Sign and strength of emotional arousal: vocal correlates of positive and negative attitudes to humans in silver foxes (*Vulpes vulpes*)

Svetlana S. Gogoleva¹), Ilya A. Volodin¹,²,⁴), Elena V. Volodina²), Anastasia V. Kharlamova³), & Lyudmila N. Trut³)

¹) Department of Vertebrate Zoology, Faculty of Biology, Lomonosov Moscow State University, Vorobievy Gory, Moscow 119991, Russia; ²) Scientific Research Department, Moscow Zoo, B. Gruzinskaya, 1, Moscow 123242, Russia; ³) Institute of Cytology and Genetics, Siberian Branch, Russian Academy of Sciences, Pr. Lavrentjeva, 10, Novosibirsk 630090, Russia

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Summary

The hypothesis of similarity in trends of acoustic characteristics regardless of the sign of emotional arousal, positive or negative, has been advanced based on human vocalizations. For non-human mammals, testing is complicated because the same stimulus cannot evoke opposite (positive and negative) internal states, to trigger the respective vocalizations. To resolve this concern, we designed an experimental procedure using Tame and Aggressive strains of silver foxes, with genetically predetermined positive or negative emotional responses to humans respectively. We analyzed features of vocalizations produced by callers at different fox–human distances, assuming changes in vocal responses reflect the shifts of human-related positive arousal in Tame foxes and human-related negative arousal in Aggressive foxes. Both strains showed similar trends for changes in calling rate and proportion of time spent vocalizing toward higher levels in response to greater emotional arousal, positive in Tame foxes and negative in Aggressive foxes. At the same time, strains showed distinctive trends for the proportions of different call types and maximum amplitude frequency. We infer that the variables with similar trends reflect the strength of emotional arousal, regardless of triggering internal states, whereas variables with distinctive trends are specifically related to the sign of emotion in silver fox.

Keywords: vocalization, human-approach test, emotional arousal, acoustic communication, Canidae.

⁴) Corresponding author’s e-mail address: volodinsvoc@gmail.com

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Introduction

Answering the questions surrounding the relationship between vocal structure and emotional arousal is of utmost importance. From a theoretical perspective vocal expressions of emotion are a common feature of human and non-human communication (Darwin, 1872; Bachorowski & Owren, 2003, 2008). From a practical perspective vocal correlates of emotional arousal can provide immediate and reliable indicators of welfare problems both in humans (e.g., Furlow, 1997; Protopapas & Lieberman, 1997) and in non-human animals (e.g., Weary & Fraser, 1995b; Watts & Stookey, 2000; Gogoleva et al., 2010a).

The term emotion is ambiguous because it is used differently in psychology, neuroscience and behaviour studies. More than a hundred definitions for the term emotion and the related terms (affect, motivational state, internal state, emotional quality) can be found in the literature, and some authors even avoid distinguishing between emotional and motivational terms (e.g., Jürgens, 1979). To date, there is no scientific consensus on emotions in animals, namely, what certain species feel and how these feelings can be examined. However, it is possible to judge unambiguously at least of the sign of emotion (negative to positive), and of the strength of emotional arousal (low to high), i.e., about trends of the negative and positive emotional arousal. Consistently, robust vocal correlates of two alternative internal states, aggression and fear, have been stated empirically across 28 mammalian and bird taxa (Morton, 1977).

Vocal correlates of the sign of emotion can be revealed from differences in vocal responses to comfort and to discomfort. Vocal correlates of gradations in emotional arousal can be revealed from shifts in values of acoustic parameters with an increase or decrease of positive or negative stimulation. For humans, vocal correlates of emotional arousal have been reported both for negative and positive emotions. In newborns an increase in positive or negative emotional arousal results in the same acoustic effect, namely in the increase of the fundamental frequency (Papousek, 1992; Scheiner et al., 2002), duration and amplitude (Papousek, 1992). In adults, responding vocally to verbal approval or censures, an increase of positive or negative emotional arousal shows similar shifts in acoustic characteristics towards a higher fundamental frequency of vowels (Bachorowski & Owren, 1995). Consistently, the amplitude, fundamental frequency, maximum amplitude frequency and