

Volodina EV, Volodin IA. Bioacoustical features of self-esteem in the cheetah.
Ref Type: Unpublished Work

Keywords: 7RU/Acinonyx jubatus/captivity/cheetah/social behavior/vocalisation/zoo

Abstract: We revealed some of the vocal indicators of the internal state in the cheetah (*Acinonyx jubatus*) in captivity. The sounds were recorded from 6 males, 8 females and 14 juveniles from 5 litters in Moscow Zoo from 1984 to 1992. The cheetah's vocal repertoire, the comparison of adult and juvenile sounds, and the dependence of the social role are described.

Bioacoustical features of self-esteem in the cheetah

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Introduction

The theory of mammalian vocal control says that most of mammal sounds (except of voluntary operant vocalizations and pain call) are secondary to emotion and derive from cerebral emotional centres (Jürgens, 1988, 1995; Jürgens, Ploog, 1981). The close relationship between certain call structures and pleasant or aversive emotional states suggests the use of animal sounds as welfare indicators. But animal sounds have a potential to provide much more extensive information about the internal state of a caller. We revealed some of the vocal indicators of the internal state in the cheetah (*Acinonyx jubatus*) in captivity.

Animals and methods

The sounds were recorded from 6 males, 8 females and 14 juveniles (1,5-3 month old) from 5 litters in Moscow Zoo from 1984 to 1992. More than 7000 sounds were analysed spectrographically. All the calls were recorded during routine everyday management (feeding, walking, pairings, separations, reunions, introduction of new members into a group, etc.). We used data pooling procedure in vocal repertoires analysis (under the procedure the data from different individuals are treated as independent events) (Leger, Didrichsons, 1994). The procedure was correct for our data, because the intraindividual diversity did exceed the interindividual one.

Cheetah vocal repertoire

The repertoire of adult cheetahs consists of three structural classes: pulsed with 4 types (chirr, growling, purring and gurgling), tonal with 3 types (chirp, miaowing and howling) and noisy with one type (hissing).

The pulsed types did differ distinctly in their pulsation periods: 54.44 ± 0.31 ms ($n=737$) in the chirr; 42.64 ± 0.29 ms ($n=221$) in the purring; 27.49 ± 0.18 ms ($n=693$) in the growling; and irregular in the gurgling. The tonal types did differ distinctly in their frequency modulations.

Comparison of adult and juvenile cheetah sounds

In cubs six of eight adult sound types have been recorded (excluding purring and gurgling). We compared statistically variabilities of adult and juvenile vocal sounds. All pitch parameters were significantly higher in cubs, however, duration was significantly higher in cubs' miaowing, and significantly shorter in their chirr, growling and howling. Chirp duration did not differ significantly among ages. These differences may not be explained by maturation process alone. We hypothesized that the structural differences in sounds may reflect a self-esteem of a caller, coming from its behavioural role (Goltsman et al., 1977), for example, "infantile" self-esteem in cubs.

The cubs are more weak and less experienced than adult animals; the routine events in the zoo are less predictable for them than for adults. High tonal sounds represent frustrate, affiliative vocalizations across different animal taxons, whereas harsh, low-frequency calls are related with self-confidence and aggression (Morton, 1977; Jürgens, 1979). So, the elongate high-frequency miaowing with local maxima, characteristic to young cheetahs, is reflecting their "infantilism". Notice, that the low-frequency howling and harsh growling were longer in adults. The chirp is a peculiar case, because the vocalization probably represents a result of ritualization process. This call is functioning to support a spatial proximity, so the constant duration may be important for the acquaintance of the sound across ages.

We suppose that the vocal "infantilisms" are not necessarily age-related. