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Abstract

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Dogs (*Canis familiaris*) are strongly responsive to human influence in general, and they also readily form preferences for specific humans, yet these lines of inquiry have not often been combined. The goal of this dissertation was to advance a more specific theory regarding the nature of the dog-human bond – that it is one characterized by dependency – and to investigate whether such bonds would influence dogs to use social strategies to solve non-social problems.

In Chapter 1, I describe the features of the relationship between the dog as a species and humans, and how this inter-species relationship is reflected in the dog's attentiveness to humans and tendency to solve problems by attending to human behavior. After describing the dog's abilities in this domain, I go on to explore the phenomenon from the perspective of two of Tinbergen's four levels of analysis: phylogeny and ontogeny. To do this, I compare the dog's reading of human social cues with that of related canid species, and I then explore within-species differences among canines. Finally, I advance a new theory that dogs can be described as uniquely dependent on humans, and I explore various specific situations in which this dependency can explain the dog's problem solving strategy choices.

In Chapter 2, I explore experimentally whether the presence of social information provided by familiar versus unfamiliar humans would influence the dog's performance when choosing between two potential food sources. This study included a number of conditions; in some conditions, a familiar person indicated a container that gave food and a stranger indicated a container that did not; in other conditions this was reversed. Results show that dogs consistently chose the container indicated by or nearest to their owner, even when this container never yielded a food reward. In contrast, in two other conditions, dogs chose at chance: a control condition in which both humans were strangers, and a condition in which the owner and stranger sat reading books and provided no social signal to the dog. These results support the dependency hypothesis in showing that the dog's performance is either facilitated or hindered, depending on whether a familiar human provides accurate or inaccurate signals.

In Chapter 3, I explore the boundary conditions of the effect of familiarity on dogs' performance when choosing between potential food sources, by examining whether a brief period of familiarization with a new person would be enough for a dog to establish a preference for that person's social signal over that of a stranger. Results were not significant; some individual dogs showed a preference for a food container indicated by the familiar person, whereas others did not, but this effect was not significant at the group level. Future studies should incrementally increase the period of time used to familiarize the dog and the new person, to establish how long it takes for such a preference to form in the dog. Such findings would establish whether dogs can quickly become influenced by the information of a familiar person, without that particular dog needing to be in a state of actual dependency on that particular person, or whether dogs need a longer time period, and an actual level of dependence on a person, for this effect to occur. If actual dependency is not required, this would indicate that dependent-like responses in dogs are an automatic part of their responsiveness to familiar people, owing to such a strategy having resulted in fitness benefits over the history of the species, regardless of whether those familiar people actually materially provision the dog.

Finally, in Chapter 4, I explore the influence of variations in the relationship between specific dogs and owners on the dog's food-choice strategies by examining whether "closeness to owner" could predict the strength of the dog's preference for a food container indicated by the owner, among dogs tested in Chapters 2 and 3. I measured closeness by creating an owner-report survey which owners completed online. Factor analysis of a large community sample of owners revealed that this set of questions yielded two discrete scales: Owner-Initiated Closeness and Dog-Initiated Closeness. I examined correlations between these two scales and the performance of dogs tested in the previous chapters. Results were generally not significant; closeness scores did not explain variation in the strength of the dog's preference for their owner's signal. Future studies should explore more detailed ways of measuring closeness (e.g., by observing dogs and owners in their homes), and should examine whether dependence specifically, rather than closeness, might better explain differences in performance between dogs.

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Chapter 1: The Ontogeny and Phylogeny of the Dog-Human Relationship

Introduction

The goal of this chapter is to introduce the phylogenetic background of the domestic dog (*Canis familiaris*), its relationship with humans, and some of the social abilities that dogs have demonstrated in their interactions with humans. Specifically, I will discuss the dog's social abilities with humans from the perspective of two of Tinbergen's (1963) four levels of analysis: phylogeny and ontogeny. I will also address some issues regarding function; this dissertation will not specifically address the question of mechanism, in terms of specific biological processes underlying dog behavior. In this chapter I will also introduce and describe the theory that dogs are not only domesticated and human-socialized, but are uniquely dependent on humans, and I will describe a variety of evidence in support of this theory, including how this theory can better explain the results of a variety of studies of dog cognition.

Dogs and humans enjoy a close and long-standing interspecies relationship. Estimates are that dogs first began to diverge from wolves (*Canis lupus*) and to live near early humans approximately 130,000 years ago (Vilà, 1997). By at least 15,000 years ago (and possibly as much as 33,000 years), they had diverged morphologically from wolves (Clutton-Brock, 1995; Gray, Sutter, Ostrander, & Wayne, 2010; Wayne & vonHoldt, 2012) and evidence of their importance to humans has been found in their appearance in cave art and human burials at approximately the same time (see Udell, Dorey, & Wynne, 2010a). Dogs have the distinction of being, in all likelihood, the first species to be domesticated (Feddersen-Petersen, 2007). Early dogs likely functioned in coordinated ways with humans, both as work partners and social companions, in relationships of mutual benefit (Coppinger & Coppinger, 2001). Arguably, they are unique in this regard; no other domesticated species works for us in such a wide range of contexts, both inside and outside the home. Estimates are that the US alone has a population of 78 million dogs and that almost forty percent of US households include a dog (American Pet Products Association, 2012). Dogs share our daily social lives, often being substantially incorporated into the family environment (Topál, Miklósi & Csanyi, 1997) to the extent that many owners think of their relationship with their dog as being similar to that with their children (Berryman, Howells, & Lloyd, 1985). Indeed, up to one-third of pet owners report feeling closer to their pets than to other family members (Barker & Barker, 1988).

It is likely that throughout the evolution of the domestic dog, changes occurred in the species' cognitive and social abilities that made dogs more compatible with humans. Indeed, dogs seem to have some aptitude in human-like social domains. For example, dogs recognize humans' attentional states: They obey commands more often and for longer when a human is facing them rather than facing away or attending to something else (e.g., reading; Schwab & Huber, 2006), positioned behind a visual barrier (Bräuer, Call, & Tomasello, 2004), or shown on a video recording (Virányi, Topál, Gácsi, Miklósi, & Csányi, 2004). They also beg from a person facing toward them rather than away from them and from a non-blindfolded over a blindfolded person (Gácsi, Miklósi, Varga, Topál & Csányi, 2004). And remarkably, evidence indicates that with training, dogs may be able to learn the generalized concept of imitation: one dog was able to imitate a series of human behaviors that he observed only once and had not been specifically trained to do (Topál, Byrne, Miklósi & Csányi, 2006). Dogs also seem to display communication-like behaviors directed toward humans, even when the human is present but otherwise non-interactive; for example they are able to communicate the location of hidden food to their owners (Hare, Call, & Tomasello, 1998; Miklósi, Kubinyi, Topál, Gásci, Virányi, & Csányi, 2003). All these findings suggest that dogs have some rather human-like social skills, which have likely arisen during our two species' long history together.

For domesticated dogs, human society is their environmental ecological niche, and dogs have had a long time period in which to become adapted to that environment ecology (Coppinger & Coppinger, 2001). Keeping close to human providers of food and shelter has likely conferred obvious enhanced reproductive fitness value, and has led to the selection of dog thus so have the behaviors to maintain and remain in proximity with humans. One such specific ability that has been investigated in dogs is their skill at reading human social gestures and using them as a source of information. For example, as Miklósi and Soproni (2006) summarize, the pointing gesture appears to be a uniquely human one, not shared by non-human primates. And yet as an increasing body of research is showing, dogs seem to be able to take information from the human point, using it find hidden food (Hare & Tomasello, 2005; Miklósi & Soproni). Indeed, as Hare and Tomasello (2005) point out, it is remarkable how much dogs' ability in this task exceeds that of non-human primates. The dog's well-established performance at such gesture-following tasks, then, can be used as a way of investigating how dog social behavior may be adapted to their close relationship with humans.

The Dog's Ability to Read Human Gestures

In the past 10 years, a wide range of studies using an object-choice paradigm have been published demonstrating the variety of circumstances under which dogs can follow the human pointing gesture (see Miklósi & Soproni, 2006, and Reid, 2009). In these studies, the dog must choose between two or more items, one of which is indicated by the gesture and contains a food reward, and their performance is usually measured against chance. The dog's facility at this task appears relatively robust, and thus a number of studies have been published that attempt to determine the boundary conditions of this ability. For example, dogs perform above chance when the gesture is at a variety of distances from the indicated object, ranging from as close as 10 cm to as far as 80 cm (Soproni, Miklósi, Topál & Csányi, 2002; Miklósi, Pongrácz, Lakatos, Topál, & Csányi, 2005), though their performance improves as this distance decreases (Reid, 2009). The dynamic nature of the gesture has also been manipulated in several studies. Their performance seems to be affected by whether the gesture is dynamic (i.e., the dog sees the arm moving) or static (i.e., the arm is fixed in position). They are able to perform above chance in both conditions, but they are more successful with the dynamic point (Reid, 2009). Dogs are also affected by the specific “shape” of the point; they are most accurate when the gesture visibly extends from the pointer’s body, and least accurate when the point appears in front of the pointer’s abdomen (Reid, 2009). In contrast, their performance does not seem to be affected by the location of the pointer. Dogs still do well at this task even if the pointer is actively taking steps away from the correct object while gesturing toward it (McKinley & Sambrook, 2000). Odor does not override a dog’s use of the human point, and indeed dogs will repeatedly make an incorrect choice if a human’s point indicates the incorrect container while odor cues indicate the correct one (Szetei, Miklósi, Topál & Csányi, 2003).

Dogs appear to reliably follow the pointing gesture only when it is given by a human. They are unable to follow pointing gestures made by inanimate objects. Udell, Giglio, and Wynne (2008) compared human pointers to points made by a doll, a stuffed dog, and a mechanical arm. They found that dogs could not reliably follow a gesture made by any of these inanimate objects, though these same dogs performed consistently well when given a human point, and could even, to some extent, follow the gesture when made by a human leg instead of an arm. Some dogs have also shown some ability to follow a “point” made by a conspecific (i.e., the conspecific’s face and body orienting toward the correct choice; Hare & Tomasello, 1999). These results have established that dogs are not simply responding to a sort of “sign stimulus” with perceptual features similar to a pointing arm.

Moreover, dogs come to rely on even indirect human social actions: they can correctly choose which of two containers hides a food reward when they see a human place a token near it (Riedel, Buttelmann, Call, & Tomasello, 2006). They can even choose correctly when the human is present but the token is placed behind a barrier, out of the dog’s sight, though they perform less accurately than when they at least see a human’s hand placing the token (Riedel et al., 2006). However, they appear unable to use a token in this way when they are not in the room during the time that the token is placed, removing the social context of the token entirely (Agnetta, Hare & Tomasello, 2000; Udell et al., 2008). These results suggest that dogs are cueing in on human social information in particular when making such choices, rather than relying on more general problem-solving strategies.

Why Are Dogs So Attentive to Human Social Information?

It appears that a dog’s ability to take information from human gestures can be classified as a form of communication, but I use this term with the specific definition used in the field of behavioral ecology. In this context, communication describes the way a signal sender can change the behavior or inner state of the receiver by means of distal signals, and these actions provide the sender (or both sender and receiver) with some benefit or advantage (Krebs & Davis, 2012). A dog’s ability to take information from human gestures and actions certainly fits this definition. Indeed, by this definition, artificial selection by humans for dogs that are “trainable” implicitly means selecting for an ability to understand human actions. And, as Reid (2009) has pointed out, it is not surprising that dogs can follow a point, given that it is often in a dog's best interest to attend to human movements and the objects humans manipulate, for example during feeding. However, a salient question is how much this ability has arisen in the evolutionary history of the dog, and how much is it recreated during the development of each individual dog. In other words, from the perspective of Tinbergen's (1963) levels of analysis, what is the interplay of phylogenetic and ontogenetic processes when explaining dog behavior in this domain? In this section, I will explore the possible ways that phylogentic and ontogenetic components might interact. For example, natural selection may have favored specific abilities in the dog, or it may have favored a more general preference for, or attention to, humans. Each of these has distinct implications for the kinds of input that would be required over ontogeny to allow for the development of these specific social abilities.

At the other end of the spectrum, where dog social abilities are constrained largely by the species' phylogeny, it is possible that dogs have evolved a specific ability to understand the human pointing gesture because humans were such an important food source for dogs (a possibility discussed by, e.g., Hare & Tomasello, 2005 and Reid, 2009). In this case, a response to the pointing gesture would require little individual learning during ontogeny. It is not an explanation favored by many researchers.

A more nuanced theory regarding the interplay of ontogeny and phylogeny in the development of this behavior in dogs is that selection pressure toward domestication first favored a lack of fear of humans, which then opened up further avenues of selection pressure (Hare & Tomasello, 2005; Wobber, Hare, Koler-Matznik, Wrangham, & Tomasello, 2009), particularly in the last several hundred years, in which dogs have been increasingly subject to purposeful breeding for various social traits (Reid, 2009; Scott & Bronson, 1964). Indeed, some researchers (e.g., Miklósi, Polgárdi, Topál & Csányi, 2000; Miklósi et al., 2003; Soproni et al., 2002) have gone so far as to conclude that dogs now possess "'human-like' communicative behaviors" (Miklósi et al., 2003, p. 765) as a result of convergent evolution with humans (Hare & Tomasello, 2005; Miklósi & Topál, 2005; Topál, Gergely, Erdohegyi, Csibra, & Miklósi, 2009).

Alternatively, selection pressure favoring lack of fear, rather than leading to further selection for new traits, may instead have led to an ability to follow human gestures that had been present in the ancestor of the dog and the closely related wolf. Such behaviors might include attending to conspecifics in order to locate prey, or social facilitation, which is widespread in vertebrates. This ability could then have been exapted in a new social relationship, that of dogs and humans, once the process of domestication was underway (e.g., Hare & Tomasello, 2005; Miklósi, 2009).

Another possibility, which indicates a somewhat different phylogenetic process, is that domestication processes favoring lack of fear have resulted in a tendency in dogs to stay in proximity with humans and accept humans as social companions, and thereby learn from them (Udell et al., 2010a). In this theory, specialized communication abilities in dogs require no specific selection pressure for these abilities themselves; any specific sensitivities to human social gestures would arise during the ontogenetic learning experiences of individual animals (Elgier, Jakovcevic, Barrera, Mustaca, & Bentosela, 2009). A similar alternative possibility, which could have occurred in conjunction with the above, is that phylogenetic constraints predisposed dogs to pay attention to social information provided by humans. This could have included a tendency to attend to the human face, resulting in a ready ability to learn how to make sense of the specific gestures provided by specific humans (e.g., Gácsi, Győri, et al., 2009; Reid, 2009; Wobber & Hare, 2009; Wynne, Udell, & Lord, 2008). Some researchers (Udell, et al., 2010a) contend that some version of these latter theories, which include a strong role for individual ontogenetic learning, is the most likely scenario. Udell and colleagues point out that phylogenetic changes during the domestication process in general are more likely to involve changes in things like frequency or duration of behaviors already existing in a species, rather than qualitative changes in the species' behavioral repertoire. Thus, they contend, it is less likely that dogs have evolved new and human-like abilities, and more likely that their existing abilities have come to be oriented toward humans.

In the remainder of this chapter, I will explore the evidence surrounding the relative influences of, and possible interactions between, the dog's phylogenetic history (e.g., their domestication) and the ontogenetic experiences of individual animals. Domestication, as the evidence that I will present suggests, appears to predispose dogs to develop a number of abilities that facilitate their interactions with humans. Social experiences that occur during ontogeny and that continue into adulthood then appear to result in learning that shapes the specific form and extent of these abilities.

I will argue in particular for a specific phylogenetic influence: that among domesticated animals, dogs occupy a unique niche that involves an especially strong degree of dependency on humans. This dependency, I will argue, has resulted in a particular predisposition, derived from their phylogeny, to attend to and take information from human social cues. This has also resulted in a tendency for dogs to rely preferentially on information provided by specific, familiar humans who have interacted with or provisioned the individual dog in the past.

Specifically, in the remaining sections of this chapter I will examine the research findings related to each of these points. First, I will discuss the ability of dogs to use human gestures, in comparison with their own closest phylogenetic relatives, other species in the family Canidae. Second, I will discuss the evidence regarding the relative influences of phylogenetic and ontogenetic processes that come from studies comparing dogs varying in age, breed, or types of human-related experience. Third, I will broaden the phylogenetic context of human-dog communication via discussion of their dependency on humans. I will argue that the circumstances of dogs as a species make them especially willing to look to humans, often prioritizing human information over other sources and forgoing solutions they might adopt on their own. One consequence of this is a dog's tendency to rely strongly and preferentially on human social information, even when other means of solving problems are readily available; another is their tendency to "trust" information from specific familiar people.

The Phylogeny—Ontogeny Interaction in Comparisons of Dogs versus Other Canids

In this section, I will compare dogs' performance on pointing and other social tasks to that of wolves (*Canis lupus*), silver foxes (*Vulpes vulpes*), and dingoes (*Canis dingo*). First, however, I will briefly outline the phylogenetic relationship between these three species. Canidae are divided into the family of Canini (including dogs and wolves) and Vulpini (foxes). Foxes diverged from the line that led to gray wolves about 12 million years ago (Spady & Ostrander, 2007). The line leading to domestic dogs seems to have diverged from that of wolves approximately 130,000 years ago (Vilà, 1997), and dogs seem to have diverged morphologically from wolves sometime between 15,000 and 33,000 years ago (Clutton-Brock, 1995; Wayne & vonHoldt, 2012); investigators disagree regarding whether dogs first arose in the Middle East, Europe, or East Asia (Ding et al., 2012; Gray et al., 2010; Wayne & vonHoldt, 2012). Domestic dogs and wolves remain so similar that there is currently variation in whether dogs are denoted as a subspecies of wolves (i.e., *Canis lupus* and *Canis lupus familiaris*) or whether the two are denoted as separate species entirely (i.e., *Canis lupus* and *Canis familiaris*). Dingoes seem to have arisen from an early branch of East Asian domesticated dogs (Ding et al., 2011) which were brought to Australia and then were subject to approximately 5,000 years of natural selection in which they regained many wild-type features (Smith & Litchfield, 2010).

Dogs and wolves.

In this section, I will first compare dogs' performance on pointing and other social tasks to that of wolves (*Canis lupus*) that have been exposed to varying degrees of human socialization. Then, I will examine the ability to follow a point in other canid species that vary in phylogenetic distance from dogs and wolves. These comparisons will illuminate the dog's unique phylogenetic position, one that enables them to learn about human social gestures with particular alacrity. I will emphasize the inextricable interaction between phylogenetic and experiential contributions to dog social abilities.

Compared to dogs, wolves are quite poor at following a human point. Early studies of wolves seemed to show that they were essentially unable to read this gesture. Two adult arctic wolves (a subspecies of gray wolf) living in a zoo (Agnetta et al., 2000) and seven wolves living in a sanctuary, some of which were human-raised (Hare, Brown, Williamson & Tomasello, 2002), were unable to use a human point to choose one of two correct locations of hidden food. However, Miklósi and colleagues (2003) did find that two of four human-socialized wolves were able to follow a point, and that all four could choose the correct container when the human touched it with the pointing hand. Later studies have shown that socialization experiences during ontogeny (specifically, being hand-reared by humans) appear to be a crucial component in wolves' somewhat tenuous ability to follow a point.

