Boitani, 2003; Mech, 1970), capable of adjusting their behavior to fit almost any surrounding environment. Grey wolves can switch between solitary lives or living in a pack simply by adjusting their feeding strategies and social behavior (Mech & Boitani, 2003). It is this flexibility that has made dogs so successful in so many niches. This flexibility is shared among all *Canis* species, including the domesticated dog. Flexibility is a

behaviorally driven trait (Breed & Moore, 2012) and works with both abiotic factors in the environment, and social cues.

Sociality is the measure of how likely individuals in a population are to form cooperative groups (Breed & Moore, 2012). Dogs have evolved from wolves and they still retain the main behavioral traits of their highly social ancestors. It is this sociality that allows dogs to become so well integrated with humans, another hyper-social mammal. Social animals have certain characteristics in common, one being well-developed communication systems (Breed & Moore, 2012). Both humans and wolves use sight and sound to communicate within their social groups. Sharing these primary modes of communication allows humans and dogs to more easily understand one another. A certain level of cognition is also needed to achieve interspecies communication. Dogs have similar levels of cognition as human children (Bensky, Gosling, & Sinn, 2013; Kotrschal, Schöberl, & Bauer, 2009; Kubinyi et al., 2007; McGreevy, Starling, & Branson, 2012; Prato-Previde, Custance, Spiezio, & Sabatini, 2003; Range & Virányi, 2014; Topál, Gácsi, Miklósi, & Virányi, 2005; Udell, Dorey, & Wynne, 2011; Udell et al., 2008, 2010; Udell & Wynne, 2008). Many published studies look at how well dogs and humans communicate (Bensky et al. 2013). Dogs can follow human visual cues like a pointing gesture to locate hidden rewards (Kubinyi et al., 2007; Udell et al., 2008, 2010; Udell & Wynne, 2008, 2011; Virányi et al., 2008). Hare (2002) found that dogs are capable of following only the eye gaze of a human for a hidden reward. In order for this result to occur dogs must understand that the eyes of a human are indicative of their attention (Bensky et al., 2013; Kubinyi et al., 2007; Miklósi et al., 2003). Dogs have also been shown to communicate to humans in the same way (Bensky et al., 2013; Kubinyi et al., 2007; Miklósi et al., 2003; Udell & Wynne, 2008). They utilize their gaze, body posture and vocalizations to lead handlers to the location of a hidden object. Some of these

tests have also been conducted with wolves (Bensky et al., 2013; Kubinyi et al., 2007; Udell & Wynne, 2008) and reveal that wolves also can develop the ability to read human facial cues but only when trained to do so.

These studies indicate that in the process of domestication dogs evolved to be sensitive to human cues associated with visual signs, like gazing and pointing. Tests comparing dogs to wolves reveal that dogs depend on human guidance when presented with a complicated task (Kubinyi et al., 2007; Range & Virányi, 2014). When a dog cannot solve a puzzle it most often returns to the handler for assistance. During dog and handler interactions dogs look at the face of the handler for information (Bensky et al., 2013; Kubinyi et al., 2007). Dogs are also aware of the directed attention of their handlers. Call et al. (2003) showed that dogs are more likely to misbehave when their handler is facing away from them, or their attention is averted. These studies demonstrate that dogs are aware that humans communicate with visually perceptible signals. In order to get what they want dogs must be attuned to the visual cues provided by their handlers.

Communication happens on multiple levels, not just visually. Humans are primarily visual beings (Horowitz, 2009) so it makes sense that we would naturally focus on this aspect of communication between dogs. For dogs, vision is one of the least influential senses (Horowitz, 2009). One prominent sense for *Canis* is smell and dogs mainly interpret their world with scent (Horowitz, 2009; Mech & Boitani, 2003). Sight helps to enhance details of the environment that cannot be gained through smell. Another important sense for *Canis* is sound. Dogs are capable of hearing sound waves significantly above and below the spectrum of human hearing (Bensky et al., 2013; Horowitz, 2009; Mech & Boitani, 2003). An improved understanding of how human

auditory stimulus influences *Canis* behavior is a key element to canid-human interactions and deserves more careful study.

Because dogs have a greater reliance on sound than sight they may have evolved stronger relationships with humans through auditory cues. Dogs can apply human auditory cues to a task, like retrieving an object (Bensky, 2013). Kamisky et al. (2004) found that one individual border collie was capable of learning over 200 words. This dog was also capable of assigning a new word to a novel object through the process of elimination (Kaminski et al., 2004). Clearly, dogs respond just as aptly to auditory stimulus as visual. But, do dogs still respond to auditory cues when they are not instructed to perform a task?

Canis Vocalizations

Most *Canis* vocalizations are used alongside other behaviors, such as body language. When pups are too young to care for themselves the only way to ensure they get attention is through vocalizations (Mech & Boitani, 2003). Young puppies use high pitched squeals to get their mother's or a pack mate's attention, the same way human babies cry when they need something. As the animals grow older and their vocal chords develop lower frequency noises can be made, like growling. These two forms of vocalizations are stereotyped throughout the *Canis* genus (Fox, 1971). High pitched noises are typically associated with puppies and therefore positive interactions (Fox, 1971; Mech & Boitani, 2003). Low pitched noises are connected with aggressive interactions and dangerous situations. Vocalizations also depend on whom the animal is interacting with. In general, when adult wolves interact with puppies they make similar high pitched squeals (Kleiman, 2011; Mech & Boitani, 2003).

Humans follow similar frequency trends of vocalization during interactions. While humans have developed numerous different languages, a few vocal behaviors transcend cultural

boundaries. One of the most consistent is the natural way human mothers 'baby talk' to their infants (Burnham & Kitamura, 2002; Falk, 2004; Saint-Georges et al., 2013). Across all cultures mothers use a specific form of speech termed "motherese" when interacting with infants. Surprisingly, this same pattern of human speech is found during interactions with animals (Burnham & Kitamura, 2002; Hirsh-Pasek & Treiman, 1980; Sims & Chin, 2002; Xu, Burnham, Kitamura, & Vollmer-Conna, 2013).

Motherese

Motherese is distinctive from other speech patterns in the use of higher pitch, elongated vowels, short utterances, and repetitions (Burnham & Kitamura, 2002; Falk, 2004; Hirsh-Pasek & Treiman, 1980; Saint-Georges et al., 2013; Sims & Chin, 2002; Xu et al., 2013). Scientists hypothesize that motherese is critical for emotional bonding between mothers and their infants during the earliest stages of development. Later on it becomes important for the earliest learning of language and syntax, even social interactions (Falk, 2004; Saint-Georges et al., 2013) for infants and young children.

Why mothers naturally use motherese when talking to infants is still under debate (Falk, 2004; Saint-Georges et al., 2013). While it is true that motherese is influential for the infant, mothers do not consciously make the decision to interact with them in such a way (Falk, 2004). Adults also use motherese when addressing foreigners and the mentally handicapped. This suggests that the reason for the usage is either language comprehension or intelligence (Falk, 2004; Saint-Georges et al., 2013). Pasek and Treiman (1982) make the argument that motherese is strictly a response to any form of social responsiveness from the listener. When studying motherese directed towards wolves and dogs it is safe to assume that the speech is not language oriented (Hirsh-Pasek & Treiman, 1980; Xu et al., 2013). Instead, humans most likely use

motherese unconsciously as a way to emotionally bond with their animals. Because dogs are socially responsive this would encourage humans to repeat the process in future interactions with different individuals (Burnham & Kitamura, 2002; Sims & Chin, 2002). This behavior is also seen across other species like cats and parrots (Sims & Chin, 2002; Xu et al., 2013). My study focused specifically on canid-directed motherese, also known as doggerel. Doggerel differs from motherese primarily by the absence of elongated of vowels (Burnham & Kitamura, 2002; Hirsh-Pasek & Treiman, 1980; Xu et al., 2013). Since dogs cannot speak languages humans naturally alter their motherese speech patterns to include only the higher pitch, repetitions, and short utterances (Saint-Georges et al., 2013).

Women are more likely than men to use motherese when addressing an animal (Mallon, 1993; McGreevy et al., 2012; Prato-Previde, Fallani, & Valsecchi, 2006; Wedl, Schöberl, & Bauer, 2010; Wells & Hepper, 1999). Wedl et al. (2010) believe this is because of their mentality towards animals. In particular, women are more likely to view their pet dogs as a peer, emotional and social supporter, whereas men view their dogs as a partner or companion (Mallon, 1993; Prato-Previde et al., 2006; Wedl et al., 2010). These mindsets transcend individual animals; women will often interact more intimately with an animal they just met than a man would (Kotrschal et al., 2009). This includes speaking in motherese. In my experience, individuals with this habit fall into it naturally, myself included, especially when confronted with a puppy.

Many owners believe that using motherese with an animal will make for a more positive experience. However, no scientific research has been conducted that tests this theory. Scientists examined how dogs are capable of understanding human communication when it comes to obedience (Bensky, 2013). Motherese is a well understood topic, for its use by humans with their

own children and how it differs from animals. Yet, no one has looked into how canids respond to motherese.

