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# The effect of different life experiences on dogs' human-directed gazing

# O efeito de diferentes experiências de vida sobre o olhar direcionado a humanos em cães

São Paulo
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*“Fall in love with a dog, and in many ways you enter a new orbit, a universe that features not just new colors but new rituals, new rules, a new way of experiencing attachment.” (Caroline Knapp)*

*“Dogs do speak, but only to those who know how to listen.” (Orhan Pamuk)*

## Abstract

Mendes, J. W. W. The effect of different life experiences on dogs' human-directed gazing (Dissertação de Mestrado). Instituto de Psicologia, Universidade de São Paulo, São Paulo.

Dogs have been a part of human society for a thousand of years, and we have a particular relationship and communicative interaction, which we discuss in chapter 1. Gazing behaviors are used by dogs to draw a person's attention, indicate the location of a desired object, and initiate communication. In the second chapter of this dissertation, we reviewed the use of the unsolvable task, a common paradigm in studying human-dog communication, discussing how their different methodologies and proxies can affect results and hinder comparisons. We additionally proposed strategies to walk towards a more homogenous use of this important paradigm. In chapter 3 we presented an experiment using the unsolvable task to evaluate the effect of different experiences with humans in dogs' gazing behaviors. We compared pet dogs living inside the house, pet dogs living outside the house, and shelter dogs. We found no difference in latency to first gaze, but pet dogs did show a higher proportion of individuals engaging in gaze alternation, a higher number of gaze alternations and a longer duration of gazing than shelter dogs. Additionally, dogs living inside the house gazed more at the experimenter than dogs living outside the house. Overall, our results indicate a strong influence of experience in the development and use of these communicative behaviors in dogs. In chapter 4 we presented an exploratory analyzes of the behavior of shelter dogs in the first solvable trial of the unsolvable task. Fifteen dogs did not obtain food (fail group) and 16 did (success group). Dogs in the fail group had a higher latency to start moving. We presented a time budget for dogs in the fail group. They spent, in average, half of the testing time out of the experimental area and allocated considerable time to walking and sniffing. We discussed these results regarding stress, fear, and the need to explore, and proposed that these are important factors to take into consideration when assessing cognitive abilities in shelter dogs. We additionally discussed strategies to better fit shelter and other non-pet dog populations in current research. Overall, this dissertation brought a new overview, data and discussion contributing to the topic of dog-human communication. This helps us to further understand the process of interspecific communication and of the role of experience in the development of social skills. Finally, but not less important, the understanding of our relationship with dogs can contribute to make the coexistence more harmonious.


Keywords: *Canis familiaris*. Communication. Human-animal interaction. Social cognition. Unsolvable task

## Resumo

Mendes, J. W. W. O efeito de diferentes experiências de vida sobre o olhar direcionado a humanos em cães (Dissertação de Mestrado). Instituto de Psicologia, Universidade de São Paulo, São Paulo.

Cães são parte da sociedade humana há milhares de anos, e nós temos uma relação e interação comunicativa particular, que discutimos no capítulo 1. Comportamentos de olhar são usados por cães para atrair a atenção de uma pessoa, indicar a localização de um objeto de interesse e iniciar comunicação. No segundo capítulo nós revisamos o uso da tarefa sem solução, um paradigma comum no estudo da comunicação cão-ser humano, discutindo como diferentes metodologias e operacionalizações prejudicam comparações. Nós adicionalmente propusemos estratégias para tornar o uso desse paradigma mais homogêneo. No capítulo 3 nós apresentamos um experimento usando a tarefa sem solução para avaliar o efeito de diferentes experiências com seres humanos no olhar direcionado a humanos em cães. Comparamos cães vivendo dentro de casa, cães vivendo fora de casa e cães de abrigo. Cães de estimação tiveram uma maior proporção de indivíduos usando alternância de olhares, uma maior frequência de alternância de olhares e uma duração mais longa de olhar do que cães de abrigo. Cães de dentro de casa olharam mais para o experimentador do que cães de fora de casa. De forma geral, nossos resultados indicam um forte efeito de experiência no desenvolvimento e uso nesses comportamentos comunicativos. No capítulo 4 nós apresentamos uma análise exploratória do comportamento de cães de abrigo na primeira tentativa com solução da tarefa sem solução. Quinze cães não obtiveram a tarefa (grupo falha) e 16 obtiveram (grupo sucesso). Cães do grupo falha tiveram maior latência para se movimentar. Apresentamos uma alocação de atividades para cães no grupo falha. Eles passaram, em média, metade do tempo fora do ambiente experimental, e alocaram tempo considerável para andar e farejar. Discutimos esses resultados em relação à estresse, medo e exploração, e propusemos que são fatores importantes a se considerar quando avaliando as habilidades comunicativas de cães de abrigo. Adicionalmente discutimos estratégias para incluir cães que não sejam de estimação de forma mais apropriada em estudos. De forma geral, essa dissertação trouxe uma nova visão, dados e discussões contribuindo para o tópico de comunicação entre cães e seres humanos. Isso nos ajuda a entender o processo de comunicação interespecífica e o papel da experiência no desenvolvimento de habilidades sociais. Finalmente, a compreensão da nossa relação com os cães pode contribuir para tornar nossa coexistência mais harmoniosa.



Palavra-chave: *Canis familiaris*. Comunicação. Interação humano-animal. Cognição social. Tarefa sem solução.

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# Chapter 1: Introduction

## 1.1 Interspecific communication

Communication is an important aspect of most, if not all, animal life. In a general manner, communication can be defined as a transfer of information from a signaler to a receiver, and it is a key strategy to solving problems. (Dugatkin, 1962). What these signals are, how they evolve, and which factors shape them have long been intriguing researchers. Conveying and perceiving information can help animals find a proper mate (Bacwell et al., 1998 Ota, Gahr, & Soma, 2015), save energy when competing with each other (Davies & Halliday, 1978; Lappin et al., 2006) and obtain food cooperatively (Frisch, 1974; Lönnstedt et al., 2014), to name a few examples among all possibilities. Several studies focus on communication between conspecifics; however, interspecific communication is also frequent in nature (Konstan, 2002).

Animals can obtain information by trial and error interactions with the environment (personal information), and by observing others interacting with the environment (social information). Furthermore, social information can be transmitted inadvertently by cues or intentionally by signals. When a bystander uses a cue that was inadvertently made by another individual, it can do so in a way that is costly to the sender (parasitism), neutral to the sender (commensalism), or in a way that benefits both actors involved (mutualism) (Magrath et al., 2014). In the case of mutualism, the use of the information may create pressures for the performer to elaborate the cue and for the bystander to comprehend the cue - transforming it into a signal throughout generations (Lotem, 1999; Alcock, 2005).

Communicative signals are also used accordingly to each species' sensory capacities and environments. Visual signals are generally effective when individuals are close enough to each other, and their interpretation depends on the species' perception of texture, motion, shape, and color (Rosenthal, 2007). Chemical signals can contain messages even after the sender is gone, for example in the case of animals that mark their territory through scratching and urine (Zub et al., 2003). The use of this kind of signal depends, among other factors, on the quantity of olfactory cells the receivers have (Elsaesser & Paysan, 2007). Acoustic communication can be adapted to many environmental conditions and situations, as it can vary in amplitude, duration, and frequency. It can be adjusted by the same animal to be more easily

identified by conspecifics and less conspicuous for a predator (Marler, 1955; Klump, Kretzschmar & Curio, 1986). That way, the same signal can have different meanings to the signaller and different receivers according to the context and according to each's sensory and cognitive skills.

Considering these aspects, it is not hard to imagine that signaling and receiving mechanisms are strongly selected within species. However, interspecific communication is an important feature and is widespread among vertebrates (Goodale et al., 2010; Magrath et al., 2014). As brought by Konstan (2002), the ability to discover meaning in interspecific signals could potentially benefit the signaler and receptor. This author proposed a model for evolution of interspecific communication, in which one species starts assessing signals of the other, following by the reverse assessment, and then, at some point, both species become able not only to assess but also to produce signals to manage the behavior of the other, which this author called mutualistic communication. An example of this complex interspecific mutualistic communication is the foraging associations between emperor tamarins (*Sanguinus imperator*) and saddle-backed tamarins (*Sanguinus fusicollis)*, where each species regulates and responds to the other's long call by approaching the signal source, helping them to maintain their conspecific and interspecific associations. (Windfelder, 2001).

It is important to note that the use of information can be inherited not only genetically but also culturally, through imitation, social facilitation, imprinting, learning, and teaching (Jablonka, 2002; Danchin, 2004). Konstan (2002) pointed out the importance of cultural evolution and of proximate dynamics of interactions in the evolution of mutualistic communication, by exemplifying with the communication between humans and the birds greater honeyguides (*Indicator indicator*). Boran and Mozambican honey gatherers attract greater honeyguides through whistles or vocal sounds, which in turn emit a distinct chattering call accompanied by referential movements. Following the birds from tree to tree, gatherers manage to increase the probability of finding a bee's nest (Isack & Reyer, 1989; Spottiswoode, Begg & Begg, 2016). According to the authors, the humans' opening of the nest allows the greater honeyguides to access food they would otherwise not be able to. The honey gatherers pass on this traditional calling throughout generations, and the honeyguides manage to correctly attribute meaning to it and respond accordingly.

Another mutualistic and culturally enhanced interspecific communication is the one between humans and dogs (*Canis familiaris)*, exemplified in Konstan's work by

human-herding dogs' interactions (McConnell and Baylis, 1985). Many other and more general relationships can illustrate this fine-tuned communication where both species assess and produce signals aimed toward each other and adjust its own behavior accordingly, as we will extensively show in the course of this essay. Some questions arise at this point: how, why, and when did this interspecific communication start?

It is expected that similar signals across species are easier to be co-opted and eventually evolve into mutualistic communication (Konstan, 2002), but that is arguably not the case for humans and dogs. While the main perceptual channel for humans is the vision, dogs live mainly in a world of scents (Horowitz, 2017; Pongrácz et al., 2017). Darwin himself had already pointed to the important distinction that "when a dog is about to attack an enemy, [...] its lower lip is retracted showing the teeth, specially the fangs", while for humans the act of showing teeth is typically a sign of happiness (Darwin, 1872). So why did humans and dogs develop such a good match communication and relationship-wise?

Mutualistic communication is more often seen in social species and when there is niche overlap and repeated interactions (Westrip & Bell, 2015). That seems to be the case for Paleolithic humans and the ancestors of domestic dogs (assessed largely by observations of wolves, the domestic dogs' phylogenetically closer relatives). Both species lived in familiar groups with cursorial hunting[1], cooperative rearing of young and territory defense, high in-group affiliative behavior and complex out-group interactions (Kotrschal, 2018). Kotrschal (2018) pointed out that another aspect in common seems to be their adaptiveness and plasticity, occupying many different environments due to their cognitive abilities and social organization. Encounters between these two species were probably recurring in that period.

The social-ecological similarities seem to have driven these species closer together and may contribute to explain this often-harmonious relationship. This partnership that turned into the domestication process started at least 15,000 years ago (Parker, 2012), with some authors estimating up to 35,000 years ago (Frantz et al., 2016). It is a consensus that the domestic dog, *Canis familiaris*, shares a direct ancestor with grey wolves, *Canis lupus* (Perri, 2014). Apart from that, there are many uncertainties on the issue of domestication. The level of human intentionality, active

[1] Hunting technique that consists in a combination of tracking, walking, and running to pursue prey to exhaustion.

approximation to wolves and effects on cognition and communication have been debated for decades.

Some authors proposed that there could have been an active adoption of wolf pups by Paleolithic humans, with selection of desirable behaviors and aesthetics (Grandin & Deesing, 2014). This proposal is based on the fact that current human hunter-gatherer societies do adopt and take care of wild animals (Kotrshal, 2018). However, these adoptions do not usually involve breeding of subsequent generations. The initial contact should happen very early in wolf pups' lives for them to become habituated to humans, when they are still dependent on their mother's milk. The time and energy necessary to do so for many generations and in such a widespread manner seems unlikely to have been spared, at least as a sole mechanism for domestication (Williams, 2015).

A more acceptable theory suggests that wolves were attracted to human settlements either by waste (Coppinger & Coppinger, 2001) or by climate change (Budiansky, 1992). Thus, wolves that showed lower levels of fear and aggression would have been tolerated and passed on their genes, while more aggressive wolves would have been driven away (Larson & Burger, 2013). While some researchers like Budiansky (1992) thought them as "freeloaders", others proposed that they had a symbiotic relationship with humans, disposing of waste and helping to keep other predators away (Olsen, 1985), or even that they affected humans' social and hunting behavior (Schleidt and Shalter, 2003). While this hypothesis of "co-evolution" remains untestable, there is archeological evidence of humans hunting alongside dogs since the eighth millennium b.C. (Guagnin, Perri & Petraglia, 2017).

In this sense, some authors discussed the relevance of the niche construction theory with regard of the domestication process and the millenary dog-human relationship (Parsons, 2015; Cabral & Savalli, 2020). Niche construction can be defined as "the process whereby organisms, through their metabolism, their activities and their choices, modify their own and/or each other's niches" (Odling-Smee, Laland & Feldman, 2003). This highlights the active role of organisms in the evolutionary process, as actors of theirs and others' evolution rather than just targets (Laland & O'Brien, 2010). Smith (2007) proposed that the domestication process is a representation of this, with humans enhancing their environment and developing new sets of behaviors according to certain species. It can also be argued that, by approximating humans, wolves actively affected the selective pressures upon

themselves. Thus, dynamics were created where their resource obtaining would be related to humans, and individuals that could better profit off that would have left more offspring. This would fit in with Jablonka's idea of reciprocal feedback between organisms (Jablonka, 2011).

### 1.2 The perception and use of human signals by dogs

Apart from the questions of how dogs' domestication took place, there is also interest in what that process did to the species. Some authors propose that domestication enhanced dog-human communication, an idea that is called "domestication hypothesis" (Hare, 2002, Miklósi & Topál, 2013). This hypothesis leads to the assumptions that dogs would have a higher sensitivity to human gestures than other non-domesticated canids, and that they would need little training or exposition to perform these human-directed behaviors. Evidence of that can be found in Hare et al.'s study (2002), where socialized wolves and dogs were compared regarding the ability of following the human pointing gesture to find a hidden food in one of two containers (object choice task). The authors found that dogs, as a group, outperformed wolves in following the gesture towards the correct container. Later, Hare & Tomasello (2005) also found that wolves failed in following a momentary distal pointing gesture (considered to be more difficult), while dogs were successful in it (Miklósi & Soproni, 2006). Some studies have found that dog pups are able to follow human communicative cues from a very young age: six weeks in Riedel et al. (2008)'s research and nine weeks in Hare et al. (2002)'s. Agnetta et al. (2000) demonstrated that dogs at four months are as skillful as adults in an object choice task.

On the other hand, regarding dogs' early use of the human pointing gesture, Wynne, Udell & Lord (2008) showed, in a re-analysis of Riedel et al. (2008)'s data, that there was a significant learning effect during development and improvement across trials. These results reinforced the role of ontogenesis. Dogs could already follow the gesture at six-weeks old, but contrary to Riedel et al.'s findings, these new analysis showed that while there was an increase in performance across trials for the youngest pups, the older dogs performed better in all point types than the youngers. The authors pointed out the importance of learning and experiences with humans in using our social cues.

That same year, Udell, Dorey & Wynne (2008) evaluated the performance of wolves that were hand-reared by humans since they were 10-14 weeks old and received food from human hands daily, compared to pet dogs living in human homes and shelter dogs. Unlike Hare (2002) and Hare & Tomasello (2005), they found that not only wolves were able to follow the momentary distal pointing gesture with no previous exposure to the specific task and after few trials, but also they performed better than shelter dogs. They proceed to argue that “domestication alone cannot be responsible for a dog’s sensitivity to human cues”.

These studies culminated in the proposition of the two-stages hypothesis (Udell et al., 2010). They presented three main points that should be taken into consideration to understand these differences in development: developmental windows, proximity to humans and conditioning. According to the authors, many comparative studies focus on chronological age, which is not necessarily the same regarding developmental stages. For example, in a decade-long experiment that tried to emulate the domestication process on silver foxes, *Vulpes vulpes* (Trut et al., 1999), it was found that the sensitive period for effective social adoption was longer in individuals that were “domesticated” through generations of artificial selection when compared to non-domesticated control foxes (Trut et al., 2004). It was proposed that, in the sensitive period, less experience would be necessary to produce a greater effect on behavior (Scott & Fuller, 1965). For dogs, the sensitive period for socialization is from three weeks to 12 or 16 weeks, while for wolves it starts a few days after birth and extends to approximately one month (Udell & Brubaker, 2016). Therefore, even when comparing individuals of the same age in communicational and cognitive tasks, it is possible that differences in this and other developmental milestones affect their performance.

Regarding the second point (proximity to humans), authors pointed out that the higher proximity and particular relationships that domesticated species have with humans cannot be completely reproduced with their wild counterparts for an exact comparison, not even when that is explicitly attempted. For example, in Hare et al. (2002), dogs were tested in an isolated room where they could have direct contact with the experimenter, while for safety reasons, the wolves were tested outside with a fence between them and the experimenter. Even when human-socialized and used to interact with unfamiliar people, it is probable that wolves have different interactions with humans than dogs, as people may behave differently towards them based on comfort

and different levels of understanding (Bentosela et al., 2016). Breed and physical characteristics in domestic dogs have been shown to affect people's perception and behavior towards them (Wright et al., 2007; Brown et al., 2013; Fratkin & Baker, 2013), thus it seems reasonable to assume the same patterns would apply to wolves when comparing to dogs. Therefore, Udell and collaborators argued that differences found in comparisons are not necessarily a genetic byproduct of domestication.

Thirdly, Udell and collaborators (2010) argued that the domestication hypothesis often overlooks the role of conditioning. Pet dogs that spend their days around people are constantly responding to human stimuli, including movement of the arm and hand, that can be used to put a bowl of food down, give treats or throw a toy. Inadvertently, we are constantly conditioning our dogs to react to certain stimuli. And, even for individuals that do not have many experiences with humans, the experimental situation by itself can be enough for operant learning. This is not to say that the tests are not appropriate to assess the species cognition and communication; after all, learning and conditioning processes are key factors in the development and use of all behaviors, and that does not mean the results from it are less "natural" or species-specific, or that they exclude additional cognitive explanations (Call, 2001). Rather, the authors pointed out the importance of taking these processes into consideration so the effects of domestication per se are not over credited.

This led to a response from Hare et al. (2010) in which they proceeded to argue in favor of the domestication hypothesis. They suggested that Riedel et al. (2008)'s previous analysis was more adequate to evaluate a possible age effect, and that Udell, Wynne and collaborators failed to take into account the result that dogs at six-weeks old would be as skillful as older dogs in understanding distal pointing gestures. They also proposed that Udell et al. (2008)'s comparison of wolves and dogs was not accurate, as the groups were not specifically reared for experimental purposes and the wolves of the educational program that were used would be highly trained. They concluded, then, that the skills of domestic dogs would be in fact a result of domestication.

In their reply, Udell and Wynne (2010) started by pointing out their areas of agreement: that dogs do show a remarkable sensitivity to human actions and gestures, and that the high exposure of their subject wolves to humans and training would have affected their responses, as they argued themselves that environment and development influence an animal's response to social cues. They discussed, then, that

the main point of disagreement is Udell and Wynne's belief that socialization and experiences would be crucial for canids to respond to interspecific cues. They did not question that domestication affected dogs' communicative abilities, or that there are differences between dogs and wolves. But they pointed out that heredity does not account alone for any phenotype, which would be a result of a complex interactions between heredity, development, and environment (Gottlieb, 2002). After arguing in favor of their own methodologies and analyzes that result in wolves being skillful in following humans and an effect of age in dogs' ability, they emphasized that behaviors develop, and that this development is affected by interactions with others and with the environment, in a manner that theses aspects cannot be ignored.

Range and Virányi, in 2015, addressed other aspects of the domestication hypothesis: the assumption that dogs, due to the evolutionary processes during domestication, would present higher social tolerance and social attentiveness than wolves. They pointed out that up to then, studies about the domestication hypothesis focused on animals' interactions only with humans, not with conspecifics. That would not allow us to understand whether there are fundamental differences in the species' tolerance or attentiveness, or whether differences would be in their readiness to interact with humans. In addition to that contribution to further understand the domestication process, these authors argued that studying dogs' interactions with conspecifics is also essential to understanding dogs' overall behavior, cognition, and communication. A large portion of dogs worldwide lives with little contact with humans, interacting mostly with other dogs (Hughes & Macdonald, 2013). And for pet dogs, many live in multi-dog households (McGreevy & Masters, 2008). Therefore, both interspecific and intraspecific interactions should be taken into account in order to unravel their overall social-communicative and cognitive capacities.

By observing dogs and wolves that were hand-reared by humans and lived in packs in large enclosures that allowed for intraspecific naturalistic interactions, Range and Virányi discussed this issue. In 2013, they presented the dogs and wolves with a local enhancement social learning task where a demonstrator hid food in one of three possible locations. The demonstrator could be either a human or a dog, both familiar to the subjects. Wolves and dogs were attentive towards the demonstrator and benefited from him, regardless of the species. In 2014, they found that wolves were more successful than dogs at opening an apparatus after watching a demonstration from a conspecific. In a 2015 study, Range, Ritter and Virányi observed that both dogs

and wolves showed rare and weak aggression in a pair-wise food competition test, with wolves presenting even higher tolerance than dogs. Based on this research, they proposed the “canine cooperation hypothesis”, postulating that wolves would show higher attentiveness, tolerance, and cooperation with conspecific than dogs. According to this hypothesis, these abilities would be already present in their common ancestor, which could have contributed to the evolution of cooperation between dogs and humans. In that sense, it would contradict the argument that dogs’ tolerance and attentiveness would be a product of domestication, but, on the other hand, it would be compatible with hypotheses that dogs would have been selected for easier socialization with humans.

In 2017, the group (Marshall-Pescini, Schwarz, Kostelnik, Virányi and Range) went on to further investigate conspecific cooperation in dogs and wolves. In a rope-pulling cooperative task, they found that wolves could more skillfully coordinate their actions in a dyad and succeed, while dogs acted in alternated moments with their conspecific and had lower rates of success. Since both species showed similar interest to the apparatus and individually learned to manipulate it, they accounted these results to a difference in their social strategies. Dogs seemed to use a conflict-avoidance strategy, which has been observed to be more common in dogs than wolves (Range & Virányi, 2015). This seems in line with wolves’ dependence on cooperative activities, like collective pup-rearing, territory defense and hunting; dogs, even living in groups, are not nearly as reliable on those aspects (Marshall-Pescini et al., 2017b). Therefore, the authors questioned the hypothesis that domestication made dogs better cooperators and emphasized the importance of taking socioecology into account when comparing current dogs and wolves and thinking about domestication. It is possible that dogs’ socioecology led to increase the tolerance towards humans, and, in turn, relaxed pressures for intraspecific cooperation.

Throughout these decades of research and in this brief recapitulation, a heated discussion regarding the roles of phylogenetic history and ontogeny can be identified. In this sense, a broad, interdisciplinary approach is important to avoid reductionist conclusions and take our knowledge forward. The overcoming of the “nature versus nurture” dichotomy can be facilitated through the developmental systems theory (Oyama et al., 2001). In it, authors focused on a bidirectional interaction between gene and environment, in a context-dependent and dynamic manner (Gottlieb, 2005). Ingold (2001), echoed by Resende and García-Mijares in a discussion about dogs (2017),

raised the point that modern science often thinks that this question is “resolved”, when, in fact, it is generally considered that animals carry genes with prepared information only to be imputed with environmental information. Bidirectionality, on the other hand, would consider that genes are affected by functions, experiences, and activities, rather than only the other way around. In that case, individuals would be seen as developing systems, with behavioral, physiological, and morphological characteristics emerging through internal and external interactions (Gottlieb, 2005).