Two studies (Gácsi, Győri, et al., 2009; Virányi et al., 2008) have tested samples of hand-reared gray wolf pups against comparable groups of dog puppies, and though the results have been more favorable for wolves, dogs still tend to outperform them. In the first, Virányi and colleagues provided wolves with especially rich human socialization, raising gray wolf pups in 24-hour contact with humans starting at the age of four to seven days until they reached two to four months of age, after which they were homed at a private wolf farm, where interaction with humans remained frequent. These wolves were compared with dog puppies reared in the same way and then homed with humans, as well as puppies reared by their dams and then adopted. These animals were tested repeatedly at various ages. The two groups of dogs performed similarly and both groups were above chance in following the human's point, even at four months of age. Wolves showed much more variable performance; none of them performed above chance at 4 months old, however some of them showed above-chance performance at 7 months and 11 months, and four wolves given extensive, repeated experience with the pointing task were able to follow the point significantly better than chance, though there was much variability in performance across test sessions.

In the second study using another sample of hand-reared wolf pups, Gácsi and colleagues (2009) tested a group of these wolf pups at the ages of eight weeks and four months, and found that though the pups that could be tested performed as well as dog puppies at eight weeks on a relatively simple proximal point, 7 of the 13 wolf pups could not be tested because they could not be handled during the task or refused to complete even preliminary trials in which food was visibly placed in containers. At four months, the wolf pups did not perform above chance on a more challenging momentary distal point, but as adults the wolves performed as well as dogs at this point type. Furthermore, the wolf pups struggled with handlers more and the youngest pups bit handlers more, compared to dog puppies, and these behaviors were associated with poorer performance in wolves but were uncorrelated with the dogs' performance (and were much less common in dogs). These behaviors decreased in adult wolves, which related to their improved performance. These results demonstrate that the socialization of wolves is not an early and brief process; to get reliable performance from wolves, extensive socialization lasting into adulthood is required to obtain the level of performance reached by eight-week-old dog puppies.

Finally, one study compared the performance of highly human-socialized gray wolves living at a wolf park to that of dogs tested under varying ecological conditions. The purpose of this study was to test the hypothesis that dogs have outperformed wolves in this task only because of details of the testing situation (e.g., wolves being tested outdoors versus dogs tested indoors). The study used a procedure in which wolves (and dogs) were first explicitly clicker-trained to approach buckets on which humans placed food, and then clicker-trained during testing trials to approach the correct container, followed by a reward placed on the container by the pointer's hand (Udell et al., 2008).

Under these conditions of relatively explicit training (though the authors do not appear to consider this to be explicit training, others disagree; Gácsi, Györi, Virányi, Kubinyi, Range, Belényi, & Miklósi, 2009), wolves appeared to slightly outperform dogs tested indoors, and to far outperform dogs tested outdoors as well as a sample of shelter dogs. However, a reanalysis of these data excluding trials in which dogs, distracted by outdoor conditions, failed to make any choice at all, showed that wolves and dogs in fact had relatively equivalent performance, but that dogs tested outdoors (i.e., in an unfamiliar setting) were less motivated to participate in the task (Hare et al., 2010). Thus, though this study appeared to show that wolves outperformed dogs, details of the testing conditions suggest that this conclusion might be premature.

Overall, wolf studies suggest that the dog's closest relative appears to have the ability to learn to follow the human point, if given purposeful, relatively extensive human socialization as well as specific training or extensive experience at the task. In contrast, wolves are better than dogs at a variety of non-social tasks requiring problem-solving abilities. Gray wolves make far fewer errors than dogs in detour tasks in which the animal must go around barriers of various shapes and lengths to get to food rewards on the other side (Frank & Frank, 1982). A sample of gray wolves were also significantly more successful than a sample of Alaskan malamute dogs at a task requiring them to perform various complex manipulations in order to obtain a food reward from inside a puzzle box (Frank & Frank, 1985). And another sample of gray wolves were faster than malamutes at a discrimination task in which they had to push a block of a certain color to obtain a food reward underneath it (Frank, Frank, Hasselbach, & Littleton, 1989).

If wolves generally outperform dogs in other problem-solving tasks, why do dogs consistently outperform wolves in pointing tasks specifically? It is tempting to conclude that something about the domestication of the dog has conferred on them the ability to readily learn about human gestures. Indeed, dogs, but not wolves, display an enduring sense of humans as "relevant" objects of attention. Dogs are more likely to engage in eye contact with humans in a variety of settings compared to wolves (Gácsi et al., 2005; Miklósi et al., 2003), wolf pups show a longer latency than dog puppies to look at humans during pointing tasks (Gácsi, Györi, et al., 2009; Virányi et al., 2008), and wolf pups that show longer latency to look at humans perform more poorly at pointing tasks (Gácsi, Györi, et al.). Virányi and colleagues (2008) and Miklósi and colleagues (2003) have both suggested that the dog's superior ability to follow a point, relative to wolves, was closely associated with their readiness to look at and orient to humans as a source of information during testing. In other research, dogs have been shown to look to nearby humans when confronted with a problem they don't understand (Topál et al., 1997) or cannot solve on their own, whereas even extensively human-socialized wolves do not do this (Miklósi et al., 2000; Miklósi, Pongrácz, et al. 2005). Specifically, after trained to pull a rope or open a bin to get a food reward, and then confronted with an unsolvable version of the task, the majority of dogs looked back at a familiar human, whereas few wolves did, and dogs began looking at the human sooner, and spent significantly longer looking at the human, compared to wolves (Miklósi et al., 2003).

Miklósi and colleagues (2003) have suggested that when confronted by an unsolvable problem, dogs look back at humans more than wolves due to dogs being "bound to a lesser degree to the 'attracting' effects of the food" (p. 764). And Frank and Frank (1982; 1985) have suggested that wolves outperform dogs in various cognitive tasks because human provisioning has buffered the dog from "the more serious consequences of its behavioral mistakes, and therefore relaxed the selection pressures that favored the evolution of complex cognitive functioning in wolves" (Frank & Frank, 1982, p. 95). I suggest that instead of these interpretations that paint dogs as "dumbed down," dogs in fact have an alternate means of solving their problem, compared to wolves: *they look to humans*. Thus dogs and wolves are adapted, both successfully, to different ecological niches. Whereas the tasks wolves confront to survive often include ways to obtain food by solving environmental "puzzles," the tasks dogs confront very often include how to obtain food by solving human social "puzzles." Indeed, Pepperberg found very similar results when comparing language-trained and non-language-trained parrots; those without language were able to solve a complex string-pulling task to obtain food, whereas language-trained parrots failed at the task and instead engaged in repeated "asking" for the food reward; Pepperberg concluded that such a bird could be considered to have "an alternative higher-order intelligence, in that it knows how to manipulate another individual to access its wants;" (Pepperberg, 2004; p. 263.)

Thus, as Reid (2009) and Udell et al., (2010a) have theorized, it seems that the dog's ability to make use of human gestures follows from a phylogenetic process strongly favoring the tendency to orient to humans. This could lead to frequent ontogenetic experiences of reinforcement not only for this attentiveness itself but also for specific responses to specific behaviors that dogs can, consequently, readily observe in humans. Thus, for example, a dog's gaze alternation between a human and a concealed food source (Hare et al., 1998) would seem to indicate the dog's expectation, based on previous experience, that the human is likely to eventually solve the dog's problem by retrieving the food. The fact that most or all dogs seem to use this solution suggests a phylogenetic predisposition to look to humans and thereby form such an expectation. Reciprocally, the wolf's poorer ability to follow a point may stem from a less rich reinforcement history, which is a consequence of a much weaker tendency in the species to orient to human presence and behavior (Reid).

As pointing performance in wolves shows, manipulating the environmental context (i.e., ontogenetic experience) of another canid species such that it more closely resembles that of dogs (i.e., providing extensive socialization to wolves) suggests that the dog's ability to follow human social gestures does not arise entirely from ontogenetic processes but rather that there must also be a phylogenetic predisposition involved. To further explore this process, we can examine evidence stemming from other canid species whose phylogenetic paths have diverged more recently (i.e., more recently domesticated species), to compare the social abilities of domesticated members of that species to those of dogs. Two species for which such evidence can be found are domesticated foxes (domesticated from the silver fox, *Vulpes vulpes*) and dingoes (*Canis dingo*).

Dogs and domesticated foxes.

In 1959, Russian researchers began a project aimed at creating a domesticated version of the silver fox (Belyaev, 1969). Silver foxes tend to show strong fear and aggression toward humans (Trut, 1999). By breeding only those individuals with the least fearful response toward humans, within about 40 generations a strain of domesticated foxes had emerged. These animals show morphological and behavioral features similar to domestic dogs: their coat colors have become more varied, their ears flop, their tails curl, and they wag their tails and whine toward, lick, and sniff humans (Trut, 1999). These behaviors are shown even in animals that have lived in cages with limited human contact (Trut, 1999). There are also changes in the ontogenetic trajectory; the development of a fear response, which occurs around 6 weeks in wild foxes, is delayed until 9 weeks or later in domestic foxes (it is 8-12 weeks in dogs; Trut, 1999).

Hare and colleagues (2005) tested the hypothesis that domestication in foxes, as in wolves, led to an increased ability to follow a human static point that was accompanied by gaze cues, by comparing dog puppies, domesticated fox kits, and wild-type fox kits. The domesticated kits performed as well as puppies, despite having experienced limited human contact, whereas the wild-type kits performed at chance. The domestic kits showed no evidence of learning during the task. Hare and colleagues also provided extra socialization for a group of wild-type kits; these socialized kits performed above chance on a pointing task, but still did not out-perform much less extensively socialized domesticated kits. Domesticated kits also preferred to investigate objects touched by humans, whereas wild-type kits did not. These results clearly indicate that domestication, even in the absence of strong ontogenetic socialization, results in an apparently spontaneous ability to follow a human point in canids. And as in the case of wolves, the results also demonstrate that extensive socialization of wild canids can result in an intermediate ability to follow a point.

The difference in point-following ability between wild and domestic foxes is remarkably similar to the difference between dogs and wolves. Yet this tendency has evolved in domesticated foxes through a mere 30 to 35 generations (40 years) of artificial selection (Belyaev, 1969; Hare & Tomasello, 2005). As Reid (2009) points out, it is not possible to determine whether the genetics of domestication or the subsequent learning is responsible for the domestic kits' ability to follow a point. But in so few generations it is unlikely that these foxes have evolved a suite of specific, human-like behaviors. It is more likely that their ability to follow a point springs from the greater inclination of the domesticated fox kits to approach people and their greater attentiveness to the humans who deliver their food, relative to their wild counterparts (Trut, 1999). Unlike those wolves that show some ability to follow a point, these foxes were not extensively human socialized; they were exposed to humans during the course of ordinary caretaking and were housed in cages, not in human homes (Hare et al., 2005). But their early preparedness to attend to humans seems to have resulted in a ready ability to learn to extract information from human gestures. The rapidity of the domestication process in foxes suggests that this is the most parsimonious course, and thus may also be the course taken by dogs during their evolutionary history.

Dogs and dingoes.

Finally, I turn to an example of a species of canid that is in some ways intermediate between dogs and wolves: the dingo. Dingoes likely come from an early branch of domesticated East Asiatic canids (Ding et al., 2011) which were brought to Australia and were subsequently subject to a long period (approximately 5,000 years) of natural selection in which they regained many wild-type features (Smith & Litchfield, 2010). They are more similar to wolves than to dogs in their behavioral organization (e.g., with regard to breeding and hunting behaviors) as well as some of their key morphological features (e.g., having a longer snout, longer canine teeth, and uniform coat color; as summarized by Smith & Litchfield, 2010). Smith and Litchfield (2010) investigated the tendency to follow a wide range of pointing gestures in seven dingoes, most of which had been exposed to human socialization from the age of three days, including some obedience training, though they were housed in conspecific social groups. The animals were tested by a familiar experimenter. Only animals that were able to be leashed and walked, and showed no fear in the testing situation, were used. As a group, these animals were able to choose the correct container significantly above chance for a variety of points. Only two dingoes were able to follow a gaze, and one was able to follow the point when the pointer stood behind the incorrect container. The authors conclude that dingoes showed lower performance than dogs for two of the point types, but comparable performance for the rest of the point types, and that dingoes outperformed wolves on all cues. Thus, this “intermediate” species showed an intermediate level of performance, which was however more similar to dogs’ performance than to wolves’.

Of perhaps greater interest, however, is that fact that other dingoes (15 of the 26 at the sanctuary site) that had been similarly exposed to socialization were easily frightened of humans and were unable to participate in testing (Smith & Litchfield, 2010). Thus, in the case of this species that is in some ways phylogenetically intermediate between dogs and wolves, it appears that there is great variation in the ability of any given animal to become human socialized and thus able to attend to human gestures. It may be that the inherited traits of each individual animal contribute strongly to their success in following a point, suggesting that the genes contributing to domestication vary widely among individuals. Again, this example highlights how much an inherited ability to be in company with, and attend to, humans contributes to the ability to make use of human gestures.

Overall, comparisons of dogs and related canid species most strongly suggest that during their phylogeny, the line of canids leading to dogs were selected for their ability to tolerate and even seek human company, with its attendant lack of fear of humans, as well as the tendency to attend to humans' behavior and find it in some way relevant in problem-solving situations. This phylogenetic process then appears to have left dogs particularly ready to very quickly and easily learn to take specific information from specific human gestures, prominently including the ability to follow the pointing gesture. In the next section, I will hone in on an examination of this process within dogs as a species.

The Contributions of Phylogeny and Ontogeny to the Dog's Use of Human Social Cues: Studies of Canines

Using comparisons among canid species, I summarized evidence that helped to identify possible specific features of the phylogenetic predispositions that lead dogs to be able to use human social cues. In this section, I will focus in on the details of this ability in dogs. I will examine comparisons among dogs with differing experiences, in order to reveal some of the specific ontogenetic, experiential processes at work. I will also look at comparisons across dog breeds, which can further delineate possible phylogenetic processes.

The role of ontogenetic experience in dogs.

A dog's tendency to look to humans begins early in ontogeny and appears to develop during the life of the dog. Their interest in humans is strong even in early puppyhood: by 5 weeks old, puppies show a preference for human company over that of other dogs and puppies, and they also show a preference for a familiar over an unfamiliar person by this age (Gácsi et al., 2005). Puppies as young as 6 to 9 weeks, even those with little exposure to humans, have begun to be able to correctly find food by following easier points that are relatively close to the target, are dynamic, and include gaze alternation (Hare & Tomasello, 2005; Riedel, 2008). Though young puppies are able to follow points, it is unclear whether their ability improves with age. Riedel and colleagues (2008) and Gácsi, Kara and colleagues (2009) have both provided evidence that young puppies don't appear to improve with age on pointing tasks, though Riedel and colleagues found they do seem to improve in the use of tokens to find hidden food. Riedel and colleagues found that puppies were even able to follow a point when the containers were placed to either side of the dog, not near the pointer, ruling out local enhancement. Based on these pieces of evidence, they theorize that the ability is essentially inborn, with minimal ontogenetic influence. In contrast, Wynne and colleagues (2008) claim to find learning effects in Riedel and colleagues' data, including evidence that 6-week-old puppies' performance seems to improve during a single testing session, though Hare and colleagues (2010) dispute this reanalysis. As Reid (2009) points out, the early appearance of this ability does not inevitably indicate that it is innate; it only requires that puppies begin carefully attending to humans very early in life. This seems a likely explanation. If humans have been a major food source for dogs in the history of the species, it is reasonable to conclude that they have evolved an ability to learn the meaning of human gestures that are relevant to food provision after only a very small amount of exposure, in the same way that animals in general require only a single trial to learn highly survival-relevant information. If the latter is correct, what kinds of experience, during puppyhood or beyond, relate to the strength of the ability to follow a point? There are at least two such possible types of experience: the dog's level of intentional training, and the extent to which the dog is socially integrated into a human family. There is evidence supporting the influence of each of these.

Evidence for the influence of training in dogs.

In two studies, more highly trained dogs were somewhat more likely to successfully make use of human gestures compared to less highly trained dogs (Hare et al., 1998; McKinley & Sambrook, 2000), however a third study found no difference between agility-trained and non-agility dogs (Gácsi, Kara, et al., 2009). McKinley and Sambrook, in particular, compared samples of well-trained working gundogs to samples of untrained gundogs and pet dogs, in a variety of conditions using various kinds of human gestures. They found that the working dogs were almost all at ceiling in following a point, outperforming both groups of untrained dogs. Further, whereas the untrained dogs made more errors when the pointer was moving away from the pointed-to container, the working dogs continued to perform almost perfectly, with only one dog making a single error. This study suggests that a general context of explicit training improves the dog's ability to follow a point. However this may only be the case for more difficult kinds of points; another study found no difference between pet dogs' and trained guide dogs' ability to follow a relatively easy, static point, with both groups of dogs being near ceiling on the task (Ittyerah & Gaunet, 2009).

Evidence suggesting a more immediate influence of training also comes from studies of shelter dogs. Hare and colleagues (2010) showed that a sample of 23 dogs at an animal shelter could follow a dynamic, repeated point with gaze alternation, and could successfully use a token placed on the correct container, if they saw the token being placed. But Hare and colleagues did not test shelter dogs' ability to follow more difficult points. Udell, Dorey, and Wynne (2010b) tested the ability of seven shelter dogs to follow various point types. These dogs were not above chance in their ability to follow a momentary distal point (more difficult because of its brevity and distance from the referenced location), though they were above chance in following a dynamic proximal point, similar to the findings of Hare and colleagues. Udell and colleagues speculated that this lowered performance was due to these dogs' relative lack of experience with human hands delivering food or other desirable items. They then attempted to train 14 shelter dogs in how to follow a momentary distal point, by providing a reward, dropped from the pointer's hand, when the dog approached the pointed-to container. Six of the dogs were able to learn the task within 15 trials, and 12 dogs learned it within 40 trials; only 2 dogs never performed above chance. All of these results are compatible with the conclusion that dogs require some level of experience in order to follow human points, but that this experience can be remarkably minimal and still result in successful learning.

These findings also raise the perhaps inevitable question, regarding studies of dogs using human gestures, of whether dogs are learning to follow the point during the experimental testing itself. There is some evidence suggesting that this might be the case: dogs can learn in roughly 30 trials to go to the container to which the human is not pointing, when they are specifically trained to do so (Elgier et al., 2009). Their response can also be extinguished relatively quickly; if neither container gives food, dogs will stop investigating either container in the presence of a point (Elgier et al.). And there is some evidence that more highly trained dogs improve in their ability to follow more subtle gestures, such as head turns and gaze direction, though these results were only marginally significant (McKinley & Sambrook, 2000). Puppies, also, may show evidence of learning during pointing trials, as argued by Wynne and colleagues (2008). But in spite of this, evidence from most pointing studies suggests that in the standard pointing paradigm with adult dogs, immediate learning is not the main driver of significant results. Dogs generally do not improve from the first to the last half of experimental trials, often because their performance starts out at ceiling (Reid, 2009), and most pointing studies give dogs a limited number of trials, usually 20 or fewer, to avoid learning effects (Reid). It is not surprising that they appear to learn minimally during pointing trials, given that in standard pointing studies, they are not given active feedback from humans regarding their performance. Their only feedback comes from finding versus not finding a reward in the location they choose. Elgier and colleagues (2009), in contrast, gave dogs explicit feedback, by dropping rewards from the pointer's hand and by giving corrections when the dog chose the incorrect container. The lack of this explicit feedback may keep dogs from actively learning during standard pointing studies. (Indeed, the fact that dogs learn readily in a situation of explicit instruction that is similar to the testing situation may be a testament to their ability to tune in to human feedback.)