Research Design

I analyze the reaction of certain groups of *Canis* to the use of motherese by humans. I worked with dogs (*Cani lupus familiaris*), captive grey wolves (*Canis lupus*), and wolf-dog hybrids. With these different animal groups I can distinguish if there is a behavioral difference between wolves and dogs in their responses to motherese. Dogs have coevolved with humans and have proven to be sensitive to their visual cues (Bensky, 2013). Response to motherese could be another level in which domestication has altered dog behavior from wolf behavior. Furthermore, little is known about wolf-dog behavior. Working with hybrids will provide some interpretation about the behavioral genetics behind this mixed breed.

It is in the best interest of a dog to receive and maintain attention from humans. Having human attention provides a higher probability of foraging success and greater overall fitness. Therefore, dogs must be able to recognize when they are being directly addressed in social interactions. It is possible that dogs recognize the use of motherese from humans as a signal of direct attention focus. Recognizing this correlation would allow dogs to maintain positive relationships with humans. Wolves do not actively seek out humans for resources and therefore should not place any value on positive interactions. I hypothesized that dogs would show the greatest interest in humans using motherese during interactions than either normal speech patterns, or no auditory stimulus at all. I hypothesized that wolves would be slightly influenced by motherese due to the higher pitch that could be compared to a puppy squeal.

During the interactions with the animals human volunteers were randomly assigned a type of speech pattern to use: motherese, adult directed speech, and no vocalizations. The

reaction of the animals to the speech patterns was measured through the total number of visits the animals had with each volunteer, how long each animal allowed physical contact, the intimacy of the interactions, and how often the animals returned to the same volunteer. These values were also compared to information about the human volunteers and the animals. I focused specifically on the effects age and sex of both the human volunteers and the animals on social interactions.

METHODS

Study Sites

I visited 3 USDA sanctioned wolf and wolf-dog sanctuaries, two within Colorado and one in Nevada: the United States Wolf Refuge (Sparks, NV), the Colorado Wolf and Wildlife Center (Divde, CO), and Mission:Wolf (Westcliffe, CO). I chose these sanctuaries because they all had well established ambassador animal programs (definition in section on animals), and the directors were comfortable allowing human strangers to interact with their animals when arranged. The two locations in Colorado provided the full wolf subjects and one low content hybrid, while the location within Nevada provided dogs and wolf-dog hybrids.

All of the sanctuaries have been inspected by IACUC and passed their inspection protocols.

United States Wolf Refuge (USWR)

USWR is a refuge run by Bill Chamberlain just outside of Sparks, NV. This refuge currently houses 16 animals. At the time of my visit two extra animals were on the property and used for this study. Most of the animals are either low to mid-content wolf-dogs or regular dogs that have been misrepresented as wolf-dogs due to their unruly behavior and similar physical

appearance. Only one animal was classified as a high content hybrid, and he was used in the study.

There are five enclosures on site ranging in size from ¾ acre to three acres. Each enclosure provides adequate shelter, water, food, and companionship for the animals. Ten animals are housed individually or in pairs within ten 15' x 15' pens. These 10 pens are located within one larger 2 acre play-pen. The animals within these enclosures are allowed time every day to run within this play pen and interact with other animals and humans. Three animals are housed within a 3/4 acre pen attached to the main building on the property. These animals were the only animals allowed inside and had constant access to care by Bill. Lastly, four animals lived permanently in pairs within two 3 acre enclosures. During my visit one of the extra animals on the property was being housed within one of these enclosures. I worked within the enclosure with three animals during my visit. The animals in the other large enclosure were too shy for human interaction.

I worked with a total of 11 animals at the USWR: 5 dogs, 2 low content hybrids, 3 mid-content hybrids, and 1 high-content hybrid.

Colorado Wolf and Wildlife Center (CWWC)

CWWC is located within Divide, CO and run by Darlene Kobobel. This sanctuary houses 16 full Grey wolves, 2 Coyotes, 1 Mexican Grey Wolf, 5 Red foxes, and 4 Swift foxes. Some horses are also found on the property, but the sanctuary focuses primarily on wild wolf conservation. The animals are provided with water and shelter within the enclosures, and fed raw meat once a day six days of the week. The enclosures for the wolves range from ¾ to 1 acre per two wolves. Most of the wolves I worked with are housed in male-female pairs, with one enclosure housing three animals, two males and one female.

On one occasion during my visits the adult male from the 3 animal enclosure was moved to a separate enclosure that houses a wolf pair also used in my study. This did not disrupt my data collection because they were all animals I was working with previous to the move. The move was also only temporary for the day; this is a recurring practice at the sanctuary and the animal was returned to his permanent enclosure by the end of the day.

The CWWC has a well-established ambassador program with the animals I worked with. Human visitors are allowed to enter the enclosures and interact with the animals in the presences of handlers for a fee. The frequency of these interactions varies with the seasons, with up to three visits a day during the spring, summer, and fall. During the winter months and holidays the animals may not receive any human interactions other than from their handlers.

Overall, I worked with 5 animals from the CWWC, all of them full wolves.

Mission: Wolf (M:W)

M:W is the largest of the three sanctuaries. It is run by Kent Weber and Tracy Ane Brooks, and currently houses a total of 53 animals, including wolves, dogs, horses, chickens, and even cats. 35 of these animals are *Canis* and permanently housed at the sanctuary. Wolf content of the animals ranges from full dogs to full wolves with every classification of hybrid. With the exception of one, the ambassador animals are full wolves. Enclosure sizes are at least 1 acre, with the largest permanent housing being 3 acres. The animals are provided with fresh water and fire bunkers in their enclosures. They are fed twice a week, with each animal receiving around 5-7lbs of raw meat at that time, these values vary depending on the age and health of an animal.

Most of the enclosures house male-female pairs. Any group of three or more wolves is technically defined as a pack (Kleiman, 1967, 2011; Mech & Boitani, 2003; Mech, 1970; Young & Goldman, 1944). There are three packs at M:W with the largest being the ambassador pack

that consists of five individuals. The ambassadors interact daily with the public via wolf visits where the human visitors and handlers are brought into the front portion of the 3 acre enclosure. Like the CWWC, number of visits and people within the visits vary with the seasons. During the summer at least one visit occurs daily, with some groups being as large as 50 people at one time. In the winter visits with the animals are mostly done with the staff that live on location, with the aim of having one per day, but this does not always happen.

I conducted my study with the ambassador pack and one other wolf at the sanctuary, providing 6 full wolves in total.

Animals

I worked with a total of 22 animals: 5 dogs, 7 wolf-dog hybrids, and 10 full wolves (Table 1). The ages of the animals ranged from 7 months to 11 years. Males and females were spayed and neutered, with the exception of one male hybrid, located at USWR. The dogs I used lived within the same conditions as the wolves, so they had similar lifestyles and cannot be classified as family pets or house animals. All of the animals have paperwork in compliance with USDA protocols.

Table 1: This table provides the age, sex, and wolf content for all of the animals. For animals with unclear paperwork on their content names are provided for the interpreters, who are also the directors of the sanctuaries listed.

Animal	Age	Sex	Content	Sanctuary	Content Interpreter
Tully	9	M	D	USWR	Bill Chamberlain
Bandit	4	M	D	USWR	Bill Chamberlain
Nikita	7	M	D	USWR	Bill Chamberlain
Yahzi	2	F	D	USWR	Bill Chamberlain
Athena	6	F	D	USWR	Bill Chamberlain
Comanche	7	M	H	USWR	Bill Chamberlain
Abe	7	M	L	M:W	Kent Weber
Keoki	6	M	L	USWR	Bill Chamberlain
Gianni	6	M	L	USWR	Bill Chamberlain
Catori	3	F	M	USWR	Bill Chamberlain
Kasa	6	F	M	USWR	Bill Chamberlain
Takota	7	M	M	USWR	Bill Chamberlain
Magpie	11	F	W	M:W	Kent Weber
Zeab	3	M	W	M:W	Kent Weber
Tiger	0.583	M	W	M:W	Paperwork
Farah	3	F	W	M:W	Kent Weber
Rosie	0.583	F	W	M:W	Paperwork
Micah	4	M	W	CWWC	Paperwork
Navi	3	M	W	CWWC	Paperwork
Kenyi	0.583	M	W	CWWC	Paperwork
Tala	4	F	W	CWWC	Paperwork
Kekoa	4	M	W	CWWC	Paperwork

When describing the animals, "content" refers to the percentage of wolf within each animal. I assigned the ranges of content on a simple, low, medium, and high basis. The wolf content of each animal was initially determined through original breeding paperwork. Paperwork for any animal is required from USDA approved breeding facilities, like breeders for zoos and films. One section of the paperwork includes the heritage of each animal. This heritage describes the parents of the animal, including species of wolf and their content. Full wolves for all of the locations used arrived primarily through official wolf breeders in the country, so their paperwork and content are well confirmed. However, many of the animals used came to the

sanctuaries through private owners or were confiscated by animal control. The original paperwork for these animals are likely to have been lost or forged in order to legally sell wolf-dog hybrids to the public according to federal and state laws. In cases like this, the sanctuaries must declare the content for their USDA paperwork based primarily on expert opinion. The expert opinions were given by the directors of the sanctuaries, with some input from myself.