Dogs, therefore, would not “come to the world equipped to learn from humans [...], rather they would constantly be formed as part of their environment, developing their anatomy, physiology and neurons, reconstructing their canine nature and thus being a developing system” (Resende and García-Mijares, 2017). Additionally, Jablonka and Lamb’s (2007) idea that patterns are inherited not only by genetics, but also epigenetics, ontogenetics, and culture is particularly relevant to studying dogs. Although some studies are rising in the investigation of free-ranging dogs (Lazzaroni et al, 2019; Marshall-Pescini et al., 2017c), most data comes not only from the limited sample of pet dogs, but also from the fraction of it that is composed by urban pets, specially from North-American and European countries. This means that they inherit, and thus develop in, a particular environment and cultural pattern, which undoubtedly affect their interaction with humans, conspecifics, and other animals. The awareness that our knowledge of dogs is limited to these constraints and the investigation of dogs living in different cultures and contexts (i.e.: free-ranging, rural, living with traditional groups, living with lower-income people) are both essential to advance in the field.

This integration of different approaches and levels of analysis could avoid two dangers often found in the animal behavior area: considering dogs’ social skills “ready at birth” or, on the other hand, seeing conditioning processes as the only means that dogs acquire communicative skills (Dahas et al., 2014). According to Dahas and collaborators, “there is no response of an organism that occurs outside of the environment without a genetic base”. The study of dogs’ cognition and particular evolution of the relationship with humans can help us overcome the dichotomy.

### 1.3 The production of human-directed communicative signals by dogs

In the previous overview of the role of domestication in dogs' communicative skills, there was a focus on dogs' perception and use of human pointing gesture (reviews can be found in Reid, 2009 and Miklósi & Soproni, 2006); but dogs can also be in the role of the sender in this communicative processes, as they produce a repertoire of signals that transfer information to humans. The human-directed communication has also been of great interest to researchers in canine ethology.

When we take a closer look at dogs' production of communicative signals, the visual modality stands out. Dogs use visual contact to monitor humans and their reactions, and pet dogs depend on their owners to obtain resources, which reinforces this use of gazing (Savalli, 2017). Regardless of intentionality, dogs that follow their owners to the table and receive food after gazing at them have this behavior repeatedly reinforced (Udell, Dorey & Wynne, 2010), as well as in many other situations throughout their daily lives. Therefore, the visual modality comprises an important part of communication between dogs and humans.

In 2000, Miklósi and collaborators showed that dogs spent more time gazing at an inaccessible toy or food when in presence of the owner than in a control situation without the owner, and that they alternated gazes between the toy/food and the owner when he/she was present. Additionally, vocalization emerged associated with gazing. This led the authors to consider gazing as an intentional and referential communicative behavior. Results in line with that were found by Savalli, Ades & Gaunet in 2014, in which dogs' behavior, when presented to out-of-reach food, met all established criteria for referential and intentional communication: the signal was found to be influenced by audience and recipient's attention; dogs displayed gaze alternation between the desired object and the recipient and used attention getting behavior; and they persisted and elaborated signals when attempts to manipulate the recipient failed. For a more detailed discussion of referentiality, see chapter 2.

There is also a discussion about the role of phylogenesis and ontogenesis in these gazing behaviors produced by dogs to communicate with humans. Miklósi et al. (2003) have shown that human-socialized wolves gaze less at the human face when presented with out-of-reach food than dogs, as well as did Bentosela et al. in 2016. In the latter study, the authors also found that dogs presented a higher tendency to approximate and spend more time near both familiar and unfamiliar people than

wolves. Although finding similar results to Miklósi and collaborators (2003) regarding differences in communication and sociability between dogs and wolves, Bentosela and collaborators took a different approach in discussing it. The authors pointed out that wolves did seek proximity to humans and turned their looks towards them in the out-of-reach food situation, but they did not prolong these behaviors as much as dogs. They proceeded to argue, then, that rather than being a response unique to domesticated canids, both species have capacity for human-directed socio-communicative behavior, but with differences in degree. This comes in line with the above-mentioned shift in literature, in which the role of ontogeny and different experiences are put more thoroughly into perspective.

Other studies have shown that dogs' gazing behaviors are affected by many different factors throughout their lifetime. The unsolvable task, in which dogs learn to solve a problem to obtain a piece of food and afterwards the problem becomes unsolvable, is often used (Miklósi et al., 2003, Marshall-Pescini et al., 2009, Lazzaroni et al., 2019). Older dogs seem to use it more often than pups (Passalacqua, 2011); agility and search and rescue dogs, that are intensively stimulated, seem to use it more than untrained dogs (Marshall-Pescini et al, 2009; D'Aniello et al., 2015), as well as dogs participating in animal-assisted interventions (Cavalli et al., 2019); breed groups seem to have an influence, with ancient breeds gazing at humans less than other groups (Konno et al., 2016).

Importantly, this behavior can be quickly established when reinforced and extinguished when the reinforcement is interrupted: In Barrera, Mustaca & Bentosela's (2011) experiment, pet and shelter dogs took the same amount of time in acquisition of gazing, but the extinction of the behavior was faster for shelter dogs. The continued and prolonged experiences in daily life of pet dogs with their owners could have entailed more persistent communicative behaviors. Further investigations about the effect of rearing and experiences with humans have rendered heterogeneous results. D'Aniello & Scandurra (2016) found that kennel dogs took longer and spent less time looking at a person than did pet dogs when presented with out-of-reach food. Marshall-Pescini et al. (2017c), on the other hand, found that pet dogs, bottle-fed dogs and free-ranging dogs behaved similarly regarding their gaze alternation in the presence of a desired food and a human.

Considering the complex human-dog relationship and discussions that arise from it, the many different interactions we construct with dogs and the developing

nature of dogs, it is important to further investigate the effect of different experiences between dogs and humans. In this sense, this study aims at 1) reviewing the use of the “unsolvable task paradigm” in the literature, regarding differences in methodology and operationalization (chapter 2); 2) identifying whether differences in the amount of time spent with humans on a daily basis influence dogs’ human-directed gazing behaviors in an unreachable food situation, comparing pet dogs that live inside the house, pet dogs that live outside the house and shelter dogs (Chapter 3); and 3) describing behaviors of shelter dogs that did not engage in the unsolvable task and discuss the importance of using methodologies inclusive of non-pet dogs (chapter 4). For the second aim of this research we hypothesized that the amount of time that dogs spent with human would provide more opportunities to develop human-directed gazing behaviors.

**References**

Agnetta, B., Hare, B., & Tomasello, M. (2000). Cues to food location that domestic dogs (Canis familiaris) of different ages do and do not use. *Animal Cognition*, *3*(2), 107–112. doi: 10.1007/s100710000070

Backwell, P., Jennions, M., Passmore, N., & Christy, J. (1998). Synchronized courtship in fiddler crabs. *Nature*, *391*(6662), 31–32. doi: 10.1038/34076

Barrera, G., Mustaca, A., & Bentosela, M. (2011). Communication between domestic dogs and humans: effects of shelter housing upon the gaze to the human. *Animal Cognition*, *14*(5), 727–734. doi: 10.1007/s10071-011-0407-4

Bentosela, M., Wynne, C. D. L., Dorazio, M., Elgier, A., & Udell, M. (2016). Sociability and gazing toward humans in dogs and wolves: Simple behaviors with broad implications. *Journal of the Experimental Analysis of Behavior*, *105*(1), 68–75. doi: 10.1002/jeab.191

Brown, W. P., Davidson, J. P., & Zuefle, M. E. (2013). Effects of Phenotypic Characteristics on the Length of Stay of Dogs at Two No Kill Animal Shelters. *Journal of Applied Animal Welfare Science*, *16*(1), 2–18. doi: 10.1080/10888705.2013.740967

Budiansky, S. (1999). *Covenant of the wild: why animals chose domestication*. New Haven, CT: Yale University Press.

Cabral, F. G. D. S., & Savalli, C. (2020). Sobre a relação humano-cão. Psicologia USP, 31. https://doi.org/10.1590/0103-6564e190109

Call, J. (2001). Chimpanzee social cognition. *Trends in Cognitive Sciences*, *5*(9), 388–393. doi: 10.1016/s1364-6613(00)01728-9

Cavalli, C., Carballo, F., Dzik, M. V., & Bentosela, M. (2019). Gazing as a help requesting behavior: a comparison of dogs participating in animal-assisted interventions and pet dogs. *Animal Cognition*, *23*(1), 141–147. doi: 10.1007/s10071-019-01324-8

Coppinger, R., & Coppinger, L. (2004). *Dogs: a startling new understanding of canine origin, behavior, and evolution*. London: Crosskeys.

Dahás, Liane Jorge de Souza, Neves Filho, Hernando Borges, Cunha, Talita Regina de Lima, & Resende, Briseida Dôgo de. (2013). Aprendizagem social em cães domésticos: Uma revisão dos estudos tendo humanos como liberadores de dicas. Acta Comportamentalia, 21(4), 509-522. Recuperado em 08 de julho de 2020, de http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S0188-81452013000400008&lng=pt&tlng=pt.

Danchin, E. (2004). Public Information: From Nosy Neighbors to Cultural Evolution. *Science*, *305*(5683), 487–491. doi: 10.1126/science.1098254

Darwin, C. (1872). *The expression of the emotions in man and animals*. Mineola, NY: Dover Publications, Inc.

Davies, N. B., & Halliday, T. R. (1978). Deep croaks and fighting assessment in toads Bufo bufo. *Nature*, *274*(5672), 683–685. doi: 10.1038/274683a0

Dugatkin, L. A. (2020). *Principles of animal behavior*. Chicago: The University of Chicago Press.

D'Aniello, B., Scandurra, A., Prato-Previde, E., & Valsecchi, P. (2015). Gazing toward humans: A study on water rescue dogs using the impossible task paradigm. *Behavioural Processes*, *110*, 68–73. doi: 10.1016/j.beproc.2014.09.022

D'Aniello, B., & Scandurra, A. (2016). Ontogenetic effects on gazing behaviour: a case study of kennel dogs (Labrador Retrievers) in the impossible task paradigm. *Animal Cognition*, *19*(3), 565–570. doi: 10.1007/s10071-016-0958-5

Elsaesser, R., & Paysan, J. (2007). The sense of smell, its signalling pathways, and the dichotomy of cilia and microvilli in olfactory sensory cells. BMC Neuroscience, 8(S3). https://doi.org/10.1186/1471-2202-8-s3-s1

Frantz, L. A. F., Venters, B. J., Pugh, B. F., Kireeva, M. L., Komissarova, N., Waugh, D. S., … Larson, G. (2016). Genomic and archaeological evidence suggests a dual origin of domestic dogs. *Science, 352*(6290), 1228–1231.

Fratkin, J. L., & Baker, S. C. (2013). The Role of Coat Color and Ear Shape on the Perception of Personality in Dogs. *Anthrozoös*, *26*(1), 125–133. doi: 10.2752/175303713x13534238631632

Frisch, K. V. (1974). Decoding the Language of the Bee. *Science*, *185*(4152), 663–668. doi: 10.1126/science.185.4152.663

Goodale, E., Beauchamp, G., Magrath, R. D., Nieh, J. C., & Ruxton, G. D. (2010). Interspecific information transfer influences animal community structure. *Trends in Ecology & Evolution*, *25*(6), 354–361. doi: 10.1016/j.tree.2010.01.002

Gottlieb, G. (2002). Individual Development & Evolution. Mahwah, New Jersey: L. Erlbaum.

Gottlieb, G. (2005). From Gene to Organism: The Developing Individual as an Emergent, Interactional, Hierarchical System. In *Brain Development and Cognition* (pp. 36–49). Oxford, UK: Blackwell Publishers Ltd. https://doi.org/10.1002/9780470753507.ch4.

Grandin, T., & Deesing, M. (2014). *Genetics and the behavior of domestic animals*. Amsterdam: Elsevier AP.

Guagnin, M., Perri, A. R., & Petraglia, M. D. (2018). Pre-Neolithic evidence for dog-assisted hunting strategies in Arabia. *Journal of Anthropological Archaeology*, *49*, 225–236. doi: 10.1016/j.jaa.2017.10.003

Hare, B. (2002). The Domestication of Social Cognition in Dogs. *Science*, *298*(5598), 1634–1636. doi: 10.1126/science.1072702

Hare, B., & Tomasello, M. (2005). Human-like social skills in dogs? *Trends in Cognitive Sciences*, *9*(9), 439–444. doi: 10.1016/j.tics.2005.07.003

Hare, B., Rosati, A., Kaminski, J., Bräuer, J., Call, J., & Tomasello, M. (2010). The domestication hypothesis for dogs skills with human communication: a response to Udell et al. (2008) and Wynne et al. (2008). *Animal Behaviour*, *79*(2). doi: 10.1016/j.anbehav.2009.06.031

Horowitz, A. (2017). Smelling themselves: Dogs investigate their own odours longer when modified in an “olfactory mirror” test. *Behavioural Processes*, *143*, 17–24. doi: 10.1016/j.beproc.2017.08.001

Hughes, J., & Macdonald, D. W. (2013). A review of the interactions between free-roaming domestic dogs and wildlife. *Biological Conservation*, *157*, 341–351. doi: 10.1016/j.biocon.2012.07.005

Ingold, T. (2001). Evolving skills. In H. Rose & S. Rose, *Alas, poor Darwin: Arguments against evolutionary psychology* (pp. 201–215). London: Random House Book.

Isack, H. A., & Reyer, H.-U. (1989). Honeyguides and Honey Gatherers: Interspecific Communication in a Symbiotic Relationship. *Science*, *243*(4896), 1343–1346. doi: 10.1126/science.243.4896.1343

Jablonka, E. (2002). Information: Its Interpretation, Its Inheritance, and Its Sharing. *Philosophy of Science*, *69*(4), 578–605. doi: 10.1086/344621

Jablonka, E., & Lamb, M. J. (2007). Précis of Evolution in Four Dimensions. *Behavioral and Brain Sciences*, *30*, 353–392. https://doi.org/10.1017/S0140525X07002221.

Jablonka, E. (2011). The entangled (and constructed) human bank. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1566), 784–784. doi: 10.1098/rstb.2010.0364

Klump, G. M., Kretzschmar, E., & Curio, E. (1986). The hearing of an avian predator and its avian prey. Behavioral Ecology and Sociobiology, 18(5), 317–323. https://doi.org/10.1007/bf00299662

Konno, A., Romero, T., Inoue-Murayama, M., Saito, A., & Hasegawa, T. (2016). Dog Breed Differences in Visual Communication with Humans. *Plos One*, *11*(10). doi: 10.1371/journal.pone.0164760

Kostan, K. M. (2002). The evolution of mutualistic interspecific communication: Assessment and management across species. *Journal of Comparative Psychology*, *116*(2), 206–209. doi: 10.1037/0735-7036.116.2.206

Kotrschal, K. (2018). How Wolves Turned into Dogs and How Dogs Are Valuable in Meeting Human Social Needs. *People and Animals: The International Journal of Research and Practice*, *1*(1). Retrieved from https://docs.lib.purdue.edu/paij/vol1/iss1/6.

Laland, K. N., & O’Brien, M. J. (2010). Niche Construction Theory and Archaeology. *Journal of Archaeological Method and Theory*, *17*(4), 303–322. doi: 10.1007/s10816-010-9096-6

Lappin, A. K., Brandt, Y., Husak, J. F., Macedonia, J. M., & Kemp, D. J. (2006). Gaping Displays Reveal and Amplify a Mechanically Based Index of Weapon Performance. *The American Naturalist*, *168*(1), 100–113. doi: 10.1086/505161

Larson, G., & Burger, J. (2013). A population genetics view of animal domestication. *Trends in Genetics*, *29*(4), 197–205. doi: 10.1016/j.tig.2013.01.003

Lazzaroni, M., Range, F., Bernasconi, L., Darc, L., Holtsch, M., Massimei, R., … Marshall-Pescini, S. (2019). The role of life experience in affecting persistence: A comparative study between free-ranging dogs, pet dogs and captive pack dogs. Plos One, 14(4). https://doi.org/10.1371/journal.pone.0214806

Lotem, A. (1999). The overlooked signaling component of nonsignaling behavior. *Behavioral Ecology*, *10*(2), 209–212. doi: 10.1093/beheco/10.2.209

Lönnstedt, O. M., Ferrari, M. C. O., & Chivers, D. P. (2014). Lionfish predators use flared fin displays to initiate cooperative hunting. *Biology Letters*, *10*(6), 20140281. doi: 10.1098/rsbl.2014.0281

Magrath, R. D., Haff, T. M., Fallow, P. M., & Radford, A. N. (2014). Eavesdropping on heterospecific alarm calls: from mechanisms to consequences. *Biological Reviews*, *90*(2), 560–586. doi: 10.1111/brv.12122

Marler, P. (1955). Characteristics of Some Animal Calls. Nature, 176(4470), 6–8. https://doi.org/10.1038/176006a0

Marshall-Pescini, S., Passalacqua, C., Barnard, S., Valsecchi, P., & Prato-Previde, E. (2009). Agility and search and rescue training differently affects pet dogs' behaviour in socio-cognitive tasks. *Behavioural Processes*, *81*(3), 416–422. doi: 10.1016/j.beproc.2009.03.015

Marshall-Pescini, S., Schwarz, J. F. L., Kostelnik, I., Virányi, Z., & Range, F. (2017). Importance of a species' socioecology: Wolves outperform dogs in a conspecific cooperation task. *Proceedings of the National Academy of Sciences*, *114*(44), 11793–11798. doi: 10.1073/pnas.1709027114

Marshall-Pescini, S., Cafazzo, S., Virányi, Z., & Range, F. (2017b). Integrating social ecology in explanations of wolf–dog behavioral differences. *Current Opinion in Behavioral Sciences*, *16*, 80–86. doi: 10.1016/j.cobeha.2017.05.002

Marshall-Pescini, S., Rao, A., Virányi, Z., & Range, F. (2017c). The role of domestication and experience in 'looking back' towards humans in an unsolvable task. *Scientific Reports*, *7*(1). doi: 10.1038/srep46636

Mcconnell, P. B., & Baylis, J. R. (1985). Interspecific Communication in Cooperative Herding: Acoustic and Visual Signals from Human Shepherds and Herding Dogs. *Zeitschrift Für Tierpsychologie*, *67*(1-4), 302–328. doi: 10.1111/j.1439-0310.1985.tb01396.x

Mcgreevy, P. D., & Masters, A. M. (2008). Risk factors for separation-related distress and feed-related aggression in dogs: Additional findings from a survey of Australian dog owners. *Applied Animal Behaviour Science*, *109*(2-4), 320–328. doi: 10.1016/j.applanim.2007.04.001

Miklósi, A., Polgárdi, R., Topál, J., & Csányi, V. (2000). Intentional behaviour in dog-human communication: an experimental analysis of "showing" behaviour in the dog. *Animal Cognition*, *3*(3), 159–166. doi: 10.1007/s100710000072

Miklósi, Á., & Soproni, K. (2006). A comparative analysis of animals understanding of the human pointing gesture. *Animal Cognition*, *9*(2), 81–93. doi: 10.1007/s10071-005-0008-1

Miklósi, Á., Kubinyi, E., Topál, J., Gácsi, M., Virányi, Z., & Csányi, V. (2003). A Simple Reason for a Big Difference: Wolves Do Not Look Back at Humans, but Dogs Do. *Current Biology*, *13*(9), 763–766. doi: 10.1016/s0960-9822(03)00263-x

Miklósi, Á., & Topál, J. (2013). What does it take to become 'best friends'? Evolutionary changes in canine social competence. *Trends in Cognitive Sciences*, *17*(6), 287–294. doi: 10.1016/j.tics.2013.04.005

Odling-Smee, F. J., Laland, K. N., & Feldman, M. W. (2003). *Niche construction: the neglected process in evolution*. Princeton: Princeton University Press.

Olsen, S. J. (1985). *Origins of the domestic dog: the fossil record*. Tucson, AZ: The University of Arizona Press.

Ota, N., Gahr, M., & Soma, M. (2015). Tap dancing birds: the multimodal mutual courtship display of males and females in a socially monogamous songbird. *Scientific Reports*, *5*(1). doi: 10.1038/srep16614

Oyama, S., Griffiths, P. E. & Gray, R. D. (2001). Introduction: what is developmental systems theory?. In S. Oyama, P. E. Grifths & R. D. Gray (Eds.), *Cycles of Contingency: developmental systems and evolution* (pp. 1-11). Cambridge (Massachusetts): MIT Press

Parker, H. G. (2012). Genomic analyses of modern dog breeds. *Mammalian Genome*, *23*(1-2), 19–27. doi: 10.1007/s00335-011-9387-6

Parsons, I. (2015). Is Niche Construction Theory Relevant to the Proposed Adoption of Domesticates by Hunter-Gatherers in Southern Africa? *African Archaeological Review*, *32*(1), 35–47. doi: 10.1007/s10437-015-9182-y

Passalacqua, C., Marshall-Pescini, S., Barnard, S., Lakatos, G., Valsecchi, P., & Previde, E. P. (2011). Human-directed gazing behaviour in puppies and adult dogs, Canis lupus familiaris. *Animal Behaviour*, *82*(5), 1043–1050. doi: 10.1016/j.anbehav.2011.07.039

Perri, A. (2014). Dog: Domestication. *Encyclopedia of Global Archaeology*, 2162–2165. doi: 10.1007/978-1-4419-0465-2_2204

Pongrácz, P., Ujvári, V., Faragó, T., Miklósi, Á., & Péter, A. (2017). Do you see what I see? The difference between dog and human visual perception may affect the outcome of experiments. *Behavioural Processes*, *140*, 53–60. doi: 10.1016/j.beproc.2017.04.002

Range, F., & Virányi, Z. (2013). Social learning from humans or conspecifics: differences and similarities between wolves and dogs. *Frontiers in Psychology*, *4*. doi: 10.3389/fpsyg.2013.00868

Range, F., & Virányi, Z. (2014). Wolves Are Better Imitators of Conspecifics than Dogs. *PLoS ONE*, *9*(1). doi: 10.1371/journal.pone.0086559

Range, F., & Virányi, Z. (2015). Tracking the evolutionary origins of dog-human cooperation: the Canine Cooperation Hypothesis. *Frontiers in Psychology*, *5*. doi: 10.3389/fpsyg.2014.01582

Range, F., Ritter, C., & Virányi, Z. (2015). Testing the myth: tolerant dogs and aggressive wolves. *Proceedings of the Royal Society B: Biological Sciences*, *282*(1807), 20150220. doi: 10.1098/rspb.2015.0220

Reid, P. J. (2009). Adapting to the human world: Dogs' responsiveness to our social cues. *Behavioural Processes*, *80*(3), 325–333. doi: 10.1016/j.beproc.2008.11.002

Resende, B. D., & Garcia-Mijares, M. (2017). Influências sociais no comportamento do cão. In C. Savalli & N. Albuquerque (Orgs.), *Cognição e comportamento de cães: a ciência do nosso melhor amigo* (pp. 105-131). São Paulo, SP: Edicon.

