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Dog (*Canis familiaris*) growls as communicative signals

Acoustic and behavioural analyses

PhD Thesis

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Background

The view of animal acoustical communication changed a lot through the last forty years. Several different species' calls were found to be not just projections of the callers' inner state, but having a communicative role (Owings & Morton 1998; Maynard-Smith & Harper 2003). The ethological studies of animal vocal communication showed that these signals can carry information about the caller's physical attributes (Fischer et al. 2004), inner state (Blumstein 2007), identity (Antunes et al. 2011), and also external objects and events (Seyfarth et al. 1980; Evans & Evans 1999).

The species of the *Canidae* family have a remarkably rich vocal repertoire (Cohen & Fox 1976). In the last decade several studies showed that the vocalizations of the family dog (*Canis familiaris*) changed significantly during the domestication, and these calls can have an important role not just in the intraspecific but in the interspecific, dog-human communication (Pongrácz et al. 2010).

In this work, we aimed to study the communicative aspects of dog growls. This vocalization is a short and repetitive or elongated, broadband, low frequency (80-300 Hz) call with low frequency variability, high amount of noise but with still visible harmonic structure (Riede & Fitch 1999). It is a common call type in the Canids, mostly used in agonistic contexts (Cohen & Fox 1976). However, the domestic dogs use it also in play contexts (Yeon 2007). This functional duality suggests that dog growls possibly carry contextual information. Recently it was also found that a dogs' growl contains size cue about the caller and humans are able to assess the size of the growling dog based on this vocal cue (Taylor et al. 2008).

Aims

We aimed to study the role of growls in both inter- and intraspecific communication, and reveal what information it can possibly convey about the caller, and its social contexts.

In our first study, we tested the acoustical differences between growls recorded in different social contexts (play, threatening and food competition). In the second study, we tested the possible context specificity of these growls. The third study aimed to test how dogs are able to assess the size of a growling conspecific based on its growl. Finally, we studied how humans perceive growls, and whether they are able to categorize them by their contexts and attribute the assumed inner state to the growling dog.

Methods

Acoustical analysis

We recorded several sequences of growls from dogs in three different contexts: (1) during play, (2) guarding a bone from another dog, and (3) reacting to a threatening human. We measured several acoustical parameters (length, fundamental frequency, formant dispersion, tonality) with Praat linguistic software, and compared the growls between the three contexts.

Behaviour analysis

Playback study

In our second study, we performed playback tests in a semi natural food guarding situation. In three groups 41 dogs participated in the test (5 had to be excluded from the analysis due to low motivation). We placed a juicy bone on the ground near a covered dog cage. Speakers were hid in the cage, and when the subject approached the bone and tried to touch it, we played back a growl from one of the three contexts. We compared between the three groups the latencies of the first contact with the bone after hearing a growl, the latency of leaving the bone last time, the frequency of contacting the bone and the time percentage of handling the bone.

Crossmodal presentation study

In the third experiment, we applied the Looking Preference Paradigm to test the size assessment in dogs. The main idea in this paradigm is that when hearing a sound parallel with the presentation of two visual stimuli, and only one of the visual stimuli can be linked to the sound, if a subject is able to link this crossmodal information, it will prefer to look first, and longer at the matching stimulus (preference). In sum 116 dogs participated, but we had to exclude 20 dogs from the analysis. We had four groups based on the presented stimuli.

Dog-Growl (DG) – matching modalities: presentation of dog growls with projection of dog pictures. (N= 24)

Dog-Noise (DN) – non-informative sound: presentation of Brownian noise with projections of dog pictures. This control was conducted to test if there was any effect caused by the size difference of the dog pictures on the looking behaviour of the subjects. (N= 24)

Shape-Growl (SG) – non-informative picture: presentation of dog growls with projection of triangles. This control group was used to test if the looking preferences of the dogs were nonspecific in that they would occur also with non-natural, unknown pictures. (N= 24)

Cat-growl (CG) – non-matching modalities: presentation of dog growls with projection of cat pictures. This control was conducted to test the effect of the nature of the pictures. (N= 24)

The presented growl was an aggressive, food guarding growl, half of them recorded from small dogs (height <52 cm), half from large ones (height >60 cm). The two presented pictures differed only in their size, one was matched to the growling dog's height, the other was 30% smaller or larger. We measured the latency of the first looking at the pictures and the looking time. We calculated the preference (looking time of one picture divided by the sum of looking times) towards the matching picture, the bigger picture and also measured the side preference, and compared these parameters between the four groups.