To summarize, evidence regarding the role of individual differences in experience suggests that dogs very quickly learn to make use of human gestures, but that the accuracy of the ability is higher in dogs that have received more explicit training. Thus, ontogenetic experiences involving behaviors in response to human cues strengthen the dog's ability to make use of human cues in general, even those that have not been explicitly trained. However, dogs that have not received strong training still have a robust ability to follow human points (Reid, 2009); thus, training, itself, cannot constitute the entirety of the ontogenetic experience required for the ability (if indeed any particular ontogenetic experience is required). In the next section, I will explore a different area of influence, that of the dog's social integration into the human family.

Evidence for the influence of social integration of dogs.

There is also evidence for the importance of social integration or "closeness" with humans in the dog's ability to use social information from humans. Topál and colleagues (1997) gave dogs a task in which they had to pull the handles of food bowls to obtain the food inside. Dogs that had a closer relationship with their owner (i.e., lived in the house as a "member of the family," as opposed to living outside, as well as having a greater tendency to follow the owner closely and rest nearer the owner) looked to their owners more often when confronted with this problem. They even delayed attempting to solve the problem themselves until encouraged by their owners, as compared with dogs with a less close dog-owner relationship, though all dogs were eventually able to successfully solve the problem. Interestingly, the amount of training dogs had received did not predict their behavior in Topál and colleagues' problem-solving task.

The influence of "closeness" on the dog's ability to follow a point has not been extensively investigated in the literature, and is a topic that I will address empirically in Chapter 4. One study (Gácsi, Kara, et al., 2009) found that dogs' living conditions (i.e., indoors versus outdoors) and amount of interaction with the owner (i.e., more or less than an hour a day) did not influence their success in following a momentary distal point. However, this may not have been a detailed enough measure to capture the effect of the closeness of the dog-owner relationship on these dogs' ability; these measures of closeness were less detailed than those of the handle-pulling study discussed in the previous paragraph (Topál et al., 1997). Indeed, there is other evidence suggesting that closeness may in fact influence dogs' performance on pointing tasks. In Elgier and colleagues' (2009) reversal-learning and extinction study, dogs' tendency to investigate the container indicated by the point took approximately three times more trials to extinguish when the pointer was their owner, compared to when the pointer was a stranger. And it took approximately four times more trials for dogs to learn to go to the opposite container when the pointer was a stranger, compared to when it was their owner. These results suggest that the dogs more readily learned a new type of cue from a familiar person, and that their tendency to follow a familiar person's point was more resistant to extinction.

This evidence, though not extensive, does suggest that greater general social integration of a dog into a human family has some amount of positive influence on the dog's ability to take information from human gestures. It would appear, then, that at least two different kinds of ontogenetic experience, training and integration with humans, influence the dog's social abilities. Whether these two kinds of influence are separate or mutually influential remains to be examined, but it would not be surprising to find that the latter is true; a highly trained dog may be likely to also be well-integrated into human social contexts. Thus, the evidence of this section and of the previous one provide some detail regarding the kinds of ontogenetic experience that may come into play, given the dog's apparent innate predispositions, outlined above. In the next section, I return to the topic of phylogeny, this time examining its timing via comparisons between dog breeds.

The role of genetic predisposition: Comparison of dog breeds.

Evidence taken from comparisons of dogs to other canid species suggested that the phylogenetic contribution to the dog's ability to use human social cues includes some combination of lack of fear of humans, seeking out of human company, and a tendency to attend to humans and human behavior. In this section, I will use comparisons among different breeds of dog to examine evidence regarding the timing of this phylogenetic process. The dog's social tendencies around humans (i.e., lack of fear, etc.) may have arisen during the longer period of selection in which wolves were slowly evolving into dogs; it may have arisen during the more recent and shorter period in which humans used artificial selection to create different breeds of dog; or both of these periods may have been important.

Though comparisons of wolves and dogs, and the relatively good performance of most dogs in communicative tasks with humans, suggest the importance of the early period of the domestication of the wild wolf, current data seem to also indicate an important role for more recent, purposeful breeding (i.e., artificial selection). McKinley and Sambrook's (2000) study of gundogs' (breeds of dog listed in the "gundog group" by the Kennel Club of the United Kingdom, such as retrievers and spaniels) ability to follow human gestures showed that though the working gundogs outperformed the untrained, pet gundogs, even untrained gundog breeds were more likely than non-gundog breeds to successfully follow human gestures including gaze direction and head orientation. Indeed, the only two dogs in this study that performed better than chance when asked to follow a human gaze (a more difficult kind of gesture to follow, given that it is more subtle) were two non-trained gundogs. These results suggest that more recent artificial selection practices contribute to the genetic component of this behavior among modern dogs. Other studies have also investigated breed differences, with the specific goal of disentangling the influences of more and less recent evolutionary history.

One study (Wobber et al., 2009) examined the ability to follow a pointing gesture in dog breeds that were more and less genetically similar to wolves (e.g., basenjis and huskies, which are more closely related to wolves than are poodles and shepherds, according to Parker et al., 2004), and found no differences. In contrast, when these breeds were split along the dimension of working versus non-working breeds, the working breeds (shepherds and huskies) showed a greater ability to follow a point compared to non-working breeds (poodles and basenjis). The authors contend that this relatively more recent period of artificial selection has had particular effects in terms of dogs' social cognition.

Another study found that working breeds whose work entails frequent attention to humans (e.g., herding dogs and gundogs) were better able to follow a momentary distal point compared to working breeds whose work does not (e.g., hounds, sled dogs, and earth dogs) as well as mongrel dogs thought to be descendents of mongrels (Gácsi, McGreevy, Kara, & Miklósi, 2009). The breed groups were matched pairwise for amount and type of training and amount of daily human interaction, among other variables. This study also compared brachycephalic (short-nosed) breeds to dolichocephalic (long-nosed) breeds, because brachycephalic breeds tend to have greater visual acuity in the center of the visual field, whereas dolichocephalic breeds have a wide "band" of acuity and thus better peripheral vision (McGreevy, Grassi, & Harman, 2004). They found that indeed brachycephalic dogs outperformed dolichocephalic ones. The authors contend that their results support the importance of recent human breeding. Their findings support this hypothesis specifically with regard to two traits: an appreciation of the cooperative nature of gestures, as revealed in the heightened performance of certain working dogs; and an increase in the ability to attend without distraction to nearby humans, as revealed in selection for central visual acuity in some breeds. These authors argue for a somewhat strong interpretation: that the ability to follow a point may not be general to the domesticated dog, but rather may have been differentially selected for during the most recent period of artificial selection for specific breeds.

This evidence suggests that the phylogenetic underpinnings of the dog's ability to use human social gestures began to arise during the long history of early canine evolution (as suggested by the fact that all dog breeds can follow points at above-chance levels) but that these underpinnings are magnified in certain modern dog breeds, as a result of the shorter-term history of purposeful breeding (as suggested by the fact that working dog breeds tend to outperform non-working breeds). In the next section, I will present a way to conceptualize the phylogenetic and ontogenetic processes at work in the dog's aptitude for reading human gestures that emphasizes the importance of the dog's dependence on humans.

Dependency: The Human as the Dog's Ecological Niche

I have reviewed evidence for some of the specific phylogenetic and ontogenetic processes involved in the dog's ability to take information from human social gestures. In this section, I will present the argument that these abilities can be more precisely explained via the notion that, for a very long time, humans created the ecological niche for the dog. That is, human societies and human groups are the environment that domestic dogs have been immersed in, and their cognitive abilities have likely been shaped toward successful exploitation of this niche. Even more specifically, I argue that this niche has been defined by dependence: dogs as a species have been dependent upon humans to provide them with food, shelter, and even safety. We have domesticated many species, but dogs stand apart in terms of the combination of their level of social integration with humans and their level of dependency on us. Selection pressure should therefore have favored in them a suite of tendencies and abilities that cause them to attend closely to humans, privilege information from humans over other information, defer to humans, and convince humans to provision them: a set of particularly human-suited social tendencies. I will expound this hypothesis first by comparing the dog's ability to understand human communication to that of chimps (*Pan troglodytes*), a species which obviously diverged from humans far more recently than did dogs; this comparison will highlight the ways in which the dog's behavioral tendencies may be particularly suited to "trusting" interactions with familiar humans. Second, I will discuss other evidence more specifically relating to the idea that dogs are, in particular, dependent on humans, including the strong bonds forged between humans and dogs, the various ways that dogs look to humans to solve their problems, the dog's clear preference for specific familiar humans, and the ways in which human presence and behavior appears to exert a strong influence on the dog's behavior, even in tasks that are ostensibly non-social.

Dogs and non-human primates.

I have described findings showing that dogs outperform their own phylogenetic relatives in following a human point. It is also noteworthy that dogs are better at following points than the closest phylogenetic relatives of humans, non-human primates, even when the latter have been extensively socialized, including having learned some human language (Bräuer, Kaminski, Riedel, Call, & Tomasello, 2006; Call, Agnetta & Tomasello, 2000; Hare & Tomasello, 2004; Hare & Tomasello, 2005; Miklósi & Soproni, 2006). Across studies, chimpanzees (*Pan troglodytes*), orangutans (*Pongo pygmaeus*), and rhesus monkeys (*Macaca mulatta*) are inconsistent in their ability to follow points, and chimps are only reliably successful at it following specific training in how to do so (though four wild-caught gorillas, *Gorilla gorilla*, were able to follow human points if the pointer's finger actually touched the pointed-to object; Peignot & Anderson, 1999). Thus dogs as a species clearly outperform non-human primates at this task. As I've described, most dogs' performance suggests a spontaneous ability to interpret the pointing gesture (see Reid, 2009), and even dogs that don't exhibit this ability initially are able to learn the skill in a small number of trials (Udell et al., 2010b). This is in spite of the fact that non-human primates generally do well in a variety of cognitive tasks, and certainly can be said to outperform dogs on such tasks (e.g., see Hare & Tomasello, 2005; Osthaus, Lea, & Slater, 2005; Premack & Premack, 1994; Spinozzi & Poti, 1993).

Chimps have demonstrated an ability to make causal inferences; for example, they will choose a food container that makes noise when shaken over one that does not, and will look for a food item under a slanted board (i.e., slanted because something is underneath it) rather than a flat board, and they choose the slanted board regardless of whether they have seen the food placed under it (Bräuer et al., 2006; Call, 2004). In contrast, dogs outperform chimps in using specifically communicative cues (i.e., seeing a human pointing at or looking at the correct container; Bräuer et al., 2006). Dogs also have a tendency to approach containers that have been manipulated by humans, resulting in above-chance performance in conditions in which the human acts upon or toward the correct container in some way (Bräuer et al., 2006). Dogs even preferred to choose a container when a human reached for and looked at that container but was "unable" to reach it. Dogs also preferred a container that was shaken by the human, whether or not that container made any noise when shaken (the latter condition resulting in poorer performance relative to chimps). Finally, dogs were able to correctly find food under a board that was slanted by the food underneath it, but only when they had seen a human manipulating the board; unlike chimps, they were unable to use this visual cue alone.

These results demonstrate that dogs respond more effectively than chimps to human gestures, whereas non-human primates outmaneuver dogs in other tasks. This divergence in abilities may stem from differences in the ways each species tends to use human social information, differences which illuminate the specific social niche that dogs as a species have adapted to fill. Specifically, as I will argue, dogs have a tendency to orient to human behavior and presence, and rely on communicative information from humans in a “trusting” way, and more than this, they have a tendency to form an enduring preference for information provided by familiar humans. As I will show, this stands in contrast to the ability of the chimpanzee to observe others’ behavior in order to glean information that could provide a competitive advantage: a more “Machiavellian” kind of social cognition (Whiten & Byrne, 1997; for a similar argument, see Hare, Call & Tomasello, 2001; Hare & Tomasello, 2004; and Pennisi, 2006).

Chimps often show an impressive ability to make mental inferences from social information, but their strongest abilities appear to reveal themselves in competitive contexts (Gomez, 2005; Hare & Tomasello, 2004). They do not follow human gaze or points to locate food sources when these cues are given cooperatively (Bräuer et al., 2006). Yet they are able to determine which of several food items a competitor (conspecific or human) can and can’t see or has or hasn’t seen in the recent past, and can use this information to strategically decide how to approach food sources so as to hide their actions from these competitors (Hare et al., 2001; Hare, Call, & Tomasello, 2006). Indeed, chimps are apparently capable of a variety of tactical deceptions with conspecifics (Whiten & Byrne, 1997). And they are able to choose the correct of two containers in a competitive context when a human or conspecific reaches for it—yet they perform at chance in a cooperative context when a human points at it (Hare & Tomasello, 2004). Even in the absence of any social cue, chimps were better able to learn which of two containers contained food when in the presence of a conspecific competitor, rather than the company of a human (Hare & Tomasello, 2004). Thus, chimps appear especially good at using social information (as well as other information sources) in a competitive context, especially when this context involves conspecifics rather than humans (for review, see Fitch, Huber, & Bugnyar, 2010).

In contrast, dogs socially orient to humans at least as strongly as they orient to conspecifics (Gácsi et al., 2005) and they demonstrate an enduring sensitivity to humans’ orientation and gaze; when retrieving a ball dogs will drop it in front of, not behind, a person, and will beg from a non-blindfolded person over a blindfolded one (Gácsi et al., 2004; Hare et al., 1998). They are also more likely to take a piece of “forbidden” food when an experimenter is distracted or has her back turned or eyes closed (Call, Bräuer, Kaminski, & Tomasello, 2003). And while chimps engage in behaviors that avoid revealing the location of food to conspecifics or human observers (Hare et al., 2001; 2006), dogs show the opposite tendency. When food is hidden in a room while a dog watches, and the dog’s owner subsequently enters the room, the dog will engage in significantly more behaviors such as alternating their gaze between the owner and the food and vocalizing, apparently attempting to blatantly reveal the location of the food (Miklósi et al., 2003). Dogs engage in similar gaze alternation and orientation to alert their owners to the location of an inaccessible toy (Gaunet, 2010). Hare, Call, and Tomasello (1998) similarly showed that a dog could successfully lead a naïve human to hidden food via barking and body orientation (Hare et al., 1998). Thus, their social cognition is both more oriented toward humans than is that of chimps, and does not seem to be “competitive” in the same way as it is in chimps.

In an informative example, Wobber and Hare (2009) tested dogs' and chimps' reversal learning in a social context, by presenting the animals with two people, only one of whom would provide a food reward if approached. When the animals had learned the association, the role of the two people was reversed. The researchers included a second condition, which they called a "non-social" control condition, in which one of two cups provided the reward, and similarly tested reversal learning. They found that whereas chimps were faster at learning the reversal in the social condition than in the non-social condition, dogs showed no difference, and were slower in general, continuing much longer to go to the human (or cup) from whom they had originally learned to receive the reward. Wobber and Hare concluded that in contrast to the findings of pointing studies, in this task chimps outperformed dogs in a cooperative social context with humans by achieving reversal learning faster. They contended that chimps were using an ability to track the reputation of other individuals as a way of quickly relearning associations, and suggested that dogs have a deficiency in this ability.

However, I have two reinterpretations of these findings, related to two associated points: first, that both of these conditions might be "social" for dogs; and second, that if this is the case, dogs' apparently poorer performance in fact could reflect a difference in the way in which each species approaches the task, pitting chimps' tendency to reassess social information against dogs' tendency to perseverate on a preference for a human who has provided rewards. In this sense, both species would then have in fact performed well, according to their different species-specific predispositions.

Wobber and Hare (2009) contended that their two tasks constituted one social and one non-social condition. However, these two conditions may not have been equivalent in their tapping of social versus nonsocial cognition across the two species, because in the non-social condition the chimps and dogs could see a human placing food rewards under the cups. Thus it is likely that both of these tasks were "social" for dogs. In other studies, dogs have been able to choose correctly between two containers when a small token is placed by the correct container or when a food reward is placed under a board displacing the board's position, but only when they are able to observe the human's actions (Bräuer et al., 2006; Riedel et al., 2006). Indeed, a context of human social interaction appears to greatly influence dogs' performance in other tasks. In one study, dogs made significantly more perseverative search errors in an "A not B" task when the human talked to and looked at the dog while hiding the object, compared to when the object was hidden in a truly non-social context (i.e., was moved by a string; Topál et al., 2009). All of this evidence indicates that viewing human manipulation of objects constitutes a social context for dogs.

In contrast, the mere presence of a human appears to have less effect on chimps; for example, viewing human manipulation has no effect on chimps' success at finding food under a board. The chimps appear to rely solely on the displacement of the board when it has food under it, regardless of viewing human manipulation (Bräuer et al., 2006).

Thus, Wobber and Hare's (2009) two tasks might not in fact be an equivalent comparison of dogs' and chimps' tendencies, because both tasks were social for dogs but only one was social for chimps.

But even if the tasks were not equivalently "social" for both species, why did dogs apparently underperform on both tasks? This apparent "underperformance," rather than reflecting a difference in cognitive abilities, may in fact reflect a different problem-solving strategy across the two species. Dogs in Wobber and Hare's (2009) study learned the initial association as quickly as did chimps, and dogs did improve significantly in their reversal learning from the first to the second half of the reversal trials, in both conditions; they simply did so more slowly than did the chimps. As stated, Wobber and Hare theorize that chimps were using an ability to track reputation in order to relearn associations, an ability lacking in dogs. But in another study, dogs were able to learn to reverse their behavior in response to a human cue relatively quickly when provided with some explicit human instruction (Elgier et al., 2009), suggesting that dogs are not deficient in their reversal-learning ability. There is also evidence that dogs preferentially rely on human information over other possible problem-solving skills: dogs rely on human gestures over obvious odor cues (Szetei et al., 2003), they look back at humans when confronted with an unsolvable task (Miklósi et al., 2003), and even when a new task is solvable, dogs will tend to look to their owners and delay attempting to solve the task themselves (Topál et al., 1997). Further, dogs begin to form preferences for specific humans after only brief periods of contact, even in the absence of any reward or food provisioning (Gácsi et al., 2001).

Thus contrary to Wobber and Hare's (2009) interpretation, I suggest that dogs have specifically evolved to perform in the way that they did in that study. They have evolved to specifically not closely monitor social reputations. This lack of ability could be an adaptive strategy for exploiting a niche in which long-term alliance with familiar humans led to long-term reproductive success even in the face of short-term lack of reward, making dogs successful in a human world. They might therefore have evolved a tendency to continue to prefer the same person, even in the face of repeated lack of reinforcement, rather than having a more flexible tendency to quickly reassess social information in the manner of chimps: this tendency would, for example, keep them close to human hunters who are not always successful. The Wobber and Hare interpretation that this is an "inability" in reversal learning in dogs may in fact be a "feature" rather than a "bug."