Riedel, J., Schumann, K., Kaminski, J., Call, J., & Tomasello, M. (2008). The early ontogeny of human–dog communication. *Animal Behaviour*, *75*(3), 1003–1014. doi: 10.1016/j.anbehav.2007.08.010

Savalli, C., Ades, C., & Gaunet, F. (2014). Are Dogs Able to Communicate with Their Owners about a Desirable Food in a Referential and Intentional Way? *PLoS ONE*, *9*(9). doi: 10.1371/journal.pone.0108003

Savalli, C. (2017). A comunicação entre o cão e o ser humano. In C. Savalli & N. Albuquerque (Orgs.), *Cognição e comportamento de cães: a ciência do nosso melhor amigo* (pp. 43-72). São Paulo, SP: Edicon.

Schleid, W. M., & Shalter, M. D. (2003). co-evolution of humans and canids an alternative view on dog domestication. Evolution and Cognition, 9(1), 57–72.

Scott, J. P., & Fuller, J. L. (1965). *Genetics and the social behavior of the dog*. Chicago: Univ. of Chicago Press.

Smith, B. D. (2007). Niche construction and the behavioral context of plant and animal domestication. *Evolutionary Anthropology: Issues, News, and Reviews*, *16*(5), 188–199. doi: 10.1002/evan.20135

Spottiswoode, C. N., Begg, K. S., & Begg, C. M. (2016). Reciprocal signaling in honeyguide-human mutualism. *Science*, *353*(6297), 387–389. doi: 10.1126/science.aaf4885

Trut, L. N., Plyusnina, I. Z., & Oskina, I. N. (2004). An Experiment on Fox Domestication and Debatable Issues of Evolution of the Dog. *Russian Journal of Genetics*, *40*(6), 644–655. doi: 10.1023/b:ruge.0000033312.92773.c1

Trut, L. (1999). Early Canid Domestication: The Farm-Fox Experiment. *American Scientist*, *87*(2), 160. doi: 10.1511/1999.2.160

Udell, M. A., Dorey, N. R., & Wynne, C. D. (2008). Wolves outperform dogs in following human social cues. *Animal Behaviour*, *76*(6), 1767–1773. doi: 10.1016/j.anbehav.2008.07.028

Udell, M. A. R., Dorey, N. R., & Wynne, C. D. L. (2010). What did domestication do to dogs? A new account of dogs sensitivity to human actions. *Biological Reviews*, *85*(2), 327–345. doi: 10.1111/j.1469-185x.2009.00104.x

Udell, M. A., & Wynne, C. D. (2010). Ontogeny and phylogeny: both are essential to human-sensitive behaviour in the genus Canis. *Animal Behaviour*, *79*(2). doi: 10.1016/j.anbehav.2009.11.033

Udell, M. A. R., & Brubaker, L. (2016). Are Dogs Social Generalists? Canine Social Cognition, Attachment, and the Dog-Human Bond. *Current Directions in Psychological Science*, *25*(5), 327–333. doi: 10.1177/0963721416662647

Von Uexku¨ll, J. (1957). A stroll through the worlds of animals and men: A picture book of invisible worlds. In C. H. Schiller (Ed.), Instinctive behavior: The development of a modern concept (pp. 5–80). New York: International Universities Press. (Original work published 1934)

Watts, H. E., & Holekamp, K. E. (2007). Hyena societies. Current Biology, 17(16). https://doi.org/10.1016/j.cub.2007.06.002

Westrip, J. R. S., & Bell, M. B. V. (2015). Breaking down the Species Boundaries: Selective Pressures behind Interspecific Communication in Vertebrates. *Ethology*, *121*(8), 725–732. doi: 10.1111/eth.12379

Williams, C. L. (2015). Why dogs: a discussion on the domestication of the dog, with an ethnographic focus on the islands of the pacific south (dissertation).

Windfelder, T. L. (2001). Interspecific communication in mixed-species groups of tamarins: evidence from playback experiments. *Animal Behaviour*, *61*(6), 1193–1201. doi: 10.1006/anbe.2000.1701

Wright, J. C., Smith, A., Daniel, K., & Adkins, K. (2007). Dog Breed Stereotype and Exposure to Negative Behavior: Effects on Perceptions of Adoptability. *Journal of Applied Animal Welfare Science*, *10*(3), 255–265. doi: 10.1080/10888700701353956

Wynne, C. D., Udell, M. A., & Lord, K. A. (2008). Ontogenys impacts on human–dog communication. *Animal Behaviour*, *76*(4). doi: 10.1016/j.anbehav.2008.03.010

Zub, K., Theuerkauf, J., Jedrzejewski, W., Jedrzejewska, B., Schmidt, K., & Kowalczyk, R. (2003). Wolf Pack Territory Marking in the Bialowieza Primeval Forest (Poland). Behaviour, 140(5), 635–648. https://doi.org/10.1163/156853903322149478

## Chapter 2

## A review of the unsolvable task in dog communication and cognition: comparing different procedures

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### Abstract

Communication between dogs and humans is a topic of growing interest, and the “unsolvable task” is a common method used to measure communicative production. In this task, dogs learn how to solve a problem to obtain a reward. After a fixed number of trials, the reward becomes impossible to access. Although useful to observe dogs’ communicative behaviors in a fairly naturalistic situation, the methodology varies among studies regarding apparatus, number of trials, and other factors. The proxies used also vary, and there are discrepancies and a debate regarding what the task actually measures. Therefore, in this study, we reviewed the usage of the unsolvable task in canids of the genus Canis, searching Web of Science for the terms “dog*”, “Canis”, “dingo*”, “wolf” or “wolves” in the title and "unsolvable task" or "impossible task" in the topic. We included twenty-four studies in this review and discussed how their different methodologies and proxies can affect results and hinder comparisons. Lastly, we propose strategies to walk towards a more homogenous use of this important paradigm.

## Introduction

Communication between domestic dogs and humans has received a considerable attention in the past two decades. Dogs appear to be particularly skillful in understanding human communicative gestures such as pointing and gazing (Agnetta et al., 2000; Miklósi & Soproni, 2006; Reid, 2009), with some studies suggesting they outperform wolves and chimpanzees in the use of such cues (Hare et al, 2002). Furthermore, dogs seem to actively emit communicative signals to engage with humans (Savalli, Ades & Gaunet, 2014; Albuquerque et al., 2018; Miklósi et al., 2003; Gaunet, 2008).

Gazing behavior is particularly relevant for dogs to establish effective communication with humans. Dogs tend to look back at a person when there is a hidden reward (Miklósi et al. 2000), when they lose access to desired food (Miklósi et al., 2003), and to increase visual communicative behaviors once they established eye contact with their owners (Savalli, Resende & Gaunet., 2016). Human-directed gazing is affected by level of training (Marshall-Pescini et al., 2009), age (Passalacqua, 2011), breed group (Konno et al., 2016), audience attention status (Masrhall-Pescini et al., 2013; Savalli, Ades, & Gaunet 2014), and associative learning (Barrera et al., 2011). These various characteristics and interactions may contribute to when, how and how much a dog communicates with humans.

In an attempt to further understand how these factors influence dogs' human-directed communication, one of the experimental protocols widely used is the "unsolvable task paradigm". In this experiment, a dog is presented with a desirable piece of food, which is immediately placed upon an apparatus. The dog then needs to solve a simple task – for example turn over a recipient - to obtain the food. After a fixed number of trials, the apparatus becomes "locked" and the task impossible to solve. There are generally humans present available for the dog to communicate with, and the dog's behavior is then observed, with a focus on gazing behaviors.

This set up allows for observing of dogs' gazing behavior in a fairly naturalistic situation – when they are trying to obtain food. With a careful manipulation of groups and conditions, researchers can focus on different factors surrounding dogs' characteristics and try to understand their effects on communication and other behaviors.

Each year more experiments use the unsolvable task paradigm as a tool; yet researchers struggle to find a well-structured and consensual methodology to follow. Studies vary in the apparatus used, number of trials, familiarity of the person who is available for visual contact and other important characteristics. Additionally, it is challenging to find a clear explanation as to what exactly the unsolvable task proposes to measure, since different interpretations could be obtained from it. It was first used to assess attraction to the human face, and it has been extensively interpreted as a way of evaluating communicative behavior, with some authors explicitly addressing it as help-seeking. It has eventually been used to assess a dog's bond with their owner and their persistence in the task. However, a recent study has even suggested that perhaps the task does not measure communication at all (Lazzaroni et al., 2020). The different measures obtained from the test (such as latency to gaze, frequency of gaze alternation and gaze duration) have been used as a proxy for different variables somewhat loosely.

Therefore, given the controversial interpretations for what this task actually measures in dogs, it is fundamental to look into these past decades' production concerning the unsolvable task and discuss how it has been used and how we could work in the direction of a more unified methodology. This work aims at 1) reviewing the use of the unsolvable task with canids of the genus *Canis*, pointing out differences in methodologies and operationalizations, 2) discussing the effect of these variations in methodologies on results and 3) presenting a framework to unify the use of the task.

## Methods

In order to comprehend the range of studies that have used the unsolvable task paradigm, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Moher, 2009) was used. The steps are described below:

a. A search was made in the database Web of Science for the terms “dog*”, “Canis”, “dingo*”, “wolf” or “wolves” in the title and "unsolvable task" or "impossible task" in the topic. 30 results were found (excluding repetitions);
b. The articles selected from Web of Science had its abstracts and methodology read. Articles that used the unsolvable task paradigm were included. Eight articles did not use the paradigm and were excluded, and one article was a part of a long experimental battery and details could not be found;
c. Among the remaining 21 articles, any study that mentioned using the unsolvable task and had not been found in the Web of Science search was included. This led to the addition of 3 articles, totalizing 24 articles.

## Results and discussion

Twenty-four studies using the unsolvable task were included in this review. Nineteen studies analyzed dogs (*Canis familiaris)*, three analyzed both wolves (*Canis lupus)* and dogs, one assessed wolf-dogs (hybrids of *Canis familiaris* and *Canis lupus*) and one assessed dingoes (*Canis dingo*). In Table 1 we present the references included and its main characteristics.

**Table 1.** References of all studies included in this review and its main characteristics.

| Reference | Number of solvable trials | Success rate in moving on to unsolvable trial | Duration of unsolvable trial | People available for communication | Apparatus | Variables (proxies) |
|---|---|---|---|---|---|---|
| Miklósi et al. (2003) | 6 | 100% | 2 minutes | Caregiver | Bin and rope in a cage | Gaze duration, latency to gaze, frequency of looking back |
| Gaunet, F. (2008) | 6 | 100% | 2 minutes | Caregiver | Bin | Gaze duration, frequency of gaze alternation |
| Marshall-Pescini et al. (2009) | 3 | 100% | 1 minute | Caregiver + experimenter | Wooden board | Frequency of gaze alternation, gaze duration, latency to gaze |
| Miller et al. (2010) | Other | Not applicable | Other | Caregiver + experimenter | Commercial feeder | Duration of touching the apparatus |
| Passacqua et al. (2011) | 3 | 66% | 1 minute | Caregiver + experimenter | Wooden board | Latency to gaze, gaze duration, frequency of gaze alternation |
| Marshall-Pescini et al. (2013) | 3 | 79% | 1 minute | Caregiver + experimenter | Wooden board | Frequency of gaze alternation |
| Passalacqua et al. (2013) | 5 | 84% | 1 minute | Caregiver + experimenter | Wooden board | Gaze duration, latency to gaze, frequency of gaze alternation |
| Smith & Litchfield (2013) | 5 | 86% | 2 minutes | Caregiver | Rope in a cage | Frequency of looking back, frequency of gaze alternation |
| D'Aniello et al. (2015) | 3 | 100% | 1 minute | Caregiver + experimenter | Wooden board | Gaze duration |
| Scandurra et al. (2015) | 3 | 100% | 1 minute | Caregiver + experimenter | Wooden board | Gaze duration, latency to gaze |
| Persson et al. (2015) | 2 | Not applicable | 3 minutes | Experimenter | Plates covered with a lid with simultaneous solvable and unsolvable trials | Gaze duration, latency to gaze, frequency of looking back |
| Konno et al. (2016) | 6 | 100% | 1 minute | Caregiver + experimenter | Wooden board | Gaze duration, latency to gaze |
| D'Aniello & Scandurra (2016) | 3 | 95% | 1 minute | Caregiver + experimenter | Wooden board | Gaze duration, latency to gaze |

| | | | | | | |
|---|---|---|---|---|---|---|
| Piotti et al. (2017) | 3 | Not applicable | 2 minutes | Two experimenters | Bottles, wooden board, commercial feeder | Gaze duration, latency to gaze, frequency of gaze alternation |
| Marshall-Pescini et al. (2017) | 3 | 91% | 3 minutes | Caregiver + experimenter | Wooden board | Gaze duration, latency to gaze, frequency of looking back, frequency of gaze alternation |
| Sanford et al. (2018) | Other | Not applicable | 1 minute | Caregiver + experimenter | Wooden board | Gaze duration |
| Rao et al. (2018) | 0 | Not applicable | Other | None | Commercial feeder | Gaze duration and duration of touching the apparatus |
| Lazzaroni et al. (2019) | 0 | Not applicable | Other | None | Feeder ball and bottle | Duration of touching the apparatus |
| Cavalli et al. (2019) | 3 | 91% | 3 minutes | Caregiver + experimenter | Wooden board | Gaze duration, latency to gaze, frequency of gaze alternation |
| Lazarowski et al. (2019) | 3 | Not applicable | 1 minute | Caregiver + experimenter | Wooden board | Gaze duration, duration of touching the apparatus, frequency of 3-phased gaze alternation |
| Maglieri et al. (2019) | 6 | 77% | 1 minute | Caregiver + experimenter | Wooden board | Gaze duration, latency to gaze |
| Sommese et al. (2019) | 3 | Not applicable | 1 minute | Caregiver + experimenter | Wooden board | Gaze duration, latency to gaze, frequency of looking back, frequency of gaze alternation |
| Carballo et al. (2020) | 3 | 89% | 3 minutes | Two experimenters | Wooden board | Gaze duration, frequency of gaze alternation |
| Lazzaroni et al. (2020) | 3 | Not applicable | Other | None | Wooden board with simultaneous solvable and unsolvable trials | Gaze duration, latency to gaze, frequency of gaze alternation, duration of touching the apparatus |

*Apparatus and procedure*

The apparatus used in the unsolvable task paradigm varied substantially across studies (Figure 1). In Miklósi et al. (2003), dogs and human-socialized wolves were tested in two tasks: opening a bin and pulling a rope. In the bin task, dogs had to open the lid of a 30cm high container after watching a demonstrator do it 10 times. There were six solvable trials before the lid was mechanically fixed. For the rope pulling task, a piece of food attached to a rope was put inside of a wire mesh cage. After an experimenter offered a piece of food through the mesh, the dog was released and could pull the rope to obtain the food six times. In the unsolvable trial, the rope was fixed to the cage. Then, the subject's behavior was recorded for two minutes.

A few years later, in 2008, Gaunet used the bin-opening task, with slight changes in size of the apparatus, to examine the effect of the visual status of the owner in the use of humans' eyes as a cue during human–dog interactions (Figure 1D). The rope-pulling task was replicated by Smith & Litchfield in 2013 to study dingoes (*Canis dingo*), also with slight changes in size of the apparatus (Figure 1A). But the most commonly used version of the task is a small transparent container on top of a wooden board, with the container being fixed to the board in the unsolvable trial (used in 16 out of 24 studies). This has the advantage of turning the task from solvable to unsolvable using the same container (Figure 1E).

With the bin, a different bin has to be pre-prepared with the lid mechanically fixed; with the rope-pulling, the rope has to be attached to the cage, which takes different movements and time. With a container in a wooden board, the lid can be previously fixed in the board; on the solvable trials, the experimenter can position the container on top of the lid without fixing it, and the dog can turn it or push it until it reaches the end of the board, freeing the food. On the unsolvable trial, the experimenter can press the same container against the lid, making it impossible to move with practically the same procedure. As it is a simpler task, it arguably dismisses human demonstrations, allowing the dog to directly learn from trial and error. Other apparatus used are variations of the board with containers, plastic bottles, balls, and commercial dog-feeding toys; although useful, commercial items could make studies harder to replicate, as the same toys are not necessarily available in different countries.

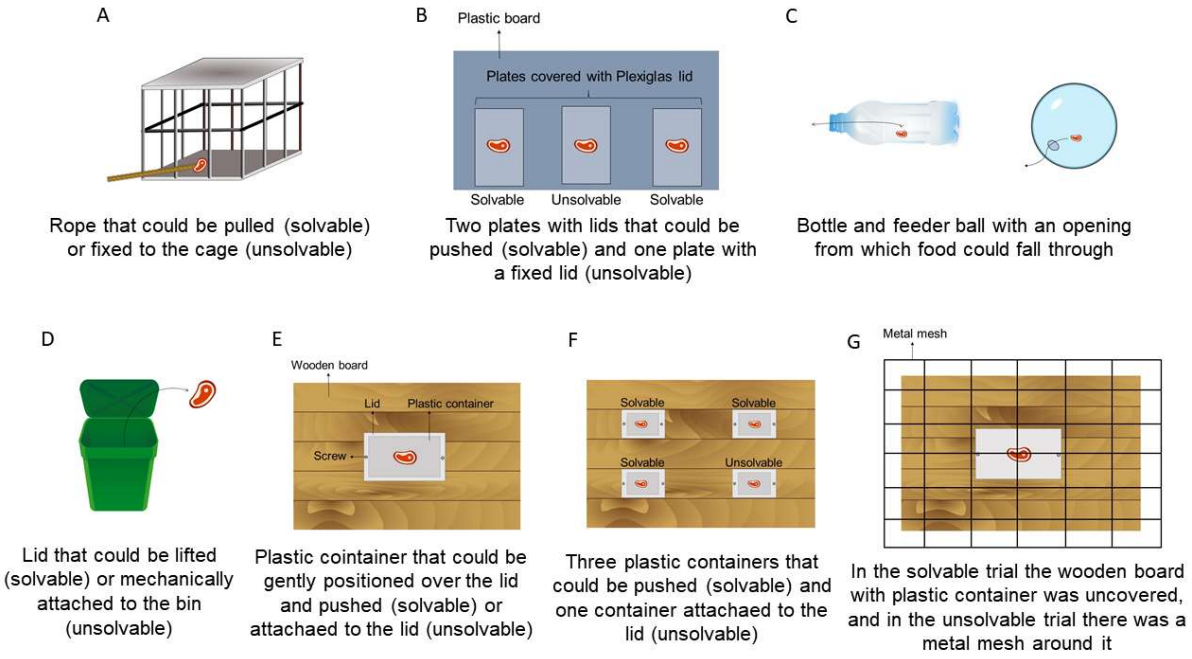


**Figure 1.** Scheme of different types of apparatus used in unsolvable task paradigm. A) a wire mesh cage with a rope attached to it. Used in two studies; B) a plastic board with three lids attached to it. Used in one study; C) a bottle and a feeder ball with an opening. Used in one study; D) bin with a lid. Used in two studies; E) wooden board with a plastic lid attached to it. Used in 16 studies; F) wooden board with three plastic lids attached to it. Used in one study; G) wooden board covered with a plastic lid attached to it and covered by wire mesh. Used in one study. Other experiments not included in the scheme used commercial dog feeders (See Table 1 that described which apparatus was used in each study)

The number of solvable trials presented for dogs also varies. Four studies provided six attempts for dogs to obtain the food before the unsolvable version, but most (13) studies used three solvable trials before the unsolvable trial. Two studies that focused on persistence went directly to the unsolvable task. One study used one solvable trial, and two other used five. In Sanford, Burt, and Meyers-Manor (2018), the number of solvable trials varies as many times as necessary until dogs succeeded three times. In Miller et al. (2010), owners were given the feeding toy and dogs could use it for 20 minutes every day for a week before the experiment. In most studies, it was required at least two successes (the dog getting the food) for dogs to move on to the unsolvable trial. By analyzing the success rate (dogs that go on to the unsolvable trial) we can have a clue about the appropriate number of solvable trials, but it is important to note that many other factors affect these results and were not controlled in those different studies. For instance, younger dogs might need more attempts to

grasp the task, while too many trials can satiate some dogs. The context needs to be taken into consideration to choose the number of trials.

In 15 studies, both the owner (or caregiver in case of non-pet animals) and an unfamiliar experimenter were available for the dog to communicate with. The duration and frequency of gazes towards both were summed up, and which person the dog gazed at first was registered. Variations included two unfamiliar experimenters, just the experimenter or just the owner. In studies assessing persistence, no one person was available for communication. It was not discussed in these studies how the absence of the owner could trigger separation related behaviors and influence results.

Four studies presented the unsolvable task for two minutes (but Smith & Litchfield interrupted earlier in case the subject trashed to release themselves). Twelve studies used only one minute, four studies used three minutes. In four studies, there was no fixed time limit: the trial lasted until the dog stopped interacting with the apparatus for a fixed amount of time (Miller et al., 2010; Rao et al., 2018; Lazzaroni et al., 2020) or left a predefined area (Lazzaroni et al., 2019). Different contexts could influence the duration of the unsolvable trials. When investigating persistence, the task could demand a longer time. On the other hand, when dogs are separated from their owners, the task needs to be shorter to avoid stress in dogs. Practical reasons could also interfere, such as the time available when doing research in shelters or kennels. Therefore, it is important to justify the duration of the trial.

*Variables and operationalizations*

In Miklósi et al. (2003), dogs looked sooner and for longer than wolves when the task became impossible, leading the authors to conclude dogs had a lower degree of attraction to the food, as they were more likely to interrupt their efforts to obtain it. As for the wolves, it was argued that they were less prone to look at humans, even when socialized, while dogs would have a predisposition to look back at humans. In that discussion, we can point out two different variables: attraction to food as a reward and the gaze at humans.

When Gaunet (2008) compared pet dogs of sighted owners with guide dogs of blind owners, no difference in gazing behaviors was found between groups, which led the author to conclude that dogs did not understand their owners' visual status. Furthermore, since the first interactive modality was gazing in both groups, it was discussed that gazing would be the key factor in human-dog communication, especially in help-seeking behaviors. It can be argued, then, that this was the first study to use the unsolvable task to explicitly discuss help-seeking.

In total, 17 studies explicitly mentioned using the task in a communicative context, and were used to investigate how communication would be affected by factors such as age, breed, specific training and experiences, anxiety, evolution, genetic differences, perception of human characteristics and even self-control. Among them, 13 considered the gazing behaviors in the task as help-seeking or requesting behavior. And, in 2018, Sanford, Burt, Meyers-Manor suggested that dogs that gazed at their owners for longer would have a stronger bond with them, therefore the gazing was interpreted as a measure of closeness.

As for persistence, Hall (2017) mentioned the use of the unsolvable task in a review of persistence in dogs, describing it as "another rapid way to measure persistence in the dog, and allows for the observation of alternative behaviors that occur when a previously reinforced response is placed on extinction". The author additionally discussed the importance of persistence in Miklósi et al. (2003)'s experiment, where it was not explicitly taken into consideration, and pointed out that perhaps dogs were more likely to turn to different food-obtaining behaviors that could have been more reinforced in throughout their lives (i.e: gazing at humans) than persisting is the task.

Since then, other researchers have used the unsolvable task to primarily evaluate persistence. Rao et al. (2018) tested equally raised dogs and wolves at the task using only the unsolvable part and in the absence of humans, aiming to assess the effect of motivational drive in the performance. Even though turning to humans was not an option in this study, dogs persisted less than wolves in the task. The authors discuss that these differences might be related to the species socioecology, pointing out that dogs evolved in a scavenging near human context, and wolves are hunters with low hunting success rate, which would favor the selection of higher persistence. Using the same methodology, Lazzaroni et al. (2019) compared the persistence of free-ranging dogs, pet dogs and captive pack dogs, and found that pet and captive dogs manipulated the apparatus for longer than free-ranging dogs. The authors suggest that previous human-mediated experiences in manipulating objects may have led to increased motivation in pet dogs and captive dogs to engage at the task even in the absence of humans. In both studies, the main variable used to assess persistence was duration of touching the apparatus.

