

Universidade de São Paulo

Instituto de Psicologia

Carine Savalli Redigolo

**FUNCTIONALLY REFERENTIAL AND INTENTIONAL  
COMMUNICATION IN DOGS (*Canis familiaris*)**

**COMUNICAÇÃO FUNCIONALMENTE REFERENCIAL E  
INTENCIONAL NOS CÃES (*Canis familiaris*)**

São Paulo

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Tese apresentada ao Instituto de Psicologia da  
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para obtenção do título de Doutor em Psicologia.

Área de concentração: Psicologia Experimental

Orientadores: Prof. Dr. César Ades (*in memoriam*)

Profª. Dra. Briseida Dôgo de Resende

Co-orientador: Profª. Dra. Florence Gaunet

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AUTORIZO A REPRODUÇÃO E DIVULGAÇÃO TOTAL OU PARCIAL DESTE TRABALHO, POR QUALQUER MEIO CONVENCIONAL OU ELETRÔNICO, PARA FINS DE ESTUDO E PESQUISA, DESDE QUE CITADA A FONTE.

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*To César*

*“I’ve heard it said  
That people come into our lives for a reason  
Bringing something we must learn  
And we are led  
To those who help us most to grow  
If we let them  
And we help them in return  
Well, I don’t know if I believe that’s true  
But I know I’m who I am today  
Because I knew you...”*

*“Wicked - Broadway”*

## César

Who does a second mastering and a second doctorate? Besides having a special interest in animals, one of the greatest motivations to face this challenge (apparent madness) was to interact and work with César...

A brilliant, open and provoking mind. An enthusiastic professor, all students became contagious from that. An ethical, meticulous researcher, and at the same time creative and challenging. He proposed studies that some people would consider excessively adventurous, like spider's memory studies and a dog using a keyboard to communicate, among others.

As a supervisor he was always there for his students. Of all the process of supervising a student, what he liked the most was to discuss ideas; he usually said "*we need a great idea*".

The most interesting quality of this outstanding professor was his multidisciplinary. He supervised students from different areas, like psychology, biology, veterinary, zootechnic among others. However, I am used to say that he reached the peak of the multidisciplinary with me! After all, I came from a really distant area, the Statistics!

In 2004, when I sent him an email saying that I was finishing my first doctorate in Statistics and I would like to start studying animal behavior with him, I did not expected such a quickly and welcoming response. I was aware of the audacity of my request. César answered me that very same day, and from that moment on, we realized that we would share many scientific interests. I found my own route thanks to him.

This last year was not easy to continue without him. Every single day I remembered him and tried to picture how he would be fascinated with the results.

This thesis is dedicated to César Ades. I was his last PhD student, and I hope that I will be able to carry a little of his enthusiasm by the animal behavior for my own students.

## César

Quem faz um segundo mestrado e um segundo doutorado? Além de ter um interesse incomum e especial pelos animais, uma das minhas maiores motivações para encarar esse desafio (aparente loucura) era interagir e trabalhar com o César...

Uma mente brilhante, aberta, instigante. Um professor entusiasmado, contagiava todos os alunos. Um pesquisador ético, meticoloso, e ao mesmo tempo criativo, ousado. Ele propôs pesquisas que muitos considerariam excessivamente aventureiras, como memória em aranhas, um cão usando um teclado, entre outras.

Como orientador estava sempre presente para seus alunos. De todo o processo de orientar um aluno o que ele mais gostava era discutir ideias, sempre dizia “*Precisamos de uma boa ideia*”.

A mais interessante qualidade desse notável professor era a sua multidisciplinaridade. Ele orientou alunos de diversas áreas, psicologia, biologia, veterinária, zootecnia entre outras. Mas eu costumo dizer que ele atingiu o auge da multidisciplinaridade comigo. Afinal, eu vim de uma área muito diferente, a Estatística!

Em 2004, quando lhe enviei um e-mail dizendo que estava terminando meu doutorado em Estatística e queria começar a estudar comportamento animal com ele, eu não esperava uma resposta tão rápida e receptiva. Eu tinha consciência da audácia do meu pedido. César me respondeu no mesmo dia, e a partir daquele momento percebemos que teríamos muitos interesses científicos em comum. Encontrei o meu caminho graças à ele.

Esse último ano não foi fácil continuar sem ele. Todos os dias me lembrava dele e tentava imaginar como ele ficaria fascinado com os resultados.

Essa tese é dedicada ao César Ades. Sou sua última aluna de doutorado, e espero ser capaz de levar um pouco do seu entusiasmo pelo comportamento animal para meus próprios alunos.

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To the **DOGS** and their **owners** that came to the laboratory Saturdays and Sundays specially to participate in this research.

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To my **family**, besides the fact that they frequently asked me to stop studying (!), they know that this is important to me. To my mom, dad and brother, thanks.

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## ABSTRACT

Redigolo, C. S. (2013). Functionally referential and intentional communication in dogs (*Canis familiaris*). Tese (Doutorado), Instituto de Psicologia, Universidade de São Paulo, São Paulo.

The exposure to the human's social environment provided a special niche for dogs to develop socio-communicative skills to cooperate with human. It has been exhaustively studied the ability of dogs to use human's communicative signals. The current study arises a question about the production of signals by dogs to communicate with humans: are dogs able to communicate by using directional signals toward some desirable entity in the environment and with "intention" to manipulate their owner's behavior in order to receive it? Since intentionality is not possible to be measured, some operational criteria can be considered as a requirement to qualify a communicative signal as functionally referential and intentional: the signal should be used socially (to be, first of all, considered as a communicative signal) and influenced by the recipient's visual direction of attention; moreover the sender of the signal should display gaze alternations between the recipient and the object or event to be communicated and getting-attention behaviors, and, finally, the sender should persist and elaborate the communication when the first attempt to manipulate the recipient failed. Dogs were submitted to an experimental study in which they could see a desirable food but they need their owner's cooperation in order to receive it. By manipulating the presence/absence of the owner/food, the position of the food (in two possible places), the owner's visual direction of attention and the owner's behavior regarding the outcome of the request (providing the food, half food or undesirable food) after a period that dogs communicated about the food, we could investigate whether these criteria of referentiality and intentionality were validated for dogs. It was found evidences that dogs use behaviors, especially gaze alternation between the

owner and the food, as communicative signals in a functionally referential and intentional way. The present exhaustive work confirms and upgrades previous results; it also highlights that different set ups can lead to some differences of referential and intentional communicative behaviors in dogs. As for other studies of social cognition in animals, it does not allow disentangling whether the dog's adaptive behaviors are based on simple mechanisms or on a theory of mind of their owners; still, it shows in dogs similar properties of communicative behaviors than in captive apes.

Keywords: Dogs. Communication. Referentiality. Intentionality.

## RESUMO

Redigolo, C. S. (2013). Comunicação funcionalmente referencial e intencional nos cães (*Canis familiaris*). Tese (Doutorado), Instituto de Psicologia, Universidade de São Paulo, São Paulo.