To summarize, a comparison of the behavioral tendencies of chimpanzees (and at times other primates) with dogs seems to highlight the particularly "cooperative with humans" social niche that dogs have evolved to exploit. Chimps have impressive social cognitive abilities, including that of making mental inferences about others' knowledge, yet these tendencies appear to be geared toward social competition in chimps (Gomez, 2005; Hare et al., 2001; 2006; Hare & Tomasello, 2004). Dogs, in contrast, seem to use cognitive strategies that bias them toward cooperation with humans, including a preference for any choice indicated by or preferred by a human (Bräuer et al., 2006; Call et al., 2003; Gácsi et al., 2004; Gaunet, 2010; Hare et al., 1998; Miklósi et al., 2003). Thus dogs can follow a human point to a hidden food source, while chimps, surprisingly, fail at this task (Hare & Tomasello, 2005). Dogs' extreme tendency to be influenced by humans thus results in either enhancement of or interference with their ability to solve various "cognitive" tasks, as a result of the dog's "trusting" stance toward any information provided by a human.

A hallmark of humans as a species is our propensity for long-term alliances in absence of immediate reward; this has been a markedly successful strategy for us as a species (Bowles & Gintis, 2004; Nesse, 2007; Tucker & Ferson, 2008). This highly social and highly cooperative context is the niche in which dogs found a place, and it is therefore not surprising that selection pressure may have favored social tendencies in them that would help them to thrive in such a niche. And given that dogs do not have the adaptive cognitive abilities of humans, it would often have been in dogs' best interest to simply defer to human decisions—making them, essentially, quite dependent on humans. In the next section, I will expand upon this argument, describing evidence in support of the idea that dogs rely not only on human information but, in particular, on information provided by specific, familiar humans.

The influence of canine dependency on dogs' cognitive performance.

The comparison of dogs and chimps highlights the way that dogs as a species have evolved toward cooperative compatibility with humans. In this section, I will examine evidence suggesting that dogs' abilities and tendencies stem from a phylogenetic history of particular dependence on humans during canine domestication (Reid, 2009; Topál et al., 1997). I will show that this dependency is reflected in dogs' especially strong orientation toward human behavior, their deference to humans and willingness to "go along" with a human's decisions, their recognition of specific humans, the enduring preferences that individual dogs form for specific humans, and dogs' particular orientation to human behavior that has communicative intent. Topál and colleagues (1997) have made similar arguments, proposing that dogs' relative inability to solve some kinds of tasks, compared to wolves, reflects a specific tendency to behave dependently toward humans rather than a general cognitive deficit. My comparison of dogs and chimps, in the previous section, pointed toward the same conclusion. Further, if humans have been dogs' primary source of food and shelter for a long time, then a specific human "provisioner" would have been an important person indeed; individual dogs should be motivated to stay in proximity to, attend preferentially to, interpret the signals of, and defer to such a person. In this section, I will first describe evidence supporting the idea of dogs as particularly socially dependent, including evidence for strong individual bonds between dogs and their owners. Then I will discuss how dependency can parsimoniously explain the kinds of behavior dogs display in social tasks with humans, including pointing studies, unsolvable tasks, and hidden food tasks. Finally, I will discuss evidence that dogs are especially sensitive to human behavior that appears to have the intent to communicate to the dog.

Throughout their lives, dogs orient to human social behavior and seek out human company (Gácsi et al., 2005). As I've described, dogs often prefer human over dog companions, starting in early puppyhood (Gácsi et al., 2005). Indeed, Feddersen-Petersen (2007) argues that dogs have become so socially geared toward humans that many breeds have difficulty forming and peaceably maintaining stable groups of conspecifics. Miklósi (2007) comes to a similar general conclusion that the dog's "social tool set" is quite different from that of wolves, and shares features with that of humans. While a preference for humans does not itself demonstrate dependence, a strong preference for humans would seem to be a requisite condition underlying dependency. But dogs do not simply prefer humans; they are also remarkably deferential toward them. Dogs are willing to remain subordinate to humans (Bradshaw & Lea, 1992), and they are highly responsive to social reinforcers and attenuators from humans (Frank, 1983).

So dogs prefer humans and are responsive to human social feedback. But individual dogs' responsiveness does not stop with humans in general; dogs quickly come to recognize specific humans. Dogs can pair specific human faces and voices accurately; after hearing their owner's or a stranger's voice, they look longer at a subsequent image that does not match the voice they heard, as compared to looking time at an image that does match (Adachi, Kuwahata & Fujita, 2007). These results show that they are able to recognize familiar humans via more than one sensory modality. The ability to recognize individual humans would seem to be required for dogs to be able to rapidly form preferences for familiar humans. Preference for a specific person has been found to arise in shelter dogs after just three 10-minute sessions with a human handler; after these sessions, dogs displayed more contact-seeking with this handler, less interest in an unfamiliar person, and stood near the door of the testing room for less time when in the presence of the familiar handler (Gácsi et al., 2001). These behaviors are remarkably similar to the attachment behaviors of human infants toward their parents (e.g., Ainsworth, Blehar, Water, & Wall, 1978).

Dogs also display other proximity-seeking and proximity-maintaining behaviors reminiscent of human attachment behavior (as described by Bowlby, 1969). They exhibit seeking behaviors (e.g., standing at the door) when alone with an unfamiliar person, and they are more likely to explore and interact in a strange and stressful situation when their owner is present than when he or she is absent (Palestrini, Prato-Previde, Spiezio, & Verga, 2005; Topál, Miklósi, Csányi, & Dóka, 1998), in a manner very similar to the behavior of human infants in similar circumstances (Ainsworth et al., 1978). Further, the presence of a familiar human is correlated with lower cortisol levels in dogs placed in a novel situation, whereas presence of a familiar dog is not (Tuber, Hennessy, Sanders, & Miller, 1996). And separation from the owner in a strange situation results in increased heart rate over baseline, even though general activity is reduced over baseline (Palestrini et al.). Topál and colleagues (1998) even found that dogs could be categorized as being either securely or insecurely attached to their human caregiver in much the same way as human infants to their parents (Ainsworth et al., 1978). This suggests that dogs are sensitive to owners' relational habits (e.g., perhaps, how sensitive and responsive they are), and develop social tendencies to match, a remarkable cross-species accomplishment. These dog-human relationships appear to be formed on the basis of affection rather than obedience; one study found that physical contact (e.g., petting) was more likely than obedience training to result in attachment behavior in shelter dogs toward new humans (Marston et al., 2005, as cited by Miklósi, 2007). (It is interesting to note that dogs do as well as human toddlers at following simple points; Lakatos, Soproni, Dóka, & Miklósi, 2009.)

In contrast, attachment behavior is not evident in hand-reared wolves, which are equally as responsive to their human caregiver as they are to an unfamiliar human when in strange or stressful situations (Topál, Gácsi, Miklósi, Virányi, Kubinyi & Csanyi, 2005). Fox (1975, cited in Topál et al., 1997) has also noted dogs' greater tendency, relative to wolves, to behave in a socially dependent manner on humans.

Thus the human-dog relationship appears, in some respects, to function similarly to that of children and parents. Indeed, the dog's emotional responses to separation from a known caregiver are in some ways analogous to that of human infants. It is well-documented that in human babies, long-term separation from an attachment figure causes acute distress and searching behavior, followed by lasting emotional disturbance upon reunion (e.g., Robertson & Robertson, 1971). Senay (1966) found similar results in young dogs; during a period of separation from their only familiar human, these dogs displayed decreased general activity, increased seeking behavior, and sometimes increased aggression, and upon reunion displayed a continuing disruption in behavior.

All of this evidence builds a picture of child-like dependency in dogs, which could have conferred fitness advantages during the course of their evolution. Specifically, keeping close to human providers of food and shelter seems clearly to have conferred an advantage to the dog's ancestors, and thus selection pressure could have favored attachment-like behaviors that would be likely to inspire caregiving on the part of humans, in addition to attention toward and preference for familiar human provisioners. Thus, not only might dogs have come to prefer specific humans, they might have evolved the tendency to exhibit dependent and juvenile-like social behaviors toward humans.

It should be noted that this conclusion is fundamentally different from the idea of dogs as "juvenile wolves." Dogs do in some superficial ways resemble young wolves, for example in their retention of playful behaviors as adults and in the smaller relative size of their heads; on this basis, as Miklósi (2007) has summarized, it has been suggested by some that dogs could be conceptualized as wolves that have been arrested at a juvenile stage. But this conceptualization is far too simplistic; adult dogs differ from juvenile wolves in many fundamental ways, and the developmental trajectory of dogs does not reveal a simplistic pattern of "arrested" wolf development. For example, with regard to morphology, the shape of dogs' heads does not resemble that of wolf pups (Drake, 2011). And behaviorally, barking emerges earlier in puppies than in wolf pups, whereas howling emerges much later (Miklósi, 2007). Indeed, adult dogs of different breeds retain only certain, specific aspects of adult wolves' hunting behaviors; for example, herding dogs stalk but do not kill-bite, whereas herd-guarding dogs do not stalk but will kill-bite if a predator comes near the herd (Coppinger & Coppinger, 2001). Thus, adult dogs of different breeds retain very specific aspects of the adult wolf's hunting behaviors, a pattern which would be maladaptive in a wolf pup, which must practice the entire suite of behaviors in order to learn to hunt successfully. With regard to dogs' attachment to humans, though the propensity to attach to a caregiver is a youthful characteristic (Coppinger et al., 1987), adult humans also retain a strong propensity to form emotional attachments (Weiss, 1991). Thus, to reduce dogs' suite of behaviors and propensities to pure neoteny is overly simplistic. Dogs are not "arrested wolves;" they are dependent on humans due to selection pressure favoring various specific aspects of dependency, which may or may not map onto the specific forms of behavior found in actual juveniles (Miklósi, 2007, p. 126-28).

Dependent social animals by definition must go to, appeal to, or rely on caretakers to have their needs met. Their social cognitive abilities and behavioral tendencies should therefore be skewed toward a preference for and deference to human presence or cues. Next I will discuss how dependency can parsimoniously explain a wide variety of findings regarding the dog's performance in social tasks with humans.

First, I address the finding that dogs tend to look to humans when confronted with tasks they can't solve (Miklósi et al., 2003), or even new tasks that they could potentially solve on their own (Topál et al., 1997). Wolves do not display such behaviors (Miklósi et al., 2003). Notably, this tendency is not strong in another domesticated species that also lives in close proximity with humans: cats (Miklósi et al., 2005). Though cats are relatively good at following a pointing gesture (Miklósi et al., 2005), they do not appear to display the same kinds of dependent behavior found in dogs. Like wolves, cats continue to attempt to solve impossible tasks on their own, and do not look to familiar humans (Miklósi et al., 2005). Thus, dependency is not the same as domestication; rather, the dog's relationship with humans appears to include dependency as a unique property. This may be because the domestic cat is less dependent on humans as they continue to forage independently by hunting for live prey. Of course, it is also possible that the dog's ancestors had more social tendencies than did the cat's to begin with, as wolves are cooperative breeders and thus live in complex social societies. This predisposition for social cooperation and dependency would have provided a prime basis for selection pressure favoring the modification of such social traits in order to interact effectively with humans. Regardless of its source, the fact remains that dogs appear to look to humans to solve their problems, whereas cats, despite also being highly integrated into human families, do not.

When dogs have a need or desire, however, they do more than simply look to humans.

They also appear to attempt to communicate their need to the human, another type of behavior that is less frequently expressed in cats (Miklósi et al., 2005). Dogs will engage in gaze alternation and vocalization toward their owners when in the presence of a hidden food item the location of which is unknown to the owner (Miklósi et al., 2003), and they can even lead a human to such a food item (Hare et al., 1998).

Perhaps even more remarkably, individual differences in the dog's tendency to look back to humans when confronted with an unsolvable task are tied to the dog's level of integration into their human family. One study found that the more socially integrated a dog was into its human family, the lower was the dog's tendency to try to solve a food-acquisition puzzle on its own, and the more likely was its tendency to look to its owner to solve the puzzle (Topál et al., 1997). Thus, the stronger the dog-human "attachment," the more strongly does the dog rely on human caregivers for solutions to their dilemmas.

As I have shown, there is strong evidence for the dog's orientation toward humans, their tendency to behave dependently toward humans, and their formation of preferences for individual people. Next I will summarize findings indicating that the dog's performance in a variety of experimental situations seems to be consistently influenced by humans' presence, behavior, relative familiarity, and even communicative intentions, and can either be enhanced or attenuated, depending on the specifics of the task and social context.

In the case of the dog's ability to follow a human pointing gesture to find hidden food, dependence on human social information clearly enhances their performance, as shown by their general ability to use a point to make a correct choice (Reid, 2009). But reciprocally, when the point provides deceptive information, dogs' continuing reliance upon the gesture results in consistently poor performance (Kundey et al., 2010). Dogs' performance does not appear to be affected in a standard pointing task when the pointer is familiar versus unfamiliar (Miklósi, Polgárdi, Topál, & Csanyi, 1998), and their continuing reliance on deceptive points appears to be the same for familiar and unfamiliar pointers, but other data indicate that familiarity does impact some aspects of the task. Elgier and colleagues (2009) investigated how long it would take to extinguish dogs' response to a pointing gesture once food was no longer placed in the indicated container. It took dogs an average of 12 trials for their behavior to extinguish when the pointer was a stranger, but it took more than twice as long for dogs to stop investigating the container if the pointer was the dog's owner. Dogs continued to attend to and use social information from a familiar human long after that information had ceased to result in reward.

Human social context can similarly enhance or attenuate dogs' performance in reversal-learning tasks. Elgier and colleagues (2009) trained dogs to choose the one of two containers that a human was not pointing to; all dogs were able to learn this non-standard association. But their speed in learning was affected by familiarity. Dogs learned to go to the non-pointed container four times faster when the pointer was the owner compared to when it was a stranger; in other words, they were faster in learning a new way to read the cues from a familiar person (Elgier et al.). And as argued in the previous section, dogs' apparent inability to quickly reverse their preference for one human provisioner over another (Wobber & Hare, 2009) may well stem from their tendency to form quick and relatively stable preferences.

A human's demonstrated preference can even influence a dog to choose a reward of smaller quantity. Prato-Previde, Marshall-Pescini, and Valsecchi (2007) first demonstrated that dogs would choose a greater over a smaller quantity of food when both were offered. They then asked owners to demonstrate "preference" for the smaller food quantity by walking to it and remarking. They showed that dogs were significantly more likely to choose the smaller quantity in this condition compared to when no owner preference was expressed. This preference for the owner's choice increased when the two reward quantities were equal. Further, closeness influenced dogs' tendency to follow the owners' choice: dogs that were rated by owners as being higher in attention-seeking and attachment to owners were also more likely to be influenced by the owner's expressed preference.

Indeed, so strong is the dog's reliance on humans that it results in decrements in their performance on tasks that on the surface do not appear to have a social element. Erdohegyi, Topál, Virányi, and Miklósi (2007) presented dogs with an object-choice task (a toy hidden under one of two containers) with various conditions, in which a human revealed the contents of one or both containers, to test dogs' ability to reason by exclusion. They found that when dogs were shown only the contents of the empty container, they tended to investigate it rather than infer that the toy was under the other. However they were more likely to choose the correct container when the human manipulated both containers but only showed the contents of the empty one. Apparently, a human's manipulation of one object over another increased its salience for dogs and overrode the dog's ability to use other information to reason about the location of the toy. Topál, Kubinyi, Gácsi, and Miklósi (2005) similarly found that social context influenced both dogs' and humans' performance in a similar, invisible displacement task. As in reversal learning tasks, human actions seem to capture dogs' attention and preempt their use of other problem-solving strategies.

Further, one study found that the dog's poor performance "rebounds" when the social context is removed from a task, and that a human's effect on dogs' performance changes depending on whether the context is explicitly communicative. Topál and colleagues (2009) showed that dogs tend to make perseverative errors in the "A not B" search task that resemble the errors of human infants: when an item has been repeatedly hidden in location A, and then is hidden in location B, dogs and infants tend to perseverate in searching at A. It has recently been shown that infants' perseverative errors disappear when it is no longer a human adult hiding the items: they no longer make the "A not B" error when the adult hiding the items refrains from the usual communicative actions toward the infant that are used in the task (Topál et al., 2008). Topál and colleagues (2009) showed that this effect is the same for dogs. When the task is placed in a social-communicative context, in which a human talks to and makes eye contact with the dog, the dog perseverates at A. When the task is presented in a non-social context, with strings hiding the items, dogs reliably switch to searching at B when the object is moved there. And when the human hides the objects but has her back turned and does not talk to the dog, a dog's performance reverts to chance (Topál et al., 2009). In contrast, extensively human-socialized wolves search at B reliably regardless of condition (Topál et al., 2009). Thus the dog's tendencies with regard to preference for social information seem to have converged with those of young humans, who are also dependent on caregivers to meet their needs. However, dogs' and infants' performance diverges in one important way. When one person hides items at A and then a new person hides them at B, infants continue to perseverate at A, but a dog's performance reverts to chance. Thus, it appears likely that dogs take their cues about specific situations from the specific people involved, whereas infants generalize the social context to new people. Again, these results highlight the particular importance dogs quickly attach to the specific humans on whose information they depend.

In this section so far, I have given specific examples of the ways in which the dog's performance in various cognitive tasks can be either enhanced or attenuated, depending on whether the human's signals favor correct or incorrect responses. Even further, dogs appear to be sensitive not only to humans' behavior but to whether this behavior appears intended to communicate to the dog or not. For example, results of the A not B task (Topál et al., 2008) suggested that dogs were sensitive to a human's communicative intent, as demonstrated by the fact that they made more errors when the human talked to and faced the dog than when the human had her back turned. Indeed, other research has explicitly attempted to show that this is the case. Virányi and colleagues (2004) tested dogs' responsiveness to recorded versions of their owners' commands when the owner was facing the dog, facing another person, or facing empty space between the dog and a person. They found that whereas dogs obeyed the command readily when the owner faced them, few dogs showed any responsiveness when the owner faced the other person. When the owner faced empty space, dogs' obedience was intermediate between the other two conditions. As the authors contend, these results suggest that the dog has not simply learned to associate human orientation to the dog with relevance of commands, but rather appears to understand something about the human's possible referential intent based on body and gaze orientation: when the human is facing empty space, dogs were more likely to respond as though commanded directly, because no other object of attention was in evidence.

Moreover, Kundey and colleagues (2010) found that dogs continued to follow a deceptive human pointing gesture and thus to choose an unbaited over a baited container even when the food was visible to the dog. The pointing gesture displayed by humans in this study was a relatively strong communicative signal: the pointer walked to the empty container, leaned over, and pointed. In other conditions that featured less strong communicative signals (i.e., the human simply stood near the incorrect container, or pointed only momentarily at it from a greater distance), the dogs chose the container with visible food. Thus the dogs were most likely to approach the incorrect container when the human's actions most clearly indicated a strong intent to signal toward that container. Kundey and colleagues then gave dogs more experience with this deceptive point. They found that after about 12 trials, dogs began choosing visible food significantly more often than an empty container that was being indicated by a point: the dogs stopped "trusting" the point. But when the food was again occluded after 24 trials, the dogs reverted to choosing the empty container more often than chance; they had not lastingly learned to "distrust" the human, and in absence of visible information, they immediately reverted to "trusting" the human gesture. In contrast to these findings, Elgier and colleagues (2009) were able to explicitly train dogs to go to the opposite container as that indicated by a human, by providing explicit communicative feedback: the handler first explicitly led dogs to the non-pointed container, and then allowed dogs to make their own choices, but gave leash corrections for incorrect choices. It would appear, then, that although dogs will continue to "trust" a human gesture that continuously misleads them, they are easily able to learn the reverse of this behavior, if they are given other forms of explicit social feedback regarding what is being asked of them. The results of both Elgier and colleagues and Kundey and colleagues highlight, in complementary ways, the dog's sensitivity to variations in human behavior that correspond with differing communicative intent on the part of the human.