Considering that the effect of persistence on task performance is often unmentioned and these inconsistencies in interpretation of gaze as a communicative behavior, Lazzaroni et al. (2020) proposed to test whether dogs' looking back at the humans is indeed a social problem-solving strategy. They presented pet dogs and free-ranging dogs with an apparatus containing simultaneously the solvable and unsolvable task: four containers were attached to a wooden board, three of them possible to move, giving access to the food, and the other one fixed. Dogs could be tested in four conditions: alone, with a human, with an object and with human-imitating dummy. In the human condition, the person was looking at the phone. No differences were found between groups and conditions regarding persistence or latency to look back. However, pet dogs alternated looks more often and gazed for a longer period at humans than at objects. In the human condition, there were no differences between pet dogs and free-ranging dogs concerning gaze alternation.

Firstly, it is important to point out that Lazzaroni and collaborators' study employs considerable modifications in the methodology, such as the apparatus with simultaneous solvable and unsolvable tasks and the fact that, when present, the experimenter was looking at her phone, when in previous studies the experimenter looked straight ahead or back at the dog. A person's inattentiveness has been shown to decrease communicative attempts (Marshall-Pescini et al., 2013). Since one of the

aims was to assess whether the looking behavior in the task is communicative, it seems not appropriate that the communication itself would be inhibited by an inattentive receptor of dogs' messages. Additionally, these changes may impair comparison with previous experiments. For instance, dogs could approach the impossible bowl at first, or open one, two or three others at first, which could arguably affect their persistence in the unsolvable bowl and willingness to communicate. The use of a human-imitating dummy (Han Solo figure) could also incite a conflict or curiosity in dogs, leading to higher durations of gaze for information assessment, which would impair comparisons with the social condition.

That authors argue that, since dogs' persistence to interact with the apparatus was the same when there was a person available compared to when there was not, their subsequent looking back behavior is a consequence of giving up rather than a request for help. And, as there was also no difference in latency to gaze, that this is more related to subject's persistence than to communication. However, reduced persistence in the face of an observer is not an indication of referential communication; dogs' persistence could be the same with or without a potential helper, but it is their behavior *after* "giving up" that contains indications of communicative intent or not.

Common indicators of referential behavior are I) an audience is required to exhibit the signal; II) there are successive gaze alternations between the recipient and the object of interest; III) the sender displays apparent attention-getting behaviors; IV) there is an influence of the recipient's attentional status; V) there is persistence and VI) elaboration of communication when previous attempts fail (Savalli, Ades & Gaunet, 2014).

In fact, in Lazzaroni et al. (2020) 's study, pet dogs did alternate more looks and gazed for longer at humans than at objects, which would be an indicative of these behaviors meeting the first indicator. Other indicators cannot be assessed through the data displayed in this study. However, a review of other studies can help bring that into light: in Marshall-Pescini et al. (2013), the authors showed that dogs used less gaze alternation when the person was inattentive (fourth indicator) and concluded that it is an intentional and referential behavior. In Marshall-Pescini et al. (2009), search and rescue dogs (who have a positive reinforcement history with barking) barked in the unsolvable trial, always concurrently gazing at the experimenter or apparatus, which can be considered an attention getting behavior (third indicator) and an elaboration of communication (sixth indicator). Numerous studies show gaze alternation between the

apparatus and the human, meeting the second criteria (Gaunet, 2008; Passalcqua et al., 2011; Piotti et al., 2017; Marshall-Pescini et al., 2017; Cavalli et al., 2019; Lazarowski et al., 2019; Sommese et al., 2019; Carballo et al., 2019).

Smith and Litchfield (2013) had previously pointed out the lack of operationalization and clarity of "looking back" in the unsolvable task affects the results and interpretations. They argue that descriptions of the behavior are too diverse and lack details, which may lead to the account of non-referential looking back. When testing dingoes (*Canis dingo*) in the unsolvable task and using the definition in Miklósi's seminal work (2003), which was "turning its head to its side with its head/nose oriented towards any part of the caretaker", eight out of the 12 dingoes looked back. But they proceeded to point out that this behavior happened often when the subject was not looking or interacting with the apparatus, which would be non-referential and likely part of the process of gathering information, or when the dingo was struggling to free itself from the leash, which would be related to escaping behavior. After considering "looking back" only in context of interacting with the task and in the sequence task-person or vice versa, three dingoes used this "referential looking back".

In agreement with Smith and Litchfield and other authors (Passalacqua et al., 2011), we argue that "referential looking back" with the sequence of target-human or human-target and within a specific time frame (usually 2 seconds) is the most appropriate measure of communicative behavior in this context. This behavioral sequence is also commonly called "gaze alternation", which may cause confusion with Merola, Prato-Previde & Marshall-Pescini (2012)'s definitions. In that work, authors called this two-steps sequence "referential gazing" while the "gaze alternation" referred to a three-steps sequence: target-human-target or human-target-human. We argue that the two-step process is enough to account for referential communication since it already promotes the triangulation among communicator, receptor, and referent. Nonetheless, whichever authors choose to use, it should be clearly specified. A standardized operationalization would benefit our understanding of communicative behaviors, facilitating comparisons and meta-analyzes of the results. At this point, a diverse kind of methodology did not assure that studies are comparable. Additionally, we echo Smith & Litchfield (2013)'s note of the advantages of studies providing raw scores.

In addition to different definitions of "looking back" being used, sometimes different variables are employed to account for communication. In fact, 11 out of 24

studies used two-steps referential looking back (target-human or human target; described in Table 1 as “frequency of gaze alternation”) and one used three-phases referential looking back (target-human-target or human-target-human; described in Table 1 as “frequency of 3-phased gaze alternation”). The other half used non-referential looking back (described in table 1 as “frequency of looking back”), gaze at human duration and latency to first look. Although informative and complementary, we propose that duration and latency should not be the main focus of the analyzes, as they are not shown to be necessarily communicative. If latency is related to time manipulating the apparatus, which needs more investigations, as it happens in Marshall-Pescini et al. (2017) and Lazzaroni et al. (2020) but not in Konno et al. (2016), perhaps it is indeed more appropriate to discuss persistence. It is additionally important to point out that latency could be described for first gaze, as it happens in all studies in this review, or latency to first *gaze alternation*. If the first gaze is associated with looking at the most salient stimulus or to gathering information, perhaps latency to first alternation can be more indicative of time elapsed before an attempt to communicate. As for the duration of gazing at human, it could be related to attraction to the human face, as discussed by Miklósi in 2003, and/or to the process of gathering information, as Smith & Litchfied propose.

**Future perspectives**

In sum, the unsolvable task has been shown to be a useful tool in the investigation of dogs' cognitive and communicative behavior, with enough evidence to characterize it as communicational when employing appropriate variables. A more precise operationalization of “looking back”, as proposed since 2013 by Smith & Litchfield, and standardization of methodological procedures for this paradigm would provide more comparable results and consequently contribute even further to our understanding of dogs’ behavior, ontogeny, domestication process and their relationship with humans.

We proposed some forms of standardization based on the available data, but perhaps a meta-analysis using raw scores (not currently available for most studies) or a specific research testing the effect of methodological variations could offer more robust arguments for the use of each choice. Additionally, it is important to notice that

the most appropriate methods depend on each research question. Therefore, it is important that authors elucidate why they are using variations when doing so.

**References**

Agnetta, B., Hare, B., & Tomasello, M. (2000). Cues to food location that domestic dogs (Canis familiaris) of different ages do and do not use. *Animal Cognition*, *3*(2), 107–112. doi: 10.1007/s100710000070

Albuquerque, N., Guo, K., Wilkinson, A., Resende, B., & Mills, D. S. (2018). Mouth-licking by dogs as a response to emotional stimuli. Behavioural Processes, 146, 42-45. doi:10.1016/j.beproc.2017.11.006

Barrera, G., Mustaca, A., & Bentosela, M. (2011). Communication between domestic dogs and humans: Effects of shelter housing upon the gaze to the human. Animal Cognition, 14(5), 727-734. doi:10.1007/s10071-011-0407-4

Carballo, F., Cavalli, C., Martínez, M., Dzik, V., & Bentosela, M. (2020). Asking for help: Do dogs take into account prior experiences with people? Learning & Behavior. doi:10.3758/s13420-020-00425-6

Cavalli, C., Carballo, F., Dzik, M. V., & Bentosela, M. (2019). Gazing as a help requesting behavior: A comparison of dogs participating in animal-assisted interventions and pet dogs. Animal Cognition, 23(1), 141-147. doi:10.1007/s10071-019-01324-8

D'Aniello, B., Scandurra, A., Prato-Previde, E., & Valsecchi, P. (2015). Gazing toward humans: A study on water rescue dogs using the impossible task paradigm. Behavioural Processes, 110, 68-73. doi:10.1016/j.beproc.2014.09.022

D'Aniello, B., & Scandurra, A. (2016). Ontogenetic effects on gazing behaviour: A case study of kennel dogs (Labrador Retrievers) in the impossible task paradigm. Animal Cognition, 19(3), 565-570. doi:10.1007/s10071-016-0958-5

Gaunet, F. (2008). How do guide dogs of blind owners and pet dogs of sighted owners (Canis familiaris) ask their owners for food? Animal Cognition, 11(3), 475-483. doi:10.1007/s10071-008-0138-3

Hare, B. (2002). The Domestication of Social Cognition in Dogs. *Science*, *298*(5598), 1634–1636. doi: 10.1126/science.1072702

Konno, A., Romero, T., Inoue-Murayama, M., Saito, A., & Hasegawa, T. (2016). Dog Breed Differences in Visual Communication with Humans. Plos One, 11(10). doi:10.1371/journal.pone.0164760

Lazarowski, L., Strassberg, L. R., Waggoner, L. P., & Katz, J. S. (2019). Persistence and human-directed behavior in detection dogs: Ontogenetic development and relationships to working dog success. Applied Animal Behaviour Science, 220, 104860. doi:10.1016/j.applanim.2019.104860

Lazzaroni, M., Range, F., Bernasconi, L., Darc, L., Holtsch, M., Massimei, R., … Marshall-Pescini, S. (2019). The role of life experience in affecting persistence: A comparative study between free-ranging dogs, pet dogs and captive pack dogs. Plos One, 14(4). https://doi.org/10.1371/journal.pone.0214806

Lazzaroni, M., Marshall-Pescini, S., Manzenreiter, H., Gosch, S., Přibilová, L., Darc, L., . . . Range, F. (2020). Why do dogs look back at the human in an impossible task? Looking back

behaviour may be over-interpreted. Animal Cognition, 23(3), 427-441. doi:10.1007/s10071-020-01345-8

Maglieri, V., Prato-Previde, E., Tommasi, E., & Palagi, E. (2019). Wolf-like or dog-like? A comparison of gazing behaviour across three dog breeds tested in their familiar environments. Royal Society Open Science, 6(9), 190946. https://doi.org/10.1098/rsos.190946

Marshall-Pescini, S., Passalacqua, C., Barnard, S., Valsecchi, P., & Prato-Previde, E. (2009). Agility and search and rescue training differently affects pet dogs' behaviour in socio-cognitive tasks. Behavioural Processes, 81(3), 416-422. doi:10.1016/j.beproc.2009.03.015

Marshall-Pescini, S., Colombo, E., Passalacqua, C., Merola, I., & Prato-Previde, E. (2013). Gaze alternation in dogs and toddlers in an unsolvable task: Evidence of an audience effect. Animal Cognition, 16(6), 933-943. doi:10.1007/s10071-013-0627-x

Marshall-Pescini, S., Rao, A., Virányi, Z., & Range, F. (2017). The role of domestication and experience in 'looking back' towards humans in an unsolvable task. *Scientific Reports*, *7*(1). doi: 10.1038/srep46636

Miklósi, A., Polgárdi, R., Topál, J., & Csányi, V. (2000). Intentional behaviour in dog-human communication: An experimental analysis of "showing" behaviour in the dog. Animal Cognition, 3(3), 159-166. doi:10.1007/s100710000072

Miklósi, Á, Kubinyi, E., Topál, J., Gácsi, M., Virányi, Z., & Csányi, V. (2003). A Simple Reason for a Big Difference: Wolves do not Look Back, but Dogs do. Current Biology, 13(9), 763-766. doi:10.1016/s0960-9822(03)00263-x

Miklósi, Á., & Soproni, K. (2006). A comparative analysis of animals understanding of the human pointing gesture. *Animal Cognition*, *9*(2), 81–93. doi: 10.1007/s10071-005-0008-1

Miller, H. C., Pattison, K. F., Dewall, C. N., Rayburn-Reeves, R., & Zentall, T. R. (2010). Self-Control Without a "Self"? Psychological Science, 21(4), 534–538. https://doi.org/10.1177/0956797610364968

Merola, I., Prato-Previde, E., & Marshall-Pescini, S. (2012). Social referencing in dog-owner dyads? Animal Cognition, 15(2), 175–185. https://doi.org/10.1007/s10071-011-0443-0

Moher, D. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. Annals of Internal Medicine, 151(4), 264. https://doi.org/10.7326/0003-4819-151-4-200908180-00135

Reid, P. J. (2009). Adapting to the human world: Dogs' responsiveness to our social cues. *Behavioural Processes*, *80*(3), 325–333. doi: 10.1016/j.beproc.2008.11.002

Passalacqua, C., Marshall-Pescini, S., Barnard, S., Lakatos, G., Valsecchi, P., & Previde, E. P. (2011). Human-directed gazing behaviour in puppies and adult dogs, Canis lupus familiaris. Animal Behaviour, 82(5), 1043-1050. doi:10.1016/j.anbehav.2011.07.039

Passalacqua, C., Marshall-Pescini, S., Merola, I., Palestrini, C., & Previde, E. P. (2013). Different problem-solving strategies in dogs diagnosed with anxiety-related disorders and control dogs in an unsolvable task paradigm. Applied Animal Behaviour Science, 147(1-2), 139–148. https://doi.org/10.1016/j.applanim.2013.05.003

Persson, M. E., Roth, L. S. V., Johnsson, M., Wright, D., & Jensen, P. (2015). Human-directed social behaviour in dogs shows significant heritability. Genes, Brain and Behavior, 14(4), 337–344. https://doi.org/10.1111/gbb.12194

Piotti, P., Spooner, R. M., Jim, H.-L., & Kaminski, J. (2017). Who to ask for help? Do dogs form an opinion on humans based on skilfulness? Applied Animal Behaviour Science, 195, 93–102. https://doi.org/10.1016/j.applanim.2017.05.024

Rao, A., Bernasconi, L., Lazzaroni, M., Marshall-Pescini, S., & Range, F. (2018). Differences in persistence between dogs and wolves in an unsolvable task in the absence of humans. PeerJ, 6. https://doi.org/10.7717/peerj.5944

Sanford, E. M., Burt, E. R., & Meyers-Manor, J. E. (2018). Timmy's in the well: Empathy and prosocial helping in dogs. Learning & Behavior, 46(4), 374–386. https://doi.org/10.3758/s13420-018-0332-3

Savalli, C., Ades, C., & Gaunet, F. (2014). Are Dogs Able to Communicate with Their Owners about a Desirable Food in a Referential and Intentional Way? PLoS ONE, 9(9). doi:10.1371/journal.pone.0108003

Savalli, C., Resende, B., & Gaunet, F. (2016). Eye Contact Is Crucial for Referential Communication in Pet Dogs. Plos One, 11(9). doi:10.1371/journal.pone.0162161

Scandurra, A., Prato-Previde, E., Valsecchi, P., Aria, M., & D'Aniello, B. (2015). Guide dogs as a model for investigating the effect of life experience and training on gazing behaviour. Animal Cognition, 18(4), 937–944. https://doi.org/10.1007/s10071-015-0864-2

Smith, B. P., & Litchfield, C. A. (2013). Looking back at 'looking back': operationalising referential gaze for dingoes in an unsolvable task. Animal Cognition, 16(6), 961–971. https://doi.org/10.1007/s10071-013-0629-8

Sommese, A., Nováková, K., Šebková, N. F., & Bartoš, L. (2019). A wolfdog point of view on the impossible task paradigm. Animal Cognition, 22(6), 1073–1083. https://doi.org/10.1007/s10071-019-01298-7

## Chapter 3

### Effect of different experiences with humans in dogs' visual communication

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**Abstract**

Dogs are particularly skillful in communicating with humans, and growing evidence points towards the importance of both our interchained evolutionary history and our intense daily partnership. Gaze alternation is a behavior used by dogs to draw a person's attention and indicate the location of a desired object. This behavior is used by dogs from a very young age and is affected by factors such as aging, experience, and training throughout their development. In this study we evaluated how different degrees of daily human interaction affect dogs' gazing behavior in the unsolvable task. In the presence of their caregiver and an experimenter, the dog learned to turn over a recipient to obtain a piece of food. After three trials, the recipient was locked, and the food became impossible to access. Three groups with different degrees of daily interactions with humans were compared: pet dogs that live inside the house, pet dogs that live outside of the house, and shelter dogs. We found no difference in latency to first gaze, but pet dogs did show a higher proportion of individuals engaging in gaze alternation, a higher number of gaze alternations and a longer duration of gazing than shelter dogs. Additionally, dogs living inside the house gazed more at the experimenter than dogs living outside the house. Overall, our results indicate a strong influence of experience in the development and use of these communicative behaviors in dogs, with groups that have more experiences with people in their daily lives being more willing to communicate with humans as a strategy to obtain a desired goal.

## Introduction

Dogs' (*Canis familiaris)* evolutionary history is interchained with that of humans for at least 15,000 years (Parker, 2012), with some authors estimating that it could be up to 35,000 years (Frantz et al., 2016). Even though 70% of the world's dog population is constituted by village and feral dogs (Hughes & Macdonald, 2013), a great number of them live out their daily lives next to humans from a very young age. In 2013, 44,3% of homes in Brazil had at least one dog (IBGE).

Dogs seem to be particularly skillful in communicating with humans, understanding human communicative gestures such as pointing and gazing (Agnetta, Hare & Tomasello., 2000; Miklósi & Soproni, 2006; Reid, 2009). Some authors suggest that these communicative skills are a result of the domestication process, as dogs that could better obtain information from humans would be able to take more advantage of this partnership. This domestication hypothesis would lead to the predictions that dogs would outperform wolves (*Canis lupus*), the species phylogenetically closest to them, in tasks involving human communication, and that dog pups with little experience would present these skills (Hare, 2002). These authors found evidence that dogs have a higher rate of success than wolves in an object choice task, where food was hidden in one of two containers and a human cue, such as pointing or gazing, was provided toward the correct one. Additionally, studies have shown that dog pups are able to follow human communicative cues from a very young age: 6 weeks in Riedel et al. (2008)'s research and 9 weeks in Hare (2002)'s. Agnetta, Hare & Tomasello. (2000) demonstrated that dogs at four months are as skillful as adults in an object choice task.

At the same time, other studies have put into perspective the importance of life experiences and contact with humans regarding dogs' socio-cognitive abilities. For example, in a study where dogs and wolves with prolonged contact with humans were tested in more similar conditions, wolves outperformed dogs in comprehending human pointing (Udell, Dorey & Wynne, 2008). The authors thus discuss that domestication is not a prerequisite to human directed communication skills. Furthermore, a re-analysis of data from Riedel et al. (2008) showed that, although 6-weeks puppies could already follow the human pointing gesture, there was a significant learning effect during development and improvement during trials, suggesting a strong learning effect (Wynne, Udell & Lord, 2008). D'Aniello and collaborators found, in 2017, that dogs that were born and raised in a kennel with limited human interaction did not understand

human pointing gestures, while pet dogs matched for breed, sex and age did. These studies show the role of rearing and experience, which we need to further investigate to understand dogs' social-cognitive skills.

In addition to comprehension of human communicative signals, evidence suggests that dogs actively emit communicative signals to engage with us (Savalli, Ades & Gaunet, 2014; Albuquerque et al., 2018; Miklósi et al., 2003; Gaunet, 2008). For instance, Worsley & O'Hara (2018) analyzed video recordings of pet dogs in their homes, interacting in spontaneous situations recorded by the owners, and found 19 referential gestures being used by dogs in communicative bouts in the dyads. Among many communicative behaviors that dogs use, human-directed gazing and gaze alternation are particularly important. Dogs alternate gaze between a desired object and an available person (Miklósi, 2000), and are dependent on their owner's visual availability to produce communicative signals (Savalli, Resende & Gaunet, 2016). Therefore, gazing triggers and facilitates dog-human communication. For instance, Miklósi et al. (2003) showed that dogs gazed for a longer period and alternated looks between humans and an unreachable food more often than did human-socialized wolves. The authors discuss that maintaining communicative interactions with humans is more relevant to dogs' socioecology, thus positive feedback would have improved their readiness to look at the human face. Upon finding similar results that dogs spend more time looking at humans than socialized wolves in the presence of food, Bentosela et al. (2016) proposed that both species can produce communicative responses toward humans, but with differences in duration and degree of those behaviors.

Many studies investigate factors that affect human-directed gazing. Older dogs seem to use it more often than pups (Passalacqua, 2011; Lazarowski et al., 2019); agility and search and rescue dogs, that are intensively stimulated, use it more than untrained dogs (Marshall-Pescini et al, 2009; D'Aniello et al., 2015), as well as dogs participating in animal-assisted interventions (Cavalli et al., 2019); breed groups seem to have an influence, with ancient breeds gazing at humans less than other groups (Konno et al., 2016). The attentional status of the audience also has an influence, with dogs using more communicative behaviors when people are visually available to them (Marshall-Pescini et al., 2013; Savalli et al., 2014), and it can be quickly established and extinguished through associative learning (Barrera, Mustaca & Bentosela, 2011).

When it comes to the effects of experience with humans, there is some heterogeneous evidence. In Barrera et al.'s (2011) experiment, pet dogs and shelter

dogs took the same amount of time in acquisition of gazing, but the extinction of the behavior was faster for shelter dogs. The continued and prolonged experiences in daily life of pet dogs with their owners could have entailed more consistent communicative behaviors. D'Aniello & Scandurra (2016) found that kennel dogs took longer and spent less time looking at a person than did pet dogs; Marshall-Pescini et al. (2017), on the other hand, found that pet dogs, bottle-fed dogs and free-ranging dogs behaved similarly regarding their gaze alternation in the presence of a desired food and a human. Carballo et al. (2020) showed that dogs gaze for longer at a person they stablished as generous in comparison to a selfish one, which the authors discuss shows that dogs use information from previous experience to communicate. More research is needed to understand the effect of experience and of dogs' different relationships with humans in their development and use of communicative skills.

This study aims at identifying whether differences in the amount of time spent with humans on a daily basis influence dogs' human-directed gazing behavior in an unreachable food situation, comparing pet dogs that live inside the house, pet dogs that live outside the house and shelter dogs. As dogs seek visual communication with humans from a very early age and improve this behavior as they age and have more opportunities for associative learning, we hypothesized that the more time dogs are around people, the more they would use human-directed gazing. It was predicted that dogs that spend more hours with humans daily would take less time to initiate visual communication, spend more time gazing at humans and alternate looks between the desired object and people more often.

## Methods

### *Subjects' selection*

In order to study different degrees of time spent with humans, three experimental groups were defined: 1) Pet dogs living inside the house; 2) Pet dogs living outside the house (in the yard, garden, or garage), and 3) Shelter dogs.

Dogs living in shelters are around their caregivers solely when being fed, cleaned, or receiving health care, thus spending few minutes alongside humans in their daily lives. Dogs living outside the house, despite being pet dogs, have less opportunities to interact and spend less time with their owners than dogs living inside the house.