Questionnaire study

Finally, we played sequences of natural growl samples recorded from 18 dogs in our three contexts for 40 adult humans. All growl samples were 10 seconds long, and contained at least three growls. All subject heard two sequences of six different growl samples, containing 2 samples from each context. We also replayed the first sample at the end of the sequence in both presentation to test the validity of our questionnaires. All subjects were asked to fill two questionnaires. In the first one, during listening the first sequence, they had to rate each growl on emotional scales. We used Visual Analogous Scales for the following emotions: aggression, fear, despair, happiness and playfulness. We asked them to guess the possible context of the growls during hearing the second sequence. In the analysis, we tested the validity of the questionnaires by measuring correlation between ratings and guesses of the repeated samples. We compared the emotional scalings between and within the three contexts. We compared the rate of the correct guesses in all the three contexts to the random level (33%). We also tested the possible effect of several background variables (age, gender, experiences with dogs), and the effect of the acoustical differences between growls.

Results and conclusion

We found that play growls differ acoustically from the other two agonistic types of growls. The agonistic growls are longer, deeper pitched and their formant dispersion was higher than the play growls'. These results suggest that growls are possibly convey context specific information.

In the second, playback study, results showed that food guarding growls deter other dogs more effectively from taking away a seemingly unattended bone than growls recorded in the threatening stranger, or the playful situation, The fact that the contextually matching growl was the most effective suggests that dogs could decipher the encoded contextual information.

In the third study our results showed that dogs look sooner and longer at the dog picture matching the size of the caller, when they hear dog growls. No such preference was found with any of the control stimuli, suggesting that dogs have a mental representation of the caller when hearing its vocalization.

In the last study, humans were able to categorize correctly the growls above chance, although they often confused the two agonistic growl types. They rated the growls' emotional background in accordance with the assumed inner states of dogs. Interestingly they found the food guarding growls significantly more aggressive than the growls from the other agonistic context.

In summary, our work provides the first evidence on the possibility of functional referential calls in a large terrestrial carnivore; also we showed first dogs' ability to assess the size of a growling conspecific, and their capability to process crossmodal information. Moreover we showed that humans are able to recognize the emotional background and the contexts of the heard growls based on their acoustical and temporal structure. All these suggest that growls can have an important role in both inter- and intraspecific communication.

The most important findings

- We found significant acoustical differences between playful and agonistic growls.
- We showed that in a modelled food competition context dogs react differently to the contextually adequate growls than the playful or the threatening stranger growls. This suggests that growls can convey context specific information, thus our work provides the first evidence of the possibility of functionally referential communication in a large terrestrial carnivore.
- We showed first that dogs are able to assess the size of a growling conspecific. We applied first the Looking Preference Paradigm in studying vocal communication in dogs.
- Our results also suggest that this size assessment is not based on a general size information, but possibly species specific, because dogs showed appropriate looking preference only in the case of matching dog-growl presentation.
- In our questionnaire study we found that our subjects were able to attribute the appropriate emotion to growls recorded from different social contexts, and they were able to correctly categorize them by their contexts.
- The humans often confused the two agonistic growls, although they scaled the food guarding growls more aggressive than the threatening stranger growls.
- The fundamental frequency and length of the growl affected the playfulness scaling: shorter and higher pitched growls were scaled to more playful. The length of growls also positively correlated with the negatively valenced scales (aggression, fear, despair) and negatively with positively valenced ones (playfulness and happiness)