In summary, humans appear to constitute a powerfully influential social context for dogs. When humans are present and interactive, the dog's performance on a variety of tasks is changed, sometimes being facilitated or enhanced and sometimes being disrupted or reduced. Dogs undoubtedly have a variety of ways of solving their various survival-related problems, but the evidence I have summarized suggests that attention or appeal to humans can often become dogs' "plan A," the strategy they employ first, with other forms of problem-solving often being relegated to a secondary "plan B" (though this is not universally the case, as seen for example in "side bias" in pointing studies; e.g., Erdohegyi et al., 2007; Gácsi, Kara, et al., 2009; also see Chapter 2). A dog's tendencies in this regard parallel those of humans in an interesting way: social context is very powerful for us as well, sometimes enhancing and sometimes disrupting or distorting our performance on various tasks (e.g., in logical reasoning tasks, Cosmides & Tooby 2008; or in simple judgments made in the presence of other people; Asch, 1992). These tendencies, so similar in humans and dogs, are clues indicating that dogs have become adapted to depend on humans and therefore to fit into and make use of human social circumstances.

In conclusion, two of the major features of dogs' human-oriented social tendencies are, first, their formation of a preference for specific, familiar humans, and second, their ready ability to respond to human social gestures. In the following three chapters, I will explore the intersection of these two aspects of canine dependence. In Chapter 2, I will manipulate the context in which social gestures are made by familiar versus unfamiliar humans, using food-finding tasks. In Chapter 3, I will examine familiarity by examining how quickly a preference for a familiar person can be established. Finally, in Chapter 4, I will examine whether familiarity can be more specifically delineated, by examining whether “closeness” to familiar people can predict differences in dogs’ performance in food-finding tasks.

Chapter 2: The Effect of Familiarity on the Dog's Behavior in a Food-Choice Task

Introduction

A dog's ability to follow the human pointing gesture to find hidden food (Miklósi & Soproni, 2006; Reid, 2009) is perhaps the most well-studied example of the influence of humans on dogs' foraging behavior. The origin and function of this behavior has been the subject of much research. It has been established that dogs can follow points when the human's hand is up to 80 cm away from the indicated object (Soproni et al., 2002; Miklósi et al., 2005), and that they can follow the gesture whether they see that the human's arm is moving or is entirely still during the trial (Reid, 2009). They can also accurately follow a point when the pointer is moving away from the correct object while pointing at it (McKinley & Sambrook, 2000). It appears that this ability emerges as early as 6 weeks of age (Hare & Tomasello, 2005; Riedel et al., 2008), although there is also evidence that experience affects it. In one sample, shelter dogs were unable to follow more difficult types of points until they had received specific training in the ability (Udell et al., 2010b). Another study found that dogs performed well when a human pointed and used a helpful tone of voice, but performed at chance when the human held out a hand in a prohibitive gesture and used a discouraging tone of voice (Pettersson, Kaminski, Herrmann & Tomasello, 2011). This suggests that dogs may be attuned to the social tone of humans' gestures, perhaps via associative learning. Regardless of the mechanism, such findings show that dogs find human social gestures especially salient (which does not appear to be as true of their closest canine relative, the wolf; Gácsi, Györi et al., 2009; Virányi et al., 2008). All of this is evidence that human social gestures are of particular interest to dogs in the context of foraging.

Dogs also come to form specific bonds with specific people. Dogs begin to show a preference for a familiar human over a stranger by four weeks of age (Gásci et al., 2005). Adult dogs show behaviors toward familiar human adults that are similar to the behaviors of human infants toward caregivers. For example, dogs' cortisol levels are lower when exploring a novel environment with a familiar human, compared to when alone or with a familiar dog (Tuber et al., 1996). Also, when placed in an unfamiliar room, they show more exploration and a higher activity level when in the presence of their owner compared to the presence of a stranger; their activity levels with the stranger are comparable to those seen when the dog is alone. Dogs also tend to show "seeking" behavior when left in an unfamiliar room with an unfamiliar human (e.g., standing by the door; Palestrini et al., 2005). Dogs even display social referencing behavior, looking to the owner when confronted with an unfamiliar object (Merola et al., 2012). One intriguing finding showed that when owners reported a closer relationship with their dog (e.g., talked to and played with their dog more often), the dog displayed more "dependent" behavior in a problem-solving task (i.e., looked to the owner more and made fewer attempts to solve the problem on its own; Topál et al., 1997).

Thus, there is evidence that dogs follow human points and that dogs form preferences for specific humans. This suggests that a long-term relationship with a particular human should result in a dog having a preference for the pointing gesture provided by this human over that of an unfamiliar human. Yet the few pointing studies that have examined this effect thus far have not supported this prediction. One study that compared owners to experimenters as pointers, in separate testing sessions, found no difference in the dogs' performance (Miklósi et al., 1998). However, in this case the dogs already tended to be at ceiling on the task, and thus any preference for the owner would be masked by dogs' general high performance in the task. In fact, the majority of dogs across all studies are able to use a single pointer's gesture to find hidden food, so familiarity is probably not being adequately tested in a single-pointer task (for a review of single-pointer studies, see Reid, 2009). Another study found that simple measures of closeness to the owner (i.e., how much time the dog spent with the owner and whether the dog spent more time indoors or outdoors) did not relate to performance on a pointing task when an unfamiliar human was the pointer (Gácsi et al., 2009). However, this study did not assess dogs' performance with owners as pointers. Thus neither study has conclusively excluded the effects of familiarity on the ability to follow a point.

A single-pointer paradigm may be inadequate as a test of the dog's preference for familiar humans' information. Here, a simple modification of the procedure is proposed that could reveal such an effect. Specifically, dogs were asked to choose directly between two human pointers in a single testing session. Because dogs ignore olfactory and visual cues in favor of human gestures when choosing between food sources and will even continue to follow a human's point when the point ceases to provide accurate information (Kundey et al., 2010; Szetei et al., 2003), it was hypothesized that dogs would follow a familiar over an unfamiliar human's point even when the familiar pointer's gesture consistently failed to yield a reward. Additionally, to rule out the possibility that this effect might be due to a dog's simply being drawn toward the owner when the owner is present, and then only subsequently choosing a nearby container, conditions were included that were designed to control for this possibility. Specifically, it was hypothesized that dogs would choose a container that the owner had indicated to the dog (i.e., by shaking it while looking at the dog) over one similarly indicated by a stranger, after both humans had left the room; and that, reciprocally, dogs would not prefer a container placed nearer the owner over one placed nearer a stranger, when there was no clear indication by either human of involvement in the choice task.

Method

Rationale.

The goal of this study was to present dogs with two possible food sources, one of which was indicated by a familiar person and the other of which was indicated by an unfamiliar person. The goal was to test whether dogs would prefer a container indicated by the familiar person. For each dog, only one of the two containers it could choose to investigate would yield a food reward. For some dogs, the owner consistently pointed to this container (the "owner-correct" condition), and for others, the stranger pointed to this container and the owner pointed to a container that would not yield a food reward (the “stranger-correct” condition). It was hypothesized that the dogs in the owner-correct condition would choose the correct container more often than the dogs in the stranger-correct condition. In other words, it was predicted that regardless of condition, dogs would tend to rely preferentially on the owner’s point, thus causing dogs in the stranger-correct condition to repeatedly choose the sham-baited container. These two groups were compared to a number of control conditions. In the first, the “two-stranger” condition, both pointers were strangers, hypothesizing that dogs in this condition would perform at chance: being unfamiliar with both pointers, they would not have a preference for either container. The two-stranger condition was also included to ensure that dogs were not learning whose point to follow during the course of the procedure. Also included was a “no-point” condition in which the owner and a stranger each stood near a container, but neither pointed, to establish whether dogs would continue to show a preference for the container nearer the owner, even in the absence of any communicative gestures. Finally, two conditions were included to control for possible effects of simple presence of the owner. In the first, the “leave” condition, the owner and stranger each held and shook their respective containers, while looking at the dog, and then left the room. In the second, the “read” condition, the owner and stranger sat at the two far ends of a rectangular table and read, and a handler placed containers near each of them and then released the dog to make a choice. In the leave condition, we hypothesized that the dog would choose the container indicated by the owner, even though the owner was no longer in the room. In the read condition, it was hypothesized that dogs’ performance would be at chance.

Subjects.

Thirty dog–owner dyads were recruited from local dog trainers. The sample consisted of a roughly equal distribution of male and female dogs (17 males), whose ages ranged from 2 to 12 years (mean = 6.16 years, *SD* = 2.91). Twelve dogs were mixed breed and 18 were purebred. All the dogs were kept as pets and lived in their owner’s household, and all had lived in their current household for at least one year (see Appendix A for breed list).

Materials.

Two identical opaque plastic cylindrical containers, 20 cm in height, were used to contain the bait. These were presented to the dogs upside-down, so that the lids were set against the floor. There were two tight-fitting lids for these containers: one of these had a hole in the middle such that a food reward would drop out when the dog tipped the container, and the other had no hole. In this way, both containers appeared visually identical to the dog during testing. For all trials, food was placed in both containers but was only available in one container for each trial. By switching lids, it was possible to alternate which container was the "correct" choice. Dog treats of a type preferred by each individual dog were used as bait. For the “read” condition, a rectangular table 76 cm deep by 183 cm long was placed in the testing space. Two standard metal folding chairs were set at each end of the table, and 16 books were spread out along the length of the table.

Procedure.

The room was familiar to 14 of the 30 dogs. Upon arrival, each dog was given a warm-up period in the room prior to testing, and was able to explore the room at liberty while the owner completed paperwork. During this period, the dog was invited to greet and become familiar with all researchers (there were either two or three researchers present, depending on the condition), establishing that the dog was not fearful of the researchers. One researcher served as the stranger and another handled the dog. For the two-stranger condition, two researchers served as the two strangers and the third handled the dog. Neither the stranger(s) nor the owner gave the dog any food rewards during the course of the procedure.

Habituation.

Following the warm-up period, the dog was given four practice trials, two with each container, during which the dog learned how to tip the containers to retrieve rewards. During these trials, no gestures were used, and the stranger and owner were not present in the testing room. Any dog that showed difficulty during this pre-training phase was not included in the study. After this, the dog was taken to an outer room separated from the testing room by a 1.2-meter-high wall for all conditions except the leave condition, in which the owner and stranger went to the outer room, while the dog and handler remained in the testing room.

Testing.

Dogs were quasi-randomly assigned to one of six conditions, each of which had 20 trials. In the owner-correct condition, the owner pointed to the correct container during all 20 trials (i.e., the one with the open lid, which would deliver the reward). In the stranger-correct condition, the stranger always pointed to the correct container. In the two-stranger condition, the owner was not in the testing room, and instead two strangers pointed to the two containers; in each of the two-stranger trials, one stranger would consistently point to the correct container. In the no-point condition, the owner always stood next to the incorrect container. In the leave condition, the owner always held and shook the incorrect container. In the read condition, the owner always sat nearer the correct container. The owner and stranger, or the two strangers, changed positions such that each appeared 10 times on the dog's right, and thus also the correct container appeared 10 times on the dog's right. Pointers switched positions in the same way for all dogs, and the same side was never correct more than twice in a row. To control for the possible influence of odor, the container designated as "correct" switched each time the dog made a correct choice (i.e., touched the correct container). The dog was not present in the testing room while the containers were being reset and the people were changing positions. During testing in the pointing trials, the two humans stood 122 cm apart in the testing room, each pointing to a container located 56 cm away (Figure 1). Each container was located 64 cm from the tip of the respective pointer’s finger. In the third, no-point condition, the two humans kept their arms behind their backs. The two humans were positioned between the two containers, and they matched their gestures as closely as possible. Both humans looked up at the line where the wall and ceiling met, to avoid any differences in eye contact with the dog, as dogs are sensitive to humans' gaze direction (Bräuer et al., 2006; Call et al., 2003). Both humans in all pointing conditions made identical static, distal points, meaning that the point was in position when the dog was brought in, and remained in position until the dog chose a container. In the read condition, the owner and stranger sat in the folding chairs, facing diagonally away from the dog's position (Figure 2), and read books continuously during all trials. The containers were placed 142 cm from each other, and each container was placed 30 cm from the edge of each chair, on the side of the table nearest the dog's entry point. For all of these trials, the handler brought the dog in and released it from a point equidistant from the two containers. The dog's attention was briefly directed away from the containers to prevent focus on either container prior to release. Containers were never handled by the stranger or owner during any of these trials. In the leave condition, the handler held the dog in the testing location while the owner and stranger entered the room and stood in marked positions 94 cm apart. Each carried a container. On the handler's mark, the owner and stranger looked at the dog and shook their containers for approximately one second, stopped on the handler's mark, looked at each other, placed their containers on marks on the floor at the same time, 15 cm from their feet, and then left the testing room. When they were out of sight and the door was closed, the handler released the dog to choose a container. In all conditions, it was determined that the dog had chosen a container when the dog made physical contact with that container. Each dog in each condition completed 20 trials, with a brief pause between trials 10 and 11, so that dogs could drink water and rest.

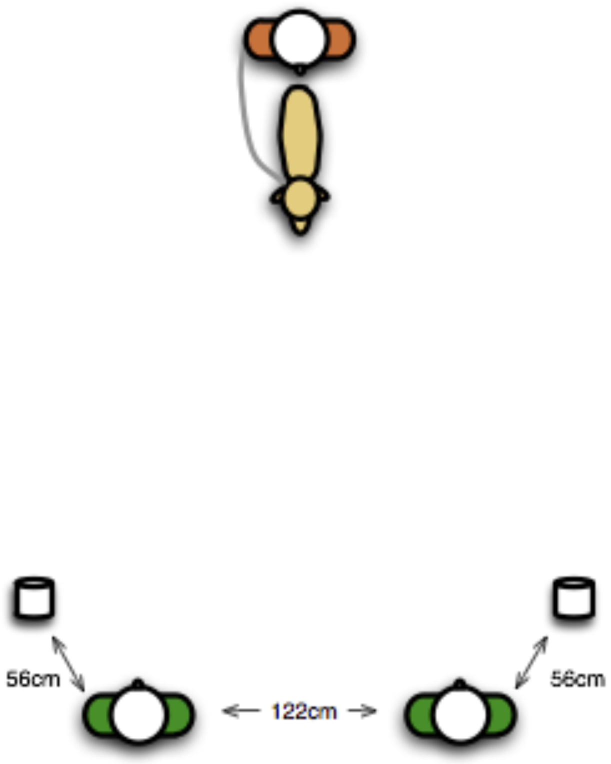

fig. 1

Figure 1. Schematic illustration of the physical layout of the two-pointer paradigm.

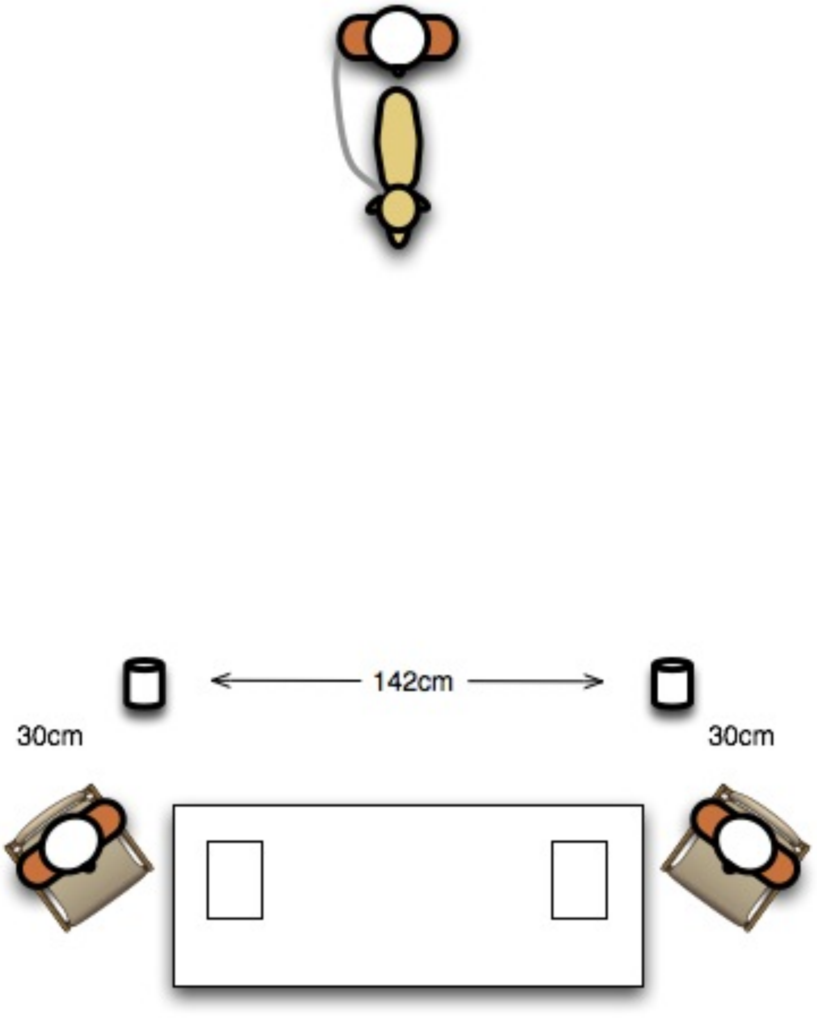

fig. 2

Figure 2. Schematic illustration of the physical layout of the read condition.

Analysis.

For the conditions in which pointing occurred, ANOVA was used to determine whether the number of correct choices by the dog (i.e., choosing the container with food available) differed among these three conditions (owner-correct, stranger-correct and two-stranger). A dog's performance was further evaluated in relation to chance performance using t-tests. Performance was tested in the no-point, read, and leave conditions using t-tests. These conditions were analyzed separately because the absence of a point and the differences in experimental setup among these conditions made each a somewhat different task for the dog. Finally, a dog's tendency to choose the left- or right-side container was evaluated using t-tests and ANOVA. Alpha was set at $p < .05$.

Results

As predicted, there was a significant overall effect of condition (owner-correct, stranger-correct, or control) on number of correct choices, *F*(2, 12) = 7.75, *p* = .007. In the owner-correct condition, dogs made an average of 12.8 (*SD* = 2.6) correct choices (i.e., chose the owner's container). In the stranger-correct condition, dogs made an average of 8.2 (*SD* = 1.8) correct choices (i.e., chose the stranger's container). Thus, even when the owner's container was the incorrect choice, dogs chose it on average 11.8 (*SD* = 1.8) times out of 20. In the two-stranger condition dogs chose correctly an average of 10.0 (*SD* = .7) times.

A further analysis examined whether the number of times the dog chose the owner’s container differed significantly between the owner-correct and stranger-correct conditions. This difference was not significant, *t*(8) = .71, *ns*. Therefore, to increase power, these two conditions were combined to determine if performance was significantly above chance. Dogs in these two conditions combined chose the owner's container on average 12.3 (*SD* = 2.2) times out of 20, significantly more often than chance, *t*(9) = 3.36, *p* = .008. Indeed, no dog in these conditions ever chose the stranger’s container more often than they chose the owner’s container.