Genetic testing at this time is unable to pinpoint exact percentages of wolf and dog DNA, even when using mitochondrial DNA for the tests. This is because all dogs are descended from wolves and thus they share similar mitochondrial DNA sequences (Axelsson et al., 2013; Coppinger & Coppinger, 2001; Iljin, 1941; Savolainen et al., 2002; Thalmann et al., 2013; Vila & Wayne, 1999; Vila et al., 2003). At this time, expert opinion is still the most accurate assessment of wolf content in a hybrid. Experts examine two aspects of the animal, physical appearance and behavior. Age of the animal is also important. It is easier to declare the content of an animal as an adult than a puppy; this is because all puppies have generalized physical appearance and behavior (Coppinger & Coppinger, 2001).

When trying to classify the wolf content of a hybrid the types of popular dog breed used in their creation is a deciding factor. Dog breeds that are commonly confused for wolves are usually working breeds, particularly huskies and malamutes. This popularity and confusion often makes huskies and malamutes the choice breeds when trying to make a hybrid that looks like a wolf but has dog heritage. Breeders will also cross-breed German Shepherds with wolves or high content hybrids to sell an animal that looks like wolf but has the obedience of the German Shepard. Other breeds are used to create a wide array of hybrids, including Border Collies; but Huskies, Malamutes and German Shepherds are the most common. When trying to determine the

wolf content of a hybrid experts must keep in mind the traits that are shared among these popular dog breeds and wolves. This will be elaborated on below.

The following measures of determination were used on adult wolf-dogs.

Physical appearance

Examining the physical attributes of the animal is the first step in deciding its wolf content. Wolves and dogs differ most noticeably in their body proportions. Grey wolves have an average weight range of 80-85 pounds for adult females, and 95-100 pounds for adult males (Mech, 1970). Even with individual variation females rarely exceed 100 pounds and males rarely go above 120 pounds (Mech, 1970). If an animal is significantly above or below these ranges then it can be said that they are predominantly dog. Malamutes in particular are often mistaken for wolves or wolf-dogs because of their coloration, but in reality they are far heavier than the average wolf. A wolf usually has a height of 26 to 30 inches (Mech, 1970). Males can be as long as 6.5 feet from the tip of the nose to the tail, with females ranging between 4.5 to 6 feet. (Mech, 1970). Any animal that significantly falls outside of the size ranges for wolves can be safely declared a dog. Still, some dog breeds like the Husky and German Shepard fall within the wolf size ranges.

Next, the body structure of the animal is examined. Wolves have narrow chests and hips that reduce energy expenditure while moving. Loping, the movement between a walk and run, is the form of locomotion that the wolf is most adapted to (Young & Goldman, 1944). As the animal lopes only the distal part of the limbs move, conserving large amounts of energy. The limbs are so close to the body that wolves are capable of locking their elbows to their chests, turning their elbows inward and their paws outward (Young & Goldman, 1944), allowing wolves to turn on a dime. Huskies have chests and hips that are broad and perfect for pulling heavy

loads. When a Husky runs the entirety of the limbs must move because of their large chests. One test of a hybrid is to push the elbows and knees together so that they're touching. If this can be done without distressing the animal then the there is a good probability of higher wolf content. This test is most helpful when ruling out breeds like huskies and malamutes.

Examining the tracks of the animal is another useful tactic. Wolf tracks are larger and narrower than the average dog. The two middle toes of a wolf track are longer and located above the outer toes, making the track look relatively narrow. The narrow body of wolves also makes for distinctive tracks. Wolf tracks often look like the animal only has two legs; this is because the back feet step in the same space as the front (Young & Goldman, 1944). Dog tracks tend to be broader, with all four toes on the same plane, and smaller in size with the exception of large breeds. The tracks also distinctly show four separate feet, with the hind foot track located next to the front track (Mech, 1970; Young & Goldman, 1944). Dew claws are strictly a dog characteristic, so if an animal has them then we know that it cannot be full wolf.

The head is one of the most distinguishing physical characteristics. First, the eyes of an animal provide good insight into its content. In my experience, healthy wolves almost always have eyes with some shade of yellow, sometimes green. Blue, black, brown, and combinations of these are strictly dog characteristics. Next, size of the head and nose are distinguishing. Wolves on average have $30cm^3$ more brain volume than dogs (Coppinger & Coppinger, 2001; Mech & Boitani, 2003), thus their heads are large. An animal with a large head and long nose will have higher wolf content.

Fur composition and coloration are often the most misleading characteristics, but also the easiest to see. Grey wolves have a soft and grey undercoat that is thickest during the winter. On top of this undercoat are guard hairs that also make up the coloration of the animal. Wolves can

range in color from pure white to pure black, and anywhere in between. Pretty much the only coat colorations that belong strictly to dogs are spots, and piebald colorations.

Lastly, the tail of a wolf is specific, accounting for 13 to 20 inches of the entire body length (Mech, 1970). When in a relaxed standing position the tail on wolves will be completely off the ground with the tip generally falling around the height of the knees. Any animal with a tail that is curled, above the back, or touches the ground in a relaxed state will have low to no wolf content.

Using this general framework for physical appearance differences between wolves and dogs helps to determine how much wolf content is physically expressed. But, genetics of wolf-dogs do not work in nice black and white outlines. Hybrids vary in which traits they possess or not. In general, any animal with multiple wolf characteristics has higher content. Physical appearance is only one aspect and can only provide a starting line for determining the wolf content of an animal. In my experience, behavior of the animal is essential to determining the content of a hybrid.

Behavior

Wolves are naturally fearful of humans. Even those that were raised in captivity and socialized at a young age show natural caution when dealing with strangers as adults (Fentress, 1967; H. Frank & Frank, 1982; Gácsi et al., 2005; Kubinyi et al., 2007; Woolpy & Ginsburg, 1967). They also show apprehension in new environments and strange situations. In my experience, during interactions with humans wolves are more restrained than dogs. While wolves greet strangers by licking them on the face, or allowing scratching, adult wolves do not let their guard down. This means that adults when interacting with humans rarely sit down, and almost never lay down. Only in instances where the animals know the handler extremely well will these

occurrences happen. In general, the less cautious an animal is around strange people and situations the lower the wolf content; the more apprehensive and aloof, the greater the content.

Barking and howling are one of the most accurate ways to determine content through behavior. Barking is used by both dogs and wolves, but in different contexts. Dogs bark frequently, and as a means to get attention and communicate. Wolves bark as a warning call (Kubinyi et al., 2007; Mech & Boitani, 2003). If an animal barks frequently in situations that would not be classified as dangerous, like people walking by, then the wolf content will be low. Furthermore, if an animal responds with fear, like hiding in a den/shelter, when other animals start to bark then the wolf content is probably a bit higher. While this response to barking is important, it does decrease with exposure, the animal becomes desensitized over time and will not respond the same as when originally exposed. The barking behavior itself, though, will tend to remain with an animal and is still a great trait when determining wolf content in a hybrid.

Wolf content of a hybrid is incredibly tricky to narrow down, with or without paperwork. For this reason, the descriptions of low, medium, and high content are frequently used to describe hybrids. The content is determined through a combination of factors, with paperwork being the most useful and reliable. In situations where the paperwork is either absent or unreliable the directors and animal caretakers of sanctuaries use the criteria listed above to provide their own professional diagnosis. As mentioned earlier, this is not an exact science and often when animals are diagnosed at a young age the content declaration can change as they grow. Unless reliable paperwork is provided hybrid puppies cannot be fully known until they reach maturity. All of the hybrids were full-grown with their content declared by the director of the sanctuaries that house them.

I selected my study animals because they are ambassadors for their sanctuaries. Ambassadors are animals that have been socialized from birth and have years of experience with wolf-human interactions. The majority of ambassador wolves are raised from around 10 days old by humans, and have close contact with humans almost daily. This constant human interaction results in the raising of the fear threshold within the animals, making them more likely to approach strange humans. Due to this style of rearing ambassadors, and all captive-born wolves and wolf-dogs, can never be released to the wild and must live in captivity their entire lives. Ambassadors are also a great education tool, allowing the public to have face-to-face interactions with a wolf promotes wildlife conservation. The work with ambassadors also ensures that human strangers are in no danger from the animals when brought into their enclosures. I used sanctuaries with ambassador programs because the directors would allow me to bring strange humans into the enclosures with their animals without putting either the animals or human volunteers in danger. This also meant that the animals were likely to have interactions with the volunteers, and not avoid them. Since my research relies on the interactions between the volunteers and the animals it was necessary to use animals that would willingly approach strange individuals without fear.

Human Volunteers

An e-mail was sent out to the Animal Behavior class roster for the fall 2013 semester at the University of Colorado, Boulder requesting volunteers for a wolf behavioral study. This resulted in 28 human volunteers, including myself in some trials: 10 women and 18 men, to travel to 3 wolf sanctuaries (see locations) and interact with the ambassador animals. Their ages ranged from 19 to 39 years. They were provided with a protocol to follow while interacting with

the animals and only differed in their use of vocal stimulus, which was determined at random for each visit.

According to my contact at the IRB office for human research I did not need to submit a Human Subjects protocol for my volunteers because they are not the primary subjects of my research.

Data Collection

The methods for this study were approved by the IACUC on May 5th, 2013: Protocol #1304.04.