Subjects were recruited from the Dog's Laboratory database of Psychology Institute – University of São Paulo, posts in social media and flyers around the University. Shelter dogs were recruited through a partnership with the non-governmental organization "Casa da Passagem São Lázaro" (Adote um Focinho), under the legal register nº 08.133.246/0001-43.

In order to be included, dogs had to be between one and 10 years old, have been living with their current owners for at least one year (for the pet dogs), be comfortable around new people and in new places, and to be motivated by food. Additionally, pet dogs could not have had formal training classes or ever worked as therapy dogs, as these characteristics could influence gazing behavior (Cavalli et al., 2019).

To ensure all participants met the requirements for this study, owners filled out an online form regarding their dogs. The following question addressed whether dogs lived inside or outside the house: "Does your dog spend more time inside or outside the house (yard, garden, garage)?" and possible answers were: "1) Exclusively inside the house; 2) Mostly inside the house, but also goes outside in some situations; 3) Moves freely between inside and outside the house; 4) Exclusively outside the house; 5) Mostly outside the house, but also goes inside in some situations; 6) Non-applicable (I live in an apartment)"

Owners who answered 1 or 6 were automatically in the group "living inside", the ones who answered 4 were in the group "living outside", and those who answered 3 were excluded. Owners who answered 2 or 5 were further questioned regarding how

often and in which situations the dog moved between different parts of the house, and were included according to the researchers' criteria (for example: dogs that lived in the yard but were allowed inside during heavy storms were included in the "outside" groups). The complete questionnaire can be found in the supplementary materials.

*Subjects*

Sixty dogs were included in the analysis, of both sexes (30 males and 30 females), from various breeds and ranging from one to nine years old.

Thirty-four dogs were originally tested in the group of pet dogs living inside the house (henceforth called "inside group"). Eleven dogs were excluded from analysis: seven of them did not pass on to the experimental trial (described below) and four stayed out of the camera framing for more than 10% of the total time and were excluded. Twenty-five dogs living outside the house (henceforth called "outside group") were tested, from which two did not pass on the experimental trial, two stayed out of framing and one was excluded because the owner interacted with the dog during the experiment. Forty-three shelter dogs were tested, out of which 20 did not pass on to the experimental trial, one stayed out of framing and five were excluded due to interruptions during the experiment. Therefore, the analysis included 23 inside dogs, 20 outside dogs and 17 shelter dogs.

*Experimental set up and apparatus*

Pet dogs were tested in the Dogs' Laboratory of the Institute of Psychology Institute - University of São Paulo. To ensure the dogs were comfortable, shelter dogs were tested at the shelter, but outside of their living space. The experiment was set up in a balcony of similar proportions to the Dog's Laboratory, which was surrounded by a low wall (Figure 1).

The apparatus consisted of a wooden board (60cm x 35cm) with a transparent plastic container lid screwed on to it. The recipient could be positioned on the lid in a manner that it could be turned over, or it could be attached to the lid and be impossible to move.

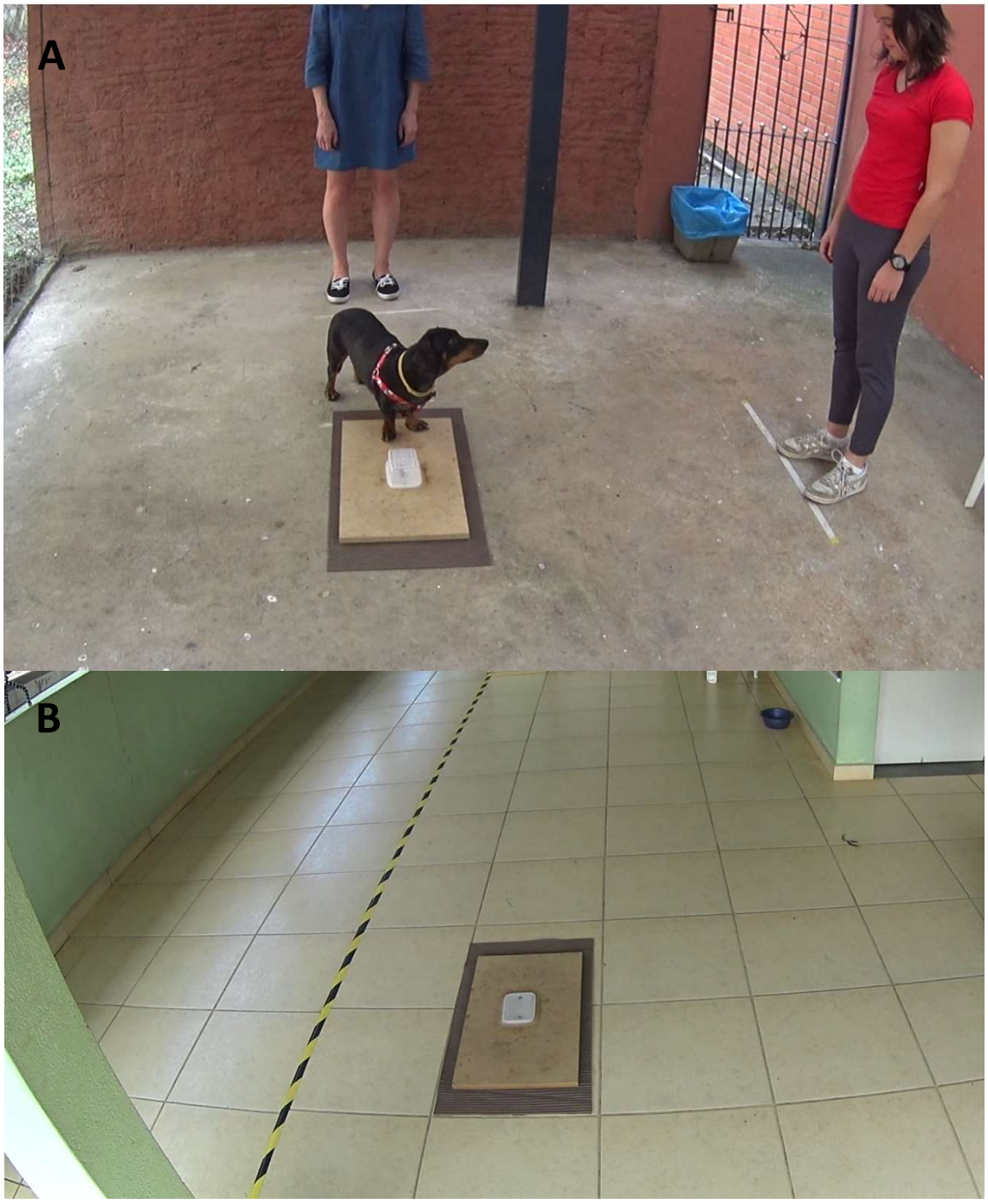



**Figure 1** Experimental area and set up for pet dogs (A) and experimental area for shelter dogs (B).

*Procedure*

Prior to the experiment there was a habituation phase where dogs could freely explore the place, which helped ensure they were comfortable and less interested in stimuli from the environment during the test. This phase took between 10 and 20 minutes and stopped when the experimenter judged that dogs were comfortable based on the absence of stress behaviors (Mariti et al., 2012); meanwhile, owners received the instructions and signed the consent term.

*Solvable trials*: To start off the experiment, both the experimenter and the owner (or caregiver in shelter group) positioned themselves 60cm from the apparatus. Each position had been previously randomized across the trials. The owner held the dog with assistance of the harness or collar when necessary. The experimenter called the dog by his/her name and showed a piece of food. The food was then put on the lid and covered by the plastic recipient (without locking it), and then the owner was instructed to release the dog. When the subject managed to turn the recipient over and eat the food the trial was finished, the owner held the dog while the experimenter took the next piece of food and switched places (if necessary). If the dog did not manage to obtain the food, the trial lasted a maximum of 1 minute, and then the owner held the dog while the experimenter and owner switched places (if necessary). This procedure was repeated a total of three times and were called solvable trials.

*Unsolvable trial*: In the fourth trial, which was immediately after the last solvable trial, the same procedure was performed, but the recipient was attached to the lid and became impossible to move. The owner and the experimenter both stood up without interacting with the dogs, but they were visually available to make eye contact in case the dog looked at them.

In order to take part in the unsolvable trial, dogs had to successfully get the food in at least two out of three solvable trials. Dogs that did not meet this criterion were excluded from analysis.

The experiment was recorded with two cameras: *Sony HDR-AS200V* and *Samsung HMX-Q10*.

*Data Analysis*

The video recordings were analyzed using the Solomon Coder (beta 09.08.02, copyright 2006–2019 by András Péter, developed at ELTE TTK Department of Ethology, Budapest, Hungary). Behaviors scored were presented in Table 1.

**Table 1** Ethogram of main analyzed behaviors. The caregiver is the owner in the case of pet dogs and a shelter employee in case of shelter dogs.

| Behavior | Description | Type |
|---|---|---|
| Gazing at caregiver | The dog's head and nose were oriented towards the caregiver's face | Duration |
| Gazing at experimenter | The dog's head and nose were oriented towards the experimenter's face | Duration |
| Gazing at the recipient | The dog's head and nose were oriented towards the recipient | Duration |
| Touching the recipient | The dog touches the recipient with its snout or paw | Duration |
| Gaze alternation (caregiver-recipient) | Gaze at the caregiver's face followed by gaze at the food (or vice-versa) within 2 seconds | Frequency |
| Gaze alternation (experimenter-recipient) | Gaze at the owner's face followed by gaze at the food (or vice-versa) within 2 seconds | Frequency |
| Total gaze alternation | Gaze at the either human's face followed by gaze at the food (or vice-versa) within 2 seconds | Frequency |

The latency of first gaze alternation between the recipient and a human (caregiver or experimenter) in seconds was registered as well.

*Statistical Analysis*

Behaviors related to the number of gaze alternations (counts variables) were analyzed with a Negative Binomial Generalized Linear Model (GLM) with an identity link. At first models with group effect and dogs' sex, breed (mixed breed or purebred), size (small, medium, or large) and age were run. Since demographic and morphological variables were not associated with behaviors related to gaze alternation, final models including just group effect were adjusted to compare the three groups.

Behaviors related to the duration of gazes towards the caregiver, experimenter or recipient were analyzed through a Gamma Generalized Linear Model (GLM) with a logarithm link, given the strong asymmetry that these variables presented. Gamma is a distribution for continue positive variables; therefore, it does not allow zero outcomes. This model was applied for duration of gazes towards experimenter, recipient, and total gaze towards human (caregiver + experimenter) which presented a small quantity of zeros. On the other hand, the duration of gaze towards the caregiver presented a large number of zeros, and then it was used a Zero-Inflated Gamma (ZIG) Model, which is a two-part model. The first part analyzes the probability that an outcome is a non-zero, and the second part analyzes the positive outcomes by using the Gamma distribution. All models were run at first with group effect and dogs' sex, breed, size, and age. Since demographic and morphological variables were also not associated with behaviors related to duration of gazes, final models including just group effect were adjusted to compare the three groups. The duration of touching the apparatus was analyzed through a Kruskal-Wallis test.

Finally, the statistical analysis for latency of first gaze alternation and latency of touching the apparatus were performed by estimating the probability of initiating the gaze alternation across the time through the Kaplan-Meier method, and curves were compared using Log-Rank Test.

The SAS software, version 9.2 (SAS Institute Inc., Cary, NC, USA) was used for all statistical analyzes and a 5% significance level was considered. A second naïve observer independently coded 22% of the sample (chosen randomly) and Kendall's concordance coefficient (W) was used. Inter-observer agreement was assessed for the following variables: gazing at experimenter (W=0.90), gazing at recipient (W=0.86), gaze alternation between the owner and the recipient (W=0.69), total gazing alternation between human and recipient (W=0.95) and the latency of first gaze alternation between a human and recipient (W=0.73). Therefore, results indicated a good or acceptable agreement between raters.

*Ethical Aspects*

This research was approved by the Animal Research Ethics Committee of The Institute of Psychology of University of São Paulo (CEUA/IPUSP nº 6288200818) and

with the current Brazilian laws on ethical standards, as well as with the rules issued by the National Council for Control on Animal Experimentation (CONCEA).

## Results

There was a significant difference among the three groups regarding the proportion of dogs that alternated gazes between the unreachable food and a human (caregiver or experimenter) ($p = 0.0267$; Fisher test): 95.7% of dogs living inside the house used gaze alternation at least once, compared to 80% of dogs living outside the house and 58.8% of shelter dogs (figure 2).


**Figure 2** Proportion of dogs that alternated gaze between human and recipient at least once according the group.

For the total number of gaze alternation (between recipient and humans), gaze alternation between recipient and caregiver, as well as between recipient and experimenter, there were no effect of dogs' sex, breed, size, or age ($p>0.05$). For these variables final models including only group effect were, then, adjusted to compare the three groups.

For the total number of gaze alternation (caregiver + experimenter), the three groups were significant different (Wald=13.26, df=2, p=0.0013). When comparing inside dogs with outside dogs, the difference was not significant at a 5% significance

level (Wald=2.79, df=1, p=0.0948), same as when comparing outside dogs and shelter dogs (Wald=3.81, df=1, p=0.0511). However, the difference between inside dogs and shelter dogs was significant (Wald=12.29, df=1, p=0.0005), as well as the difference between pet dogs (by grouping of inside and outside dogs) and shelter dogs (Wald=12.07, df=1, p=0.0005). It is relevant to report that for each group the mean number of total gaze alternation was significantly greater than zero ($p<0.0001$) for inside and outside groups, and p=0.0001 for shelter group), see Figure 3A.

Regarding gaze alternation between the recipient and caregiver, the three groups were also significantly different (Wald=15.59, df=2, p=0.0004). The difference between outside dogs and shelter dogs was significantly different (Wald=6.89, df=1, p=0.0087), as well as between pet dogs and shelter dogs (Wald=15.30, df=1, $p<0.0001$). However, there was no difference when comparing inside dogs and outside dogs (Wald=0.63, df=1, p=0.4268). Also, for each group the mean number of gaze alternation between recipient and caregiver was significantly greater than zero ($p<0.0001$ for inside and outside groups, and p=0.0302 for shelter group), see Figure 3B.

Finally, regarding gaze alternation between recipient and experimenter, the three groups were also significantly different (Wald=6.50, df=2, p=0.0388). The difference between inside dogs and shelter dogs was significant (Wald=6.42, df=1, p=0.0113), as well as between pet dogs and shelter dogs (Wald=4.18, df=1, p=0.0410). There was no difference when comparing outside dogs with shelter dogs (Wald=0.52, df=1, p=0.4710) and a marginally significant difference when comparing inside dogs with outside dogs (Wald=3.52, df=1, p=0.0608). Once more, for each group the mean number of gaze alternation between recipient and experimenter was significantly greater than zero ($p<0.0001$ for inside and outside groups, and p=0.0005 for shelter group), see Figure 3C.

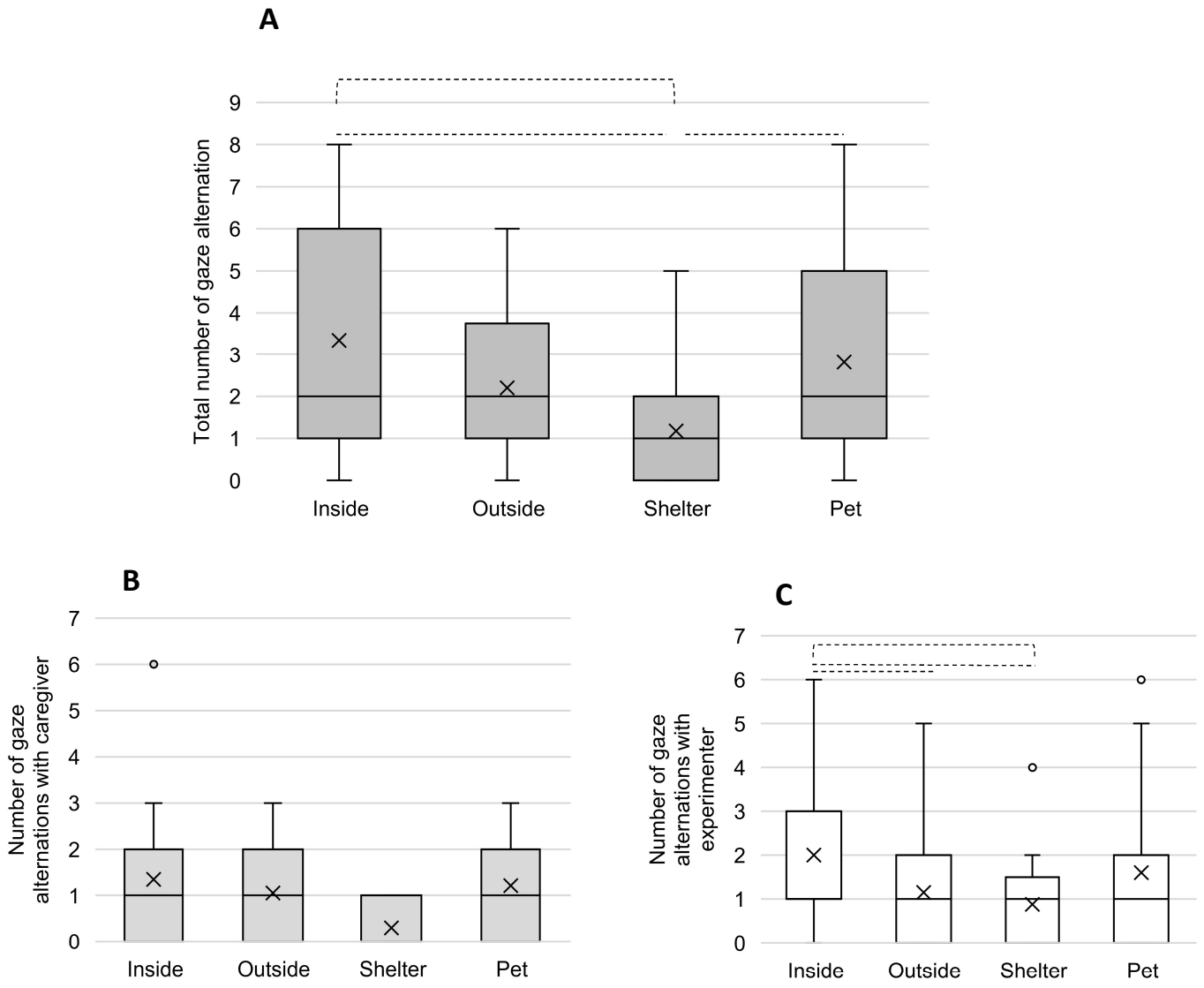
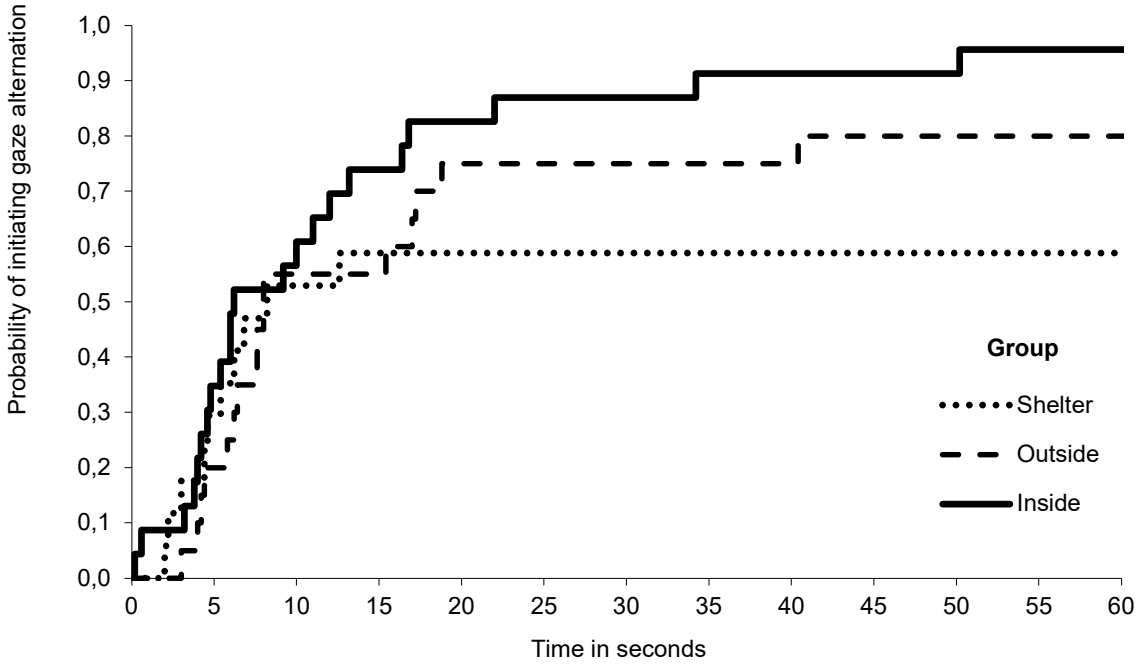



**Figure 3** Median, inter-quartile range (box) and mean (X symbol) of number of total number of gaze alternation (A), of gaze alternations with caregiver (B) and of number of gaze alternations with experimenter (C). The category "pet" is the grouping of dogs living inside and dogs living outside. Dotted line indicates $p<0.05$.

Regarding the latency for the first gaze alternation, Kaplan-Meier curves were presented in Figure 4 and showed that the probability of engaging in communication throughout the time, i.e. probability of initiating the gaze alternation across the time, was not different for all groups ($X^2=4.54$, df=2, $p=0.1031$, Log-Rank test). By comparing pet and shelter dogs there was also no difference ($X^2=2.45$, df=1, $p=0.1176$, Log-Rank test).




Number of dogs that initiate the gaze aternation across the time

| Time (sec) | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Shelter | 5 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Outside | 4 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 |
| Inside | 8 | 14 | 17 | 19 | 20 | 20 | 21 | 21 | 21 | 21 | 22 | 22 |

**Figure 4** Kaplan-Meier curves representing the probability of dogs initiating the gaze alternation across time. The numbers below the abscissa refer to the number of dogs that initiate the gaze alternation across the time.

For duration of gazes towards the caregiver, experimenter, both, and towards the recipient there were no effect of dogs' sex, breed, size, or age ($p>0.05$). For these variables final models including only group effect were, then, adjusted to compare the three groups.

The analyzes of total duration of human-directed gazing (experimenter + caregiver) including just group showed a significant difference between the three groups ($X^2=7.21$, df=2, $p=0.0272$; Gama model, Figure 5A). The comparison between inside dogs and shelter dogs showed a significant difference ($X^2=6.97$, df=1, $p=0.0083$), as well as the comparison between pet dogs (inside + outside) and shelter dogs ($X^2=4.40$, df=1, $p=0.0359$).

Regarding the duration of gaze towards the experimenter, the Gamma Model identified significant difference between the three groups ($X^2$=7.75, df=2, p=0.0207). Inside dogs gazed significant longer towards the experimenter than outside dogs ($X^2$=4.06, df=1, p=0.0440). Outside dogs gazed significant longer towards the experimenter than shelter dogs ($X^2$=6.65, df=1, p=0.0099), see Figure 5B.

Concerning the duration of gazes towards the caregiver, the ZIG model indicated that there was no difference between the three groups regarding the proportion of dogs that never gaze towards the caregiver (Wald=0,36, gl=2, p=0,8335), and, additionally there was also no difference regarding the mean duration of gazing towards the caregiver, for those dogs that at least once (Wald=3.03, gl=2 p=0.2194).