In the no-point condition, the stranger was always standing nearer to the correct container. Dogs chose correctly (i.e., the stranger's container) an average of 6.60 times (*SD* = 2.41) out of 20 trials, significantly less often than chance, *t*(4) = 3.16, *p* = .034.

In the read condition, the owner was always sitting nearer to the correct container. Dogs choose correctly (i.e., the owner’s container) an average of 10 times (*SD* = 1.22) out of 20, which was not significantly different from chance, *t*(4) = .00, *ns*.

In the leave condition, the stranger always indicated the correct container. Dogs chose correctly (i.e., the stranger’s container) on average 7 times (*SD* = 2.00) out of 20, significantly less often than chance, *t*(4) = -3.35, *p* = .028.

Dogs in all conditions also appeared to be using a second strategy for choosing between the containers. Many dogs appeared to be exhibiting a side bias: they preferred the container on the left or right. Combining all dogs’ preferences for either left or right, dogs chose one side or the other significantly more often than chance, *t*(29) = 8.23, *p* < .001. There was a slight tendency for dogs to prefer the container on the left (mean = 10.77 out of 20 trials, *SD* = 5.99), but this effect was not significantly different from chance, *t*(29) = .701, *ns*. The side bias was not significantly stronger in any one test condition over the others, *F*(5, 24) = 1.04, *ns*.

Finally, to determine whether there were differences in motivation among conditions, I analyzed the number of trials on which dogs “wandered” around the room (i.e., any behavior besides moving in a direct line toward a container, such as sniffing the floor, walking in a direction away from either container, standing still, or watching the handler) before choosing a container. When tested using an ANOVA comparing all conditions, dogs did not wander significantly more often in any one condition, *F*(5, 24) = 1.94, *p* = .13. In the owner-correct (pointing) condition, dogs wandered on .40 (*SD* = .89) trials; in the stranger-correct (pointing) condition, dogs wandered on .40 (*SD* = .55) trials; in the no point condition, they wandered on .8 (*SD* = 1.79) trials; in the two-stranger condition they wandered on .40 (*SD* = .89) trials; in the leave condition they wandered on 2.00 (*SD* = 3.46) trials; and in the read condition they wandered on 4.40 (*SD* = 4.72) trials. Similarly, four dogs wandered in the read condition, whereas no more than two dogs wandered in any of the other conditions. These results suggest that dogs may have had a somewhat greater tendency to wander in the read condition.

Discussion

The goal of this study was to investigate the influence of familiarity on the problem-solving behavior of domestic dogs. The results showed that various kinds of information provided by the dogs' owners affected the way that the dogs performed on a food-choice task. First, results show that dogs did not attend to all humans equally; they preferentially focused on and were influenced more by familiar humans. When given the choice of a familiar versus an unfamiliar human information source, dogs preferred the familiar source, even when this source repeatedly provided information that led to no reward. These results were significant when analyzed both from the perspective of the number of correct choices and the strength of dogs' preference, compared to chance, for the owner's container. Regardless of whether the owner was providing accurate information, dogs in general continued to respond preferentially to this information. This was true whether or not the familiar human remained in the testing space when the dog was making a choice, as indicated by their preference for the owner's container in all pointing conditions, the no-point condition, and the leave condition. However, notably, the preference for the owner's container disappeared in the read condition, when the owner was no longer providing any kind of social signal that could give the dog information regarding which container to choose. In the read condition, in spite of the owner's consistent proximity to the correct container, dogs chose at chance.

Although across conditions some dogs more strongly preferred the owner's container than others, no dog ever chose the stranger's container more often than chance, aside from one dog in the read condition that chose the stranger's container 12 times. However, dogs in this study did not rely entirely on human social signals when solving the task. They also relied on at least one non-social source of information in making their decisions: specifically, the results revealed a side bias, in which dogs tended more often to choose either the container on the right side or the left side. Some dogs had a right-side preference and some had a left-side preference, and neither preference was seen significantly more often. Interestingly, many dogs that had a side bias would only choose the non-preferred side when the owner was standing on that side, revealing an apparent combined use of one social and one non-social strategy to solve the task. It is notable that, in spite of this strong source of noise in these results, the preference for the owner's container remained a robust finding. These results also demonstrate that dogs are not simply automatically deferring to a familiar human. Instead, they are actively engaging in attempts to solve the task, and one of their preferred strategies is to attend to the behavior and/or location of a familiar human.

This active reliance by dogs on both social and non-social strategies has been seen in other contexts (e.g., Erdőhegyi et al., 2007; Pongrácz, Vida, Banhegyi, & Miklósi, 2008). Other pointing studies have similarly found that dogs tend to develop a side bias. For example, McKinley and Sambrook (2000) tested dogs' ability to use a variety of human gestures to find hidden food, and found that when the cue was particularly subtle (e.g., the human gazed at the correct container), dogs that happened to get rewarded in one or another location would develop a preference for that location. They found that this effect was especially apparent in trials in which the dogs received no physical cuing from the experimenter. In a similar example, Gácsi and colleagues (2009) found that 53% of their dogs that failed on a standard pointing task did so because of a strong side bias that developed after success in the first two trials. In a somewhat different paradigm, Szetei and colleagues (2003) found that dogs would override olfactory cues to follow a human point, except when the odor cues were extremely strong; that is, they would override a social strategy with a non-social one only when the non-social information was especially unambiguous. Thus, a side bias seems to be a common strategy that dogs adopt in food-finding tasks. However, dogs in this study were clearly relying on a social strategy as well, which involved a clear preference for the owner, and this preference appeared to be specific to social information that the dog was taking from the owner.

Some specifics of how this reliance on social strategies may work in dogs become clear when comparing the various experimental conditions. The no-point condition demonstrated that a point was not necessary for a dog to choose the owner's container. In this condition dogs preferred the container that the owner was merely standing nearer to. This result demonstrated that an explicit gesture by the human was not required; dogs seemed to be influenced by the owner's position in space in this condition. However, position in space was clearly not itself adequate to influence dogs: they performed at chance in the read condition, in which the owner sat near the correct container while facing away and reading. Thus, having the owner stand near the container while facing the dog induced dogs to choose the owner's container more; having the owner sit facing away, with attention on a book, did not. It is not entirely clear from these results which aspects of owners' behavior were required to cause a difference in dogs' performance, but it is likely that these aspects include the direction the owner was facing and whether the owner's attention was taken up with another task. Regardless of which aspects of the owner's behavior were most salient, the comparison of these two conditions strongly suggests that dogs were interpreting human behavior as a social signal in all conditions except the read condition, and that they demonstrated a preference not merely for the owner's physical location but for the owner's signal.

Results of the leave condition strengthen this interpretation by further demonstrating that the owner's immediate presence in the room was not required to induce dogs to choose the owner's container more often. When owners provided a clear social signal to dogs (i.e., held and shook the container while looking at the dog, and then left the room), dogs preferred that container. Notably, in this condition, the owner and stranger had to leave the room via a doorway that was positioned slightly to the dog's right; yet dogs continued to prefer the owner's container even when it was positioned on their left, meaning that they had to move away from the owner's last visible location to go to it.

On the basis of the no-point condition's results alone, it could have been argued that the observed preference for the owner's container was reducible to local enhancement: the dog being drawn toward the owner due to a history of reinforcement, and then investigating the container that it incidentally finds there. However, dogs' performance in the read and leave conditions directly contradicts this interpretation; when the owner was present and his or her attention was elsewhere, dogs chose at chance; when the owner was absent but had provided a clear signal, the dog preferred the owner's container. Anecdotally, it was only in the read condition that dogs would occasionally run first to the owner and then appear to subsequently "notice" one or the other container. Notably, even these dogs did not then necessarily "notice" the owner's container over the experimenter's.

Dogs' preference for the owner likely does involve associative learning, as does any learned preference, but this does not undermine the finding that dogs clearly preferred social information taken from specific, familiar humans over that of strangers. Most importantly, they preferentially used information from this familiar person to make decisions in a foraging context, even when (in the experimenter-correct situations) this information consistently misled them. It is also important that the owner always indicated the incorrect container in the leave condition and sat nearer the correct container in the read condition; in this way, the experimental setup implicitly favored results counter to the hypotheses. Thus, even if associative learning could be considered a mechanism by which dogs' preference for their owner arose or was demonstrated, the salient result remains the fact that in no condition did dogs demonstrate preferential behavior toward the stranger. This result is not trivial; it could easily have been argued that dogs might prefer the stranger's container due to neophilia, or that dogs might learn during the task which person was indicating the correct container. But they didn't; there remained a robust tendency for dogs to rely on social information from their owners when finding food, regardless of its mechanism.

Conclusion

Why do dogs show this preference for social signals provided by a familiar human? Repeatedly choosing the owner's container in the stranger-correct condition never yielded a reward, and thus in the short term it was not a good strategy. But it is likely to have been a successful strategy in the long term for most domestic dogs, throughout their shared evolutionary history with humans. The domestic dog has likely been shaped by its phylogenetic history to attend to and rely on cues provided by humans (Kundey et al., 2010; Reid, 2009; Pongrácz, Miklósi, Timar-Geng & Csányi, 2003), to form an affinity for specific humans (Gácsi et al. 2005; Gácsi et al., 2001), and to maintain a persistent orientation toward or preference for cues provided by those familiar humans (Elgier et al., 2009; Prato-Previde et al., 2007; Topál et al. 1997). This suite of traits is likely to have led to fitness benefits in a variety of ways (Coppinger & Coppinger, 2001), and thus could be influencing the dog's choice of strategies when they are faced with tasks that can be solved via both social and non-social means.

Although this study has not identified the mechanism underlying this strategy choice, one plausible function of this mechanism, consistent with this as well as prior studies, is that these behaviors function to maintain a dog's state of general dependence on humans. Therefore, they may show a suite of behaviors characteristic of and beneficial to dependents. For example, they have a tendency to attach to specific humans (i.e., form preferential, relatively long-lasting bonds with individual people; Palestrini et al. 2005; Topál et al., 1998, Tuber et al., 1996), to orient preferentially to these humans, and to look to these humans (or, at a minimum, to humans in general) to solve various problems (see Topál et al., 1997, for a similar argument). This use of the social relationship in their problem-solving strategies, over other kinds of more non-social, independent strategies, is reflected in a variety of findings. For example, when faced with an unsolvable object-manipulation task, dogs quickly initiate and maintain a gaze toward the owner (Miklósi et al., 2003). Further, dogs will reposition themselves in order to view a human informant, but will not do so to view an inanimate information source (McMahon, Macpherson, & Roberts, 2010).

This dependence may also explain why a dog's performance in some tasks is hampered by the presence of humans (e.g., Erdőhegyi et al., 2007; Topál et al., 2006; Topál et al. 2009). For example, dogs will choose a smaller over a larger pile of food, and a less desirable over a more desirable type of food, if their owner or an experimenter has shown interest in the smaller or less desirable food (Marshall-Pescini, Passalacqua, Miletto Petrazzini, Valsecchi, & Prato-Previde, 2012; Marshall-Pescini, Prato-Previde, & Valsecchi, 2011). Findings such as these have at times been considered to reflect a deficiency in the dog's cognitive or problem-solving ability. An alternative interpretation, however, is that the dog is choosing a human-oriented social strategy that, in the long run, has benefited the dog, and which simply fails to benefit the dog in the specific setup of a given study. Poor performance in a given task may reflect a mismatch between dogs' preferred social means of solving that type of task, and the non-social strategy that would lead to a correct response in that particular experimental setup.

Although dogs in the current study relied on both social and non-social strategies to solve the task, no dog ever used a social strategy that involved a preferential reliance on the information provided by a stranger, even when the stranger consistently indicated the food source and the owner consistently did not. When dogs did not clearly prefer the owner's cue, this was almost always due to their use of a non-social strategy (i.e., a side bias), which indicates that dogs were actively attempting to solve the task, rather than simply deferring to humans. These results support the claim that dogs not only strongly prefer familiar humans, but they also look to and are more strongly influenced by signals coming from these humans compared to those of strangers. A question for further research is whether or not this is an effect of domestication (and therefore would be seen in other domesticated species), or is specific to the dog-human relationship.

In the next chapter, I will investigate the influence of closeness more carefully, via an experimental study in which I will expose dogs to a brief interaction with a new person. I will then test these dogs in a two-pointer food-choice task, to see whether this brief interaction is enough for the dog to establish a preference for this person's point over that of an entirely new person.

Chapter 3: How Quickly Do Dogs Establish a Preference for a Familiar Human's Gestures? An Experimental Manipulation

Introduction

In Chapter 2, I established that dogs tend to choose a container indicated by their owner over that indicated by an unfamiliar person. In this chapter, I will explore how long it might take for a dog to form such a preference for a familiar person: can it be formed relatively quickly when the dog has a brief opportunity to have positive interactions with a new human, or does it require somewhat more sustained contact? In other words, how familiar does a person have to be to a dog, for that dog to privilege information from that person over information from an entirely unfamiliar person?

There is some evidence that dogs can rapidly form a preference for a new human. Shelter dogs have been found to form a preference for a specific, new person after spending three 10-minute sessions with that person, during which the human talked to, petted, and attempted to play with the dog; after these sessions, the dogs displayed more contact-seeking with the person, they showed less interest in an entirely unfamiliar person, and they stood near the door of the testing room for less time when the person was in the room (Gácsi et al., 2001). However, shelter dogs have at times been found to perform relatively poorly on pointing tasks, perhaps because they are living under conditions generally considered to be stressful, and perhaps also because they have not been exposed to as much enriched human interaction as have owned dogs (see Udell et al., 2010b).

Thus, in order to test whether pet dogs would form a rapid preference for a new human that would be reflected in performance on a two-pointer task, I recruited and tested dogs in the context of a pet dog daycare (i.e., "doggie daycare") facility. This design had the advantage that dogs were in a familiar place and thus may have been relatively less stressed than they might have been in an unfamiliar testing room, but they did not have their owners present, making them potentially more aware of and available to become familiar with other humans. In this study, an experimenter spent a brief period of time, 15 minutes, either playing with or training each dog, and then the dog's preference for that experimenter's point over that of an absolute stranger was tested using the same two-pointer paradigm as that used in Chapter 2. In addition, due to time constraints in access to the daycare facility, I tested some dogs in the same paradigm that were recruited via local dog owners, and were tested using the same procedure, but at the same dog training space used for testing in Chapter 2.

I included both training-with-food and play-only sessions for these dogs, in order to examine the hypothesis that food provisioning would result in the same kind of quick preference-formation as has play and interaction in shelter dogs (Gácsi et al., 2001). Some evidence has suggested that physical contact is more effective than obedience training in eliciting attachment behavior in shelter dogs toward new humans (Marston et al., 2005, as cited by Miklósi, 2007). However, because the pointing task is inherently about finding food rewards, the inclusion of this condition allowed me to test whether the dogs' preference for their owners' points in Chapter 2 could be attributed to a history of provisioning by the owners.

Method

Subjects.

Seven dogs were recruited from a doggie daycare facility in the San Francisco Bay Area. Owners were asked to sign consent forms at the front desk of the facility, and once an owner had signed, his or her dog became eligible to participate. The sample consisted of 5 males and 2 females whose ages ranged from 1.5 to 10 years (mean = 4.92 years, *SD* = 3.20). Three dogs were pure-bred and 4 were mixed-breed. I attempted to test an additional 2 dogs, but these could not be included because they appeared stressed and refused to choose either container in the first two trials. All the dogs were kept as pets and lived in the human household, and all had lived in their current household for at least one year.

An additional three dogs were recruited from personal contacts, and were tested using the same procedure as the daycare dogs, but at a separate dog training space. Owners brought these dogs to the testing facility and signed consent forms at this location. This sample consisted of 1 male and 2 females whose ages ranged from 4 to 7 years (mean = 5.17, *SD* = 1.61). Two of these dogs were pure-bred and one was mixed breed.

Materials.

As in Chapter 2, two identical opaque plastic cylindrical containers, 20 cm in height, were used to contain the bait. These were presented to the dogs upside-down, so that the lids were set against the floor. There were two tight-fitting lids for these containers: one of these had a hole in the middle such that a food reward would drop out when the dog tipped the container, and the other had no hole. In this way, both containers appeared visually identical to the dog during testing. For all trials, food was placed in both containers but was only available in one container for each trial. By switching lids, we were able to alternate which container was the "correct" choice. Dog treats of a type preferred by each individual dog were used as bait.

Procedure.

Testing of the daycare dogs took place in the same doggie daycare from which dogs were recruited. The play space was an indoor, fenced area approximately 6 m x 6 m, which contained one small play structure and was otherwise bare; this space was familiar to the dogs. The testing space was a separate and adjacent fenced area of the same size, also familiar to the dogs, which contained only the pointers and containers. Each dog was brought to the testing areas by a daycare staff person, and was invited to greet and familiarize itself with all study personnel. Following this, the dog spent 15 minutes in the play area with one experimenter, who later served as the familiar pointer. In one condition, the dog simply played with this experimenter, either with or without toys; in the other condition, the experimenter trained the dog using food for 15 minutes. This training consisted of reward-based training only, without corrections. The experimenter trained well-known behaviors such as sit, down, and hand-targeting, using a continuous reinforcement schedule.

Testing of the remaining dogs took place in the same 8 m x 17 m test room that was used in the pointing study described in Chapter 2. These dogs were brought to the space by their owners, who did not otherwise participate in testing but remained in an outer room of the space during testing. The procedure used for these dogs was the same as that described above for the daycare dogs, except that the training or play session took place in the same room as did the testing. The food containers were not present in the room during the training and play sessions.

Following the play period, the dog was given four practice trials, two with each container, during which she learned how to tip the containers to retrieve rewards. During these trials, no gestures were used, and these trials were carried out by a different researcher, who then served as the dog handler during the pointing trials. A third researcher served as the stranger in the pointing trials, and a fourth recorded the dog’s performance. The dog was also videotaped during both the play session and the pointing task.

Following the training trials, the dog completed the pointing task. The arrangement of this task was identical to that used in Chapter 2. During the pointing task, the stranger and the familiar experimenter stood 122 cm apart in the testing room, each pointing to a container located 56 cm away. The two pointers were positioned between the two containers (see Figure 1, Chapter 2). Each container was located 64 cm from the tip of the respective pointer’s finger. Both looked up at a mark where the wall and ceiling met, to avoid eye contact with the dog, and both gave identical static points: the point was in position when the dog was brought in, and remained the same until the dog chose a container. The handler brought the dog in and released her from a point equidistant from the two containers. For the daycare dogs, the entry to the experimental area was covered such that the dog’s view of the pointers and containers was occluded until the dog had reached the release point. It was determined that the dog had chosen a container when the dog made physical contact with one container.

Each dog completed 20 trials, with a brief rest between trials 10 and 11. The design was between-subjects. The experimenter who played with or trained the dog was always pointing to the correct container during all 20 trials (i.e., the one with the open lid, which would deliver the reward). The two pointers changed positions such that each appeared 10 times on the dog's right, and thus also the correct container appeared 10 times on the dog's right. Pointers switched positions in the same way for all dogs, as in Chapter 2 (see Figure 1, Chapter 2). To control for the possible influence of odor, the container designated as "correct" switched each time the dog made a correct choice (i.e., touched the correct container).