All of the human volunteers were required to be complete strangers to the animals, to ensure the interactions were on a first impression basis. This is to eliminate any potential bias towards individuals the animals have already met. For each visit with the animals I assigned, randomly, three varying degrees of auditory stimulus to each volunteer: motherese, normal, and mute. These correspond to the volunteers either speaking with motherese, using their normal form of communication and voice, and not speaking at all. The volunteers that were not speaking during the interactions were encouraged to use body language to try and initiate an interaction with the animals, as long as they remained seated in the same location.

Motherese was defined to the volunteers as a form of baby-talk. This required the volunteers to speak predominantly with a higher pitch, and longer vowels (Burnham & Kitamura, 2002; Falk, 2004; Hirsh-Pasek & Treiman, 1980; Saint-Georges et al., 2013). Each volunteer was given these general guidelines to follow for how their voice should sound prior to the animal interactions. The volunteers were allowed to speak freely to the animals; no specific directions were provided for what the volunteer should say. They were encouraged to start talking to the animals once eye contact was made, but this was not limiting to when or to whom

the volunteer could speak As long as the volunteer maintained a baby voice when talking to the animals the session was valid.

I video recorded each interaction with a hand-held camcorder. The volunteers sat in a designated area within each animal enclosure; this area was decided on ease of access for the volunteers and cameraman, along with being a neutral territory for the animals. This allowed the animals to easily remove themselves from the interactions without needing to remove the volunteers.

Each visit was capped at 20 minutes, to keep the interactions as a first-impression basis. If the animals lost interest in the volunteers before this time limit was reached and left the designated interaction area I terminated the video recording. The visit lengths were also determined by the schedule of the sanctuaries and sometimes ended before the time limit was reached. To work with these restraints at least one volunteer during the interactions portrayed each voice type to keep the timing for each relatively equal.

Data Analysis

I used the free statistical programming software R for all of my data analysis. R was used to run linear models and ANOVAs on the data collected. I compare how the behavior of the human volunteers, specifically speech, influences the actions of the animals. The variables measured include how many times an animal visits a volunteer, how long they interact together, and the types of interactions that occur. Different styles of interactions are weighted according to intimacy. Low contact interactions, such as simple scratching are weighted lower than more intimate interactions, such as licking the face. Actions that can be classified as active submission, like laying down and revealing the stomach, are weighted the most highly on the interaction scale.

Each volunteer was asked to complete a simple questionnaire including details such as age, height, weight, experience with animals, etc. This information on individual volunteers was used to look for any particular patterns outside of speech that might have influenced the behavior of the animals. I focused primarily on sex and age of the human volunteers.

I also examined how the wolf content of the animal might have influenced their behavior around the human volunteers. The animals were grouped into three categories: full dog, all levels of hybrids, and full wolves. These groups were then tested against each other.

Orthogonal contrast codes were used when analyzing speech pattern data and wolf content. The first vocal code compared the effect of both motherese and normal speech patterns to none. Motherese and normal speech were compared to each other in the second voice contrast code. Orthogonal contrast codes were also used to compare the different wolf content categories to each other when examining response to vocal cues.

RESULTS

Responses to Speech Patterns

My main hypotheses addressed how the wolves, dogs, and hybrids responded to three different uses of auditory stimulus: motherese, normal speech, and no stimulus. I predicted that all animals would show a preference for motherese over normal speech patterns, and that any type of auditory stimulus would be preferred over none. I used orthogonal contrast codes to divide the three forms of stimulus into the desired statistical tests. Without any additional variables in the models there was no statistical difference between how the animals responded to the three options of auditory stimulus. Testing both motherese and normal speech patterns against no auditory stimulus also showed no overall difference.

Wolf Content

Next, the wolf content of the animals was worked into the models also using orthogonal codes. The animals were grouped into three categories: full dog, all levels of hybrids, and full wolves. These groups were then tested against each other using orthogonal contrast codes. Wolf content proved to greatly influence the responses to human volunteers, with statistical significance in all four of the measured variables.

Auditory Stimulus vs. Mute: This category compared the responses of the animals to any type of speech pattern (motherese or normal) over no auditory stimulus at all. The one statistically significant code grouped wolves and dogs together, and compared their responses to hybrids. Collectively, wolves and dogs preferred any type of auditory stimulus, motherese and normal speech, over none during the visits, determined through total social interactions with the human volunteers ($F_{3,223}$=2.84, p-value=.0392). Hybrids on the other hand showed a preference for no auditory stimulus over the others ($F_{3,223}$=2.84, p-value=.0392).

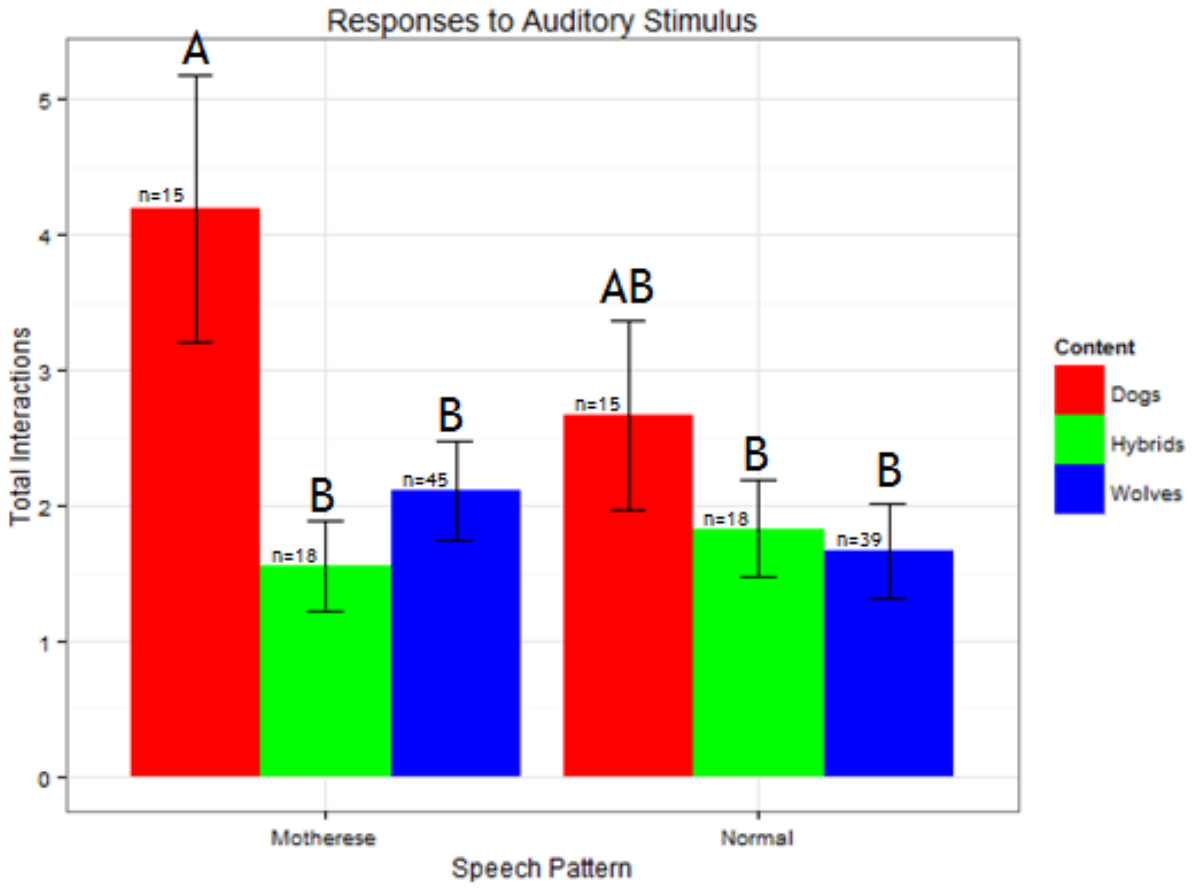
Motherese vs. Normal Speech: Here I compared the animals' responses to motherese versus normal speech patterns. Wolves varied significantly from dogs across all four measured variables (Table 2). Dogs showed significant differences from hybrids in total behavioral interactions and return visits to the human volunteers. Hybrid encounters followed almost an exact pattern as full wolves, showing less preference for motherese (Figure 1). Overall, dogs behaviorally interacted significantly more with the human volunteers compared to wolves and hybrids. Furthermore, dogs showed a strong preference for volunteers speaking in motherese.

Table 2: How wolves, dogs, and hybrids reacted to motherese compared to regular speech patterns. The reactions of each group of animals are compared to each other as well as the vocal stimulus.

Motherese vs. Normal Speech					
	Comparisons	d.f	F	p-value	Interaction p-value
TI	Wolves/Dogs	3,223	7.538	7.94E-05	0.00069
	Dogs/Hybrids	3,223	7.78	5.78E-05	0.01353
TT	Wolves/Dogs	3,223	2.689	0.04724	0.00541
	Dogs/Hybrids	3,223	1.168	0.3229	0.104
TW	Wolves/Dogs	3,223	2.228	0.08578	0.0132
	Dogs/Hybrids	3,223	1.158	0.3265	0.103
RV	Wolves/Dogs	3,223	7.459	8.81E-05	0.00045
	Dogs/Hybrids	3,223	8.334	2.82E-05	0.00676

Yellow= statistically significant values. TI= total interactions, TT= length of interactions, TW= weighted interactions, RV= return visits.