A exposição ao ambiente social humano ofereceu aos cães um nicho especial para desenvolver habilidades socio-comunicativas para cooperar com o ser humano. Tem sido exaustivamente estudada a habilidade dos cães de usar sinais comunicativos do ser humano. O presente estudo levanta uma questão sobre a produção de sinais pelos cães para se comunicar com o ser humano: Os cães são capazes de se comunicar usando sinais direcionados a algum item de interesse no ambiente e com “intenção” de manipular seus tutores de tal forma a recebê-lo? Como intencionalidade não é possível de mensurar, alguns critérios operacionais podem ser considerados como requisitos para qualificar um sinal comunicativo como funcionalmente referencial e intencional: o sinal deve ser usado socialmente (para ser, antes de mais nada, considerado um sinal comunicativo) e influenciado pela direção da atenção visual do receptor; além disso o emissor do sinal deve apresentar alternância de olhares entre o receptor e o objeto ou evento a ser comunicado e comportamentos de chamar a atenção, e, finalmente, o emissor deve persistir e elaborar a comunicação quando a primeira tentativa de manipular o receptor falhar. Cães foram submetidos a um estudo experimental em que eles podiam ver uma comida desejável mas precisavam da cooperação de seus tutores para recebê-la. Manipulando a presença/ausência do tutor/comida, a posição da comida (em dois possíveis lugares), a direção da atenção visual do tutor e o comportamento do tutor quanto ao resultado do pedido (dar a comida, metade da comida ou uma comida indesejável) após um período em que os cães comunicavam a comida, pudemos investigar se esses critérios de referencialidade

e intencionalidade eram válidos para os cães. Foram encontradas evidências de que os cães usam comportamentos, especialmente a alternância de olhares entre o tutor e comida, como sinais comunicativos de uma maneira funcionalmente referencial e intencional. O presente e exaustivo estudo confirma e atualiza estudos anteriores; ele também enfatiza que diferentes cenários podem levar a diferenças nos comportamentos referenciais e intencionais dos cães. Assim como em outros estudos sobre cognição social em animais, esse estudo não permite separar se os comportamentos adaptativos dos cães baseiam-se em mecanismos simples ou em uma teoria da mente do seu tutor; ainda assim, ele mostra nos cães propriedades dos comportamentos comunicativos similares aos dos pongídeos que vivem em cativeiro.

Palavras chaves: Cães. Comunicação. Referencialidade. Intencionalidade.

# **Chapter 1 - Introduction**

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# 1 Introduction

In his book “Kinds of minds” Dennet (1996) remembered that we share a common ancestor with all other mammals, reptiles, fishes, plants and even with macromolecules. All have bodies that follow a self-regulation. We are actually composed by a group of cells, and although each cell has a function and executes it in a systematic way, we do not expected that these cells will have a conscious or intentions to execute these tasks. Our cells are specialized and form different systems (eg. metabolic, immunologic, among others) that, each one with its function “communicates” with others by means of mediators. The neuronal system that appeared in some animals is a very competent innovation of the evolution that allows a more efficient exchange of information. Despite this information exchanges by means of mediators or neuronal systems, we also do not expect that all these complex systems will communicate each other intentionally. Then, Dennet (1996) suggested that an organism constituted by a group of unconsciousness parts can have consciousness, as we have. So the natural question is: what is necessary to produce consciousness and to have beliefs and plans? What is necessary to act and communicate intentionally? There is no simple answer.

Questions about intentions, desires, plans, beliefs and understandings are of interest of cognitive ethologists. Before Griffin (1976), classical ethologists usually explained animal behavior by using parsimonious explanations based only on conditioning and associative processes. Griffin was the pioneer in attributing mentalist interpretations for animal behaviors: he arose the possibility that animals can also possess subjective states since they sometimes present smart and planned behaviors. Zuberbuhler (2003) affirmed that analogies with human mental states, the anthropocentric approach, can help, although he called attention to the danger of assuming this posture when the species being studied have a

considerably less complicated nervous system. Nowadays there is a clear tendency in the literature of cognitive ethology and psychology to use mentalist terms and interpretations for animal behavior. The crucial problem is that subjective states are not measurable and researches should concentrate and limit their conclusions to the behaviors that are observable; it seems more adequate to take careful conclusions without losing the perspective that complex mechanisms can be involved. Shettleworth (2010) defends that an interpretation based on learning and associative processes can be enough to explain the most of animal behavior. And she states that these processes also involve sophisticated mechanisms as well as the more “cognitive” mechanisms. Therefore, this author suggests that a cautious posture would be to interpret these mentalist terms by its functional meaning.

Traditionally, researchers interested in investigating animal cognition, defined by Shettleworth (2010) as a set of mechanisms by which animals acquire, store and process information of the environment, focused their studies on apes, our closest relatives. However, recently dogs (*Canis lupus familiaris* or *Canis familiaris*<sup>1</sup>) appeared to be a more suitable model than apes, specially for answering questions about communication, for many reasons that will be discussed along this text. The purpose of this current research is to investigate whether dogs are able to communicate with humans apparently referentially and intentionally. Hence, in order to better achieve this goal it is necessary to introduce basic concepts of communication, referentiality and intentionality.

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<sup>1</sup> It is already established by the geneticists that the nearest living relative of the dogs is the gray wolf (*Canis lupus*), and dogs are usually categorized as a sub-species of wolves, *Canis lupus familiaris*, based on evidences that they can interbreed and that they are not sufficiently different for a species-level discrimination. However, another line of thought about definition of species, based on the adaptation to a specific niche, leads some researches to consider the dog as a different species (*Canis familiaris*) since dogs and wolves are adapted to different niches (Miklósi, 2007). This discussion is already controversial.

## 1.1 Communication

Communication is a process that involves an interaction between two individuals, a sender who transmits a signal to a recipient and influences his behavior. It is not even necessary an active process, sometimes it is done in a passive way by the sender as, for example, the aposematic insects that transmit by its colour the message that they are not palatable and this information modifies the behavior of their predators that avoid them (Alcock, 2005). The function of a signal can be inferred by the recipient's response.

Shettleworth (2010) suggested that usually the recipient of a message can be thought as acting as a "mindreader" (as well as a user of the sender's signal), in the sense that he can anticipate the next step of the sender and respond appropriately. Sometimes the sender acts as if "manipulating" the recipient's behavior and even as "deceiving" in order to achieve its goal. Nevertheless, this does not imply that animals think and reflect about manipulating or deceiving, but instead they are probably behaving based on previous experiences.

The evolution of a new communicative signal and the adaptative value of a communication system for both sender and recipient of the signal are topics of interest for the evolutionary Ethology. According to Alcock (2005), if by transmitting a signal or by paying attention to it would decrease the fitness of the sender or the recipient, then it would be expected that the behavior of the sender would tend to cease since it would not be adaptative. According to Seyfarth et al. (2010a), if there is no benefit, on average, for the recipient to respond a signal, then recipients should evolve to ignore it, and finally signaling would not have a function to the signaler.

Signals can emerge from incidental movements that have originally given information about future actions and the selection may favor the recipients able to anticipate the future behavior of signaler (Scott-Phillips et al., 2011). For example, a dog can snort without the will (or

intention) to show that it is thirsty. However, the owner can interpret this behavior as thirst and gives him water. Gradually the dog learns that this signal influences its owner's behavior and it acquires a communicative function. The associative learning has, therefore, an important role in the development of communicative signals.