Results

For the dogs that had spent 15 minutes playing with the experimenter before the pointing task, these dogs did not choose the container near that pointer more often than chance, *t*(4) = 1.725, *p* = .160. These dogs chose the container nearer the familiar pointer on average 11.6 (*SD* = 2.07) times out of 20. These dogs, on average, did not exhibit a significant side bias; they did not choose either side significantly more often than chance, *t*(4) = 1.969, *p* = .120. There was relatively wide variation between dogs in their performance; the number of correct choices varied from 9 to 14 out of 20. Three of the dogs did seem to show some preference for the familiar pointer's container, choosing it 12, 13, and 14 times out of 20, respectively.

For the dogs that had spent 15 minutes being trained by the experimenter before the pointing task, these dogs, counter to expectations, chose the container nearer to the completely unfamiliar pointer more often than chance, *t*(4) = -3.539, *p* = .024. These dogs chose the container nearer the familiar pointer on average 7.6 (*SD* = 1.52) times out of 20. These dogs also showed a significant side bias, choosing the container on the right side on average 14.00 (*SD* = 2.12) times out of 20, significantly more often than chance, *t*(4) = -4.216, *p* = .014.

Discussion

The results from this study indicated that after spending 15 minutes either playing with or being trained by a new person, dogs did not form a preference for a food container indicated by that person, over one indicated by an entirely new person. However, there was some indication that some of the dogs in the "play" condition had in fact formed a preference for the familiar pointer, as indicated by the fact that three of the dogs chose the familiar pointer's container 12 or more times out of 20. It is thus possible that the speed with which a dog is prone to form a preference for a specific person may vary substantially from dog to dog. If this is true, then a larger sample would have been required in the current study to detect this effect, to overcome the error variation added by these individual differences. This result also indicates that spending a somewhat longer time playing with each dog would strengthen the effect size and result in significant findings even given a small sample. Both of these possibilities should be examined in future work. This possibility also suggests that a within-subjects design, in which the amount of time spent with each dog was incrementally increased until that dog began to form a preference for the familiar pointer, could yield interesting findings regarding individual differences in this process among different dogs.

It is interesting that results for the training condition not only did not reveal any established preference for the familiar pointer, but in fact yielded significant results in the opposite direction, with dogs significantly preferring the container indicated by an entirely unfamiliar pointer. In this condition, not a single dog showed a preference for the familiar pointer's container, with one dog choosing exactly at chance and the rest preferring the unfamiliar pointer's container, choosing it between 12 and 14 times out of 20. These results were unexpected and their meaning is not entirely clear. It is possible that the training session was somehow aversive for dogs, and that the dog's subsequent preference for the unfamiliar pointer's container was a result of the dog actively avoiding the container nearer the familiar pointer. This possibility does not seem very likely, given that the training session was intentionally designed to involve only interactions and food rewards, and no dog ever received a correction from the trainer.

Another intriguing possibility is that these results reflect a combination of two processes: first, that training using food was not a reliable way to establish a relationship (whereas play may be), and that given this circumstance, dogs chose the unfamiliar pointer due to a neophilic preference for the unfamiliar person's information. This possibility obviously requires further testing, but if supported, it would reveal very specific conditions under which a familiarity preference versus a neophilic preference might direct a dog's behavior differently, given relatively small changes in the situations to which they are exposed. The suggestion in these results that playing with dogs may have some power to induce a familiarity preference, whereas training did not appear to do so, suggests that in general, a dog's preference for its owner's points (as shown in Chapter 2) is not due to a history of provisioning by the owner. This greater importance of play over food and training would also be consistent with previous results. Specifically, the results of Topál and colleagues (1997) showed that owners' reports of how much they trained their dogs didn't predict how much dogs turned to the owner to solve a food-acquisition puzzle, whereas variables measuring how much the dog lived "as a member of the family" did predict this behavior. Similarly, Gácsi and colleagues (2001) showed that shelter dogs began to show attachment-like behavior (e.g., increased contact-seeking and less interest in an unfamiliar person) toward a new person after three 10-minute interaction sessions, which did not involve either training or food. Finally, simple physical contact appears to be more effective than obedience training in eliciting attachment behavior in shelter dogs toward new humans (Marston et al., 2005, as cited by Miklósi, 2007).

Indeed, it is interesting to compare Gácsi and colleagues' (2001) results with those of the current study. Gácsi and colleagues were able to induce a relatively strong preference for a new person in shelter dogs after relatively brief interaction sessions, whereas brief interactions did not appear to be sufficient for dogs in the current study to form such a preference. But shelter dogs, by definition, do not have any currently active "attachments" to specific humans, and thus it may be quite easy to get such dogs to form a preference for any human who shows an interest in them. In contrast, dogs who are owned (dogs in the current study had been living with their current owner for at least a year), and therefore by definition have current, active attachments to specific people, may be less ready to form relationships with new people, and may need a longer period of time before a new person becomes preferred. Thus it would be informative to replicate the current study using a sample of shelter dogs; in such a sample, stronger results would be expected. Interestingly, as mentioned in the

Introduction, I had chosen owned dogs over shelter dogs because shelter dogs tend to perform less well on pointing tasks (Udell et al., 2010b); however, given the current results, testing these dogs may in fact reveal useful information.

Finally, I found that the dogs in the train condition showed a right-side bias. It is unlikely that this arose as a consequence of the physical layout of the testing space, because this bias was evident in the performance of both daycare dogs and the two dogs tested at the training space, and because it was not seen among dogs in the play condition, though these dogs were tested in the same two locations. Thus this result may be nothing more than random noise, given the small sample size. However, it does reveal that dogs in the training condition often relied on a non-social strategy to solve this task, and thus underscores the finding that a 15-minute training period was not sufficient to induce a preference for a specific person.

Chapter 4: The Influence of Closeness on a Dog's Performance in Pointing Tasks: Owner-Reports of Closeness

Introduction

In Chapter 2, dogs used a variety of strategies to solve the food-finding task. Whereas most of them relied on information from the owner to at least some extent, a few relied exclusively on a side bias, and did not use any information from the owners. In this chapter, I address the question of what may be one possible source of these individual differences in performance. In Chapter 1, I summarized findings indicating that "closeness" to their owners may affect a dog's performance in various tasks (e.g., Elgier et al., 2009; Topál et al., 1997). How does such closeness become established, or put another way, what kinds of interactions does "closeness" consist of? Results of Chapter 3 suggest that a brief interaction period is not enough to establish a preference for a specific human. Is it possible that some dogs, owing to characteristics of their situation with their owners, form a relatively weaker preference than other dogs? In other words, are some dogs "less close" to their owners? If so, this may explain why some dogs in Chapter 2 did not appear to use information from their owners to solve the task.

It seems clear that a period of time longer than 15 minutes, probably combined with some specific type of interaction or time spent with the owner, are necessary for dog-owner closeness to form. There is some evidence indicating the kinds of home situations that might foster this preference in a dog. One study that investigated individual differences in the dog's ability to follow a human point found no differences between dogs that lived primarily indoors versus outdoors, or between dogs that spent more than or less than an hour a day with their owners (Gácsi, Kara, et al., 2009). However, these are both relatively coarse-grained measures of closeness; there are many other more detailed ways to assess a dog's closeness to its owner. In fact, studies that have examined the dog-owner relationship via the lens of attachment theory have found that dogs show behavior that can be classified as "secure" or "insecure" in relation to the owner (Topál et al., 1998), suggesting that it may matter as much how the owner treats the dog as how much time the dog spends in the owner's company. Indeed, another study found that dogs that were more "socially integrated" into their human families (i.e., not only lived indoors but also had a greater tendency to follow the owner closely and rest near the owner, and were considered by owners to be "members of the family") were less likely to try to solve a food-acquisition puzzle on their own, and were instead more likely to look to their owners when confronted with the puzzle, and even to wait to solve the puzzle until encouraged by their owners (Topál et al., 1997). This study used detailed measures of closeness, but did not test their ability to find food using information from humans. Thus, studies that have addressed closeness to owner in a detailed fashion have not examined closeness in relation to food finding behavior, whereas studies examining food-finding behavior have not measured closeness in a precise fashion. In this chapter, I will address this gap in the literature. Specifically, I will address the question of whether using more detailed measures of closeness would reveal that closeness does in fact affect a dog's performance on a food-finding task, using detailed owner-report closeness measures (in part modeled on those of Topál et al., 1997) to examine whether closeness can explain variation in a dog's preference for their owner's information among dogs tested in the previous two chapters.

In this study I also took the opportunity to address the problem that there are as yet no existing surveys of dog-owner closeness that have been used extensively or been checked for their validity and reliability. I examined various possible ways of measuring dog-owner closeness via owner report, by asking a large number of dog owners to complete a series of questions measuring many possible features of the dog's home situation that might reflect closeness. These surveys asked owners to report on various aspects of the dog's daily life, including questions such as how much time it spends with the owner, how much training the owner and dog do together, and where the dog sleeps (see Appendix B). I then employed a factor analysis of this dataset to create a dog-owner closeness measure with adequate psychometric properties. I also asked owners of all the dogs that participated in the studies described in Chapters 2 and 3 to complete the same survey, and I used their responses to investigate individual differences in dogs' performance in the two-person food-finding task. Finally, I use the larger sample of responses to investigate various associations between features of dog owners' opinions about their dogs.

I hypothesized that, first, responses to the owner survey among the larger sample could be factor analyzed to create a coherent measure of dog-owner closeness with adequate psychometric properties. Second, I hypothesized that in the Chapter 2 sample, the owner's reports of closeness would correlate with individual differences in their dog's performance, with higher closeness scores relating to a stronger preference for the owner's container, across conditions. Third, I hypothesized that in the Chapter 3 sample, an owner's reports of closeness would correlate with individual differences in a dog's tendency to prefer the container indicated by the more familiar experimenter. However, for these dogs, it was unclear whether it should be expected that closeness scores should correlate positively or negatively with performance. That is, it could be anticipated that dogs that are closer to their owners are more able to also form a preference for other humans rapidly, but it could also be that dogs that are less close to their owners have more ability to orient to other humans and form such a preference. Thus, the analyses for the Chapter 3 sample should be considered somewhat exploratory. Finally, I explored other associations among the variables in the larger survey sample.

Method

Participants.

There were 30 dogs in the original pointing study (Chapter 2); 19 of the owners (17 women) completed the online survey, resulting in responses for 25 dogs. These responses were distributed evenly among the dogs in the different experimental conditions of that study, with surveys for 3 of the 5 dogs in the "owner correct" condition, 4 of the 5 dogs in the "experimenter correct" condition, 5 of the 5 dogs in the "no point" condition, and 4 of the 5 dogs in the control condition, 4 of 5 dogs in the "leave" condition, and 5 of 5 dogs in the "read" condition. These owners had an age range of 26-65. There were 10 dogs in the daycare study (Chapter 3); 9 of the owners (4 women) completed the online survey, resulting in responses for 9 dogs. These owners had an age range of 26-55. Information regarding breeds and ages of these dogs can be found in the previous 2 chapters. Additionally, the survey was given to 281 dog owners (254 women; one additional participant only completed the first three questions) in the larger community, whose dogs had not participated in either of the previous two studies. These owners ranged in age from 18-69 (mean = 39.44, *SD* = 13.53), though one declined to report his or her age. The dogs in this survey had an average age of 5.16 (*SD* = 3.59), with 182 pure breeds and 99 mixed breeds.

Materials.

I created an online questionnaire for dog owners, based partly on a similar questionnaire used by Topál and colleagues (1997). See Appendix B for the text of the survey. The survey asked owners to report on such topics such as where the dog sleeps, how much training the dog gets from the owner, how close the owner feels to the dog, and the frequency and length of walks.

Procedure.

The survey was emailed to owners after their dogs had participated in one of the previous two studies. The survey was also posted on national public websites Craigslist.com and Facebook.com so that other dog owners in the larger community could volunteer to participate. Specifically, I posted a link to my survey in the discussion forums area of Craigslist (which has a nationwide audience), and in the general pets section on Craigslist in several US cities. I picked one mid-sized city from each region of the country, making sure that there were at least 30 postings a day in each particular section, ensuring adequate survey was posted to Facebook, and I encouraged participants to invite others. The survey was posted only one time in each section. Also, a link to the survey took owners approximately 15 minutes to complete; owners were not compensated for their time and could complete this survey at their convenience.

Results

Factor analysis results.

First, I examined the large survey sample, to determine the factors underlying the concept of "closeness" between dogs and owners. I first explored possible underlying factors in the survey items using factor analysis. There were 22 survey items that attempted to measure closeness in various ways (see Appendix B), and thus the sample size of 281 completed responses was adequate for factor analysis (a minimum of 10 cases per item is often considered enough for adequate power; see Zhao, 2009). The survey items had scales ranging from four to six response options each. I used a principal components analysis with direct oblimin rotation (with Delta set to 0), because

I expected that all the items would inter-correlate to some extent, all being attempts to measure closeness to owner (Field, 2005). Bartlett's test was highly significant (p < .001), and the KMO measure of sampling adequacy was .731, meaning that there were enough appropriate intercorrelations among the items for use in factor analysis (Field, 2000; Field, 2005). However, the determinant of the correlation matrix was .009, indicating that the data did not have excessive multicollinearity (values over .00001 are adequate; Field, 2000).

In the first exploratory factor analysis, I did not constrain the number of factors, to examine the patterns that would emerge in the data. This first analysis resulted in eight factors with eigenvalues over 1. However, the scree plot pointed clearly to a three-factor solution. The top three factors had eigenvalues of 3.62, 2.75, and 1.62, and accounted for 16.47%, 12.49%, and 7.36% of the variance, respectively. I thus ran a second factor analysis specifying a three-factor solution. This solution converged in 16 rotations. Examining the factor loading plots showed that four items did not have a loading of greater than .4 on any of the three factors. These were items asking the owner how much he or she thought that the dog loved him or her, how often the owner groomed/bathed the dog, how much time during the day the dog spent alone, and how many training classes the owner and dog had attended together. An additional two items loaded less than .5 on all of the factors; for these items, I examined distribution statistics to determine whether to keep the items in the next factor analysis. One of these items, asking for the length of any training sessions the owner did with the dog, loaded only .45 onto the first factor, but it had a relatively low mean but had good skewness and kurtosis statistics (1.002 and .730, respectively), and thus I included it in the next analysis. The second of these items, whether the owner considered the dog to be a friend, had a kurtosis statistic of 3.112, indicating a very flat distribution, as well as a skewness statistic of -1.908, indicating a strongly skewed distribution, and thus I dropped it from analyses.

I next ran a factor analysis on the remaining 17 items, without specifying the number of factors. Again I used a principal components analysis with direct oblimin rotation (with Delta set to 0). For this analysis, the KMO measure was .711 and Bartlett's test was highly significant (*p* < .001), and the determinant of the correlation matrix was .023, again indicating adequacy for factor analysis. This resulted in six factors with eigenvalues over 1, however the scree plot once again indicated a three-factor solution. I re-ran the analysis specifying this three-factor solution. These three factors had eigenvalues of 3.24, 2.52, and 1.56, respectively, and accounted for 19.04%, 14.80%, and 9.19% of the variance, respectively. The factor loadings for these items showed that one new item, asking how often owners played with their dogs, did not load stronger than .5 on any one factor, but loaded above .4 on two of the factors, and so it was also dropped from analysis.

I ran a final analysis on the remaining 16 items, again principal components with direct oblimin rotation and Delta set to 0, specifying a three-factor solution. For this analysis, the KMO measure was .690 and Bartlett's test was highly significant (*p* < .001), and the determinant of the correlation matrix was .035, again indicating adequacy for factor analysis. The first three factors had eigenvalues of 2.92, 2.51, and 1.56, respectively, and accounted for 18.22%, 15.68%, and 9.73% of the variance, respectively. Factor loadings for these items can be found in Table 1. I examined these items and found that in general the first factor seemed to reflect dog-initiated elements, whereas the second factor seemed to reflect owner-initiated elements of closeness. The third factor seemed somewhat hard to interpret, and perhaps reflected the owner's opinions regarding some of the dog's "personality" traits.

Given that two factors seemed to coherently describe two aspects of closeness, I re-ran the factor analysis, specifying a two-factor solution. In this analysis, successive iterations of the two-factor solution resulted in the dropping of the three variables that had loaded onto the third factor: how independent the owner felt the dog was, how easy the owner found it to teach the dog new behaviors, and how many words the dog knew. The remaining 13 items loaded strongly onto only one of the two factors (Table 1), and seemed to make sense conceptually, apparently describing owner-initiated and dog-initiated elements of closeness, respectively. This final two-factor analysis had a KMO measure of .695, a Bartlett's test result that was highly significant (*p* < .001), and a determinant of the correlation matrix of .076. The two factors had eigenvalues of 2.59 and 2.45, and accounted for 19.91% and 18.84% of the variance. These thirteen items were then used to create mean owner-initiated closeness (OIC, factor 2 items) and dog-initiated closeness (DIC, factor 1 items) scores. Alpha reliability for the OIC was .652 and for the DIC it was .717. Final mean scores for these scales were 2.44 (*SD* = .65) for OIC and 4.00 (*SD* = .49) for DIC.

Other analyses on the large survey sample.

I examined various hypotheses regarding the interrelationships between different variables, using the sample gathered from a larger community population (the sample from which the OIC and DIC scores were originally derived). First, I examined whether OIC and DIC scores would be higher for "only dogs" (i.e., owners who reported having no other dogs in the home, perhaps leading them to "bond" more strongly with this dog), for owners who had not previously had any other dogs (i.e., owners who feel more "bonded" to their first-ever dog), and for owners who did not have a minor child in the household (i.e., those who reported that the youngest person in the household was 18 or older, thus leaving more time and energy to devote to the dog). OIC scores were not significantly different between owners who had and those who did not have other dogs, but OIC scores were significantly higher for owners who had not had any previous dogs, compared to those who had (Table 2). OIC scores were also higher at trend level for owners who did not have a minor child in the home (Table 2). No significant differences in DIC scores were found.

Table 1

Factor Loadings of the Items Assessing Closeness from the Large-Scale Owner Survey

	Factor loadings[a]				
	Three-factor solution			Two-factor solution	
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2
Where does your dog spend his or her time?		.578		-.513	
Where or with whom does your dog sleep?		.645		-.652	
How much does your dog stay near you?		-.662	-.312	.567	
How much does your dog seem to be attempting to communicate?		-.643	.361	.714	
How independent do you think your dog is?		.318	.719		
How often do you pet, cuddle, hold or sit with your dog?		.654		.700	
How long are play sessions with your dog?	.525				.656
How often do you walk your dog?	.527				.488
How long are these walks?	.635				.627
How often do you take your dog to off-leash areas?	.671				.570
How long are these outings?	.720				.679
How close is the relationship between you and your dog?		.639		.689	
How easily can you teach your dog a new behavior?			.634		
How many words does your dog seem to understand?			.540		
How much time do you spend training your dog?	.450				.534
How long are these training sessions?	.410		.327		.561

[a] Loadings less than .30 are not shown.

Table 2

T-tests Comparing Owner-Initiated and Dog-Initiated Closeness Scores According to Family Composition Features

Variable		mean	*SD*	*n*	*t*	*p*
Other dogs						
OIC	None	2.49	.63	116	-.95	.341
	Other dogs in home	2.41	.66	162		
DIC	None	3.97	.49	117	.73	.465
	Other dogs in home	4.02	.48	164		
Previous dogs						
OIC	None	2.61	.59	85	-2.94**	.004
	One or more	2.37	.66	192		
DIC	None	3.99	.44	85	.17	.863
	One or more	4.00	.51	195		
Child in home						
OIC	No	2.48	.64	209	1.76*	.079
	Yes	2.32	.67	69		
DIC	No	4.02	.48	211	1.36	.175
	Yes	3.93	.51	70		

*$p < .10$. **$p < .005$.

