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**The comparative investigation of the Pedagogical Stance
The role of ostensive-communicative cues in social learning in
dogs and human infants**

PhD thesis booklet

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Introduction

The frequent and highly flexible use of communicative information transmission is a unique skill of the human species. Without it and without the underlying cognitive mechanisms it would be hard to cooperate, share information with others or teach new generations to acquire culturally relevant knowledge. Consequently, communication – again, with its whole cognitive machinery in the background – is a key to understand how humans became one of the most adaptive species that could spread across the world.

Relying on this assumption, the theory of Natural Pedagogy proposes that communication has to have a presumably evolutionary ancient, innate basis to recognize communicative actions and to interpret them as conveying relevant and generic information. The present thesis applies these assumptions, therefore investigates the communicative skills in humans and dogs in a comparative manner to identify what makes us able to recognize and interpret communicative information transfer.

More specifically, the present thesis explores the sensitivity to and function of ostensive cues in dogs, which can express the communicative intention of humans in order to diagnose whether dogs have a similar ability in this domain than adult humans and human infants in line with the suggestions of previous empirical findings. Besides this, the present thesis also tries to unfold the human-specific features of informative signals through the thorough investigation of the sensitivity to and use of human pointing in dogs and human infants.

Therefore, the four studies in this dissertation will address 1) whether dogs are also sensitive to social contingencies which can signal communicative information transmission, 2) whether for dogs – similarly to humans – ostensive cues can express communicative

intention, 3) how dogs interpret human pointing, and 4) why human infants produce pointing.

Thesis points

Thesis I.: Dogs can attribute agency on the basis of contingent reactivity, similarly to human infants

Within the broader framework of the Natural Pedagogy theory (Csibra, Gergely, 2006, 2009, 2011; Gergely, 2013) we investigated dogs' sensitivity to ostensive cue of contingent reactivity and dogs' ability to recognize and attribute agency depending on the degree of the contingent reactivity observed (Tauzin, Kovács, Topál, 2016). We hypothesized that dogs – like human infants – are able to differentiate between the different degrees of contingency displayed by third-party entities, moreover on the basis of highly contingent behavior they can attribute agency to the entities. To test these hypotheses dogs were presented with a self-propelled agent which responded by movement actions to vocal commands played from a computer. In the Perfect Contingency condition the vocal command was always followed by the movement action of the self-propelled agent. In the High-but-Imperfect Contingency condition the response rate was smaller, as the agent responded to the vocal commands only 2/3 of the cases. In the Low Contingency condition the agent had an even smaller response rate. It moved only 1/3 of the cases when a vocal command was played. In the test phase the self-propelled agent approached one of two target objects in four trials. Since empirical results suggest that dogs preferentially choose an object which was previously visited by an agent (Hare, Tomasello, 1999) we assumed that dogs will select the target approached if they had attributed agency to the self-propelled entity. In contrast, in the lack of agency attribution, dogs would select between the targets randomly. We found that dogs selected the previously approached target object significantly above

chance in the Perfect Contingency condition and they choose randomly among the two objects in the Low Contingency condition resulting in a significant difference between these two conditions. The performance of dogs was in between these conditions in the High-but-Imperfect Contingency condition. These results suggest that in line with our main hypotheses dogs can differentiate between the distinct degrees of contingent reactivity and they attribute agency when the degree of contingency is (near) perfect. This ability is similar what was found in human infants (Deligianni, Senju, Gergely, & Csibra, 2011; Johnson, Slaughter, Carey, 1998; Meltzoff, Brooks, Shon, Rao, 2010; Movellan, Watson, 2002; Watson, 1972; Watson, 1994) implying that the sensitivity to contingent reactivity might play a role in the understanding of agency and interactions also in non-human species which could provide a basis for communicative and social skills.

Thesis II.: Dogs follow referential pointing only, if it was preceded (and not followed) by ostensive cues indicating communicative intent. In human-dog communication the order of ostensive and referential signals is fixed similarly to human-human communication

The ostensive-inferential accounts of communication (Csibra, 2010; Sperber, Wilson 1986; Scott-Phillips, 2014; Wilson, Sperber, 2012) posit that a necessary prerequisite of human the understanding of communication is the recognition of communicative intent. According to these theories communicative behavior and the informative content in it can only be identified if communication involves or preceded by ostensive cues that expresses the communicative intent of the speaker. As dogs are highly sensitive to ostensive cues (Kaminski, Schulz, Tomasello, 2012, Topál, Kis, Oláh, 2014) and some referential signals, such as pointing (Hare, Call, Tomasello, 1998; Miklósi, Soproni, 2006; Riedel, Schumann,