As this previous example, probably great amount of signals emerge by a process called *ritualization* (Scott-Phillips et al., 2011), in which a behavior or a cue that initially had a reason to exist independently of the effect that it could cause in other individual, becomes a signal if it elicits a reaction in a recipient that ends up to be positive for the one that displayed the behavior.

There are various modalities of communication (e.g., visual, sonorous and odorous) and each one presents costs and benefits. Sound is very flexible, varies in tone, volume and the harmonic structure, it is convenient, for example, for birds that live in dense forests. Odor is less flexible but represents smaller energy cost and last in the environment for more time, an advantage for territorialist animals. Colors printed in the animals body remain permanently and can be an advantage to attract females or a disadvantage if attract predators (Shettleworth, 2010). The visual communication depends on the visual perspective and attention of the recipient. What is important to note is that the production and reception of a signal depends on the perception system of the recipient and also the physical properties of the environment (Shettleworth, 2010; Alcock, 2005).

Production and "comprehension" (as wrote Seyfarth & Cheney, 2010b; but could as well be "use") of a signal (measured by the individual's response and use of the signal) involve different mechanisms for the signalers and recipients. While "comprehension" is more flexible and can adapt with experience, depending on mechanisms of learning; vocal production, for example, is more constrained by the acoustic structures that animals is able to utter, depending on mechanisms of phonation (Seyfarth & Cheney, 2010b). Many species of

birds and mammals have a limited repertoire of acoustical vocalisations, but individuals can learn to respond to new sounds in new contexts throughout their lives.

Some examples in the literature strengthen this flexibility of “comprehension”. Among dogs for example, Rico, a border collie breed dog, was able to learn labels of more than 200 different objects (Kaminski et al., 2004), Chaser, another border collie, was able to learn more than 1000 words (Pilley & Reid, 2011), and, Sofia, a mongrel dog, was able to respond appropriately to object-action requests presented as single sentences and generalized the learning for different contexts (Ramos & Ades, 2012).

On the other hand, even though production is more constrained, this does not mean that it is completely fixed. Some studies were successful in training animals to use an artificial wider repertoire of sign production, like, for example, signing bonobo (*Pan paniscus*) as Kanzi (Savage-Rumbaugh, 1994) and again the dog Sofia (Rossi & Ades, 2008), that was also trained to use a keyboard with lexigrams to make requests. Nevertheless, undoubtedly in the wild the production is clearly less flexible and plastic than comprehension (Seyfarth & Cheney, 2010b).

This study will focus on production of spontaneous signals by dog communicating with the owner in a naturalistic context of requesting food. Two important features of communication are of interest for this study, the referentiality and intentionality, so these features will receive a special attention in this work.

## **1.2 Referential communication**

The referential communication involves three components: the signaler, the recipient and a referent. Signals emitted by animals that inform about objects or events in the environment are considered as referential signals (Evans, 1997). It is expected that the production of

referential signals do not occur at a high rate in inappropriate contexts, for example the production of a call that supposedly refer to a certain kind of predator would not be used in the presence of another kind of predator; this property was called “production specificity” by Macedonia and Evans (1993). Moreover, the referential signal should be sufficient for a recipient to select an appropriate response, even in the absence of the object or event that elicited the signal (Shettleworth, 2010); for example, by hearing a call of a conspecific that supposedly refer to a certain kind of predator, the recipient should react with a specific escape response that will save its life from that predator, even if the predator is not visible; this property was named as “context independence” by Macedonia and Evans (1993).

Referential signals should be studied by taking into account that many factors are involved in their production: the physical properties of the stimulus, the environment, the sensory system of the recipient, the historical and social context. Evans (1997) pointed out that studies conducted in laboratories in which animals are placed in a completely novel environment provide *conservative results* for functional reference due to lack of historical context. This should also be taken into account when interpreting laboratory results.

It is not exclusive of the human language to communicate about environmental objects or events. Honeybees (*Apis mellifera*), for example, are well known for being able to communicate about the site of distant food sources by using the waggle dance (Von Frisch, 1955). According to Xitco et al. (2001) dolphins (*Tursiops truncatus*) in captivity are able to produce referential signs. Two bottlenose dolphins were observed using pointing and monitoring behaviors related to both caregiver and object. The posture while pointing and monitoring according to the authors were clearly different from inspecting behavior. They were most likely pointing to indicate food, and the pointing was more likely to include monitoring when the recipient was more distant; moreover, they pointed only in the presence of a human, suggesting that this behavior seems to be influenced by an audience effect and

also by the attentional direction of the recipient. Still, many other mammals produce signals to refer about food, predators or in social contexts.

The most studied form of referential communication was the one based on calls in apes and monkeys. However, postural deictic behaviors are additionally considered as a referential communication, even having different properties.

### 1.2.1 *Referential communication based on calls*

Vocalisations and calls are used by animals mainly for three reasons: food discovery, predatory contexts and social interactions (Townsend & Manser, 2012; Seyfarth et al., 1980; Slocombe & Zuberbuhler, 2005; Slocombe & Zuberbuhler, 2007). Chickens (*Gallus gallus domesticus*), for example, produce food calls to provide information about presence of food for their conspecifics which, in turn, respond with an anticipatory feeding movement (Evans & Evans, 1999). For chimpanzees (*Pan troglodytes*) and bonobos, vocalisations seem to refer to distinct external events: they vocalise when finding food, and these food calls are adjusted to contexts: for example, more often when the source of food is divisible they use a different acoustically call when they find their preferred food, maybe a referential label (Zuberbuhler, 2008). However, Clay et al. (2012) suggested that food calling in mammals could be considered as referential signals only in a few number of species within primates, since some cases food calls are produced also in non-food contexts.

Several species produce acoustically different alarm calls for different predators, as for example, the well-studied vervet monkeys (*Cercopithecus aethiops*) (Seyfarth et al., 1980). These animals use different alarm calls when facing an eagle, a leopard or a python, and, each call elicits a different adaptative response by theirs conspecifics, that act accordingly to what they hear. According to Zuberbuhler (2003), it is unlikely that these calls are just expressing

an emotional reaction to the presence of the predator, since by listening to a playback of eagle alarm calls, for example, it elicits a response to look at the sky and run for cover even in the absence of the visual stimuli of the predator. An audience effect was described for females that adjust the alarm calls according to the presence of their offspring (Cheney & Seyfarth, 1985), and males, that call more often when females are present. Although infants and juveniles sometimes make mistakes in the usage of the calls, these mistakes are not completely at random: they use, for example, leopard alarms to other terrestrial mammals (Seyfarth & Cheney, 1986; Seyfarth et al., 1980), and as the time passes by they acquire experience and their calls become more specific and accurate (Seyfarth & Cheney, 1990), which emphasizes the role of ontogenesis in the alarm call's usage.

Concerning dogs, Faragó et al. (2010) showed that they produce different growl for different external social event and that this is meaningful for the recipients. By hearing a playback of “food guarding” growl, dogs spent less time in contact with the food than when they heard “play” growls or “threatening unknown human” growls. These authors suggested that the effect of food guarding growls could be interpreted in the functionally referential framework.