Second, I tested whether the variables of the dog's age, how long the owner had had the dog, and the owner's age correlated with OIC or DIC scores. No significant correlations were found for DIC scores. OIC scores correlated significantly with dog's age, $r(278) = -.317$, $p < .001$, and with how long the owner had had the dog, $r(278) = -.276$, $p < .001$, and correlated at trend level with owner's age, $r(275) = -.117$, $p = .053$. Thus, younger owners, those with younger dogs, and those who had had the dog for less time, reported higher OIC scores.

Closeness analysis in the Chapter 2 sample.

I next created mean OIC and DIC scores for the dogs that had participated in the original pointing study described in Chapter 2. For these dogs, I examined whether these owner-report scales correlated with individual differences in the strength of their preference for their owner in the food-choice tasks. To achieve adequate power, I combined the dogs from the "owner correct," "experimenter correct," "leave," and "no point" conditions, and did not include dogs from the control condition or the "read" condition because the owner had not been one of the pointers in the former condition and dogs did not show a preference for the owner in the latter. The mean OIC score for all dogs in these conditions was 2.99 ($SD = .532$) and the mean DIC score for all dogs in these conditions was 3.93 ($SD = .46$). There were no significant correlations between OIC or

DIC scores and the number of times, in 20 trials, that the dog chose the owner's container, *r*(16) = .116, *ns*, and *r*(16) = -.189, *ns*, respectively.

I also examined other possible predictors of a dog's performance, via other questions on the owner survey which had not been included in the OIC or DIC. I investigated whether the number of times that the dog chose the owner's container correlated with other potential predictive variables. The length of time that the dog had lived with the owner did not correlate with this performance, *r*(16) = -.198, *ns.* Nor did an owner's reports of a dog's independence, *r*(16) = .122, *ns*, or an owner's report of how easy they thought it was to teach their dog a new behavior, *r*(16) = .296, *ns* correlate with this performance. Although the correlation with a measure of how many words owners estimated that their dog knew approached significance, *r*(16) = -.497, *p* = .05, an examination of the scores suggested that this result was due to two somewhat outlying scores. A correlation with the owner's reports of how often they played with their dog was also not significant, *r*(16) = -.366, *p* = .163.

Finally, I examined whether any of the other survey responses that had related to OIC scores in the larger community survey sample would relate to a dog's performance. These included dog's age, owner's age, how long the owner had had the dog, whether the owner had had any previous dogs, and whether there were minor children living in the home. None of these variables were related significantly to how often dogs chose the owner's container.

Closeness analysis for dogs in the Chapter 3 sample.

I next created mean OIC and DIC scores for the dogs that had participated in the daycare study described in Chapter 3. Mean OIC score for these dogs was 2.77 (*SD* = .65) and mean DIC score was 3.85 (*SD* = .47). For these dogs, I examined whether the owner-report scales correlated with individual differences in the strength of a dog's preference for the experimenter who either played with or trained them (i.e., the more familiar experimenter), in the subsequent food-choice tasks. To achieve greater power, I combined the dogs from the "play" and "train" conditions. There were no significant correlations between OIC or DIC scores and the number of times, in 20 trials, that the dog chose the container indicated by the more familiar experimenter, *r*(9) = -.497, *p* = .173, and *r*(9) = .045, *ns*, respectively.

As I had done with dogs in the Chapter 2 study, I also examined whether other questions on the owner survey which had not been included in the OIC or DIC might relate to a dog's performance. None of these correlations reached significance, however some reached trend level, which is perhaps noteworthy given the small sample size. Correlations were not significant between performance and the length of time that the dog had lived with the owner, how many words owners estimated that their dog knew, how easy owners thought it was to teach their dog a new behavior, how often they played with their dog, or how much the owner thought that the dog loved him or her. Owner reports of how easy it was to teach the dog a new behavior also did not relate to dogs' performance, *r*(9) = -.536, *p* = .137. However, trend-level results were revealed for correlations between performance and an owner's report of their dog's independence, *r*(9) = .622, *p* = .074.

Finally, I examined whether any of the other survey responses that had related to OIC scores in the larger community survey sample would relate to dogs' performance. These included dog's age, owner's age, how long the owner had had the dog, whether the owner had had any previous dogs, and whether there were minor children living in the home. None of these variables were related significantly to how often dogs chose the familiar experimenter's container, although the measure of how long the owner had had the dog showed a weak trend toward being correlated with the dog's preference for the familiar experimenter's container, *r*(9) = -.573, *p* = .107.

Discussion

Factor analysis of the large survey sample of owners showed that owner-initiated reports of their dogs' habits at home, as well as the owner's own habits with their dogs, resulted in two coherent factors which appeared to describe owner-initiated closeness (OIC) and dog-initiated closeness (DIC). These measures were created via an exploratory process, based on questions that were written in an attempt to measure any aspect of the dog's daily life that might be an indicator of closeness, which were then submitted to factor analysis. In terms of face validity, the items in the OIC scale did indeed seem to very clearly reflect owner-initiated and owner-controlled activities; they included number and length of outings, play sessions, and training sessions, all of which are indeed controlled mainly by the owner. However, the items in the DIC scale were less clearly cohesive; the activities they included could have been dog-initiated but could also have included elements of owner control. For example, where a dog sleeps and how much time the dog spends outdoors could be determined by the dog's preference or could be directed wholly or partly by the owner. Similarly, petting/cuddling sessions could be initiated by either owners or dogs, or both. Indeed, the ambiguity in this scale may account for the relatively low alpha reliability among the items in this scale, as well as the lack of significant associations between this scale and other variables in the study. The interpretation of this scale as reflecting "dog-initiated" closeness should be examined in further studies. Specifically, in a future survey, items should be included that clearly ask the owner to report on whether activities were indeed dog-initiated.

Analysis comparing the OIC and DIC scores to other variables in the dataset showed that OIC scores were significantly higher for owners for whom this was their first dog, and were also higher at trend level for owners who did not have a minor child in the home. OIC scores were also higher for owners who had had their dogs for less time, owners with younger dogs, and perhaps also younger owners (results were at trend level for owner age). In contrast, DIC scores were not significantly related to any of these variables. Taken together, these results suggest that there is a "newness" effect, in which young owners, young dogs, owners with their first dog, owners with a new dog, and perhaps also those without minor children to care for, devote more time and attention to their dog. Yet this time and attention does not appear to translate into differences in dog-initiated closeness behaviors, as indicated by the lack of findings for the DIC (though, as noted, this lack of findings may relate to ambiguity in some of the items making up the DIC). Similarly, as indicated by results comparing OIC scores to the dogs' performance in the Chapter 2 and Chapter 3 samples, differences in an owner's closeness behaviors with dogs did not translate into a greater tendency for dogs to choose their owner's container in a food-choice task. Thus, it would appear that although some situational variables relate to the amount of time that owners are devoting to their dogs, these differences do not strongly influence the dog's experience of the owner, at least not in terms of variables measured in the food-choice task. It is possible that other individual differences between dogs, akin to personality differences, may explain differences in a dog's performance in the food-choice task. However, it is unclear what these differences might explain in terms of a dog's decision-making, given that DIC scores also did not relate to their performance, though such an association might be found with a more precise version of the DIC.

A number of other variables, including how long the owner had had the dog, an owner's reports of the dog's level of independence, how easy owners thought it was to teach the dog a new behavior, how many words the owner thought the dog knew, whether the owner thought that the dog loved him or her, and how often owners reported playing with their dog, did not relate significantly to differences in dogs' performance in the food-choice task in either the Chapter 2 or Chapter 3 samples. However, for the Chapter 3 sample, there were some indications that differences in a dog's performance may have been weakly correlated to their owner's reports of the dog's independence and the owner's reports of how long the owner had had the dog. Dogs that were reported to be more independent or who had lived with owners for a shorter time showed a trend toward choosing the familiar experimenter's container. These results need to be replicated in a larger sample, but they suggest that dogs that maintain some level of independence from the owner, or that have a less-well-established relationship with the owner, might have more capacity to find relative strangers' behavior relevant and influential. It would make sense that, according to the hypothesis put forward in Chapter 1, dogs that are less dependent on their owners are able to use social information more flexibly, learning to quickly prioritize information from new people after only brief interactions.

In contrast to the variable performance of the dogs in the Chapter 3 study, dogs reliably preferred the owner's container in the Chapter 2 study, regardless of the length of time that the owner had had the dog, and these dogs had all been owned for at least a year at the time of the study. In contrast, many dogs in the Chapter 3 sample showed no preference for the familiar experimenter's container after 15 minutes of interaction, individual differences in this tendency notwithstanding. These results, taken together, suggest that the length of time that the average dog needs in order to establish a preference for a familiar person must be greater than 15 minutes and less than 1 year. Obviously this is a wide range that must be narrowed in future research. It is also worth noting that closeness and familiarity are different concepts; it may be that familiarity influences a dog's choice in a food-finding task, regardless of closeness between dog and owner, making the variations in closeness measured in this study irrelevant to a dog's performance. It is also possible, of course, that closeness could be measured in some other way that might in fact relate to differences in a dog's preference in the food-finding task. For example, observations of dogs and owners in their homes, which are then used to make third-party ratings of closeness, might reveal more than an owner's self-report can, because an observer's view of the dog's behavior might be more objective. Of course, there are other potential variables, not measured in the current studies, that might relate to individual differences in a dog's performance; for example, variations in reinforcement history might have explanatory power if some dogs have been given more food during training than others. Future replications of this study should include more specific questions about training, including how much food and how many corrections owners use during training. Additionally, of course, larger sample sizes may reveal effects that the current study simply did not have the power to detect.

Chapter 5: Conclusion

The goal of this dissertation was to advance the theory that dogs can be described as dependent on humans, and to examine various ways in which dogs rely on humans in making decisions.

In Chapter 1, I advanced the theory that it is most appropriate to describe dogs as living in a state of dependency on humans, characterized by deference, enduring attention, and attachment-like behavior toward specific humans. I further theorized that the effects on canine cognition resulting from this dependency can explain, and should be used to guide the study of, dog behavior in any task that involves viewing or interacting with humans, particularly familiar humans. I outlined the argument that human presence and behavior can either enhance or attenuate a dog's performance in tasks that ostensibly test "cognitive abilities," and thus human presence and behavior should be carefully controlled and considered in any research testing canine cognitive performance.

I went on in Chapters 2-4 to describe three empirical studies in which I explored one particularly salient aspect of this dependence: a dog's differential behavior toward familiar versus unfamiliar humans. In Chapter 2, I found that dogs would repeatedly choose a potential food container that was being indicated by a familiar person, over one being indicated by an unfamiliar person, even if the familiar person consistently indicated a container that yielded no food. Yet they would choose at chance when the familiar person no longer gave the dog any social signal toward either food source, and was not attending to the dog. Thus, these results suggest that dogs not only prefer to attend to a familiar person, but they prefer the specifically social *signals* of a familiar person to those of a stranger. These results are in accord with the theory that domestic dogs have been shaped by evolution to persist in attending to and relying on cues provided by individual, familiar humans, and that these tendencies have resulted in fitness benefits in the long run. Indeed, these results point toward dogs as specifically dependent on humans, as dogs tended to persist in following the familiar person's gestures even when it led to no food. A creature that is willing to weight this heuristic more heavily than alternative sources of information while foraging, should be at a selective disadvantage in all cases except one in which the contingency was, more often than not, rewarded. Dogs are largely dependent on humans for survival, and therefore have probably been shaped toward stronger and stronger tendencies to let us provision them. This strategy could have paid off richly indeed, across the span of evolutionary time, to result in an animal that will run in the direction of a small pile of food indicated by a human gesture even when it means running away from a clearly larger pile of food (Prato-Previde et al., 2007).

In Chapter 3, I investigated how quickly a preference for a newly familiar human's social gestures could be formed. I found that 15-minute interaction periods were not sufficient for dogs to form such a preference. These results leave open the question of whether an individual dog must be in some way actually dependent on the specific human gesturer in order to prefer that human's gesture, or whether simple familiarity is sufficient for dogs to form this preference, but 15 minutes is simply not long enough. Shelter dogs will begin to show attachment behavior after about 30 minutes of interaction (Gácsi et al., 2001), but it has not been established whether this might translate into preference for the newly familiar person's gestures. And these dogs are currently without an owner of their own and thus may be particularly prone to form rapid preferences for new humans. Though this itself begs the question of whether dogs with and without current owners might show quite different patterns in terms of how quickly they might come to rely on a new person's gestures. The dogs in my study were tested at a daycare facility; they all had owners. Future studies should thus both examine increased periods of interaction and should test dogs both with and without current owners.

In Chapter 4, I attempted to explain individual differences in the strength of different dogs' preferences for food sources indicated by familiar humans' gestures, by testing whether the performance of dogs in Chapters 2 and 3 was related to an owner-reported measure of dog-owner closeness. I did not find any strong associations, but this study in particular may have suffered from a small sample size, given the relatively large number of associations being investigated. It may also be the case that owners' reports are not a sensitive enough measure of individual differences in closeness; observational or other such measures should be tried in further studies.

The results described in this dissertation begin to reveal how profoundly human social contexts influence the domestic dog's decision-making process. Future studies are needed to address at least two big questions. First, it remains unclear how long a dog needs in order to form a preference for a familiar person that is strong enough to influence the dog's performance in a food-choice task. A future study might recruit dogs who have been relatively recently adopted by new owners, or might introduce dogs to a new person over a time period spanning some number of hours, days, or weeks. Second, future work should attempt to examine the sources of individual differences between dogs in the strength of their preference for their owner's information. These might include using larger sample sizes and investigating other possible predictors that might be sought from owners or perhaps gathered via observations of the dog's behavior in the home or in other settings. Alternatively, detailed case studies of individual dogs might reveal associations between closeness and performance and thus might point toward important variables to measure in testing this association. In conclusion, the theory and studies outlined in this dissertation help us to realize how profoundly dogs are affected by their human social environment, with implications not only for research but for dog trainers, owners, and enthusiasts in terms of how we understand the propensities, cognitive biases, and problem-solving strategies of the species that is perhaps the most closely intertwined with our own: the domestic dog.

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Appendix A: Breed List

Chapter 2 List
French Bulldog
Golden Retriever
Labrador Retriever mix
Beauceron
Australian Cattle Dog mix
Whippet mix
German Shepherd
Boston Terrier
Rhodesian Ridgeback
Australian Cattle Dog
Australian Shepherd
Labrador Retriever
Mexican Hairless
Rhodesian Ridgeback mix
Rottweiler mix
American Pit Bull Terrier mix
Jack Russell Terrier mix
Belgian Malinois
Bearded Collie
Cavalier King Charles Spaniel
Cardigan Welsh Corgi
Unidentifiable mixed breed

Chapter 3 List
French Bulldog
Golden Retriever
Goldendoodle
Mini Goldendoodle
Rough Collie
Unidentifiable mixed breed
Beauceron Mix
Boston Terrier
Smooth Collie Mix

Appendix B: Chapter 4 Owner Self-Report Questions

How did you get to this survey?
A friend emailed me a link to this survey
I saw it on Craigslist
I saw it on a flyer at the dog park/pet food store/shelter/etc.
I saw it on Facebook

If you have more than one dog, please choose one of your dogs and answer this survey only about that dog. What is your dog's name?

Is [dog name] male or female?
Male
Female

Is [dog name] spayed/neutered
Yes
No

How old is [dog name], in years?

How many other dogs do you own?

How many people does [dog name] live in the same house with, including you?

What is the age of the youngest person [dog name] lives with?

How many dogs have you previously owned (as an adult), other than those you currently have?

What do you like most about [dog name]?

What is your gender?
Male
Female

What is your age?

Where does [dog name] spend his or her time?
Always indoors
Mainly indoors
Both indoors and outdoors, equally
Mainly outdoors
Always outdoors

Where or with whom does [dog name] sleep?
Mostly with a family member, in his or her bed
Mostly in the room of a family member (e.g., on the floor, in a crate)
Mostly in another room in the house
Mostly outdoors

How much does [dog name] try to stay near you (e.g., in the same room of the house)?
Seldom; [dog name] is fairly independent
Sometimes
Frequently
Always; [dog name] follows me from room to room as soon as I move

How often does [dog name] seem to be attempting to communicate or "tell you something"?
Seldom
Occasionally
Sometimes
Regularly
Every day

Do you think that [dog name] loves you?
No
I'm not sure
Yes

How independent do you think [dog name] is?
Not very independent
A little independent
Moderately independent
Very independent
Extremely independent

How often do you pet, cuddle, hold, or sit with [dog name]?
Never
Occasionally
Sometimes
Often
Very often

How often do you groom or bathe [dog name]?
Never
Occasionally
Sometimes
Often
Very often

How often do you play interactively with [dog name]? (For example, playing with dog toys, teaching tricks, or other games.)
Seldom: less than monthly
Occasionally: at least monthly
Sometimes: at least weekly
Regularly but not every day
Every day

How long are these play sessions?
Usually 10 minutes or less
Usually 10-30 minutes
Usually 30-60 minutes
Usually more than 60 minutes

How often do you walk [dog name] around your neighborhood?
Seldom: less than monthly
Occasionally: at least monthly
Sometimes: at least weekly
Regularly but not every day
Every day

How long are these walks?
Usually 10 minutes or less
Usually 10-30 minutes
Usually 30-60 minutes
Usually more than 60 minutes

How often do you take [dog name] to dog parks or other off-leash areas?
Seldom: less than monthly
Occasionally: at least monthly
Sometimes: at least weekly
Regularly but not every day
Every day

How long are these walks?
Usually 10 minutes or less
Usually 10-30 minutes
Usually 30-60 minutes
Usually more than 60 minutes

How close is the relationship between you and [dog name]?
Not very close
A little close
Moderately close
Very close
Extremely close

Do you consider [dog name] to be your friend?
Definitely not: animals are not people
Not really: that's not the kind of feelings I have about [dog name]
Maybe: but I wouldn't characterize it that way
Probably: I love [dog name] like I love my friends
Definitely: [dog name] is as important as any of my friends

How easily can you teach [dog name] a new behavior?
It's very difficult: [dog name] often doesn't learn the behavior
It's moderately difficult: [dog name] learns the behavior after many repetitions
In between: [dog name] learns fairly well with some repetitions
It's moderately easy: [dog name] learns the behavior after few repetitions
It's very easy: [dog name] learns the behavior almost immediately

How many words does [dog name] seem to understand (e.g., commands, questions, other words such as "park" or "cookie")?
Probably none
Just a few
Around 10
Around 20
Around 30
More than 30

How much time does [dog name] spend alone per day?
Less than an hour
1-5 hours
6-9 hours
10 or more hours

How much time do you spend training [dog name] per week?
Seldom: less than monthly
Occasionally: at least monthly
Sometimes: at least weekly
Regularly but not every day
Every day

How long are these training sessions?
Usually 10 minutes or less
Usually 10-30 minutes
Usually 30-60 minutes
Usually more than 60 minutes

How many training classes have you and [dog name] completed?
None
One or two
Three to five
Six to ten
More than ten
We are in continuous training classes (e.g., for agility)

Is there anything else you'd like us to know about [dog name]?