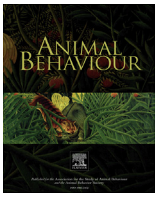
Animal Behaviour 108 (2015) 137–144

Contents lists available at ScienceDirect

Animal Behaviour

journal homepage: www.elsevier.com/locate/anbehav



Dogs rapidly develop socially competent behaviour while interacting with a contingently responding self-propelled object

Anna Gergely [a, b, *], Judit Abdai [a], Eszter Petró [a], András Kosztolányi [c, d], József Topál [b], Ádám Miklósi [a, e]

[a] *Department of Ethology, Eötvös Loránd University, Budapest, Hungary*
[b] *Institute of Cognitive Neuroscience and Psychology, Hungarian Academy of Sciences, Budapest, Hungary*
[c] *Department of Ecology, Faculty of Veterinary Science, Szent István University, Budapest, Hungary*
[d] *MTA-DE "Lendület" Behavioural Ecology Research Group, Department of Evolutionary Zoology, University of Debrecen, Debrecen, Hungary*
[e] *MTA-ELTE Comparative Ethology Research Group, Budapest, Hungary*

ARTICLE INFO

Article history:
Received 16 December 2014
Initial acceptance 4 March 2015
Final acceptance 2 July 2015
Available online 24 August 2015
MS. number: 14-01026R

Keywords:
Canis familiaris
dog–human communication
dog–robot interaction
pointing
social behaviour

The relative contribution of evolutionary and ontogenetic mechanisms to the emergence of communicative signals in social interactions is one of the central questions in social cognition. Most previously used methods utilized the presentation of a novel signal or a novel context to test effects of predisposition and/or experience. However, all share the common problem that the familiar social partners used in the test context as actors carry over a variety of contextual information from previous interactions with the subjects. In the present study we utilized a novel method for separating the familiar actor from the action. We tested whether dogs behave in a socially competent way towards an unidentified moving object (UMO) in a communicative situation after interacting with it in a different context. We found that dogs were able to find hidden food based on the approach behaviour of the UMO only if they obtained previous experience with it in a different context. In contrast no such prior experience was needed in the case of an unfamiliar human partner. These results suggest that dogs' social behaviour is flexible enough to generalize from previous communicative interactions with humans to a novel unfamiliar partner, and this inference may be based on the dogs' well-developed social competence. The rapid adjustment to the new context and continued high performance suggest that evolutionary ritualization also facilitates the recognition of potentially communicative actions.

The key question in sociocommunicative interactions is how communicative signals achieve their function, i.e. how the action of the sender becomes a signal for the receiver. It is widely accepted that two mechanisms may play a fundamental role in the emergence of communicative interactions. (1) The process of evolutionary ritualization assumes (Hinde & Tinbergen, 1958) that during evolution an executive behaviour is transformed into a communicative behaviour with signal properties if it has the potential to predictably modify the behaviour of the partner. During this process the behaviour pattern is subjected to changes making it repetitive, exaggerated and stereotyped. (2) Ontogenetic ritualization takes place if the individuals mutually shape their behaviour during repeated instances of social interactions; that is, regularly occurring behavioural actions gain communicative function (Hinde, 1970). In this case one individual performs behaviour X to which its partner reacts consistently with behaviour Y. As a consequence of many dyadic interactions the first individual comes to anticipate the other's action. Importantly, action X is not a communicative signal at the start of the process but develops into one as a result of mutual interaction and learning (Tomasello, 1996).

Several studies have focused on the relative contribution of evolutionary versus ontogenetic mechanisms controlling certain communicative signals and their species- or context-specific aspects. For example, Halina, Rossano, and Tomasello (2013) examined gestural communication of captive bonobos, *Pan paniscus*. Based on the flexibility and variability of these signals they suggested that ontogenetic ritualization is the primary underlying mechanism for the emergence of diverse signalling behaviour. In contrast, Hobaiter and Byrne (2011) argued that ape gestures are rather innate and are acquired through evolutionary ritualization even if they are often used intentionally and flexibly.

---

* Correspondence: A. Gergely, Csikó sétány 11 Fsz. 4, 1214 Budapest, Hungary.
E-mail address: anna.gergely66@gmail.com (A. Gergely).

http://dx.doi.org/10.1016/j.anbehav.2015.07.024
0003-3472/

A similar argument has emerged in relation to the comprehension of human pointing gestures in dogs, *Canis familiaris* (for reviews see Miklósi & Soproni, 2006; Udell, Dorey, & Wynne, 2009). One assumption is that dogs must learn to use human communicative signals during early ontogeny (ontogenetic ritualization); thus this ability emerges as a consequence of habitual interaction between dog and owner (Bentosela, Barrera, Jakovcevic, Elgier, & Mustaca, 2008; Udell & Wynne, 2010). The alternative but nonexclusive explanation is that during the process of domestication dogs have been selected by humans to be sensitive to specific human behavioural cues (e.g. pointing: Riedel, Buttelmann, Call, & Tomasello, 2006; gazing: Soproni, Miklósi, Topál, & Csányi, 2001; human voice: Rossano, Nitzschner, & Tomasello, 2014). The superior performance with the human pointing gesture in young dog puppies over socialized wolf puppies provides support for this latter argument (e.g. Gácsi et al., 2009).