It is important to point out that not all studies on primates succeed to show an explicit relationship between the alarm calls and the response that it elicits (Fisher et al., 2001; Fisher & Hammerschmidt, 2001; Fichtel & Kappeler, 2002). Macedonia and Evans (1993) also called attention to the fact that alarm calls of ground squirrel (*Spermophilus beecheyi*) reflect differences in the response urgency instead of denoting a specific predator, and, then, cannot be considered referential.

On their side Seyfarth & Cheney (1990) defended that vervet monkeys should have some representations of the objects or events denoted by different alarm calls. Furthermore, Diana monkey (*Cercopithecus diana*) and Campbell's monkey (*Cercopithecus campbelli*) seems to anticipate the presence of a particular predator type when hearing a certain conspecific alarm

call (Zuberbuhler et al., 1999; Zuberbuhler, 2000). Although the leopard's growl and the monkey's leopard alarm calls are sounds acoustically different, monkeys respond as if they judge them to be similar, which indicate that the alarm calls relies on a semantic content of the signal rather than a simple acoustic perception.

The fact that the non-visually stimulus elicits the appropriate escape response for some animals suggest that the calls could be associated to a mental representation of the external object or event, however this conclusion remains controversial (Zuberbuhler, 2003). Whether the referential signals evokes the representation of the referent in the "mind" of the recipient is not possible to confirm, but some animals do act "as if" they understand the semantic content of the vocalisation (Townsend & Manser, 2012).

Since the exact cognitive mechanism related to the alarm calls are unclear, to be parsimonious some researchers prefer to use the term "*functionally referential*" for non-human animals (Evans, 1997; Townsend & Manser, 2012) in order to indicate that their abilities look like the referential communication in humans. Accordingly, it is considered that animals behave "as if" their signals provide sufficient information about external stimuli for a recipient selecting a response, without necessary assuming that there is a mental representation (for example, a concept of the class of the predator – Zuberbuhler et al., 1999).

### 1.2.2 *Referential communication based on deictic behaviors*

Differently from the alarm calls that can be used in the absence of the referent and allows for both sender and recipient to surpass the immediate sensory perception, the manual deixis or pointing, is a kind of nonverbal reference that requires the immediate sensory perception and joint visual attention (both sender and recipient's looking toward the same referent), and is used to direct the recipient's attention (Leavens, 2004a). The act of referring to something by

means of gestures and deictic behaviors is the way that the human infant individual communicates with a recipient about something that is in his/her focus of attention and that he/she wants to share (Bruner, 1998). When the individual did not succeed in transmitting the message by means of these nonverbal referential behaviors, he/she should figure out what else he/she needs to do in order to achieve the goal of directing the recipient's attention to the referent.

Pollick and de Waal (2007) observed that some gestures communicate different messages or intentions depending on the social context. A chimpanzee, for example, stretches out an open hand toward others to "ask for help" in a fight or to require food. In the last example the gesture could be referential since it refers to a third entity in the environment (the food), even not being a pointing gesture with the extended finger (there is an anatomical difference between humans and apes in the shape of pointing: pointing gesture with index finger seems to be frequent only for language-trained apes, see Leavens, 2004a).

It is important to note that gestures are seldom produced in the absence of other communicative cues, such as gazing and vocalisations (Pollick & de Waal, 2007), which suggest that studies on referential communication should integrate when possible multimodal behaviors. Not only the explicit manual gestures should be examined, but especially gaze following, which is also considered as a deictic cue to guide other's behaviors (Shepherd, 2010). It was already verified that in an object choice task, in which dogs had to choose between two containers (only one with food) based on the human's pointing gestures, when this cue was associated with gaze alternations between the recipient of the message and the target, the performance of the use of human's point by the animals increased (Miklósi & Soproni, 2006).

Leavens et al. (2005b) stated that pointing gesture could be used to manipulate the recipient's behavior or to call the recipient's attention, but it would not be possible to assure by means of

an observable behavior, that it would be, in fact, associated to a mentalist representational process.

### **1.3 Intentionality**

Shettleworth (2010) stated that intentionality is a property of mental state, as well as beliefs and desires, plans and understandings. Tomasello et al. (2005), in turn, suggested that an intention would be a plan of action in order to achieve a goal. Intentionality would require the ability to reflect about ways of achieving goals and its consequences (Rochat, 2007).

Dennett (1983) proposed that intentionality should not be treated as a binary trait that animal possess or not, but instead as an attribute that presents a gradation. The zero-order of intentionality would be a simple response to a stimulus, which would represent the absence of intentionality. An animal that possesses beliefs, desires about other's behaviors would have a first-order of intentionality, and if, additionally, it has a concern about the other's mental states, the animal would have a second-order of intentionality. A third-order of intentionality would refer to a level in which the animal would want to make others believe in something, in another words, would consist in manipulating the other's mental states. When humans communicate, they assume that they are modifying not only the recipient's behavior but also his/her mental state (Shettleworth, 2010), therefore the human communication involves a third-order of intentionality. The theory of mind, imputing mental states to others, which would constitute a second order of intentionality, should be present, for example, in an intentional deception, and also when the individual communicates with intent to inform (Shettleworth, 2010). Intentional deception would imply a possibility of creating false beliefs, being, therefore, a way to manipulate other's mind.

The deceiving behavior was already described for many animals. For example, in order to defend its nest, a plover (*Charadrius melodus*) is able to drive away from the nest while pretending a broken-wing as a strategy to distract a predator fox. This behavior is typically interpreted as a response to a stimulus, however its flexibility to achieve the goal challenges the parsimonious explanations (Ristau, 1991 cited by Shettleworth, 2010). Another well-known example of deceiving, presented by Byrne (1995), is the subordinate male baboon (*Papio hamadryas*) that solicits sexual contact with a female when he is out of the dominant's sight, as if he possesses an understanding of what the dominant can see and believe. This behavior can be explained as having a high level of intentionality, however it is also possible to offer a parsimonious explanation, a result of previous experiences in which the subordinate would have not been punished when he was out of dominant's view. Griffin (1976) advocated that a parsimonious and more careful explanation based on associative processes (the so called "low-level" interpretation) should be challenged by a more complex and cognitive explanation (the "high-level" interpretation) when we want to explain the animal behavior. However, it is important to remember that the high-level interpretation cannot rely on observable behaviors. Besides, social learning of complex behavior may be accomplished through simple processes like classical or operant conditioning. Those mechanisms have an important role in modeling animal, including human, behaviors (Fragaszy & Visalbergh, 2001).

All in all, the fundamental question is: what differentiates intentional from motivational or non-intentional action or communication? Since intentions are not directly measurable, researchers have no option other than inferring signalers' intentions through observable external behaviors like gestures, vocalisations or gaze direction. According to Cartmill and Byrne (2010), what seems to be wise is that the study of intentionality of communicative

gestures should be restricted to behaviors that the recipient's reaction matches the presumed goal of the signaler. This is a good route.

### 1.3.1 *The development of intentionality in infants*

Rochat (2007) defended that intentionality emerges in infants as a by-product of reciprocal face-to-face communicative exchanges with their caregivers, which allows them to differentiate an accidental sneezing or coughing from contingent gazing and smiling.