The Gamma model showed a significant difference between the groups regarding gazing at the recipient ($X^2$=23.01, df=2, p<0.0001). Shelter dogs gazed at the recipient significantly less than outside dogs ($X^2$=11.32, df=1, p=0.0008) as well as less than inside dogs ($X^2$=22.22, df=1, p<0.0001), as shown in Figure 5C.

The Kruskal-Wallis test showed a significantly different duration in touching the apparatus, with shelter dogs spending less time touching it ($X^2$=7,25, df=2, p=0.0267), as seen in Figure 6. As for latency to touch the apparatus, the Log-Rank test showed no significant difference ($X^2$=0.9178, df=2, p=0.6320).

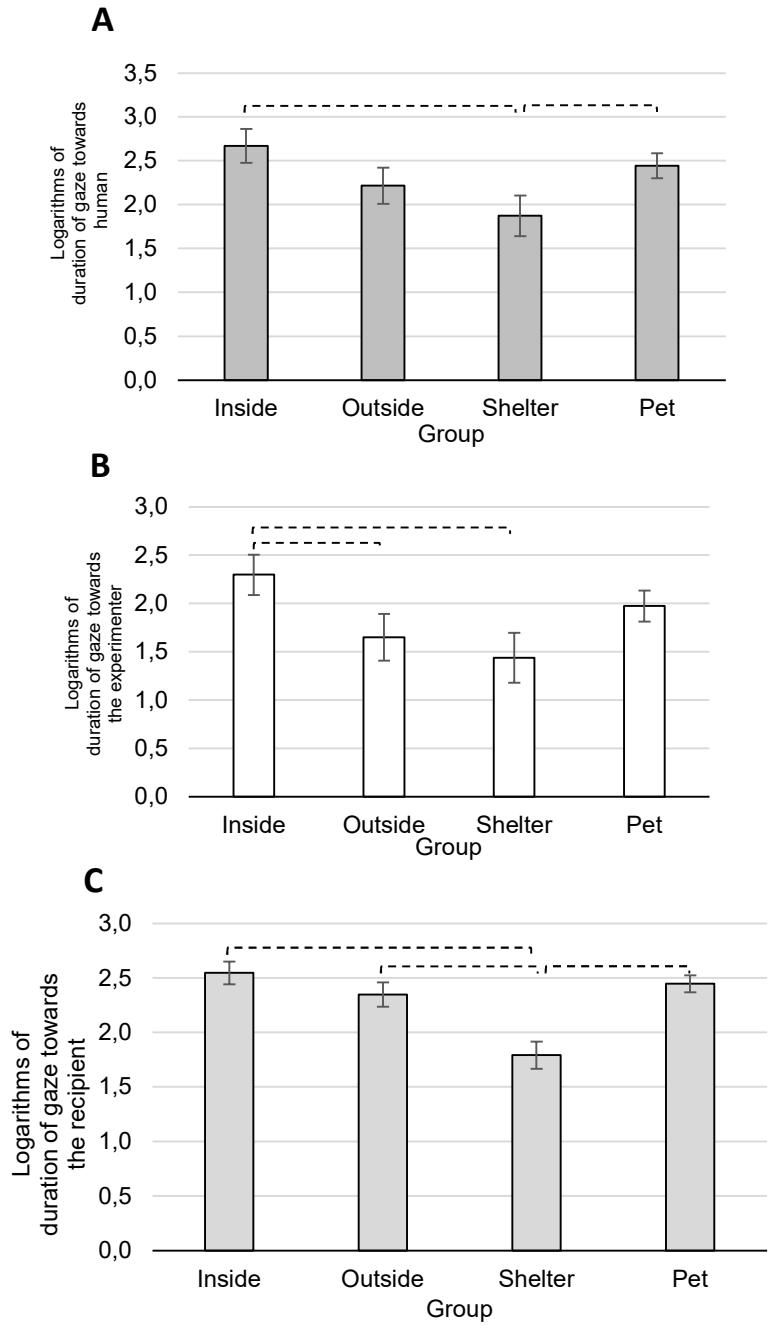



**Figure 5** (A) Logarithms of total duration of gaze towards human (caregiver + experimenter). (B) logarithms of gaze duration towards the experimenter. (C) Logarithms of duration of gaze towards the recipient. The category “pet” is the grouping of dogs living inside and dogs living outside. Dotted line indicates $p<0.05$

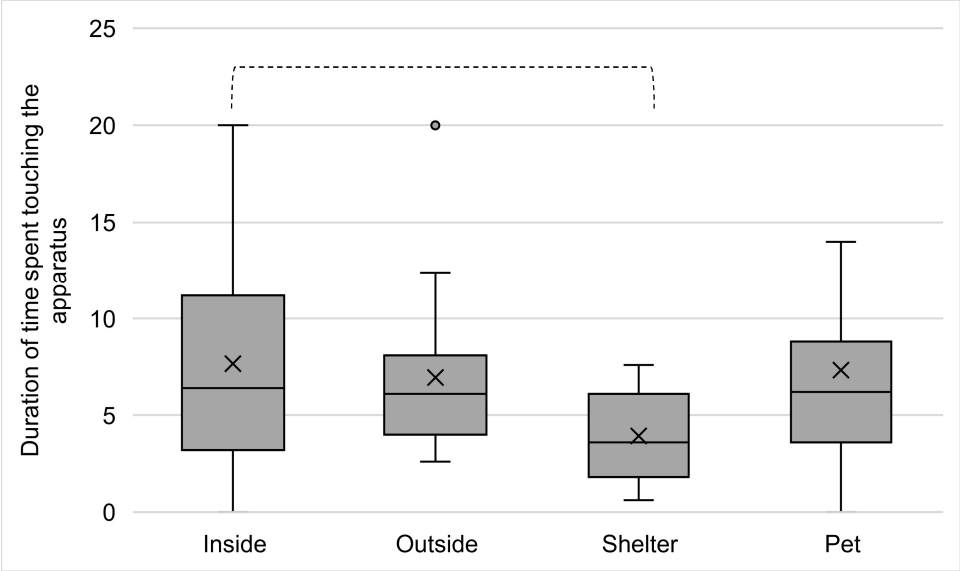



**Figure 6** Median, inter-quartile range (box) and mean (X symbol) of duration (in seconds) of touching the apparatus. The category “pet” is the grouping of dogs living inside and dogs living outside. Dotted line indicates $p<0.05$

## Discussion

The aim of this study was to investigate possible effects of dogs' different experiences with humans in their human-directed communicative behavior, by comparing pet dogs (living inside and outside the house) and shelter dogs' human-directed gaze duration, number of gaze alternations and the latency to the first gaze alternation. Our results showed no significant difference in latency, which means that there is no difference among the three groups regarding the probability of initiating the communication across the time. On the other hand, the groups of dogs that spend more time with people did show a higher proportion of individuals that engage in alternate gazes, a higher number of gaze alternations and a longer duration of human-directed gazing. Overall, results indicate a strong influence of experience in the development and use of these communicative behaviors in dogs. The more the experience with people in the daily routine the more the willingness to communicate with humans as a strategy to obtain a desired goal.

This is in accordance with Passalacqua et al. (2011)'s study that shows the effect of age in frequency of gaze alternation when other factors are controlled, as older pet dogs have had more experiences with people. In their unsolvable task experiment, less than 5% of 2-months-old puppies used gaze alternation, and adult dogs used it more often than 4.5-months-old puppies. The authors also observed that breed differences emerge with age, which shows that age and experience are necessary to the development and use of human-directed communicative behaviors according to each dog's characteristics.

Our results also agree with D'aniello & Scandurra (2016)'s research, where they used the unsolvable task to assess the effect of different housing conditions in Labrador retrievers and found the kennel dogs had a shorter duration and higher latency in human directed gazing when compared to pet dogs. Another study in that direction is Barrera et al. (2011)'s, where shelter and pet dogs that were explicitly trained into acquisition of gaze in a desired but unreachable food situation showed no differences during acquisition of the behavior, but shelter dogs did have a faster extinction. The authors discuss that pet dogs have more opportunities to learn to persist in their communicative behaviors when not immediately rewarded. The fact that in the present study dogs were not previously and explicitly trained to alternate looks

adds a new evidence that highlights the importance of our daily interactions, from which dogs gather information.

In our study, the proportion of shelter dogs that alternated gazes with humans was smaller than that of pet dogs; they also presented a lower number of gaze alternation and shorter gaze duration. These differences are even more evident when comparing the two extremes of experiences, the inside dogs, that spent more time with their owners, and shelter dogs, whose experience with the caregiver is limited to the feeding and cleaning moments. It is important to note that shelter dogs could have had previous negative experiences with humans and thus be inhibited from using human-directed gazing. Dogs living in shelters have few opportunities to use visual communication with humans and be rewarded by it, as it happens daily with pet dogs. This comes to show that dogs' exposure and experiences with human shape, at least partly, their human-directed gazing. These results do not mean that shelter dogs are unable to communicate with humans; they merely point to the importance of providing enough stimulation to the use of these abilities. It is in fact remarkable that shelter dogs do use gaze alternations with little exposition. This is further supported by the fact that, among dogs that did use gaze alternation, there was no difference in latency to first communication between the three groups, neither when comparing shelter dogs with pet dogs. Latency to gaze at humans is often regarded as an indication of persistence in the task (Marshall-Pescini et al., 2017). Other analyzes of apparatus-directed behaviors showed that the shelter dogs spent less time touching it. It is possible they were less interested in interacting with the apparatus due to stress, fear, or excitability over new stimuli of the environment.

One of the challenges of comparing pet dogs and shelter dogs is that stress levels and fear-related behaviors are higher in shelter dogs (Hennessy et al., 1997; Barrera, Jakovcevic, Bentosela, 2008), and it is impossible to disentangle that influence from the results. The assessment of dogs that spend less time with people but are not subject to the stress of kenneled living presents a more comparable situation; thus the differentiation of pet dogs living inside and outside the house in the current study can contribute to the matter. Differences in communicative behavior were more strongly seen across all groups and between pet dogs and shelter dogs rather than inside dogs and outside dogs, which indicates that the stress imposed by the confinement may indeed be an important part of this equation. Nonetheless, the

comparison of inside and outside dogs provides an important discussion in our different relationships with our pet dogs.

Shore, Riley and Douglas (2005) investigated the equivalent groups of “house dogs” and “yard dogs”, and found that owners of dogs living inside rated higher on two attachment measures than owners of dogs living in the yard, and that more inside dogs received higher levels of attention towards their physical and safety needs, as well as higher level of “enriched care” (i.e: the pet has its own toys, is walked every day, stays on someone’s lap). Agility training, exercising with a member of the family and being taken to pet events, on the other hand, occurred in equal proportions for inside and outside dogs. Other studies show that time spent together is important in modulating the dog-human relationship (Arhant et al., 2010), which affects emotional closeness (Meyer & Forkman, 2014; Payne, Bennett & Mcgreevy, 2015). These results show that there are relevant differences in the relationship dynamics between owners with dogs living inside and those with dogs living outside. This must be taken into account in our framework, since a positive relationship with the owner is correlated with an increased use of human-directed gazing (Cimarelli et al., 2019) and exploration behaviors (Solomon et al., 2018).

We speculate that the buffering effect of the relationship with the owner can contribute to explain our result that inside dogs gazed for longer at the experimenter than did outside and shelter dogs. When considering a secure base effect, it is expected that dogs that have a more secure relationship with their owners would be more confident in exploring novelty (Horn, Huber & Range, 2013; Topál et al., 1998), and consequently, towards the stranger. However, this possible effect was not in the scope of the current research and we did not implement tools to assess attachment styles between owners and dogs. Further research would be necessary to investigate this speculation, especially considering that there are also discrepancies in these data, as other studies have found a preference for looking at the owner in the case of trained dogs (Marshall-Pescini et al. 2009; D’Aniello et al. 2015).

Although this difference in experimenter-directed gaze duration was the only significant one between inside and outside dogs, there was a tendency of difference in number of gaze alternation with the experimenter and overall in the same direction. Although it did not reach the statistical level of significance adopted, it should not be overlooked. In Topál et al. (1997) study, dogs observed an experimenter pulling strings

to obtain food, and then had the opportunity to do the same, with a time limit of 150s. Dogs living inside gazed more at their owners and took longer to start manipulating the apparatus, leading the authors to discuss that these dogs are more dependent on people and have a reduced problem-solving capacity. In the light of current evidence in literature and framework, it can be argued that dogs living closer to humans have a different approach to problem-solving rather than a less effective one, as using humans as tools to obtain their goals through communication is a complex problem-solving strategy by itself. Our results suggest that outside dogs in our sample (which consisted of owners willing to take their dogs to a research without compensation) received enough stimulation in their daily lives to allow and/or prompt them to use human-directed communication, even if there is a tendency to use these behaviors less than inside dogs, as found in Topál and collaborators' experiment.

Overall, our results show the importance of dogs' different experiences with humans in their use of interspecific communication, adding up to a growing body of literature that reveals different factors throughout dogs' lives that contribute to the shaping of communication between our two species. Dogs have a high social plasticity (Reid, 2009; Udell & Brubaker, 2016), and their interactions with the environment and with other individuals, including humans, actively construct their behavioral repertoire (Resende, in press). It is, then, crucial to understand how our relationships with them affect this construction. Little experience with people is enough to trigger dogs' human direct-gazing and gaze alternation, as shelter dogs also present these behaviors, and more frequent interactions lead to a more frequent use of these communicative behaviors as well. This comes to show the ever-changing building of dogs' communication with humans, allowed by both our intertwined past and present, and the mutual relation between their socio-ecological environment and their behavior.

References

Agnetta, B., Hare, B., & Tomasello, M. (2000). Cues to food location that domestic dogs (Canis familiaris) of different ages do and do not use. Animal Cognition, 3(2), 107-112. doi:10.1007/s100710000070

Albuquerque, N., Guo, K., Wilkinson, A., Resende, B., & Mills, D. S. (2018). Mouth-licking by dogs as a response to emotional stimuli. Behavioural Processes, 146, 42-45. doi:10.1016/j.beproc.2017.11.006

Arhant, C., Bubna-Littitz, H., Bartels, A., Futschik, A., & Troxler, J. (2010). Behaviour of smaller and larger dogs: Effects of training methods, inconsistency of owner behaviour and level of engagement in activities with the dog. Applied Animal Behaviour Science, 123(3-4), 131-142. doi:10.1016/j.applanim.2010.01.003

Barrera, G., Jakovcevic, A., & Bentosela, M. (2008). Calidad de vida en perros alojados en refugios: Intervenciones para mejorar su bienestar. Suma Psicológica, 15(2), 337-354.

Barrera, G., Mustaca, A., & Bentosela, M. (2011). Communication between domestic dogs and humans: Effects of shelter housing upon the gaze to the human. Animal Cognition, 14(5), 727-734. doi:10.1007/s10071-011-0407-4

Bedford, P. (2019). Dog and cat pet population worldwide 2018. Retrieved June 30, 2020, from https://www.statista.com/statistics/1044386/dog-and-cat-pet-population-worldwide/

Bentosela, M., Wynne, C. D., D'orazio, M., Elgier, A., & Udell, M. (2016). Sociability and gazing toward humans in dogs and wolves: Simple behaviors with broad implications. Journal of the Experimental Analysis of Behavior, 105(1), 68-75. doi:10.1002/jeab.191

Carballo, F., Cavalli, C., Martínez, M., Dzik, V., & Bentosela, M. (2020). Asking for help: Do dogs take into account prior experiences with people? Learning & Behavior. doi:10.3758/s13420-020-00425-6

Cavalli, C., Carballo, F., Dzik, M. V., & Bentosela, M. (2019). Gazing as a help requesting behavior: A comparison of dogs participating in animal-assisted interventions and pet dogs. Animal Cognition, 23(1), 141-147. doi:10.1007/s10071-019-01324-8

Cimarelli, G., Marshall-Pescini, S., Range, F., & Virányi, Z. (2019). Pet dogs' relationships vary rather individually than according to partner's species. Scientific Reports, 9(1). doi:10.1038/s41598-019-40164-x

D'Aniello, B., Scandurra, A., Prato-Previde, E., & Valsecchi, P. (2015). Gazing toward humans: A study on water rescue dogs using the impossible task paradigm. Behavioural Processes, 110, 68-73. doi:10.1016/j.beproc.2014.09.022

D'Aniello, B., & Scandurra, A. (2016). Ontogenetic effects on gazing behaviour: A case study of kennel dogs (Labrador Retrievers) in the impossible task paradigm. Animal Cognition, 19(3), 565-570. doi:10.1007/s10071-016-0958-5

D'Aniello, B., Alterisio, A., Scandurra, A., Petremolo, E., Iommelli, M. R., & Aria, M. (2017). What's the point? Golden and Labrador retrievers living in kennels do not understand human pointing gestures. Animal Cognition, 20(4), 777-787. doi:10.1007/s10071-017-1098-2

Frantz, L. A. F., Venters, B. J., Pugh, B. F., Kireeva, M. L., Komissarova, N., Waugh, D. S., … Larson, G. (2016). Genomic and archaeological evidence suggests a dual origin of domestic dogs. *Science, 352*(6290), 1228–1231.

Gaunet, F. (2008). How do guide dogs of blind owners and pet dogs of sighted owners (Canis familiaris) ask their owners for food? Animal Cognition, 11(3), 475-483. doi:10.1007/s10071-008-0138-3

Hare, B. (2002). The Domestication of Social Cognition in Dogs. Science, 298(5598), 1634-1636. doi:10.1126/science.1072702

Hennessy, M. (1997). Plasma Cortisol Levels of Dogs at a County Animal Shelter. Physiology & Behavior, 62(3), 485-490. doi:10.1016/s0031-9384(97)80328-9

Horn, L., Huber, L., & Range, F. (2013). The Importance of the Secure Base Effect for Domestic Dogs – Evidence from a Manipulative Problem-Solving Task. PLoS ONE, 8(5). doi:10.1371/journal.pone.0065296

Hughes, J., & Macdonald, D. W. (2013). A review of the interactions between free-roaming domestic dogs and wildlife. Biological Conservation, 157, 341-351. doi:10.1016/j.biocon.2012.07.005

Instituto Brasileiro de Geografia e Estatística. (2015). Pesquisa nacional de saúde 2013: acesso e utilização dos serviços de saúde, acidentes e violências: Brasil, grandes regiões e unidades da federação (100 pp.). IBGE, Coordenação de Trabalho e Rendimento. Rio de Janeiro: IBGE.

Konno, A., Romero, T., Inoue-Murayama, M., Saito, A., & Hasegawa, T. (2016). Dog Breed Differences in Visual Communication with Humans. Plos One, 11(10). doi:10.1371/journal.pone.0164760

Lazarowski, L., Strassberg, L. R., Waggoner, L. P., & Katz, J. S. (2019). Persistence and human-directed behavior in detection dogs: Ontogenetic development and relationships to working dog success. Applied Animal Behaviour Science, 220, 104860. doi:10.1016/j.applanim.2019.104860

Mariti, C., Gazzano, A., Moore, J. L., Baragli, P., Chelli, L., & Sighieri, C. (2012). Perception of dogs' stress by their owners. Journal of Veterinary Behavior, 7(4), 213-219. doi:10.1016/j.jveb.2011.09.004

Marshall-Pescini, S., Passalacqua, C., Barnard, S., Valsecchi, P., & Prato-Previde, E. (2009). Agility and search and rescue training differently affects pet dogs' behaviour in socio-cognitive tasks. Behavioural Processes, 81(3), 416-422. doi:10.1016/j.beproc.2009.03.015

Marshall-Pescini, S., Colombo, E., Passalacqua, C., Merola, I., & Prato-Previde, E. (2013). Gaze alternation in dogs and toddlers in an unsolvable task: Evidence of an audience effect. Animal Cognition, 16(6), 933-943. doi:10.1007/s10071-013-0627-x

Marshall-Pescini, S., Rao, A., Virányi, Z., & Range, F. (2017). The role of domestication and experience in 'looking back' towards humans in an unsolvable task. Scientific Reports, 7(1). doi:10.1038/srep46636

Meyer, I., & Forkman, B. (2014). Dog and owner characteristics affecting the dog–owner relationship. Journal of Veterinary Behavior, 9(4), 143-150. doi:10.1016/j.jveb.2014.03.002

Miklósi, A., Polgárdi, R., Topál, J., & Csányi, V. (2000). Intentional behaviour in dog-human communication: An experimental analysis of "showing" behaviour in the dog. Animal Cognition, 3(3), 159-166. doi:10.1007/s100710000072

Miklósi, Á, & Soproni, K. (2006). A comparative analysis of animals' understanding of the human pointing gesture. Animal Cognition, 9(2), 81-93. doi:10.1007/s10071-005-0008-1

Miklósi, Á, Kubinyi, E., Topál, J., Gácsi, M., Virányi, Z., & Csányi, V. (2003). A Simple Reason for a Big Difference: Wolves do not Look Back, but Dogs do. Current Biology, 13(9), 763-766. doi:10.1016/s0960-9822(03)00263-x

Parker, H. G. (2012). Genomic analyses of modern dog breeds. Mammalian Genome, 23(1-2), 19-27. doi:10.1007/s00335-011-9387-6

Passalacqua, C., Marshall-Pescini, S., Barnard, S., Lakatos, G., Valsecchi, P., & Previde, E. P. (2011). Human-directed gazing behaviour in puppies and adult dogs, Canis lupus familiaris. Animal Behaviour, 82(5), 1043-1050. doi:10.1016/j.anbehav.2011.07.039

Payne, E., Bennett, P., & Mcgreevy, P. (2015). Current perspectives on attachment and bonding in the dog–human dyad. Psychology Research and Behavior Management, 71. doi:10.2147/prbm.s74972

Reid, P. J. (2009). Adapting to the human world: Dogs' responsiveness to our social cues. Behavioural Processes, 80(3), 325-333. doi:10.1016/j.beproc.2008.11.002

Resende, B. (in press). Da interação bicho humano com os outros bichos: discutindo afetos e bem-estar. In E. Otta. & V. Bussab (Orgs.), *Estados afetivos e comportamento humano: bases psicoetológicas* (no prelo, Cap. 7). São Paulo: EDUSP.