Figure 1: Responses of the animals to motherese and normal speech patterns.



Animals

Here I measure the effects of age, sex, and content of the animals on the behavioral interaction variables. These variables were first tested independently against the data and then run together for any significant statistical interaction. Only the statistically significant results are reported.

Age & Sex

I tested the effects of age and sex of the animals on their encounters with the human volunteers. Age and sex were first tested individually on the measured variables. I then combined age and sex in the same model and measured the interaction statistic. Table 3 provides the statistical findings for the age and sex of the animals and how these variables influenced the number, length, and style of interactions. Independently age had a significant relationship with the number of behavioral interactions and was borderline significant for return visits. As an animal increases in age they are slightly more likely to initiate encounters with the human volunteers. However, age had no impact on the length of encounter or the behaviors during the interactions.

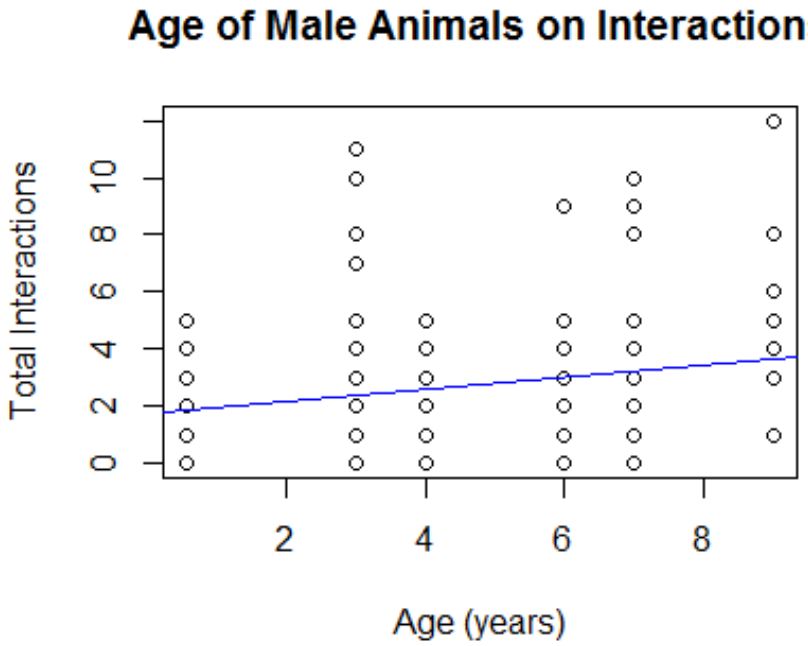
Sex was independently significant for all four of the measured variables, with males being the most sociable of the sexes. Within males age was found to be significant in determining the number of encounters (Figure 2) and return visits. The older the male the more likely they were to intermingle with the human strangers. Females did not have any relationship with age in the overall data. Thus, the results for all animals being influenced by age is attributed to the trend observed within males.

Table 3: Statistical values for the influence of age and sex across all animals.

Animal Data (Overall)					
	Test	d.f	F	P-value	Interaction p-value
TI	Age	1,225	4.898	0.0279	N/A
	Sex	1,225	12.63	0.000461	N/A
	Age + Sex	3,223	7.261	0.000114	0.08584
TT	Age	1,225	0.0611	0.439	N/A
	Sex	1,225	10.48	0.001392	N/A
	Age + Sex	3,223	3.882	0.009849	0.38985
TW	Age	1,225	0.01063	0.918	N/A
	Sex	1,225	9.481	0.002334	N/A
	Age + Sex	3,223	3.228	0.02334	0.6008
RV	Age	1,225	3.457	0.06429	N/A
	Sex	1,225	8.183	0.004626	N/A
	Age + Sex	3,223	5.272	0.001566	0.0651

Yellow= statistically significant values. TI= total interactions, TT= length of interactions, TW= weighted interactions, RV= return visits.

Figure 2: The effects of age on male animals for the total number of behavioral interactions with human volunteers.



Content

Wolf content in the animals was most noticeably significant when comparing full blooded wolves to dogs, and dogs to all of the hybrid levels (Table 4). These relationships were only apparent in the number of behavioral interactions and return visits with the human volunteers. Dogs had more total encounters with the volunteers than the wolves or hybrids. There were no significant correlations with the wolf content of the animals and the length or style of the behavioral interactions.

Table 4: This table compares the responses of the three main content groups to each other for the measured variables.

Behavioral Responses Between Content Groups				
	Comparisons	d.f	F	p-value
TI	Wolves/Dogs	1,225	9.958	0.00182
	Dogs/Hybrids	1,225	16.79	5.83E-05
TT	Wolves/Dogs	1,225	0.1099	0.7405
	Dogs/Hybrids	1,225	0.6774	0.411
TW	Wolves/Dogs	1,225	0.4339	0.5108
	Dogs/Hybrids	1,225	0.7889	0.375
RV	Wolves/Dogs	1,225	8.925	0.00312
	Dogs/Hybrids	1,225	17.09	5.04E-05

Yellow= statistically significant values. TI= total interactions, TT= length of interactions, TW= weighted interactions, RV= return visits.

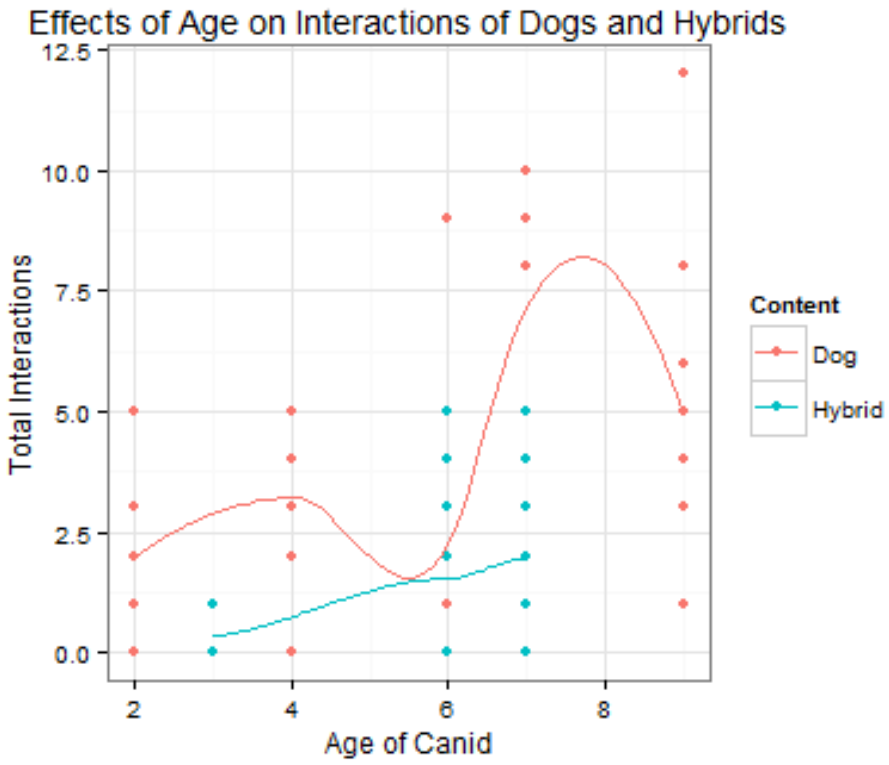
Content & Age: Table 5 provides the statistical values of how age statistically interacts with the wolf content of the animals. Age was not found to be a significant variable among wolves, but was significant for both dogs and hybrids. As both a dog and hybrid ages they are more likely to initiate encounters with humans (Figure 3). The values for the length and type of behavioral interactions were not significant across all content levels.

Table 5: Influence of age on the three main content groups.

Content & Age				
	Content	d.f	F	p-value
TI	Dogs	1,43	5.663	0.02183
	Hybrids	1,52	7.48	0.008514
	Wolves	1,126	0.4126	0.5218
TT	Dogs	1,43	4.333	0.04336
	Hybrids	1,52	2.645	0.1099
	Wolves	1,126	1.192	0.277
TW	Dogs	1,43	0.8938	0.3497
	Hybrids	1,52	2.333	0.1327
	Wolves	1,126	0.8663	0.3538
RV	Dogs	1,43	5.534	0.0233
	Hybrids	1,52	4.489	0.03891
	Wolves	1,126	0.1418	0.7071

Yellow= statistically significant values. TI= total interactions, TT= length of interactions, TW= weighted interactions, RV= return visits.

Figure 3: Effects of age on hybrids and dogs.



Content & Sex: Table 6 provides statistical results for the content levels (wolves, dogs, & hybrid) influenced by the sex of the animals. Males for both dogs and hybrids interacted

significantly more with the human volunteers, including return visits. Within dogs specifically, males behaviorally interacted longer but not more intimately than the females. Full wolves showed reversed data, females initiated contact with the volunteers equally as much as the males. But, male wolves spent more time with the volunteers and they behaved more intimately.

Table 6: Influence of sex on varying content contrast codes.