According to Tomasello et al. (2005), 12-months-old infants "understand" (as said by the authors) when adults try to achieve goals that they keep trying persistently after failed attempts and stop when they succeed, which imply an understanding that adults have a perception of the environment and monitor their own actions.

On the other hand, from D'Entremont and Seamans (2007)'s point of view, 12-months-old infants would be able to read cues and determine where others are attending, but this would not imply that they understand others, like self, as intentional agents. This stage would require an understanding of the subjective experience of others and these authors defended that only 18-24-months-old infants appear to be aware of others' subjective experiences, believes, emotions and desires, and, therefore, only at this age, infants could recognize when other's visual perspective is different from their own.

For Tomasello et al. (2005), when infants engage in activities that involve themselves, the caregiver and some outside entity toward which both direct their actions, as for example giving or taking objects, that would require a joint attention (the infants' looking coordinated with other's looking toward the relevant outside objects), they are already in the *triadic* engagement phase. By seeking the joint attention of others, infants would reveal an ability of perceiving that others can see the same thing as themselves.

Tomasello et al. (2005) go further and state that a next step would take place when infants would begin to understand one another as intentional, by forming what they called *shared intentionality*, which refers to a cooperative and coordinated action with a shared goal. It would require that both individuals involved should be mutually responsive to one another, with roles known by both. According to them, in a truly cooperative action with a shared goal, each individual would have goals with respect to the other's goals, in such a way that allowing role reversal and mutual helping, what these authors suggested it would be the critical difference between human intentional communication and the social interactions of other primates. They defend that this is unique for humans (Tomasello & Rakoczy, 2003; Tomasello et al., 2005).

Not all researchers agree with this uniqueness defended by Tomasello et al. (2005). According to Boesch (2005) and Shepherd (2010), in theory, in order to coordinate and synchronize their movements with their group-mates, like for example during collaborative hunts, chimpanzees would use the intended movements of others. Recently Yamamoto et al. (2012) showed that chimpanzees use the information about the conspecific goals and help them appropriately: they are able to select an appropriate tool to give to a conspecific so that it could solve a task to obtain a juice reward. This result should be better investigated, but it could be an example outside the human species of joint attention and a cooperative action.

### 1.3.2 *Referential and intentional pointing gesture in infants*

Various studies focused on the emergence of referentiality and intentionality in infants prior to the development of the language, at around 12-months-old, when they start to use deictic gestures, such as designating a target with referential intentions and cooperative purposes as

an attempt to establish joint attention (Liszkowski, 2011; Tomasello & Rakoczy, 2003; Tomasello et al.; 2005, Tomasello et al., 2007).

The production of pointing gestures comes after the ability to use pointing gesture emitted by humans and it would be a product of learning and social interaction with adults, i.e., it would require a comprehension of others' referential, social, and communicative intentions. Some authors suggested that infant at that age would "understand" people as intentional agents and would know what others see and intend (Liszkowski, 2011; Tomasello & Rakoczy, 2003; Tomasello et al., 2005; Tomasello et al., 2007). This would require the ability of imputing mental states to others, a second order of intentionality according to Dennet (1983).

Legerstee and Barillas (2003) verified that infants who pointed produced more points, gazes and vocalisations when experimenter and infant were looking at different toys, an evidence that infants are taking into account the direction of the visual focus of the human when pointing, and that they use attention-getting behaviors to direct the attention to what they want.

When an adult does not react after infants point, infants persist in their communicative behaviors: they repeat the gesture, by alternating gazes between the event and the adult and increase vocalisations significantly more than when the adult does react by showing interest and sharing attention (Liszkowski et al., 2004). Moreover, infants point less when the adult is not attending to them and cannot see them (Liszkowski et al., 2008).

Additionally, according to Liszkowski et al. (2009), infants pointed as if to referring intentionally to a desirable target even when it was absent. These authors argue that referring to absent entities suggest that these entities exist on a mental level, and that would be an exclusive human skill. Besides, when infants had attended to an interesting event and it had ceased, they continued to point to that location (Liszkowski et al., 2007a).

Two kind of pointing gesture in infants are described in literature (Baron-Cohen, 1999; Leavens et al., 2005b). The first one, the *imperative gestures*, would be used to request and manipulate the recipient's behavior, while the second kind of pointing, the *declarative gestures*, would be used to manipulate the recipient's mental state. Some authors indeed suggest that declarative pointing is found exclusively in human infants and it is the only one that should be considered as genuinely referential and intentional, which means that the pointing used to request would not be considered as intentional (Baron-Cohen, 1999).

On the other hand, Leavens (2004a) described several declarative pointings by language-trained apes that, differently from other captivity apes, have a close emotional bonding with human caregivers. Moreover, he also pointed out that chimpanzees that use gestures usually also exhibit gaze alternation between the recipient of the message and the referent.

According to Leavens et al. (2005b) it would not be possible to assure, by means of observable behaviors, that even the pointing gesture used to call the attention of a recipient would be, in fact, associated to a complex mentalist representational process exclusively found in humans.

A request would also require coordination of attention and skills to engage in cooperative interaction (Gómez, 2007). Both types of pointing gestures would require an association between behaviors and a target through attention; the difference would reside on the goal for pointing: in the case of requesting, the goal would be to make the recipient do some action with the target, and in the case of declarative gesture the goal would be to make the recipient look at and emotionally react *about* the target.

When infants point, their caretakers respond emotionally (i.e., with behaviors acknowledged as positive to the sender). Then Leavens et al. (2005b) suggested that the emotional reaction of signaling about distant objects or events could be the main motivation for infants to engage in joint attention. From this point of view, if the initial motivation for infants to point would

be the manipulation of their social caregiver's emotions, it would not be necessary to assume differences in the psychological process between two kinds of pointing, or to assume that pointing used to call the attention for some object or event would necessarily involve a mentalist concept of the recipient, that the other kind of pointing do not.

Finally, adults also point to request and they supposedly understand others' mental state (Liszkowski, 2007b). Given all these arguments, Leavens et al. (2005b) suggested that we could consider both kinds of gestures as *non-verbal reference*.

#### **1.4 Operational criteria to infer about referentiality and intentionality**

Based on observations and studies with human infants, Leavens et al. (2005b) described some operational criteria to consider a communicative signal as referential and intentional. They suggested that the sender of a signal is communicating referentially and intentionally when:

- a) the signal is used socially, which means that there is an audience effect;
- b) there is an influence of the recipient's visual direction of attention;
- c) there are successive gaze alternations between the recipient and the object or event to be communicated;
- d) the sender presents getting-attention behaviors;
- e) there is persistence, and,
- f) elaboration of communication when the first attempt to manipulate the recipient failed.

The rationalization of these criteria is as follow. The first criterion is necessary to assure that the signals are, in fact, communicative instead of just motivational. Comparisons between a situation with both recipient and object present in the same place and situations without one

of them (recipient or object) allow evaluating the audience effect and the referentiality of the signals respectively: when the recipient is absent it is expected that sender's behaviors towards the object decrease and when the object is absent, the sender's behaviors towards the recipient should decrease. The comparison between the situations with the object present and absent allows investigating whether the sender's signals refers to the object.