Riedel, J., Schumann, K., Kaminski, J., Call, J., & Tomasello, M. (2008). The early ontogeny of human–dog communication. Animal Behaviour, 75(3), 1003-1014. doi:10.1016/j.anbehav.2007.08.010

Savalli, C., Ades, C., & Gaunet, F. (2014). Are Dogs Able to Communicate with Their Owners about a Desirable Food in a Referential and Intentional Way? PLoS ONE, 9(9). doi:10.1371/journal.pone.0108003

Savalli, C., Resende, B., & Gaunet, F. (2016). Eye Contact Is Crucial for Referential Communication in Pet Dogs. Plos One, 11(9). doi:10.1371/journal.pone.0162161

Shore, E. R., Riley, M. L., & Douglas, D. K. (2006). Pet owner behaviors and attachment to yard versus house dogs. Anthrozoös, 19(4), 325-334. doi:10.2752/089279306785415466

Solomon, J., Beetz, A., Schöberl, I., Gee, N., & Kotrschal, K. (2018). Attachment security in companion dogs: Adaptation of Ainsworth's strange situation and classification procedures to dogs and their human caregivers. Attachment & Human Development, 21(4), 389-417. doi:10.1080/14616734.2018.1517812

Topál, J., Miklósi, Á, Csányi, V., & Dóka, A. (1998). Attachment behavior in dogs (Canis familiaris): A new application of Ainsworth's (1969) Strange Situation Test. Journal of Comparative Psychology, 112(3), 219-229. doi:10.1037/0735-7036.112.3.219

Udell, M. A., Dorey, N. R., & Wynne, C. D. (2008). Wolves outperform dogs in following human social cues. Animal Behaviour, 76(6), 1767-1773. doi:10.1016/j.anbehav.2008.07.028

Udell, M. A., & Brubaker, L. (2016). Are Dogs Social Generalists? Canine Social Cognition, Attachment, and the Dog-Human Bond. Current Directions in Psychological Science, 25(5), 327-333. doi:10.1177/0963721416662647

Worsley, H. K., & O'Hara, S. J. (2018). Cross-species referential signalling events in domestic dogs (Canis familiaris). Animal Cognition, 21(4), 457-465. doi:10.1007/s10071-018-1181-3

Wynne, C. D., Udell, M. A., & Lord, K. A. (2008). Ontogeny's impacts on human–dog communication. Animal Behaviour, 76(4). doi:10.1016/j.anbehav.2008.03.010

## Effect of different experiences with humans in dogs' visual communication

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**Supplementary materials**

Questionnaire presented to owners about their dogs, excluding personal information:

1) **What is your dog's name?**
2) **Sex?**
3) **Age? (in years, approximate)**
4) **Breed:** mongrel or other (please specify)
5) **Size:** small, medium, or large
6) **Does your dog have any known health issues?**
7) **Does your dog live in your home for at least 1 year?**
8) **What is your dog's favorite food?**
9) **Does you dog get very motivated with their favorite food?**
10) **Does your dog accept their favorite food from strangers?**
11) **Does your dog accept their favorite food outside the house?**
12) **Is your dog used to leaving the house and meeting new people?**
13) **When you go out with your dog, is he/she insecure?**
14) **Is your dog afraid of new people?**
15) **Does your dog have specific feeding times or is food always available?**
16) **Does your dog have any food restrictions?**
17) **Could you avoid feeding your dog for four hours before the experiment?**
18) **Do you take your dog for walks? How often**
19) **Do you live in a house or in an apartment?**
20) **If you live in a house, does your dog spend more time inside or outside (yard, garage, garden)?** 1) Exclusively inside the house; 2) Mostly inside the house, but also goes outside in some situations; 3) Moves freely between inside and outside the house; 4) Exclusively outside the house; 5) Mostly outside the house, but also goes inside in some situations; 6) Non-applicable (I live in an apartment)"
21) **With how many people does your dog interact in your house?**
22) **Does your dog participate or has ever participated in obedience training classes?**
23) **Is your dog, or has your dog ever been, a therapy dog?**
24) **Does your dog participate, or has ever participated, in agility classes or competitions?**

## Chapter 4

## Exploratory analyzes of the behavior of shelter dogs facing a cognitive task

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### Abstract

Dogs' cognitive and communicative skills seem to be affected, among many factors, by different experiences with humans. A rising number of studies with shelter dogs propose to evaluate their problem-solving strategies and interactions with humans. Increased fear, stress, and need to explore may influence their behavior in testing situations. In this study we analyzed the behavior of shelter dogs in a task in which they had one minute to turn over a recipient and obtain food. Fifteen dogs did not obtain food (fail group) and 16 did (success group). Dogs in the fail group had a higher latency to start moving. We present a time budget for dogs in the fail group. They spent, in average, half of the testing time out of the experimental area and allocated considerable time to walking and sniffing. We discuss these results regarding stress, fear, and the need to explore, and propose that these are important factors to take into consideration when assessing cognitive abilities in shelter dogs. We additionally discuss strategies to better fit shelter and other non-pet dog populations in current research.

## Introduction

In an attempt to understand our different relationships with dogs, and how they affect their cognitive and communicative skills, researchers have started turning their attention to different populations other than pet dogs. This is an essential step to broaden our understanding of dogs, since pet dogs, in which most of our knowledge is based, represent only 30% of the world's dog population (Hughes & Macdonald, 2013).

The growth of the field and the adjustment of common methodologies have been leading to the first steps in that direction. For example, free-ranging dogs living in the streets of Morocco have been assessed and found to be less manipulative and persistent in a task with inaccessible food (Lazzaroni et al., 2019). Marshall-Pescini and collaborators (2017), on the other hand, found that dogs living in the streets of India behaved similarly as pet dogs in the same task. In 2018, Santos described the demographic characteristic and relationship between dogs and people in *tekoas* (indigenous villages) in Brazil.

The study of shelter dogs also has important theoretical and practical contributions. Many hypotheses regarding the development and evolution of dogs' social and communicative skills are based on groups that are extensively exposed to humans. Therefore, understanding dogs that have a different level and quality of interactions with humans can bring insight to the essential role of ontogeny in the use of many behaviors that are often attributed to a genetic consequence of domestication (Udell, Dorey & Wynne, 2009).

Additionally, the abandonment of dogs is a problem in many societies. Abandonment can have impacts in human health, due to zoonoses, in conservation, due to hunting and contamination, and in economy, regarding management strategies (Alves et al., 2013), as well as in the dogs' welfare. Free-ranging dogs tend to have impaired physical and mental health (Stafford, 2007). In Latin America, it is common that dogs live out their lives permanently in shelters, which are often full and not adequately equipped to care for all the residents (Barrera et al., 2008). This is mostly due to the lack of resources and public politics regarding animal abandonment. Factors of both dog and owner affect chances of adoption and of abandonment. A study in Botucatu, São Paulo, found that people that adopted dogs were mostly adults (mean

age: 39, dp=14) living with a partner and children (Paploski et al., 2012). In Ibiúna, São Paulo, 70% of adopted dogs were male (Soto et al., 2006). A study in the United States has shown that length of stay in a shelter increased linearly with age, and when considering size, medium dogs had the longest length of stay (Brown, Davidson & Zuefle, 2013). Although no study assessing these factors was found regarding dogs in shelters in Brazil, it seems reasonable to deduce that size and age also affect adoption rates in this country, in a direction that has yet to be investigated.

Most studies evaluating causes of relinquishment come from the United States, but, in spite of different realities, authors of a review of abandonment in Brazil pointed out that this is an important step to understand this issue in this country and the rest of Latin America (Alves et al, 2013). The most common cause for relinquishment is behavioral issues, followed by a change in space or in social conduct rules of the owner. Owner's lifestyle, erroneous expectations, and the great commitment required to care for a dog also come up (Salman et al., 1998). A study in Italy in 2004 also found behavioral problems as the main cause of returning a dog that had been adopted from a shelter (Mondelli et al., 2004).

Therefore, further understanding the behavior of dogs living in shelters can bring us insight into their welfare and chances of a successful adoption. In addition to commonly having suffered from trauma before living in shelters (Dufour et al., 2005), they have higher levels of stress caused by the confinement and lack of stimuli in the shelter (Hennessy, 1997). Stress is an important response to adverse situations, however, when prolonged and chronic, it can lead to low immunity, stereotypical behaviors, and tissue atrophy (Möstl & Palme, 2002), in addition to impairing cognitive functions (Sandi, 2013; Cordner & Tamashiro, 2016).

A growing body of literature proposes to evaluate shelter dogs' problem-solving strategies and interactions with humans. In addition to the high stress susceptibility, dogs living in shelters have limited exposition to humans, who they mostly interact with during feeding and cleaning, and to diverse cognitive challenges. Some authors point out that it is challenging to disentangle the effect of stress and the low exposure to humans in testing with shelter dogs since they usually come along (Barrera, Mustaca & Bentosela, 2011).

Since dogs can stablish bonds with humans that can be characterized as attachment (Topál et al., 1998; Payne, Bennett & McGreevy, 2015), Gácsi et al., in 2001, set out to investigate attachment behavior in shelter dogs, a group that has little social contact with humans. Forty adult dogs from rescue centers were handled by a previously unknown experimenter 10 minutes per day for three consecutive days. Twenty control dogs were not handled. Then, the dogs were tested in an adapted Stranger Situation Test, as in Topál et al. (1998). The test consisted of seven episodes where the dog remained in a new room with the caregiver-experimenter, with a stranger, with both, or alone. The dog's behavior in the separation and reunion episodes was then observed and categorized. The authors found that dogs in the handling group behaved differently than the control group, fulfilling all criteria for attachment (secure base effect, proximity seeking, and specific response to separation) towards the caregiver-experimenter, even with such a short interaction. They proceeded to discuss, then, that dogs deprived of frequent social interactions were highly responsive to humans, with a readiness to form attachment relationships.

Knowing that shelter housing affects dogs' behavior, Barrera et al. investigated, in 2010, dogs' reaction to a stranger in Argentina. Thirty-four shelter dogs and 14 pet dogs were exposed to an unknown experimenter that behaved in a friendly manner. Shelter dogs showed fear-appeasement behavior more often, which can be related to their stressful situation and possible previous negative experiences; nonetheless, they spent more time near the stranger. The authors discussed that, in line with Gácsi and collaborators (2001), shelter dogs showed a remarkable need for social contact, despite being more fearful than pet dogs in that situation.

Contributing to that matter, Feuerbacher and Wynne, in 2012, investigated the efficacy of food and social interaction as reinforcement for shelter and pet dogs (as well as wolves). After performing a trained behavior (nosing the experimenter's hand), one group received a small piece of food and the other group received four seconds of scratching around the neck with verbal praising. Shelter dogs performed the trained behavior slightly more often in the social reward condition than pet dogs, although all groups performed the behavior more often in the food reward condition. Later in 2014, the same authors further investigated this preference with a concurrent choice between food or petting. Dogs could walk freely in a room and choose to approximate two experimenters: one who provided food or another who petted him or her. Time

allocation directed to each experimenter was analyzed. Shelter dogs, when compared with pet dogs tested with both their owners and a stranger, showed the highest preference for petting. They discussed that shelter dogs live in a stressful environment, which might facilitate the establishment of contact as a form of comfort and reinforcement.

These consequences of stress and deprivation of human interaction have been mentioned as possible explanations, at least partly, for shelter dogs' initial failure in following a human momentary distal pointing gesture (Udell, Dorey & Wynne, 2010). The two-choice task, with a variation of pointing gestures, has been widely used to investigate dogs' and other animals' understanding of human communicative cues, and pet dogs consistently perform above chance in it (Miklósi & Soproni, 2006). In the study from Udell, Dorey, and Wynne (2010), the authors argue that dogs' sensitivity to human stimuli cannot be fully explained as a product of domestication, rather it is also affected by experience, since that group that has little contact with people did not perform above chance in the task. Additionally, when presented with further experience (40 trials), shelter dogs were able to learn how to successfully follow the momentary distal pointing gesture.

Another important contribution of that study (Udell, Dorey & Wynne, 2010) was that, in the additional training experiment, authors assigned the shelter dogs into one of two groups: a control and a "play-train condition". In the play-train condition dogs spent time in the testing environment with the experimenter and assistant, with play, petting and free exploration permitted. It was expected that, if the novelty of the test was the cause of dogs' poor performance (due to stress, distraction, or excitement), dogs in the play-train condition would have had time to habituate to the situation and would learn to follow the pointing gesture in fewer trials. This study did not find difference between groups; dogs in the "play-train condition" and dogs that went straight to the testing performed similarly. Therefore, they concluded that habituation did not influence the results.

The performance of shelter dogs has also been assessed in a context of communicative production towards humans. In that context, human directed gaze and gaze alternation are often observed, as they are forms of initiating communication and directing attention to a desired object (Miklósi et al., 2000). Barrera et al. (2011) compared pet dogs and shelter dogs' gazing behaviors in an out-of-reach food

situation. No differences were found in the acquisition of gazing, but shelter dogs did have a faster extinction when the reward was withdrawn. The authors discussed that pet dogs have more opportunities to learn to persist when not immediately rewarded, pointing out the role of experience modulating communicative behaviors. The effect of stress and fear-appeasement is also taken into consideration, although it was argued that if they had a great influence, that would have appeared in the acquisition phase as well. Nonetheless, there was a remarkable ability to use interspecific communication. The authors highlighted the effect of ontogeny in their results.

D'Aniello & Scandurra investigated, in 2016, the effect of housing in communicative production comparing kennel dogs with pet dogs. Although in a different situation than shelters, dogs living in kennels have some aspects in commons such as less stimuli, a restricted area to explore, and reduced interactions with humans. The authors used the unsolvable task, where dogs had three solvable trials in a simple task to obtain food from a container, then an immediate impossible trial was presented. Dogs' interaction with the apparatus and gazing behavior towards the experimenter was observed. It was found that both groups interacted the same amount of time with the apparatus, but kennel dogs gazed with higher latency and for less time at the humans.

These studies demonstrated that shelter dogs have a willingness for human social interaction, can quickly form bonds, have a capacity to communicate with humans, and show a high plasticity in these communicative behaviors. Additionally, all these results emphasized that these dogs have particularities, and that fear, stress, and novelty may weigh on that. As with free-roaming and wild animals, often the origin, exact age, and previous experiences are unknown for shelter dogs, opposed to pet or working dogs. Put together, these characteristics make them more challenging to evaluate, and it is possible that usual methodologies do not apply completely. But, if we want to understand the behavior of dogs in general, we have to rise up to the challenge of designing experiments that can test shelter and other population of dogs alongside the more convenient pet samples (Udell et al., 2010).

Therefore, the current exploratory study proposed to evaluate the behavior of shelter dogs that participated in another experiment designed to evaluate the production of communicative signals: the unsolvable task (see Werneck et al., in press, for details of the procedure). In order to be included in that study, dogs were presented

with three solvable trials, and had to succeed in at least two out of three to move on to the unsolvable trial. In the main study (Werneck et al., in press), it was observed that 54% of shelter dogs did not meet that criterion, compared to 15% of pet dogs. So, to further understand the shelter dog's low engagement, this exploratory and qualitative analysis was performed. The aim of the current study was to compare two groups, dogs that met the criterion (success group) and dogs that did not (fail group), in the first solvable trial, which represented the first contact with the experimental situation and apparatus, regarding the activity budget and behaviors such as avoidance, fear, stress, and excitement. We then raised a discussion on the effectiveness of current methodologies.

## Methods

Dogs were recruited through a partnership with the non-governmental organization “Casa da Passagem São Lázaro” (Adote um Focinho), a shelter under the legal register (CNPJ) nº 08.133.246/0001-43. In order to be included, dogs had to be between one and 10 years old, have been in the shelter for at least six months and be comfortable enough around the experimenter to take a piece of food from her hand. Thirty-one dogs (15 females and 16 males) between one and a half and eight years were assessed. Their age was estimated by caregivers from the shelter based on dogs’ teeth. All dogs were mixed breed. Two dogs (Grow and Cookie) that previously failed in the task were tested again at least four months later and succeeded in the re-test, thus they are included in both samples. The dogs’ characteristics can be found in Table 1.

**Table 1** Name, sex, and estimated age (in years) of dogs in the fail and in the success group.

| Group | Name | Sex | Age |
|---|---|---|---|
| Fail | Charlie | Male | 8 |
| Fail | Farofa | Male | 3 |
| Fail | Cookie | Male | 1,5 |
| Fail | Marie | Female | 3 |
| Fail | Grow | Male | 3 |
| Fail | Yolanda | Female | 5 |
| Fail | Panda | Male | 1,5 |
| Fail | Lucy | Female | 5 |
| Fail | Billy | Male | 8 |
| Fail | Amora | Female | 2 |
| Fail | Tina | Female | 7 |
| Fail | Josepha | Female | 7 |
| Fail | Francisca | Female | 7 |
| Fail | Doris | Female | 2 |
| Fail | Aisha | Female | 7 |
| Success | Café | Male | 8 |
| Success | Suzie | Female | 7 |
| Success | Fubá | Male | 3 |
| Success | Catatau | Male | 4 |
| Success | Patrick | Male | 2 |
| Success | Iara | Female | 3 |
| Success | Sara | Female | 3 |
| Success | Budy | Male | 5 |
| Success | Logan | Male | 1,5 |
| Success | Fusca | Male | 6 |
| Success | Cookie | Male | 1,5 |

| | | | |
|---|---|---|---|
| Success | Savana | Female | 4 |
| Success | Neymar | Male | 1,5 |
| Success | Lucy | Female | 5 |
| Success | Grow | Male | 3 |
| Success | Agatha | Female | 4 |

*Experimental set up and apparatus*

The dogs were tested at the shelter, out of their living space in an area they do not have access to. The area was a balcony surrounded by a low wall. The apparatus consisted of a wooden board (60cm x 35 cm) with a transparent plastic container lid screwed on to it (Figure 1). The recipient could be positioned on the lid in a manner that it could be turned over, or it could be attached to the lid and be impossible to move.

**Figure 1** Experimental area and set up.

*Procedure*

Prior to the experiment there was a habituation phase when dogs could freely explore the place, which helped ensure they were comfortable and less interested in stimuli from the environment during the test. This phase took approximately 10 minutes and stopped when the experimenter judged that dogs were comfortable based on the absence of stress behaviors such as shaking, paw lifting, panting, and scratching (Mariti et al., 2012).

The experiment was part of a broader study with two parts: in the first part, dogs had three trials of up to 60 seconds to obtain a piece of food covered by the container in the apparatus. If they accomplished that at least two times, they went on to the unsolvable part: a trial of 60 seconds where the container was attached to the lid and could not be opened.

To start off the experiment, both the experimenter and the caregiver positioned themselves in front of the apparatus. Each position had been previously randomized across the trials. The caregiver held the dog with assistance of the harness or collar when necessary. The experimenter called the dog by his/her name and showed a piece of food. The food was then put on the lid and covered by the plastic recipient (without locking it), and then the caregiver was instructed to release the dog. When the subject managed to turn the recipient over and eat the food the trial was finished, and the caregiver immediately repositioned the dog and the next trial was initiated. If the dog did not manage to obtain the food, the trial lasted a maximum of one minute, and the next trial was immediately initiated. If the dog did not obtain the food for the second time, the test was finished, and the dog was assigned to the “fail group”. If the dog obtained the food at least two times out of three trials, he/she moved on to the unsolvable trial and was assigned to the “success group” (see chart 1). It was not the aim of the current study to evaluate the unsolvable trial (see Werneck et al., in press, for more information about it). In all trials the experimenter and a caregiver from the shelter (both women) stood up next to the apparatus without interacting with the dogs, but they were visually available to make eye contact in case the dog looked at them.

**Chart 1** Possible outcomes of each trial and the resulting grouping

| | Trial 1 | Trial 2 | Trial 3 | Group |
|---|---|---|---|---|
| Food obtaining | Yes | Yes | Yes | Success |
| | Yes | Yes | No | |
| | No | Yes | Yes | |
| | No | No | - | Fail |

The experiment was recorded with two cameras: *Sony HDR-AS200V* and *Samsung HMX-Q10.*

*Data Analysis*

The focus of this study was dogs' behavior in the first solvable trial. The duration of the trial could be different for each dog. For dogs that did not manage to obtain the food, the trial lasted for 60 seconds, while for dogs that did get the food the trial lasted the time it took for them to achieve the food. Therefore, duration and frequency of behaviors during the trial were not comparable, and analyses were just exploratory. The only possible comparison between groups (success and fail) was the latency to walk, which can be interpreted as willingness to explore (Marshall-Pescini et al., 2017). This comparison was performed by a Wilcoxon rank-summed test, considering the significance level of 5%.

For dogs from the fail group, those that did not manage to obtain the food in at least two of three attempts, the duration and frequency of behaviors were described in Table 2 as a time budget. Time budgets are generally used to understand how animals order their lives and prioritize activities (Ross & Giller, 1988). It can be a useful tool, in this context, to offer an insight into dogs' lack of motivation to engage in the task and about behaviors they are prioritizing. It is important to note that these behaviors were not necessarily mutually exclusive (e.g. stand still can occur associated to gazing at the recipient or touching the experimenter, walking can occur associated to sniffing). For the purpose of the current study the time budget was present for each behavior separately. Solomon Coder (beta 09.08.02, copyright 2006–2019 by András Péter, developed at ELTE TTK Department of Ethology, Budapest, Hungary) was used.

**Table 2** Ethogram of main analyzed behaviors. The caregiver is the owner in the case of pet dogs and a shelter employee in case of shelter dogs

| Behavior | Description | Type |
|---|---|---|
| Gazing at caregiver | The dog's head and nose were oriented towards the caregiver's face | Duration |
| Gazing at experimenter | The dog's head and nose were oriented towards the experimenter's face | Duration |
| Gazing at the recipient | The dog's head and nose were oriented towards the recipient | Duration |
| Touching the caregiver | The dog touches any body part of their caregiver with any part of their own body | Duration |
| Touching the experimenter | The dog touches any body part of the experimenter with any part of their own body | Duration |
| Touching the recipient | The dog touches the recipient with its snout or paw | Duration |
| Walking | The dog moves its legs and body, occupying a different space than in the previous frame | Duration |
| Sniffing | The dog's snout is close to the floor or walls and makes quick and repetitive movements of inhaling and exhaling | Duration |
| Standing still | The dog's body occupies the same space as in the previous frame | Duration |
| Out of experimental area | The dog's head is not appearing in the area delimited as part of the experiement | Duration |
| Yawn* | The dog opens its jaws wide without vocalising | Frequency |
| Paw lifting* | A single fore paw is lifted off the floor for at least 2 seconds | Frequency |
| Scratch* | The dog repeatedly pushes its hind paw against its head or body | Frequency |
| Shake* | The dog makes short, quick, and repetitive movements from one side to the other with its body | Frequency |

*Stress behaviors

### *Ethical Aspects*

This research was approved by the Animal Research Ethics Committee of The Institute of Psychology of University of São Paulo (CEUA/IPUSP nº 6288200818) and with the current Brazilian laws on ethical standards, as well as with the rules issued by the National Council for Control on Animal Experimentation (CONCEA).

## Results

The comparison between success and fail groups regarding the latency to start walking indicated that there was a significant difference (Wilcoxon=292.5, p=0.0472). Dogs that met the criterion to obtain the food in at least two of three attempts, i.e. dogs of success group, took significantly less time to start walking in the first trial than dogs of fail group (Figure 2). We observed that there was one dog that did not move during all the 60 seconds and it was considered an outlier. We performed the same test by removing this observation in order to evaluate its impact on the results. The new analysis indicated that the difference between success and fail groups was less clear (Wilcoxon=261.5, p=0.0756). Still, there is a tendency of starting to move later in the fail group, that should be discussed.

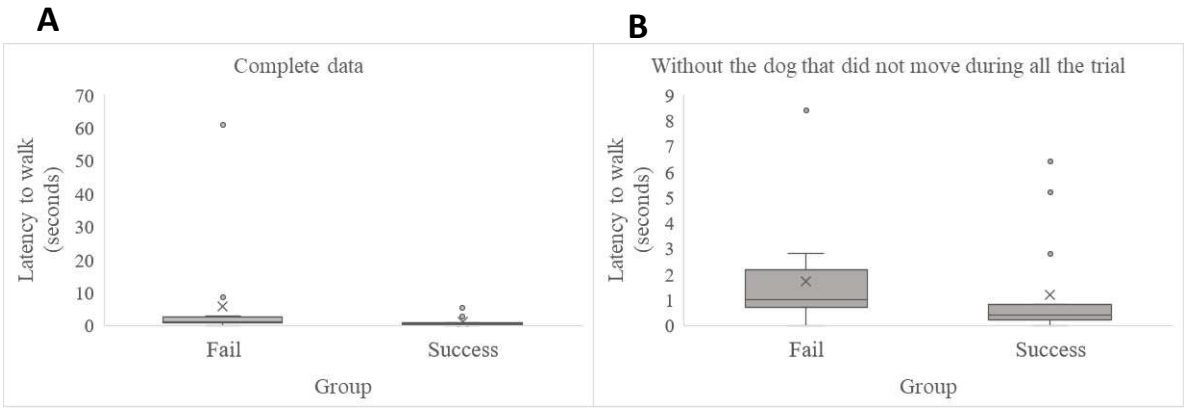


**Figure 2** Boxplots for the latency to walk according the group. (A) considering all dogs (B) by removing the dog that did not move during all the trial and was considered as an outlier.