Content & Sex				
	Content	d.f	F	p-value
TI	Dogs	1,43	12.28	0.001083
	Hybrids	1,52	12.05	0.001049
	Wolves	1,126	0.8715	0.3523
TT	Dogs	1,43	4.522	0.03924
	Hybrids	1,52	1.47	0.2309
	Wolves	1,126	7.325	0.007745
TW	Dogs	1,43	0.6124	0.4382
	Hybrids	1,52	1.778	0.1882
	Wolves	1,126	7.977	0.00551
RV	Dogs	1,43	10.58	0.00223
	Hybrids	1,52	6.278	0.01539
	Wolves	1,126	0.2651	0.6075

Yellow= statistically significant values. TI= total interactions, TT= length of interactions, TW= weighted interactions, RV= return visits.

Human Volunteers on Animal Characteristics

In this section I tested the influence of age and sex of the volunteers against the dependent variables. I also measured the interaction statistic between the descriptive variables of the animals and the humans, namely: age, sex, and content. This was done to measure how variables other than voice might have influenced the behavioral encounter outcomes.

Age & Sex of Human

In this category I tested the effects of age and sex of the human volunteers on the dependent variables. The two were first tested independently and then together, measuring th interaction coefficient. Independently neither age nor sex of the human volunteers had significant

difference across all four measured variables. Together, the interaction of age and sex of the volunteers also had no statistical significance with the data.

Age of Animal & Sex of Human

Here I measured the interaction variable for the age of the animal and the sex of the human volunteers. In this instance I saw a relationship between the age of the animals and the sex of the volunteers (Table 7) with all four interaction variables. Women in particular had a significant number of interactions with young adult and elderly animals (Figure 4). This relationship did not exist with male volunteers.

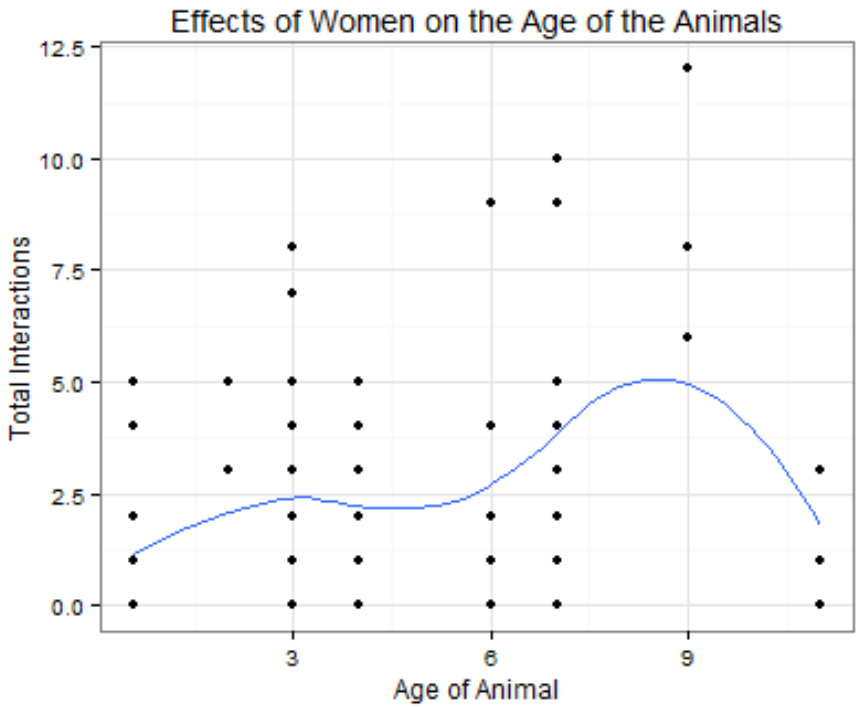
Table 7: How age and sex of human volunteers interacts with age and sex of the animalss.

Female Volunteers & Animals				
	Test	d.f	F	p-value
TI	AW+SH	1,74	5.479	0.02194
	SW+SH	1,74	9.666	0.002664
	AH+SWM	1,138	1.837	0.1775
	AH+SWF	1,85	0.0201	0.8876
TT	AW+SH	1,74	1.879	0.1746
	SW+SH	1,74	9.635	0.002704
	AH+SWM	1,138	2.457	0.1193
	AH+SWF	1,85	0.00043	0.9835
TW	AW+SH	1,74	2.169	0.1451
	SW+SH	1,74	7.609	0.007312
	AH+SWM	1,138	1.725	0.1912
	AH+SWF	1,85	0.0083	0.9275
RV	AW+SH	1,74	3.873	0.05282
	SW+SH	1,74	8.576	0.004526
	AH+SWM	1,138	2.819	0.09542
	AH+SWF	1,85	0.1022	0.75

Male Volunteers & Animals				
	Test	d.f	F	p-value
TI	AW+SH	1,149	0.9413	0.3335
	SW+SH	1,149	4.347	0.03878
TT	AW+SH	1,149	2.86	0.09288
	SW+SH	1,149	3.937	0.04908
TW	AW+SH	1,149	1.13	0.2894
	SW+SH	1,149	3.646	0.05814
RV	AW+SH	1,149	0.6522	0.4206
	SW+SH	1,149	1.805	0.1812

Yellow= statistically significant values. AW= Age of animal; AH= Age of human; SW= Sex of animal; SH=Sex of human; SWM= Sex of animal male; SWF= Sex of animal female; TI= total interactions, TT= length of interactions, TW=weighted interactions, RV=return visits.

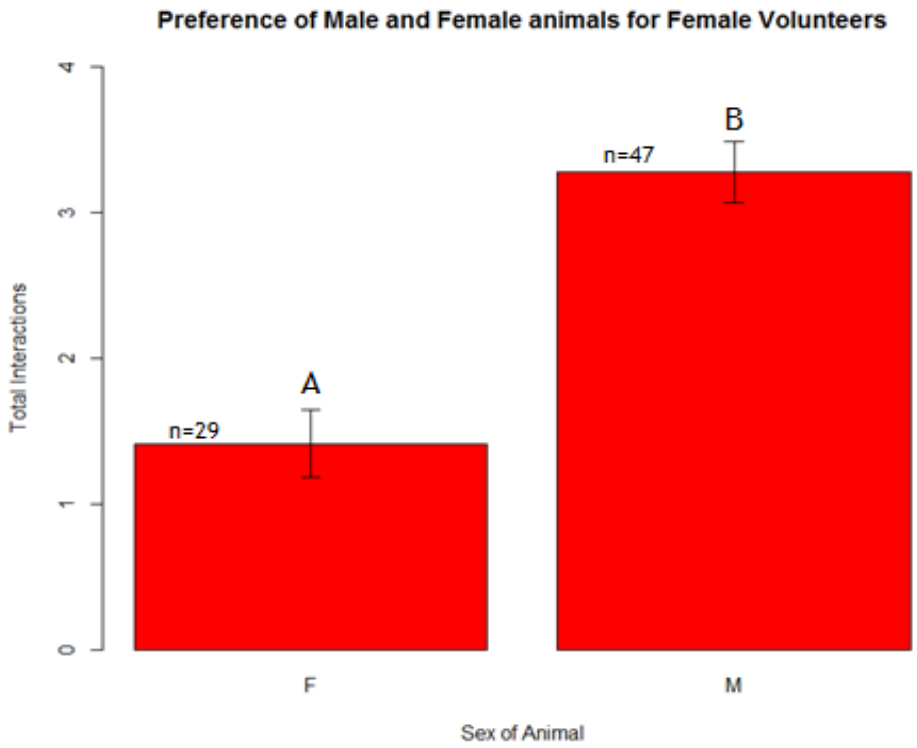
Figure 4: An interaction plot between women volunteers and the age of the animals.



Sex of Human & Sex of Animal

I tested the effects of the sex of both the human volunteers and the animals. There was a strong correlation between the sex of the animals and the human volunteers (Table 7), with the animals preferring humans of the opposing sex (Figure 5). This relationship was seen most strongly between male animals and female volunteers, and was found throughout all four of the measured variables.

Figure 5: The average number of encounters female volunteers received from each sex of the animals.