Kaminski, Call, Tomasello, 2008) or gazing (Téglás, Gergely, Kupán, Miklósi, Topál, 2012) we tested whether dogs – similarly to humans – are also sensitive to the order of ostensive and referential cues (Tauzin, Csík, Kis, Kovács, Topál, 2015). In order to test this issue, in a within-subject paradigm dogs were provided with signal triplets in two different orders. In the Relevant Sequence condition ostensive cues (looking at the dog while saying the dog's name) preceded the pointing of a human experimenter at one of two lateral target objects and these signals were followed by a non-ostensive attention getter (the clapping of hands). In the Irrelevant Sequence condition the ostensive and non-ostensive signals were switched, therefore the attention of the dog was raised before pointing but without the expression of the communicative intent of the experimenter. After the different signal triplets the dogs were allowed to choose between the two objects. We hypothesized that if dogs are sensitive to the order of ostensive and referential signals and ostensive signals cue the communicative intent of the human to them they will be more likely to follow the referential pointing only in the Relevant Sequence condition and perform around chance level in the Irrelevant Sequence condition. In contrast, if the mere presence of the ostensive cues are enough for the dog to process the referential cue (for instance due to heightened level of attention of the dog) we predicted an above chance performance in both conditions. Our results, however, did not support this latter prediction. We found that dogs follow the pointing of the human experimenter reliably if this referential gesture was preceded by ostensive cues, but choose between the objects randomly when the ostensive cues were produced after the referential signal. This implies that – similarly to humans – ostensive cues serve as a means to convey information about the speaker's communicative intentions for dogs and can indicate that the referential signal is addressed to the dog. These results suggest that the recognition of ostension is not a human specific adaptation and can occur in non-human species as well.

Thesis III.: Ostensive signals cue communicative intention for the dogs. Similarly attention-grabbing non-ostensive cues do not induce the following of referential pointing

A common critique of the sensitivity to ostension holds that ostensive cues are merely efficient attention-grabbing stimuli (e.g. Szufnarowska, Rohlfing, Fawcett, Gredebäck, 2014). The attention modulation hypothesis predicts that all the salient gestures (for instance nodding or shivering) can have similar effects to ostensive cues, therefore they can also trigger the following of subsequent indexical behaviors. This low-level interpretation can be applied to dogs' behavior as well (and probably to other species' behavior also, see e.g. Kaminski, Riedel, Call, Tomasello, 2005; Miklósi, Pongrácz, Lakatos, Topál, Csányi, 2005), suggesting that although the communicative abilities of human infants and dogs seem similar, these skills are, indeed, different and only the characteristics of dogs' and infants' attentional processes are the same. In contrast, the theory of Natural Pedagogy would predict that ostensive cues are more than simple attention-grabbing stimuli as they express the communicative intent of the human. To investigate these alternative interpretations we presented dogs with mere pointing gestures in one condition and pointing preceded by a highly attention-grabbing cue – the clapping of hands – in the other to measure the effect of a salient cue on the following of pointing (Tauzin, Csík, Kis, Kovács, Topál, 2015). We performed this experiment in the same setup as described above at Thesis II. We hypothesized that clapping of hands should induce the following of pointing compared to mere pointing if the attention modulation account is appropriate. However, dogs should show similar performance in both conditions if the clapping of hands cannot have the same role as ostensive cues. We found that dogs' performance did not differ significantly in the two conditions, however they followed pointing significantly above chance if the clapping of hands preceded pointing. This pattern of results indicate that although the clapping of

hands was sufficiently attention-grabbing stimulus for the dogs, they failed to interpret that as an indicator of the communicative intent of the human. Therefore, it seems that the attention modulation account could not explain dogs' sensitivity to ostensive cues and the special role it plays in human-dog communication.

Thesis IV.: In contrast to humans, ostensive pointing by default refer to a location and not to an object for dogs

Referential gestures, in particular referential pointing could convey information about different kind of referents. Although humans usually point to an object and interpret pointing as referring to an object from very early on (Liszkowski, Carpenter, Tomasello, 2006; Tomasello, Carpenter, Liszkowski, 2007) pointing could also indicate a location or direction (Liszkowski, Carpenter, Striano, Tomasello, 2006). By default, human infants seems to have a bias to interpret ostensive pointing as an indexical cue that assigns a specific object. In contrast, they encode location better if a non-ostensive reaching is directed towards a target object at a given location (Yoon, Johnson, Csibra, 2008). Based on these empirical results and considering that dogs are often treated as a model species of human communication (Topál, Kis, Oláh, 2014) we investigated whether dogs have a similar bias than human infants when they follow the pointing gesture of a human communicator (Tauzin, Csík, Kis, Topál, 2015). We presented dogs with one-one lateral target objects on the left and right side of the human communicator who pointed at one of them in an ostensive or non-ostensive manner. After pointing, the human communicator swapped the sides of the two target objects in full view of the dog, and the dog was then allowed to choose one object from the two. We hypothesized that if the default function of pointing is the same for dogs than for humans dogs will select the indicated object at the new location in the ostensive

communicative context. However, if the default function of pointing is different in the two species, they will choose the new object at the previously indicated direction. Our results supported the latter hypothesis. Dogs chose the new object at the indicated direction significantly above chance if ostensive cues manifested the communicative intent of the human experimenter. In contrast, dogs' performance did not differ significantly from chance in the non-ostensive condition yielding a significant difference between the ostensive and non-ostensive conditions. These results imply that the default function of pointing might be different in the two species. For dogs, the sensitivity to referential pointing is presumably evolved to indicate the location where the dog is expected to perform an order given by a human communicator. Unlike human infants, it might have less ecological relevance to them to use pointing as a signal that conveys information about an object or its properties (see Bräuer, Kaminski, Riedel, Call, Tomasello, 2006). Consequently, pointing might be perceived as a protoimperative rather than a protodeclarative gesture by dogs. These findings also highlight that despite the similarities in the overt behavior with humans, non-human species might show these behaviors based on a different cognitive background with a potentially different function.