Recent discussion has converged to the idea that both mechanisms might play a role in the emergence of such interspecific signalling (Miklósi & Topál, 2013; Udell, Ewald, Dorey, & Wynne, 2014); however, it is still an open question how the relative contribution of evolutionary and ontogenetic ritualization could be determined. Methodologically, three different approaches have been used so far: (1) deprivation of social experience (e.g. shelter dogs: Hare et al., 2010; Udell, Dorey, & Wynne, 2010); (2) demonstration of the effect of learning on the performance in a communicative interaction between dogs and humans (Elgier, Jakovcevic, Mustaca, & Bentosela, 2009; Udell, Dorey, & Wynne, 2008); (3) testing the effectiveness of (relatively) novel communicative human signals in typical dog populations (Lakatos, Soproni, Dóka, & Miklósi, 2009).

Tomasello, Call, and Gluckman (1997) proposed that observing infants' and apes' reaction to novel signals would be a feasible method to examine their understanding of communicative signals. They also argued that any genetic predisposition would lead to lesser need for learning (or experience) or rapid learning. The method of triangulation (e.g. Heyes, 1997) is useful for such investigations: (1) first, the naïve individual is exposed to a specific experience (or has to learn to discriminate) in Context 1 then (2) the individual is exposed to a novel context (Context 2) which overlaps only in specific ways with Context 1 by sharing only a small set of specific features. This method, however, is not really informative when investigating communication skills because the social partner carries over a considerable part of the contextual information from Context 1 to Context 2. For example, dogs experience human pointing gestures in everyday life (Context 1), and this experience with humans, including a possible genetic predisposition, does not allow researchers to set up an experiment (Context 2) that overlaps only specifically with Context 1 because the human is present in both contexts. Thus it is difficult to judge the relative role of evolutionary/developmental processes. The introduction of an unfamiliar communicative partner might be a solution to this problem because it has the potential to reveal subjects' ability to recognize the communicative aspects of the partner's behaviour.

In this paper we propose a new method which is based on the idea of introducing an unidentified moving object (UMO) to the experimental setting. Accordingly, (1) the subject is exposed to a particular type of social interaction in Context 1 and to a different kind in Context 2; (2) in order to reduce the potential effects of previous experience, the social agent (UMO) shares no physical attributes with either the subject (dog) or other potential social partner (human); (3) social interactions share specific features with the natural social interactions among conspecifics and/or heterospecific familiar social agents (A).

The underlying assumptions are that (1) the subject has earlier experience with A and knows that A is able to perform actions X and Y, (2) it recognizes that the UMO is performing action X in Context 1, (3) and it infers that the UMO can also perform action Y in Context 2.

In the present study dogs were presented with two different partners (Human and UMO) in four different conditions in a between-subjects design. The Interactive UMO and the Noninteractive UMO were remote-controlled cars. In the Interactive Human and Noninteractive Human conditions the partner was an unfamiliar female human (see Gergely, Petró, Topál, & Miklósi, 2013). During the familiarization phase, dogs in the Interactive UMO and Human conditions were presented with a problem situation (Context 1) in which the UMO or a human helped the dog to get an unreachable food reward (see Gergely et al., 2013; Miklósi, Polgárdi, Topál, & Csányi, 2000). In contrast, no such interaction took place in the Noninteractive conditions. Then in the test phase (Context 2) all dogs had the opportunity to find the hidden food based on the indicating ('signalling') behaviour (directional movement towards one of the two potential hiding places) of the UMO or the human partner. The differences in the familiarization phase tested for the effect of previous social experience with the Human or UMO partner on dogs' choice behaviour when observing the partner's indicating behaviour (Context 2).

METHODS

Ethical Note

Our experiment is based on noninvasive procedures for assessing dogs' behaviour. Noninvasive studies on dogs are currently allowed to be done without any special permission in Hungary by the University Institutional Animal Care and Use Committee (UIACUC, Eötvös Loránd University, Hungary) as under current law ('1998. évi XXVIII. Törvény', the Animal Protection Act) they are not considered as an animal experiment. The owners responding to our advertisement at the department's homepage (http://kutyaetologia.elte.hu) volunteered to participate.

Subjects

We recruited 82 adult pet dogs (36 females, 46 males, mean age ± SD 4.1 ± 2.4 years, from 23 different breeds and 25 mongrels) from the Family Dog database of the Department of Ethology, Eötvös Loránd University, Hungary. Dogs were randomly divided into four conditions (groups): Noninteractive Human, Noninteractive UMO, Interactive Human and Interactive UMO. We only tested dogs that could be motivated by food. Fourteen dogs lost interest (i.e. they did not make their choice in 60 s in the test trial). We also excluded eight dogs because they showed strong side bias (they always approached the same pot either on the left or on the right in all 16 trials: two dogs in the Noninteractive Human condition; two dogs in the Noninteractive UMO condition; three dogs in the Interactive Human condition; one dog in the Interactive UMO condition). However, including these dogs in the analyses does not change our conclusions (for the analysis see Appendix). After these exclusions we had 60 dogs in the four conditions: 15 in the Noninteractive Human (six males, nine females, mean age ± SD 4.70 ± 2.48 years), 15 in the Noninteractive UMO (seven males, eight females, mean age ± SD 3.57 ± 1.69 years), 15 in the Interactive Human (10 males, five females, mean age ± SD 4.20 ± 2.46 years) and 15 in the Interactive UMO condition (six males, nine females, mean age ± SD 17 ± 2.05 years). Dogs' age did not differ significantly between conditions (ANOVA: $F_{3,56} = 1.42$, $P = 0.25$). Each subject participated only in one condition.