Sex of Human & Content of Animals

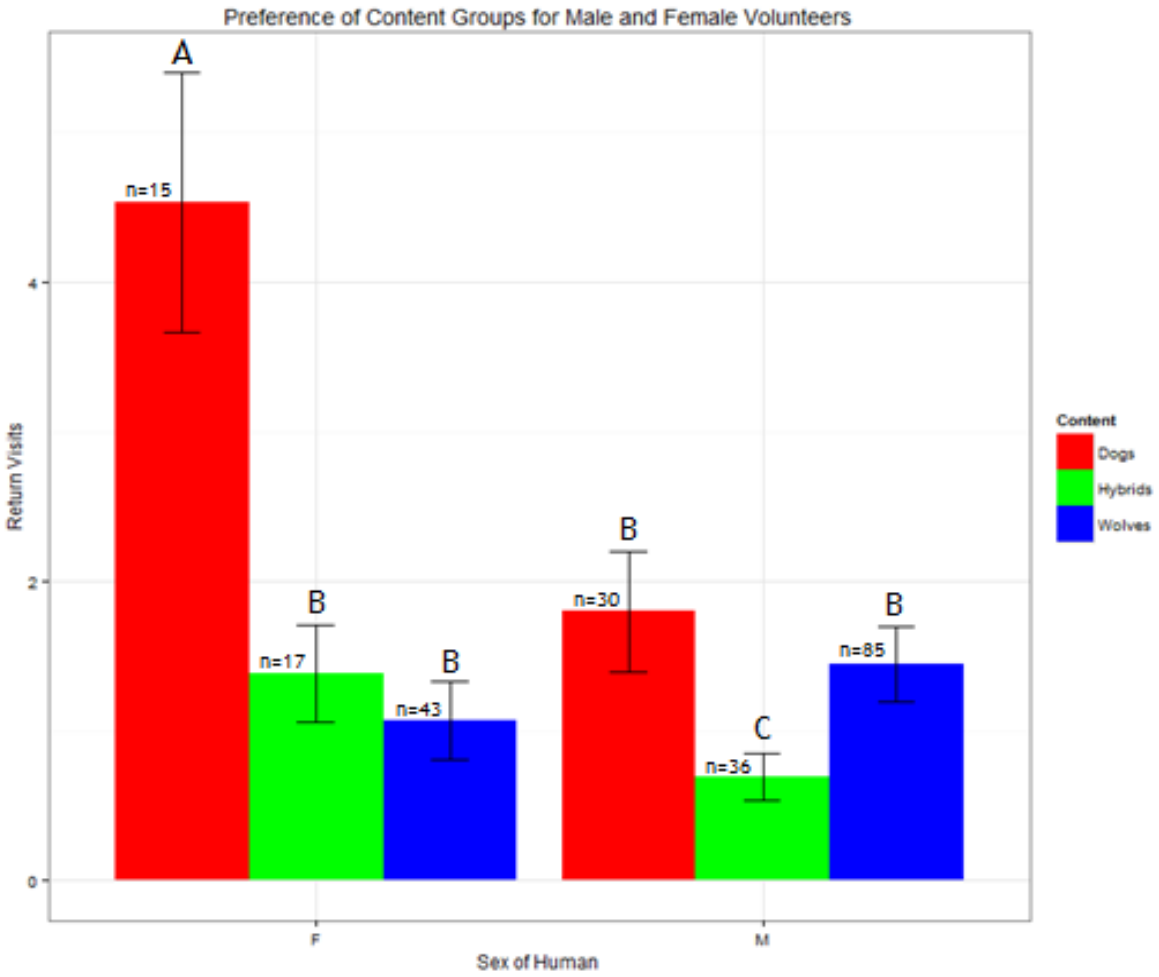
Table 8 shows the relationship between the sex of the human volunteers and the wolf content of the animals. Dogs showed significant results across all but the weighted time variables. Hybrids had a significant statistic for the number of times they returned to volunteers. The results for both dogs and hybrids show favoritism towards women volunteers rather than men (Figure 6). Wolves have no preference for the sex of the volunteer and they appear to be initiating contact randomly.

Table 8: This table shows the influence of volunteer sex on the content of the animals. In all highlighted boxes the preference of the animal is toward women.

Content & Sex of Volunteer				
	Content	d.f	F	p-value
TI	Dogs	1,43	11.21	0.001702
	Hybrids	1,52	2.993	0.08953
	Wolves	1,126	1.071	0.3027
TT	Dogs	1,43	7.939	0.00728
	Hybrids	1,52	1.028	0.3153
	Wolves	1,126	2.68	0.1041
TW	Dogs	1,43	1.107	0.2986
	Hybrids	1,52	0.9846	0.3257
	Wolves	1,126	2.581	0.1106
RV	Dogs	1,43	10.69	0.002125
	Hybrids	1,52	4.86	0.03193
	Wolves	1,126	0.8926	0.3466

Yellow= statistically significant values. TI= total interactions, TT= length of interactions, TW= weighted interactions, RV= return visits.

Figure 6: Return visits of the animals to the human sexes.



DISCUSSION

The use of motherese significantly influenced dog behavioral responses during encounters with human volunteers. This was most prominent in the total number of interactions that occurred. Wolves showed no difference in speech pattern preference, but spent just as much time with the volunteers as the dogs. Hybrids collectively tended to match wolf behavior more strongly than the behavior of the dogs. Overall the data suggest that dogs initiate more interactions with human strangers than wolves, with a strong preference for volunteers using motherese. Wolves interact just as long and as intimately as dogs but with fewer total volunteers, with no correlation to any form of speech patterns being used.

Hennessy et al. (1998) showed that impounded animals have lower cortisol levels when being petted by women compared to men. Many trainers and sanctuary personnel believe that women in general work better with animals than men (Lore & Eisenberg, 1986; McGreevy et al., 2012). Women did not receive more attention than men from the animals overall. For all studies comparing human preferences, encounters between women and dogs need to be narrowed down to more specific indicators, not just sex.

Women had more interactions with younger and older animals. One hypothesis to explain this is that women are typically seen as the more nurturing of the two sexes (Breed & Moore, 2012; Falk, 2004). In my experience, younger and less experienced animals will approach the least intimidating individuals. These individuals tend to be women (Lore & Eisenberg, 1986; Mallon, 1993). In this case the animal might feel secure from harm interacting with a human of a gentle nature. This is perhaps the same for elderly animals. Elderly animals tend to be in weaker physical conditions than adults (Cain et al., 2008; Mech & Boitani, 2003), therefore they are naturally wary of potentially dangerous situations. Women may come off as the least

intimidating of the sexes and therefore younger and older animals feel less threatened and more comfortable initiating interactions.

Female volunteers gained the most interactions from male dogs. Although male dogs interacted with people significantly more than any of the other animals, they chose to interact most with women. This type of favoritism is often observed between female owners and their male dogs, with fewer cases occurring between men and female dogs (Kotrschal et al., 2009; Mallon, 1993; McGreevy et al., 2012; Prato-Previde et al., 2006; Wedl et al., 2010). Hybrids showed some favoritism towards women, but only in the number of return visits. A sex biased reaction was not seen within wolves. Female volunteer favoritism shown by male dogs and hybrids could be influenced by two different aspects: scent, and cultural history.

All of the female volunteers were sexually mature. Male dogs and hybrids could have been responding to the sex pheromones that women naturally give off (Jezierski & Sobczyńska, 2012). Although data was not measured, any women that were menstruating or ovulating during the data collection interactions could have drawn more attention from the male dogs. All of the animals, except one male, were spayed or neutered. But, with the animals being sexually mature they still respond to sex pheromone (Breed & Moore, 2012) emitted by females. If this were the case then the wolves would have likely shown a preference for women over men. Since they remained neutral towards the sexes perhaps another explanation is needed as to why the dogs and hybrids showed a preference but the wolves did not.

All wolves were raised as ambassador animals. This means that they experienced positive interactions with both men and women during their upbringing. The fact that they show no sexual preferences towards any of the volunteers could be a result of this neutral treatment. However, the dogs and hybrids came to the sanctuaries with previous human experiences that are

not always known. Before their lives at the sanctuaries the dogs and hybrids could have experienced cultural events that influence their preference for women over men. The majority of dog-human aggression occurs between men and male dogs (Kotrschal et al., 2009; McGreevy et al., 2012). Dogs at the sanctuary could have experienced domestic violence by men prior to their arrival. An association with men and unpleasant encounters might therefore be influencing the animals' decisions to interact more with women. Future studies into the nature of dog and human aggression could help to understand the effects of sexual preference towards humans.

Overall, male animals interacted significantly more often with humans than the female animals. With the exception of one individual from M:W the females tended to be naturally more shy than the male within the same enclosures. Of the three puppies (7 months in age) the two males were significantly more sociable than the female. The encounters seen from males could be attributed to higher levels of testosterone. Animals with heightened levels of testosterone are more dominant and aggressive than others (Breed & Moore, 2012; Serpell & Hsu, 2005). The dominant individuals in a wolf pack are the first to explore novel situations (Mech & Boitani, 2003; Mech, 1970), this trait could still exist in dogs. Although all but one of the adult male animals are neutered, Serpell and Hsu (2005) found that neutering does not always change the behavior of the animal. The more socially interactive males may have had higher levels of testosterone, making them more dominant and interactive with the humans. Sex could play a role in willingness to interact, but species of *Canis* have personality arrays practically as diverse as humans (Inoue-Murayama, 2009). More research is necessary on a larger scale across all age ranges of *Canis* to confirm exactly how sex influences confidence to initiate encounters within an individual.

Age was also an important factor in measurements of confidence of the animals. All of the animals were raised by humans and conditioned to be ambassadors. They interact with strange humans throughout their lifetime. As the animal ages it will accumulate ambassador visits and therefore experience working with strangers. I saw a trend in which older animals interacted significantly more than the younger animals. One might argue that this data should be skewed with the use of puppies because puppies are naturally more sociable with humans than adults (Fentress, 1967; H. Frank & Frank, 1982; Gácsi et al., 2005; Kleiman, 2011; Kubinyi et al., 2007; Mech & Boitani, 2003; Woolpy & Ginsburg, 1967). However, the puppies used were seven months old and past the age of hyper sociality.