In order to validate the second criterion the sender's behavior should be analyzed facing an "attentive" and a "non-attentive" recipient. To infer about what another individual sees, the sender must perceive and use his/her body posture, head and eyes, which would give information not only about how the recipient may respond given previous experiences, but also about the shared environment. The availability of eye contact should be a stimulus to a visual communication: by looking at the recipient's gaze it is possible to monitor his/her attention and reaction, which would show the use of other's direction of visual attention or learning of previous postural and outcome contingencies (Leavens et al. 2005b; Gómez, 2007).

As for criteria (c) and (d) we should analyze the situation in which both recipient and object are present in the same place. In this scenario, if we observe gaze alternation and attention-getting behaviors ("strategies" to guide the recipient's attention to the object), this would indicate that the sender "understands" something about the basic relation between the signal and the causality, and therefore uses the communication signal as a referential tool. It is, in fact, this triangulation of attention between the sender of a signal, the recipient and the object, usually exhibits by means of gaze alternation, that best characterizes referential communication (Gómez, 2007).

Finally, persistence in communicating and the use of elaborated repertoire and new signals until the recipient responds are both mechanisms associated to intentional communication in humans. It is the way to become more "explicit" about the "intentions". In order to evaluate

the persistence and elaboration criteria, the sender should experience different outcomes of its first attempt to communicate regarding the recipient's reaction. In order to validate the persistence criterion, the sender's behaviors should not decrease if the recipient does not react according to the sender's expectation, but decrease significantly if he/she does. Regarding elaboration, if the recipient does not respond to the sender's signals, it is expected that the sender presents a more elaborate repertoire of behaviors when compared to a situation in which the recipient react according to the sender's expectation, and eventually changes the strategy of communication by presenting different behaviors than the ones previously used.

These are observable and measurable criteria that are directly associated to what is considered a referential and intentional communication in humans; therefore, the validation of these criteria on other animals would provide strong evidences that their way of communicating about outside entities can be qualified as functionally referential and intentional.

### **1.5 Referential and intentional communication in apes**

The use of pointing gestures with the right hand by infant is usually associated with the development of language, which supports the link between the left-hemisphere specialization for language and gestural communication. Interestingly, Hopkins et al. (2005) found that chimpanzees also prefer to use the right hand when communicating by means of gesture, an evidence that humans and chimpanzees could share lateralized specialization for use of manual gesture communication.

According to Tomasello et al. (2005), although in the wild apes do not present the same ability as humans to share experiences, interest and attention via declarative gesture and do not engage with others in collaborative activities with shared goals and joint intentions, apes

that are raised in captivity become more like humans, which strengthen that the development of use of intentional action depends on social environment and interactions.

Liszkowski (2011) pointed out that, for apes in captivity, most gestures are ritualized during ontogenesis from individual actions and, consequently, are not shared with others, which means that they would not understand other's gestures. Moreover, chimpanzees would be more prone to compete than to cooperate, which is related to the evolutionary and ecological demands of their sociality (Hare & Tomasello, 2004). These could be the reasons why they fail to use a human's pointing gesture indicating the location of a hidden food (Call et al. 2000; Hare & Tomasello, 2004; Miklosi & Soproni, 2006), which is an informative gesture intended to cooperate and guide the search of the individual. According to these results, we could conclude that apes would not "understand" human's informative pointing and intention, and then they would use themselves pointing gestures only to recruit help, but not to share attention and communicate their referential intents. Nevertheless, this is still controversial.

Gardner (2005), on the other hand, suggested that the comparison between infants that live in a very rich environment and chimpanzees that live in cages, usually under deprived social interactions conditions, is not a fair comparison. This author goes further and asserts that: "*credible comparisons depend on comparable conditions*". Following a similar line of thought, Boesch (2005) also defended that we should not try to validate the hypothesis about human uniqueness by considering only experimental data and disregarding observational data, treating them as mere anecdotes; this author defends that it would be more reasonable if we take into account what animals do in real life before taking our conclusions, since social and meaningful interactions are difficult to evoke in a laboratory.

Leavens and Hopkins (2007) pointed out that studies on apes that found effects of audience and visual direction of attention on communication have observed spontaneous and untrained communicative behaviors. On the other hand, studies that failed in this same goal have first

exposed animals to operant training and then evaluated the response under different manipulations of observer's visual direction. The pre-training and unnatural context could have negative impact on the results.

The simplification of interpretation based on apes in captivity submitted to controlled experimental tests could be the reason of some negative results obtained by, for example, Povinelli & Eddy (1996), in which chimpanzees reared in captivity failed to discriminate between a person with a bucket over his head and another one without it, and many other negative results already mentioned previously. This could also be the reason that leads Hare et al. (2002) and other authors to conclude that dogs are more skillful than great apes in many social tasks in which they must read human communicative signals (this will be better discussed in the next section) since dogs' natural habitat is, actually, the human environment.

Besides the skepticism of some researchers, there are several studies suggesting that pointing gestures that emerges spontaneously in captivity, without explicit training (although the associative processes contributes) (Leavens et al., 2005a) follow the operational criteria mentioned in the previous section and can be consider as a form of functionally referential and intentional communication. More recently also wild chimpanzees were observed using pointing gestures and a referential communicative gesture to request grooming in a specific body area (Hobaiter & Byrne, 2011; Pika & Mitani, 2006).

Several studies reported that apes do not point in the absence of an observer (Call & Tomasello, 1994; Leavens et al., 2004b) and that they adjusted the communication modality in line with the direction of the recipient's gaze (Leavens et al., 2004c; Leavens et al., 2010; Hopkins et al., 2007). They preferred to use visual signals when the recipient was facing them and used other modalities when the recipient was facing away (Tomasello et al., 1994). They were more prone to show begging behaviors towards humans when humans were oriented to the them with body and face; body orientation would be a more clear cue of direction of

attention and indication of willingness to give food than more subtle signals, like for example the status of the eyes, open or closed (Kaminski et al., 2004). Although Hostetter et al. (2001) suggested that chimpanzees use vocalisations to attract human's attention and manipulate his/her attentional status, another study that investigated sequence of gestures revealed that when the recipient of the message was "inattentive", chimpanzees did not use at first a behavior to manipulate his attentional status before a second visual gesture but, instead, they preferred to use another strategy: they modified their location by moving around to face the experimenter, and, only then, they used visual gesture (Liebal et al., 2004).

Gaze alternation between food and the human has also been described on apes (Leavens et al., 2004b; Leavens et al., 2005b) and even in trained squirrel monkeys (Anderson et al., 2007) as a way of guiding other's attention.

Apes use pointing gestures followed by attention-getting behaviors and gaze alternations, and they persist until being rewarded (Leavens et al., 1996; Leavens et al., 1998; Russel et al., 2005; Zimmermann et al., 2009). Orangutans and gorillas were also described using a set of gestures flexibly with clear intentional meaning and functional consequences (Cartmill & Byrne, 2010; Pika et al., 2003; Genty & Byrne, 2010).

Genty et al. (2009) observed in gorillas persistence in goal-directed attempts if the expected result was not obtained. According to Cartmill et al. (2007) orangutans persisted in their communicative attempts when their goal was not met, but they distinguished between being partially understood and completely misunderstood (as said by the authors; but instead of "understood" it could as well be "rewarded"). After communicating about a desirable food, if half of the food was given, they were more likely to repeat gestures; on the other hand, in a total failure situation, they more often presented novel gestures. They also used pantomime to elaborate their messages, a gestural communication that involves physically acting out a message (Russon & Andrews, 2010).