The description of time budget for dogs of fail group is presented in Table 3 and Figure 3. Dogs spent an average of 53% (SD=25%) of the time out of the experimental area, 27% walking (SD=19%) and 20% (SD=24%) standing still. They spent 16% (SD=16%) of the time sniffing. As for apparatus-directed behavior, they gazed at it for an average of 3% (SD=2%) of the time and touched it for 1% (SD=1%). Human-directed behaviors involved gazing at people for 5% (SD=5%) of the time and touching people for 3% (SD=3%) of the time.

**Table 3** Median, standard deviation, minimum, median and maximum of percentage of time that the 15 dogs in the fail group allocated to each behavior.

| Behavior | Mean | Standard Deviation (SD) | Mininum | Median | Maximum |
|---|---|---|---|---|---|
| Out of exp. area | 53% | 25% | 0% | 55% | 87% |
| Walking | 27% | 19% | 0% | 22% | 67% |
| Standing still | 20% | 24% | 4% | 16% | 100% |
| Sniffing | 16% | 16% | 0% | 10% | 48% |
| Gazing at apparatus | 3% | 2% | 0% | 3% | 9% |
| Touching apparatus | 1% | 1% | 0% | 1% | 3% |
| Gazing at humans | 5% | 5% | 0% | 5% | 16% |
| Touching humans | 3% | 3% | 0% | 1% | 10% |

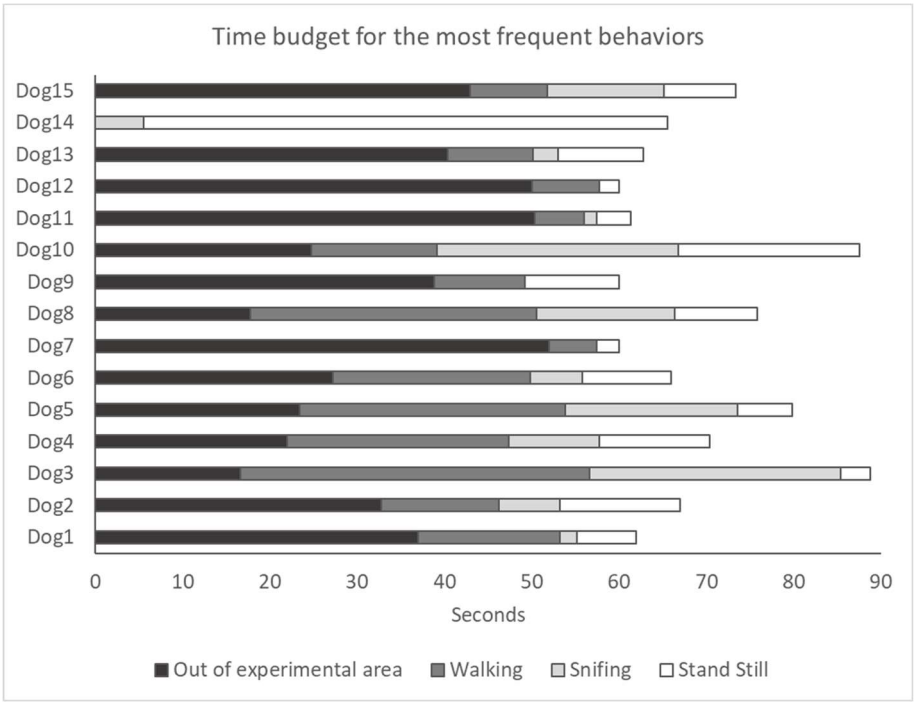


**Figure 3** Time (seconds) spent by each dog in fail group for the most frequent behaviors. Since behaviors were not mutually exclusive, the sum is not necessarily 60 seconds.

The stress-typical behaviors we accounted for were rare in the first trial. No dogs yawned nor scratched itself, one dog raised a paw one time and other dog shook its body one time.

## Discussion

Our analysis showed that shelter dogs that did not engage in the unsolvable task tended to take longer to make a first move when compared to dogs that did engage, and that they spent on average half of the trial time out of the experimental area. This could be due to elevated fear and stress, leading to avoidance behavior. The fact that they spent a considerable amount of time standing still could be another evidence in that direction, since freezing is a known response to fear (Ogata et al., 2006). However, after starting to move, dogs that failed to engage in the task spent a great amount of time out of the experimental area and walking, instead of inspecting the apparatus. Going outside of the experimental area could then be a result of a need to explore. Dogs in the shelter spend most of their time in small enclosures, with few novel scents in their environment. Therefore, the opportunity to walk and sniff could have a higher value than obtaining a treat. It does not seem likely that they were not motivated by the food, since they accepted it both from the experimenter and caregiver's hand before the experiment started. But it would make sense for them to be *more* motivated to explore than to eat a treat. Therefore, they allocated, on average, considerable time to walking and sniffing in the experimental area.

It was initially predicted that interacting with people could be more valuable than obtaining the food, since in Feuerbacher & Wynne (2014) shelter dogs showed a unique high level at preference for petting when presented with petting and food. Results did not meet this prediction, as dogs directed little time into interacting with either the experimenter or the caregiver. In their study, Feuerbacher & Wynne also discussed that shelter dogs do not have a recent history of reinforcement to produce strong attachment to any particular person. Although it has been shown that shelter dogs can quickly form attachment (Gácsi et al., 2001), not much is known about the strength and effect of that bond. It seems reasonable to assume that a bond that is less constant and reinforced, like the one between shelter dogs and caregivers, is less strong than that of pet dogs and their owners, for example. This could explain the fact that dogs rarely touched the experimenter or caregiver, or even gazed at them.

It is challenging to assess the role of fear and stress based on our data. As mentioned above, without further context, walking and going out of the experimental area could be related to both exploring or to stress. We were unable to consider the most common stress signals such as mouth-licking, and panting, since the situation

involved food and the environment had high temperatures, making the cause of these behaviors unclear. Other stress signals (yawn, raise paw, shake and scratch) were rare. The 60 seconds of the trial might not be enough to trigger such behaviors. Or, in fact, the situation was not stressful for those dogs, on the contrary, it was an opportunity to explore.

In the future, other studies could specifically attempt to clear out the effect of stress and excitability. Either way, both arguably play a role in shelter dogs' particular behavior in testing situations and vary accordingly to each dog's individual characteristics. In that light, what can researchers do to better fit shelter dogs - and dogs of other populations than pets - in our experiments?

Since shelter dogs have less exposition to novel stimuli such as different environments and people, it could be proposed that a longer habituation phase could help with their increased excitability, curiosity, or immediate fear. Nonetheless, when comparing a group of shelter dogs with prolonged habituation to a group of shelter dogs with no habituation, Udell and collaborators (2010) found no difference in the time they took to learn to follow a point gesture. It could be that their levels of excitability are so increased that the time needed to habituate was not reached - and it would likely be impractical in most experiments. Additionally, chronic stress can lead to cortisol levels that are not quickly lowered - in Henessy et al. (1997), a positive interaction of 20 minutes with a human had no effect in the plasma cortisol of shelter dogs.

The value of the food reward could also be increased, perhaps with testing of more options for each individual. Effects of different types of food reward on dogs' performance would also need additional testing.

Ultimately, methodologies to compare pet and shelter dogs should take into account that the difference between them is not just a matter of exposure to human contact. Shelter dogs spend most part of their lives enclosed in small rooms. These population of dogs are usually deprived of space, smells, and also intraspecific social contact, which are important aspects of the species as a developing system. We argue that in order to study cognitive abilities in this population it is necessary to plan methodologies that encompass these issues. A bottom-up approach, regarding the *Canis familiaris* as a species with all their particularities, environments, and different conspecific and interspecific associations, instead of a top-down where the western,

urban pet dog is the model to which others must be adapted, could greatly benefit our understanding.

Udell, Dorey, and Wynne (2010) discuss, in that topic, that the study of shelter and feral dogs has similarities with research on wild species, in the sense of having little or no knowledge of their history and experience and being harder to assess experimentally. We add to this consideration that the study of shelter dogs is even more challenging, since besides the lack of their previous history, there is also a current confinement effect that affects their behaviors.

As dogs' social plasticity and the role of different experiences become increasingly clearer in their cognition and communication, thinking of ways to broaden our assessment and understanding of dogs becomes imperative. We propose that 1) a more careful look to current laboratory experiments, allowing us to identify their limitations, 2) exploratory observations of different populations of dogs, and 3) learning from the rich field of *in situ* wild species research could contribute to new, bottom-up approaches to understanding dogs as its own species.

**References**

Alves, A. J., Guilloux, A. G., Zetun, C. B., Polo, G., Braga, G. B., Panachão, L. I., . . . Dias, R. A. (2013). Abandono de cães na América Latina: Revisão de literatura. *Revista De Educação Continuada Em Medicina Veterinária E Zootecnia Do CRMV-SP, 11*(2), 34-41. doi:10.36440/recmvz.v11i2.16221

Barrera, G., Jakovcevic, A., & Bentosela, M. (2008). Calidad de Vida en Perros Alojados en Refugios: Intervenciones para Mejorar su Bienestar. *Suma Psicológica, 15*(2), 337-354. doi:10.14349/sumapsi2008.43

Barrera, G., Jakovcevic, A., Elgier, A. M., Mustaca, A., & Bentosela, M. (2010). Responses of shelter and pet dogs to an unknown human. *Journal of Veterinary Behavior, 5*(6), 339-344. doi:10.1016/j.jveb.2010.08.012

Barrera, G., Mustaca, A., & Bentosela, M. (2011). Communication between domestic dogs and humans: Effects of shelter housing upon the gaze to the human. *Animal Cognition, 14*(5), 727-734. doi:10.1007/s10071-011-0407-4

Brown, W. P., Davidson, J. P., & Zuefle, M. E. (2013). Effects of Phenotypic Characteristics on the Length of Stay of Dogs at Two No Kill Animal Shelters. *Journal of Applied Animal Welfare Science, 16*(1), 2-18. doi:10.1080/10888705.2013.740967

Cordner, Z. A., & Tamashiro, K. L. (2016). Effects of chronic variable stress on cognition and Bace1 expression among wild-type mice. *Translational Psychiatry, 6*(7). doi:10.1038/tp.2016.127

Dufour, A. B., Viggiano, E., Palme, R., Palma, C. D., Natoli, E., Fantini, C., & Barillari, E. (2005). Evaluating the temperament in shelter dogs. *Behaviour, 142*(9-10), 1307-1328. doi:10.1163/156853905774539337

Feuerbacher, E. N., & Wynne, C. D. (2012). Relative Efficacy Of Human Social Interaction And Food As Reinforcers For Domestic Dogs And Hand-Reared Wolves. *Journal of the Experimental Analysis of Behavior, 98*(1), 105-129. doi:10.1901/jeab.2012.98-105

Feuerbacher, E. N., & Wynne, C. D. (2014). Most domestic dogs (Canis lupus familiaris) prefer food to petting: Population, context, and schedule effects in concurrent choice. *Journal of the Experimental Analysis of Behavior, 101*(3), 385-405. doi:10.1002/jeab.81

Gácsi, M., Topál, J., Miklósi, Á, Dóka, A., & Csányi, V. (2001). Attachment behavior of adult dogs (Canis familiaris) living at rescue centers: Forming new bonds. *Journal of Comparative Psychology, 115*(4), 423-431. doi:10.1037/0735-7036.115.4.423

Hennessy, M. (1997). Plasma Cortisol Levels of Dogs at a County Animal Shelter. *Physiology & Behavior, 62*(3), 485-490. doi:10.1016/s0031-9384(97)80328-9

Hughes, J., & Macdonald, D. W. (2013). A review of the interactions between free-roaming domestic dogs and wildlife. *Biological Conservation, 157*, 341-351. doi:10.1016/j.biocon.2012.07.005

Lazzaroni, M., Range, F., Bernasconi, L., Darc, L., Holtsch, M., Massimei, R., . . . Marshall-Pescini, S. (2019). The role of life experience in affecting persistence: A comparative study between free-ranging dogs, pet dogs and captive pack dogs. *Plos One, 14*(4). doi:10.1371/journal.pone.0214806

Mariti, C., Gazzano, A., Moore, J. L., Baragli, P., Chelli, L., & Sighieri, C. (2012). Perception of dogs' stress by their owners. Journal of Veterinary Behavior, 7(4), 213-219. doi:10.1016/j.jveb.2011.09.004

Marshall-Pescini, S., Virányi, Z., Kubinyi, E., & Range, F. (2017). Motivational Factors Underlying Problem Solving: Comparing Wolf and Dog Puppies Explorative and Neophobic Behaviors at 5, 6, and 8 Weeks of Age. *Frontiers in Psychology, 8*. doi:10.3389/fpsyg.2017.00180

Marshall-Pescini, S., Rao, A., Virányi, Z., & Range, F. (2017). The role of domestication and experience in 'looking back' towards humans in an unsolvable task. *Scientific Reports, 7*(1). doi:10.1038/srep46636

Miklósi, A., Polgárdi, R., Topál, J., & Csányi, V. (2000). Intentional behaviour in dog-human communication: An experimental analysis of "showing" behaviour in the dog. *Animal Cognition, 3*(3), 159-166. doi:10.1007/s100710000072

Miklósi, Á, & Soproni, K. (2005). A comparative analysis of animals understanding of the human pointing gesture. *Animal Cognition, 9*(2), 81-93. doi:10.1007/s10071-005-0008-1

Mondelli, F., Previde, E. P., Verga, M., Levi, D., Magistrelli, S., & Valsecchi, P. (2004). The Bond That Never Developed: Adoption and Relinquishment of Dogs in a Rescue Shelter. *Journal of Applied Animal Welfare Science, 7*(4), 253-266. doi:10.1207/s15327604jaws0704_3

Möstl, E., & Palme, R. (2002). Hormones as indicators of stress. *Domestic Animal Endocrinology, 23*(1-2), 67-74. doi:10.1016/s0739-7240(02)00146-7

Ogata, N., Kikusui, T., Takeuchi, Y., & Mori, Y. (2006). Objective measurement of fear-associated learning in dogs. *Journal of Veterinary Behavior, 1*(2), 55-61. doi:10.1016/j.jveb.2006.06.002

Paploski, I. A., Babboni, S. D., Gonzalez, G. K., Giarola, R. M., Rodrigo, S. A., & Cerqueira, A. D. (2012). Characteristics of dog adopters in the urban area of Botucatu/Caracteristicas dos adotantes de caes na area urbana de Botucatu/Caracteristicas de las personas que adoptan perros en la region urbana de Botucatu. *Veterinaria E Zootecnia, 19*(4). Retrieved June 18, 2020, from repositorio.unesp.br/handle/11449/141378

Payne, E., Bennett, P., & Mcgreevy, P. (2015). Current perspectives on attachment and bonding in the dog-human dyad. *Psychology Research and Behavior Management,* 71. doi:10.2147/prbm.s74972

Ross, R. A., & Giller, P. S. (1988). Observations on the activity patterns and social interactions of a captive group of blackcapped or brown capuchin monkeys (Cebus apella). *Primates, 29*(3), 307-317. doi:10.1007/bf02380954

Salman, M., New, J. J., Scarlett, J. M., Kass, P. H., Ruch-Gallie, R., & Hetts, S. (1998). Human and Animal Factors Related to Relinquishment of Dogs and Cats in 12 Selected Animal Shelters in the United States. *Journal of Applied Animal Welfare Science, 1*(3), 207-226. doi:10.1207/s15327604jaws0103_2

Sandi, C. (2013). Stress and cognition. *Wiley Interdisciplinary Reviews: Cognitive Science, 4*(3), 245-261. doi:10.1002/wcs.1222

Santos, B. S. (2018). *“Aqui tem mais cachorro do que índio”: Relações humano-animal entre os Mbya-Guarani no* Jaraguá *(São Paulo/SP)* (Unpublished master's thesis). Universidade Federal de São Carlos.

Soto, R. M., De Souza, A. J., Risseto, M. R., & Lima, B. F. (2006). Adoção de cães no município de Ibiúna – SP – Brasil: Análise crítica. *Revista Ciência Em Extensão, 3*(1). Retrieved June 18, 2020, from ojs.unesp.br/index.php/revista_proex/article/view/360.
Stafford, K. J. (2007). *The Welfare of dogs*. Dordrecht: Springer.

Topál, J., Miklósi, Á, Csányi, V., & Dóka, A. (1998). Attachment behavior in dogs (Canis familiaris): A new application of Ainsworths (1969) Strange Situation Test. *Journal of Comparative Psychology, 112*(3), 219-229. doi:10.1037/0735-7036.112.3.219

Udell, M. A., Dorey, N. R., & Wynne, C. D. (2010). What did domestication do to dogs? A new account of dogs sensitivity to human actions. *Biological Reviews, 85*(2), 327-345. doi:10.1111/j.1469-185x.2009.00104.x

Udell, M. A., Dorey, N. R., & Wynne, C. D. (2010). The performance of stray dogs (Canis familiaris) living in a shelter on human-guided object-choice tasks. *Animal Behaviour, 79*(3), 717-725. doi:10.1016/j.anbehav.2009.12.027

## Chapter 5

## General discussion and conclusions

Dogs have been part of all human societies for thousands of years, in a cooperative and affective relationship that is changing in many ways throughout this time, and in a particularly fast manner in the recent postindustrial societies. Communication between dogs and humans has an important role in this relationship.

In this dissertation, we discussed the process of interspecific communication, and how this applies to the particular situation of domestic dogs and human beings. Additionally, we presented different views about the role of domestication and experience during the lifetime in the dogs' communicative abilities, and we suggested that an interdisciplinary approach and a developing systems view can contribute to the advancement of the field.

In Chapter 2, we reviewed how the unsolvable task has been used to assess dogs' gazing behavior. Their performance in the task has been extensively considered as a reflection of their communicative behaviors, but with a great variation on how to measure them. The role of persistence in dogs' performance has also been recently included in the discussion, with a study (Lazzaroni et al., 2020) using this measure to argue that the task would be actually asocial. We argue that persistence cannot be used as an indicator of a presence or absence of a communicative process in an unsolvable task. As a matter of fact, the persistence is necessary for dogs to perceive that they will not be able to solve the problem by themselves, which encourages the use of human as a social tool to help them to reach the desirable food. The communicative episode starts after dogs persist and fail in the task. We also argue that there is enough evidence to consider dogs' gaze alternation in the task as referential and intentional communication, and that two-steps alternation (target-person or person-target) should be the main predictor of that. We highlight the importance of standardizing this operationalization as well as methodological aspects.

In Chapter 3, the main goal was to assess how different experiences with humans affect dogs' human-directed communicative behavior. Comparing shelter dogs, pet dogs living outside the house, and pet dogs living inside the house, we found that groups that spend more time with people, pet dogs, presented a higher frequency of gaze alternation and higher gaze duration. There was no difference in latency, which

seems to indicate a similar persistence for all groups. The differences were, therefore, observed after dogs failed in the task, i.e. in the communicative behaviors. We discuss the role of experiences in the development and use of communicative behavior in dogs.

In line with literature, shelter dogs in our study showed the lowest level of gazing toward humans. In addition to that, our inclusion of a group of pet dogs living outside the house allowed for a more direct comparison with pet dogs living inside, which is the population primarily assessed. These dogs living outside presumably spend less time with their owner but are not subject to the stressful environment of the shelter. There was a tendency of difference in frequency of gaze alternation between inside and outside dogs, but the only consistently significant difference was in experimenter-directed gaze. We discuss the effect of attachment and secure base effect, since dogs with a stronger bond should be more confident in exploring and interact with strange people. It is possible that dogs that spend more time with their owners develop a more secure attachment, but this was not in the scope of our research and should be further investigated.

Overall, our research shows dogs' social plasticity and the importance of experience in their use of interspecific communication. Little experience with humans was enough to trigger human-directed gazing, and the frequency and quality of these experiences had an active role in the use of this behavior. We discuss that our relationships with dogs and their social-communicative skills are mutually affected by each other.

Chapter 4 was a discussion on shelter dogs' particularities. We presented a research on non-pet dogs, with a focus on the current literature of dogs living in shelters. This population has limited interactions with humans, which leads authors to choose them as a model to study the role of experience (Barrera et al., 2010; Feurbacher & Wynne., 2012; Gácsi et al., 2001; Udell, Dorey & Wynne, 2010). Nonetheless, it is important to highlight that they are subject to a stressful environment and often have an unknown history, which can range from mistreatment to a previous life as a pet dog, most of them came from streets. These factors should be accounted for not only in discussions, but also in our methodologies to study them.

We presented our data of shelter dogs that did not engage in the unsolvable task: these 15 dogs were considered as the "fail group", while the 16 dogs that took

part in the main experiment (presented in Chapter 3) were in the “success group”. These groups were compared regarding the latency to move. Specifically for the fail group we also presented a time budget for some behaviors during the 60 seconds of the first solvable trial, which was the first contact with the apparatus, experimenter and experimental set up. The fail group took longer to initiate walking than the success group. Dogs from fail group spent on average half of the test time outside of the experimental environment, which could be related to increased fear and stress or the need to explore. The rest of time was mostly allocated to walking and sniffing, which reinforced that they were more motivated to explore than to obtain the food.

We discussed the challenge of differentiating the role of exploration and excitability from fear and stress in our framework and proposed that both play a role in shelter dogs’ particular behavior in testing situations. It is important, then, to start planning methodologies that incorporate this information. It is also essential that future studies can focus on other populations different from urban pet dogs. We propose that identifying limitations in current methodologies and an interdisciplinary, bottom-up approach would greatly contribute to our understanding of *Canis familiaris* as its own, heterogeneous species.

Overall, this dissertation brought a new overview, data and discussion contributing to the topic of dog-human communication. This helps us to further understand the process of interspecific communication and of the role of experience in the development of social skills. Finally, but not less important, the understanding of our relationship with dogs can contribute to make the coexistence more harmonious.

**References**

Barrera, G., Jakovcevic, A., Elgier, A. M., Mustaca, A., & Bentosela, M. (2010). Responses of shelter and pet dogs to an unknown human. *Journal of Veterinary Behavior, 5*(6), 339-344. doi:10.1016/j.jveb.2010.08.012

Feuerbacher, E. N., & Wynne, C. D. (2012). Relative Efficacy Of Human Social Interaction And Food As Reinforcers For Domestic Dogs And Hand-Reared Wolves. *Journal of the Experimental Analysis of Behavior, 98*(1), 105-129. doi:10.1901/jeab.2012.98-105

Gácsi, M., Topál, J., Miklósi, Á, Dóka, A., & Csányi, V. (2001). Attachment behavior of adult dogs (Canis familiaris) living at rescue centers: Forming new bonds. *Journal of Comparative Psychology, 115*(4), 423-431. doi:10.1037/0735-7036.115.4.423

Lazzaroni, M., Marshall-Pescini, S., Manzenreiter, H., Gosch, S., Přibilová, L., Darc, L., . . . Range, F. (2020). Why do dogs look back at the human in an impossible task? Looking back behaviour may be over-interpreted. Animal Cognition, 23(3), 427-441. doi:10.1007/s10071-020-01345-8

Udell, M. A., Dorey, N. R., & Wynne, C. D. (2010). The performance of stray dogs (Canis familiaris) living in a shelter on human-guided object-choice tasks. *Animal Behaviour, 79*(3), 717-725. doi:10.1016/j.anbehav.2009.12.027