While wolves do not reach sexual maturity until about two years of age (Kleiman, 2011; Kubinyi et al., 2007; Mech & Boitani, 2003) they begin to lose their boldness with strangers after the critical socialization period of 10 days old to six weeks (Coppinger & Coppinger, 2001; Fentress, 1967; H. Frank & Frank, 1982; Gácsi et al., 2005; Kubinyi et al., 2007; Woolpy & Ginsburg, 1967). The style of socializing puppies between the two sanctuaries (M:W & CWWC) was important by influencing how they interact with strangers. The CWWC ambassador program socializes their puppies with strange humans more aggressively than M:W. More intense socialization during the critical period conditions the animals to be less fearful of humans as they age (Fentress, 1967; H. Frank & Frank, 1982; Gácsi et al., 2005; Kubinyi et al., 2007; Woolpy & Ginsburg, 1967)Age and experience are not the only factors determining boldness of an animal, the socialization process during the critical period is also a deciding factor.

Hybrids responded almost identically to wolves in their reactions to the speech patterns. These data suggest that wolf-like behavioral traits are dominant genetically. The hybrids used in my study were housed at the sanctuaries because of poor behavior. These hybrids almost always

arrive at sanctuaries after first living with a family and failing. Every case is different, but in general hybrids do not work out with a family because they are uncontrollable and often bite someone and/or destroy property (Hope, 1994). The hybrids may show greater similarities to wolves because of their necessity to be housed within a sanctuary. Almost 250,000 hybrids are privately owned in the U.S (Hope, 1994), many of them are family pets. Pet hybrids can behave drastically different than hybrids in a sanctuary of the same wolf content. While my research shows hybrids in sanctuaries react similarly as wolves, this behavior cannot be attributed to hybrids living within homes. To successfully pin down the inherited behaviors of hybrids more studies must be conducted using both sanctuary hybrids and pet hybrids.

Dogs responded strongly to the usage of motherese. Motherese is a specific speech pattern that can be easily directed to one target (Falk, 2004). Human adults do not speak with each other in this form, and only use it when faced with a social individual of limited to no language capacity (Burnham & Kitamura, 2002; Falk, 2004; Saint-Georges et al., 2013; Sims & Chin, 2002). Since dogs are not capable of using language it's believed that humans slip into motherese unconsciously because they are interacting with another social organism. I believe that dogs are intelligent enough to recognize that motherese is directed towards them and not another adult human. Their increased interactions with volunteers speaking motherese reflect a dog's knowledge of which humans are providing the most attention. Soliciting attention from humans using motherese narrows the playing field for dogs, directing their efforts towards humans most interested in interacting with the animal.

The motivation beneath the unconscious use of motherese by humans is still unclear. State of mind is thought to be a contributing factor to the behavior. Women use motherese more often than men, especially when interacting with animals. Wedl et al. (2010) believe this is due

to the way men and women perceive animals. Women are more likely to view dogs as emotional and social support, while men treat animals more as companions. With women feeling emotionally connected to the dog they treat them more like a young human infant, leading to the usage of motherese. Both men and women were instructed to use motherese, removing any natural gender bias. But, dogs still showed a preference for women over men and motherese enhanced this likelihood. Other studies provided evidence for female preference by dogs (Hennessy & Williams, 1998; Mallon, 1993; Prato-Previde et al., 2006; Wedl et al., 2010; Wells & Hepper, 1999). Since women are more likely to use motherese during interactions with new dogs this could be one of the determining factors for female preference found within other studies.

Women owners are known to form attachment bonds with their dogs similar to those of mothers and infants (Prato-Previde et al., 2003; Prato-Previde et al., 2006; Topál et al., 2005). Before infants have the capacity to learn language motherese is thought to be essential in creating an emotional bond between the mother and her child (Falk, 2004; Saint-Georges et al., 2013). Prato-Previde (2003) argue that using motherese with their dogs creates a stronger emotional bond between woman and pet. Motherese seems to have a similar effect on dogs as it does with infants.

Attachment bonds between a dog and its owner create a secure relationship between the two. The more the animal is attached the greater its loyalty and drive to please the human handler (Kubinyi et al., 2007; Prato-Previde et al., 2003; Topál et al., 2005). This type of bond would have been essential during the early stages of domestication. Dogs not only need to attract human attention, but also maintain a positive relationship with the human that provides the best resources. Motherese could be a form of creating such a relationship, bonding the dogs to the

human and the human to the dog. Once a human is emotionally attached to a dog, the dog's fitness will increase exponentially. This is because humans ensure the survival of their dogs, with some breeders ensuring reproductive success. Humans that deeply care for their dogs are likely to provide for their dog for the rest of its life (Kubinyi et al., 2007; Prato-Previde et al., 2003). During domestication dogs that responded to humans using motherese would have had greater fitness than those that did not. Over time this behavioral trait could have become universal across dog breeds.

Motherese is just one contributing factor fostering the emotional relationship between humans and dogs. Further research into dog responses to human behavior is needed to discover any other traits that could be connected with dog domestication. Ideas can be found simply by watching dogs interact with different people. Trainers know that dogs, wolves, and hybrids show clear preferences for certain personality types than others, but there have been few studies into why. Often women have stronger influences over the animals than men, but this is not always the case. By disentangling the web of behaviors used by people with good canid karma we can even pinpoint which behaviors might have coevolved. The tricky part is the personality variance found both within *Canis* and humans. Each individual is different and attempting to figure out either group as a whole is difficult, but can lead to some great discoveries.

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APPENDIX A

Wolf Visit Protocol

This is an exact copy of the directions I provided every human volunteer with before arriving at the sanctuaries.

Entering/Leaving the Enclosure:

- All volunteers will enter the enclosure at the same time, for the sake of efficiency.
- Upon entering the volunteers will completely ignore the animals until in position.
    - No touching, talking to, or looking at the animals
    - If an animal is in the way continue to ignore them (they will move)
- Volunteers will walk in upright and with confidence at a steady pace single file.
- All volunteers need to represent their own entity, separate of the group. To do this they will be spread out randomly within a designated area of the enclosure.

During the Visit

- Volunteers will be paired with their behaviors given a random number generator. This pairing will be different for every enclosure entered.
- Behaviors to be portrayed are as follows:
    1. Regular speech patterns (as if talking to a peer)
    2. Motherese speech patterns (as if talking to a baby)
    3. No speaking (Mute)
- Volunteers will sit cross legged on a level piece of ground, unless a bench is provided

- Any movement (walking, turning around, etc.) will not be permitted. All volunteers must remain in the same location for the duration of the visit. They must also remain facing the same direction, even if the animal is directly behind them.
    - The movement of arms and hands will be permitted to redirect the animal if necessary
    - Handlers will be in the enclosure to redirect any mischievous animals
- All volunteers will avoid making prolonged direct eye contact with the animals
- All volunteers must be actively aware of where each animal is in relation to them.
- Volunteers will have their hands relaxed and facing outwards slightly away from their bodies. This provides a safe base for the animals to investigate without getting too close.
- If an animal solicits physical interactions within an arm's length from the volunteers it will be returned.

Human Safety Procedure:

It is absolutely necessary that these protocols be followed exactly when interacting with the wolves. These are designed with the safety of the experimenters in mind. Wolves are still wild animals, even though the ones we will be working with are highly socialized. Handlers and I will be in the enclosure during these interactions to interfere if necessary. It is important that you memorize these moves and practice using them (a neighbor's dog would be a good teacher) before we get to the sanctuary.

- **Never** reach over the head of the animal.
- Any petting/rubbing will always be **calm and slow stokes.** Scratching of itchy places is the only rapid movement allowed.

    - If the animal appears to be getting excited return to calming strokes.
- When reaching to touch the animal this should not change the volunteer's body position. Only the arm is allowed to reach.
    - When reaching the movement will be slow and calm, **never** reach rapidly or lunge towards the animal.
- If available, initiate touching via the chest of the animal
- During physical interactions it is permitted to look the animal in the eyes
    - Still do not directly stare for any long amount of time
- During a formal greeting the animal will approach the face
    - At this moment volunteers will continue talking and petting the animal
    - Experimenters will pull back their lips and reveal their teeth
        - Keep the mouth shut (otherwise a wolf tongue might find its way in)
    - The animal will either smell the teeth or lick the face
        - **Do not pull back**, volunteers will remain in the same position
        - If the wolf is pushing into the face volunteers will push back, not forcefully, just enough to keep from falling over
        - Look the animal in the eye (this is how they recognize one another)
            - It is important to keep the eyes open, even if being licked
    - In rare cases the animals might provide a nibble greeting and will mouth the face. This is gentle and does not provide any danger.
        - Usually this happens when the animal is too excited because of rapid petting from the human volunteer.

        - Volunteers should drastically calm their petting and energy, speaking to the animal in calming tones until it calms down.

- During the entire experiment and physical interactions the volunteers must **never laugh**, especially if a wolf is misbehaving.
    - If anything is taken from the experimenters, such as glasses, or the animals are getting frisky the group must remain calm and indifferent.
- If an animal attempts to "take" anything treat them like a toddler.
    - Do not hide whatever it is they are interested in
    - Do not pull back
    - Place a free hand underneath the jaw of the animal and pull them up towards your face.
        - Continue doing this until they lose interest
    - Handlers present will assist if the volunteer does not feel comfortable enough doing this on their own