In Leavens et al. (2005b) chimpanzees were presented to three experimental outcomes after communicating an inaccessible banana: (i) the experimenter gave the entire banana (control), or, (ii) the half-banana (partial success of communication), or, (iii) a chow instead of the banana (complete failure of communication). In the complete failure situation they presented more multiple gestures than when they were given the banana.

All things considered, although Tomasello's group affirmed that gestural communication of nonhuman primates shows few signs of referentiality and intentionality (Pika et al., 2007), many studies here described evidences that all observable and operational criteria required to qualify the communication as referential and intentional are present. Nevertheless, gestures on apes may neither be dismissed as simple conditioned reactions nor be recognized as fully equivalent to human referential and intentional gestures (Gómez, 2007).

### **1.6 Referential and intentional communication in dogs**

A natural question that arises from these conclusions with apes is: are dogs able to communicate referentially and intentionally with human? The hard criticism and skepticism to a great amount of studies with captivity apes, lead us to conjecture that possibly dogs are, in fact, a better model than apes to investigate communicative skills: even though dogs are not so genetically close to us as great apes are, they developed throughout more than 30.000 years of domestication process (Davis and Valla, 1978; Galibert et al. 2011) social skills to cooperate with human, which makes this question plausible.

Furthermore, dogs developed a special and unique relationship with humans, an attachment pattern with their owners comparable to a child-mother attachment (Topal et al. 2005; Prato-Previde et al. 2003). The human environment is in fact the natural habitat of modern dogs; the experience and exposure to the human's social environment is usually compared to that of

children (Miklósi & Soproni, 2006). The extensive contact to humans during lifetime provided a favorable scenario for the dogs to develop functionally similar communicative skills, which suggests a possible convergent evolution (Miklósi et al., 2004).

Not surprisingly dogs present a readiness to follow (Soproni et al., 2001; Miklosi et al., 2003; Téglás et al., 2012) and direct (Miklosi et al., 2000; Miklosi et al., 2003; Gaunet, 2008) human gaze in a foraging situation, suggesting that they possibly share attention with humans, an ability that could have been selected and facilitated during the domestication process (Miklosi et al., 2003; Hare et al., 2002). The tendency of following the human's gaze is even higher when it was preceded by the expression of communicative and ostensive addressing by the human (Téglás et al., 2012). However, Agnetta et al. (2000) failed to show that dogs follow the human's gaze into empty space.

Dogs rely on the visual contact with human to monitor his desires and reactions and to respond appropriately to his gestural signals (Miklósi et al., 1998; Miklósi et al., 2003). The readiness to monitor human's attention cues could even overcome the one directed to their conspecifics (Range et al., 2009a; Range et al., 2009b).

Dogs also use body location of a human or a dog as a local enhancement cue (Udell et al., 2008a), which arises the question on whether they use their own body as a local enhancement cue to communicate what they want (Gaunet & Deputte, 2011). They are also skillful in finding hidden food based on human's deictic gestures (Brauer et al., 2006; Hare & Tomasello, 2005; Miklósi & Soproni, 2006).

With all these skills to monitor gestures and signals of attention of a human partner, dogs become able to cooperate with humans in several activities like hunting and herding, among others (Hare et al., 2002; Miklósi, 2007; Hare & Tomasello, 1999). The truly cooperative action with shared goals that is considered by Tomasello et al. (2005) as a requirement to attribute intentionality for infants, seems to be present in this interspecific relationship.

There is an extensive discussion in the literature concerning the role of domestication, that is, phylogenesis, and the role of learning during the ontogenesis on this ability to respond to human's social cues, like pointing or gazing. The domestication hypothesis is supported by results that showed that puppies, from a very young age, are as competent as adults (Riedel et al., 2008; but see Wynne et al., 2008 that contradict it by reanalyzing their data), and, wolves after extensive socialization with humans fail to follow human's cues (Kubinyi et al., 2007; but see Udell et al., 2008b that contradict it). The subsequent selection for working in cooperation with continuous visual contact with their human partner (e.g. herding dogs, gundogs) also seemed to result in breeds that use human's social cues more efficiently compared to non-cooperative breeds of dogs (Gácsi et al., 2009; Wobber et al., 2009). However, the classification of breeds in cooperative or non-cooperative is not still well defined as pointed out by Passalacqua et al. (2011).

On the other hand, by living close to humans and depending on them on a daily basis for all, food, water, social interaction, dogs have all opportunities and motivation to learn how to read/use human's cues (Reid, 2009). It is reasonable to admit that this pre-disposition to respond to human's social cues would be shaped during the lifetime and according to the environment and experiences (Riedel et al., 2008; Wynne et al., 2008; Udell & Wynne, 2010; Dorey et al., 2010, Passalacqua et al., 2011). For example, agility dogs and search-and-rescue dogs are more proficient to use human's gaze as a communicative cue than untrained dogs (Marshall-Pescini et al., 2009).

Both explanations seem to be complementary instead of concurrent. Dogs may have a predisposition to be attentive to human social cues and willing to interact, which might be selected as a by-product of domestication, and also these abilities are constantly reinforced by the intensive social contact with humans during lifetime.

Therefore, it has been claimed that dogs are able to use human communicative signals given the long history of domestication and extensive interaction during lifetime. We then hypothesized that maybe dogs could also be a more suitable model than apes to investigate the production of communicative signals toward humans and its characteristics as the referentiality and intentionality.

The role of domestication in the development of the dog's communicative production is also evident. When facing an unsolvable problem in a manipulation task to reach a piece of food, dogs spent more time gazing at the human and they started to gaze earlier than wolves (their closest relatives) with extended socialization with humans since very young (Miklósi et al., 2003).

There are few studies that explored the intentional and referential communication in dogs. In Miklósi et al. (2000), a target (a piece of food or a favourite toy) was hidden in one of three inaccessible places and dogs should show it to their owners, who was naive about where the target was, in order to receive it. In order to control for the motivational effects of both owner and target present in the room, two additional conditions were presented: only with target and only with the owner. Dogs tried to call the owner's attention to the place of the hidden target, they gaze more often at their owner when the target was present, and they gaze more often at the location of the target when the owner was present. When both owner and target were present dogs also used vocalisation and alternated gazes between the owner and the hidden target. The authors discussed that the "showing" behavior has both a directional component related to a target and an attention-getting component that intends to guide the recipient's attention to the target. The results, interpreted as functionally intentional communication, validate criteria a), c) and d) previously described.

Gaunet and Deputte (2011) also brought evidences to validate these criteria. Dogs witnessed the hiding of their toy in an inaccessible place, and were observed with regard to

communicative deictic behaviors and to their position in relation to the toy's place. Experimental conditions included toy and owner present, only the toy or only the owner present. Results showed that gazing at the toy's place and gaze alternation between the owner and toy's place were used as functionally referential communicative behaviors; moreover dogs used their own position as a local enhancement signal.