Thesis V.: Besides its protodeclarative and protoimperative function, referential pointing can also have a protointerrogative function in human infants

The aim and function of infants' referential pointing has been discussed for a long time (Bates, Camaioni, Volterra, 1975). Since then, it was claimed that infants' pointing can either direct the attention of others to interesting objects or events, thus pointing can serve as a protodeclarative gesture or it is produced to indicate which object the infant would like to retrieve, in other words it has a protoimperative aim (Tomasello, Carpenter, Liszkowski,

2007). Recently, it was proposed that referential pointing can also have a protointerrogative meaning for infants (Harris, Lane, 2013; Southgate, van Maanen, & Csibra, 2007) produced to induce an informative response in adults about the referent object. To test this latter proposal and to compare the predictions of the protointerrogative and protodeclarative account we designed a study (Kovács, Tauzin, Téglás, Gergely, Csibra, 2014) in which infants were shown with toy objects from behind a curtain to elicit infants' pointing behavior. If the infant pointed at the object displayed the experimenter reacted to the referential gesture either with giving information about the referent (to satisfy a protointerrogative need – Informing condition) or expressing shared attention without giving any new information (Sharing condition). The new information were emotional reactions in Experiment 1 and pseudowords in Experiment 2, while the sharing of attention was the expression of positive interest (with nodding and saying “ühüm”) or already known labels of objects, respectively. We found that significantly more infants pointed at the toy object in the Informing than in the Sharing condition. Moreover, in contrast to the Sharing condition in the Informing condition there was no decline across trials in the proportion of infants who pointed at the referent. Our results suggest that infants might expect new information about the referent they pointed at, using this referential gesture in a protointerrogative manner. This, however, does not imply that pointing cannot have a protodeclarative meaning in some contexts, rather it suggests that pointing can have more functions than it was previously assumed.

Conclusions

On the basis of the present results we can conclude that dogs have a similar sensitivity to ostensive cues as humans, but they do understand informative signals, at least deictic

pointing in a different way. Although ostension indicates the communicative intention of a speaker for both species – perhaps because dogs were selected to be sensitive to the cues that humans regularly use in their communicative routine – this is not sufficient to have the same communicative skills in dogs and humans, due to the lack of a proper understanding of informative signals in dogs. The fundamental differences between the communicative abilities of these two species, therefore, are meaningful and highly relevant, because they can shed light on one of the causes why humans but not dogs are able to form diverse cultures through vertical information transmission.

From a broader perspective the present results support the theory of Natural Pedagogy on different levels. On the one hand, our findings indirectly suggest how crucial are ostensive cues in human communication through the fact that dogs are also sensitive to those signals. Because dogs were presumably selected to be sensitive to ostension and this could foster interspecies communication among owners and dogs, it can be concluded that ostensive signals are reliable enough to be used by the individuals of an other species in order to discriminate communicative action from non-communicative behavior in humans.

On the other hand, the present findings suggest that humans have a specific set of innate abilities that can help them to understand and perform communicative actions which, importantly, includes both ostensive and informative signals. Because dogs have human-like abilities only in the understanding of ostensive signals, and have only an extremely restricted understanding of informative signals, we could conjecture that dogs do not possess the same set of sensitivities and biases that evolved in humans – but only a part of it. This supports the original claims of Natural Pedagogy but also adds to them by proving that humans' unique social learning abilities are not simply rely on the understanding of ostensive cues but on the specific biases these ostensive signals can trigger.

Thesis-related publications

1. Kovács, Á. M., Tauzin, T., Téglás, E., Gergely, Gy., Csibra, G. (2014) Pointing as Epistemic Request: 12-month-olds Point to Receive New Information. *Infancy*, 19(6), 543-557. doi: 10.1111/infa.12060
2. Tauzin, T., Csík, A., Kis, A., Topál, J. (2015) What or where? The meaning of referential human pointing for dogs (*Canis familiaris*). *Journal of Comparative Psychology*, 129(4): 334-338. doi: 10.1037/a0039462
3. Tauzin, T., Csík, A., Kis, A., Kovács, K., Topál, J. (2015). The order of ostensive and referential signals affects dogs' responsiveness when interacting with a human. *Animal Cognition*, 18(4), 975-979. doi: 10.1007/s10071-015-0857-1
4. Tauzin, T., Kovács, K., Topál, J. (2016) Dogs identify agents in third-party interactions based on the observed degree of contingency. *Psychological Science*, 27(8) 1061-1068. doi: 10.1177/0956797616647518

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