Publications

Publications giving the basis of the dissertation

Faragó Tamás, Pongrácz Péter, Friederike Range, Virányi Zsófia & Miklósi Ádám (2010) ‘The bone is mine’: affective and referential aspects of dog growls. *Animal Behaviour* 79:917-925 DOI: 10.1016/j.anbehav.2010.01.005

Faragó Tamás, Pongrácz Péter, Miklósi Ádám, Ludwig Huber, Virányi Zsófia, Friederike Range (2010) Dogs’ Expectation about Signalers' Body Size by Virtue of Their Growls. *PLoS ONE* 5: e15175. DOI: 10.1371/journal.pone.0015175

Publication in connection with the dissertation

Maros Katalin, Pongrácz Péter, Bárdos György, Molnár Csaba, Faragó Tamás & Miklósi Ádám (2008) Dogs can discriminate barks from different situations. *Applied Animal Behaviour Science* 114:159-167 DOI: 10.1016/j.applanim.2008.01.022

Molnár Csaba, Pongrácz Péter, Faragó Tamás, Dóka Antal & Miklósi Ádám (2009) Dogs discriminate between barks: the effect of context and identity of the caller. *Behavioural Processes* 82:198-201 DOI: 10.1016/j.beproc.2009.06.011

Other publications

Faragó Tamás, Friederike Range, Virányi Zsófia & Pongrácz Péter (2009) The bone is mine!—context-specific vocalization in dogs. *Journal of Veterinary Behavior: Clinical Applications and Research* 4:56–57 (CSF 2008 - Conference abstract) DOI: 10.1016/j.jveb.2008.09.026

Conference participations

Faragó Tamás, Friederike Range, Virányi Zsófia & Pongrácz Péter (2009) The bone is mine!—context-specific vocalization in dogs. 1st *Canine Science Forum, Budapest*, Poszter

Faragó Tamás, Friederike Range, Virányi Zsófia, Pongrácz Péter & Miklósi Ádám (2009) „Az a csont az enyém” – a kutyamorgás mint lehetséges funkcionálisan referenciális jelzés MAKOG Konferencia, Oral presentation

Faragó Tamás, Pongrácz Péter, Friederike Range, Virányi Zsófia, Miklósi Ádám (2009) Affective and referential aspects of agonistic and non-agonistic dog vocalizations 31st *International Ethological Conference, Rennes*, Oral presentation

Faragó Tamás, Pongrácz Péter, Miklósi Ádám, Ludwig Huber, Virányi Zsófia Friederike Range (2010) ‘Beware, I’m big and dangerous’ - Dogs can assess the caller’s body size when hearing dog growls 2nd *Canine Science Forum, Vienna*, Oral presentation

Faragó Tamás (2011) Communicative aspects of dog growls 1st *Workshop on Vocal communication and Social Cognition, Zürich*, Invited speech

Szabó Csanád, Róka András, Faragó Tamás, Gácsi Márta, Miklósi Ádám & Korondi Péter (2011). Building a Human-Dog Interaction Inspired Emotional Engine Model. *Proceedings of the 2nd International Conference on Cognitive Infocommunications*. Budapest, HU: IEEE. Oral presentation and conference proceedings paper.

Not published scientific essays and reports:

TÁMOP ETOCOM Project (TÁMOP-4.2.2-08/1/KMR-2008-0007):

- 1. Az akusztikai kommunikáció etológiai modellje - Adatbázis leírás**
- 2. Ethological model of acoustic communication**
- 3. A viselkedés etológiai modellezése**
- 4. Az emóció etológiai értelmezése**
- 5. Egy érzelmi dinamikai modell**
- 6. Az evolúció fogalmának értelmezése az informatikai rendszerekre**
- 7. Az evolúció értelmezése egy info-kommunikációs rendszerre - A mobiltelefonok evolúciója**
- 8. Az etológia fogalmának kiterjesztése informatikai rendszerekre**
- 9. Ember-robot szociális interakciók**

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