In a study designed to investigate the sensitivity of dogs to a helper's "knowledge state" regarding the location of a hidden toy and a stick (a tool for getting the out-of-reach toy), Virányi et al. (2006) provided evidences that dogs were able to present communicative signals about the place of the toy, but rarely about the location of the stick. Moreover, dogs signaled the place of the toy more often if the helper had been absent during toy-hiding than when he witnessed the hiding.

Especially concerning the gaze alternation, in Gaunet (2008), after being trained to open a container in order to achieve a piece of food, dogs were presented to a test situation with the container locked. Dogs, irrespectively of being guide-dogs or pet dogs, gazed at their blind or sighted owners and alternated gazes between the owner and the container when they could not open it.

Besides, it is not only in requesting situations that dogs use gaze alternations; this behavior was also described as a social referential looking. Dogs searched for additional information from their owner by seeking out and monitoring the direction of their gaze, when faced with an ambiguous and fearful stimulus (Merola et al., 2012). Gaze alternation is therefore considered as an important aspect of dog's social cognition when interacting with humans.

There are convincing evidences that dogs tend to gaze at the human's face as a manner to communicate in situations of unsolvable tasks. This tendency may be reinforced and shaped by associative learning. Barrera et al. (2010) showed that in a situation of an unreachable but interested food, dogs gaze at the human's face in order to communicate what they want, the

duration of gaze increased significantly during a reinforcement phase and decreased during an extinction phase when dogs were no longer reinforced. Interestingly, dogs that lived in shelters without constant contact with humans, displayed faster extinction of the gaze behavior than pet dogs, probably because pet dogs are frequently reinforced in their daily interaction with their owner and became more resistant for the extinction. These results were extended when comparing less sociable and more sociable dogs; the first group also gazed shorter at the experimenter during extinction trials (Jakovcevic et al., 2012).

Furthermore, many studies have shown that dogs take into account the observer's direction of attention to beg (Gácsi et al., 2004; Virányi et al., 2004) or to perform forbidden actions (Call et al., 2003). However, dogs are more sensitive to the direction of the head and face of the human rather than eyes (Gácsi et al., 2004; Yamamoto et al., 2011). Gaunet and Deputte (2011) varied the height of the target and the direction of gaze of the owner: the dogs looked at the owner differently according to these experimental manipulations: they positioned themselves as if they had learnt the better place to be seen or to see both the target and the owner.

In the presence of visual barriers, dogs prefer not to approach a forbidden food when they are viewed by a human (Brauer et al. 2004). Also Kaminski et al. (2009) revealed that dogs are sensitive to the human's visual access when asked to fetch a toy. Udell et al. (2011) recently suggested that in a perspective-taking task in which dogs should discriminate between an "attentive" and "inattentive" person, dogs are more prone to choose the "attentive" person when the other option was a situation faced in their environment, like a person reading a book, than when the other option was a situation never experienced before, when the "inattentive" person was with a bucket over the head. This result emphasized the role of the experience in the lifetime, but did not invalidate all evidences that dogs have, and can improve, the use of the visual perspective of others (or of previously learned contingencies

between behaviors of others in particular contexts), which is considered as evidences in favour of the criteria b) previously described.

As far as we know, only one study has investigated the persistence and elaboration on dogs. In Gaunet (2010), 12 guide-dogs and 12 pet dogs participated to a study in which a desired toy was positioned in an inaccessible place and two experimental conditions were presented as an outcome of the dogs' communication: 1) a non-familiar object was returned or 2) the toy itself was returned. Both guide-dogs and pet dogs tried to call the owner's attention using gaze alternation between the toy and owner. Dogs exhibited persistence when the non-familiar object was returned, but they did not present new behaviors, which was interpreted as an absence of elaboration in communication. Therefore, this study validated criterion e) of persistence, and challenged the criterion f) of elaboration.

A dog-human artificial communication that showed indications of intentionality was presented by Rossi and Ades (2008). They trained a mongrel dog, Sofia, to communicate her desires such as, *food*, *water*, *crate*, *walk*, *toy* and *petting*, by pressing her paw in a keyboard with arbitrary signs (lexigrams). Many episodes of keyboard use were video-taped in naturalistic situations and the preceding and following behavior were observed. All objects associated to the keys were always in the room as well as the experimenter. It was found a significant correspondence between the preceding behavior directed to the object and the key pressed. Moreover, Sofia gazed at the experimenter frequently, especially after pressing a key, which suggests that the keyboard use is being associated to the behavior that produces in the experimenter, and it may also be a way of calling his attention. When the experimenter did not respond to the Sofia's request, she pressed repeatedly the same key until receiving what she wanted, a kind of persistence behavior. In addition, Sofia do not use the keyboard when alone, which means that she uses it only in social contexts, and, also the communication through the keyboard is influenced by the human visual access to it (Savalli, Resende & Ades

(in prep.); Savalli et al., 2009). Therefore, even being a case study, there are evidences that some features of the intentionality are present in this especial communication.

Besides most studies indicate strong evidences that dogs, in fact, communicate with their human partner what they want, a recent study failed to show whether dogs would be also able to communicate in order to inform the location of some hidden object that was important only for the human (Kaminsky et al., 2011). By manipulating the interest in objects that could be shared or not by dog and human, this study showed that the experimenter was able to find the object, based on dog's communicative behaviors, more frequently when dogs were interested themselves in the object than when only the experimenter was interested. This result suggested that dogs communicate to request what they themselves want but not to inform what would be of interest only for the human. However, when the owner of the dog replaced the position of the experimenter in this study, dogs were more motivated, as said by the authors, to indicate the location also of the object that their owners wanted; this was evidenced by the performance of the owner in using dogs' behaviors, and thus in finding the object. It is important to discuss that the outcome observed in this study relied on the human's ability to read the dog's communicative behavior, which do not necessary reflects the ability of the dog to communicate. Therefore, this result should be taken carefully and need further investigation regarding the dog's communicative behaviors.

## **Chapter 5 - Conclusion**

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## 5 Conclusion

Leavens et al. (2005b) suggest an operational perspective to evaluate the referential and intentional communication: if an audience and “visual attention” are required for an individual to exhibit a behavior and to coordinate the behavior orientation towards the interested item in the environment and the recipient, if he/she persists and elaborates it when facing a communication failure, then this behavior can be considered as an apparent intentional and referential communication, “about” a specific item of interest. By verifying these criteria for dogs, especially for the gaze alternation behavior, we brought exhaustive evidences that dogs do, in fact, communicate in a functionally referential and intentional way about an entity in the environment.

This study answer some questions and arises many others that can be addressed in the future, as for example, how the production of dog’s communication is influenced by demographic features of the dog, as for example sex, age, breed, or by demographic features of the owner, as for example sex and age, and by the relationship established between them, since there is a huge variation in the way owners treat and interact with their dogs. Additionally, the role of the experience in the dog’s life and level of training on dog’s production of communication can also be investigated.

It is plausible to use “*evo-devo*” approach to explain dog’s behavior. The role of ontogenesis and the learning is outright, but did not exclude a “predisposition” to communicate in this special manner (Miklósi et al., 2000). From an evolutionary perspective, communicating with humans and being especially able to learn cues from humans (i.e., to adjust to them) in order to request a food in an apparent referential and intentional way could have brought a selective advantage for dogs.

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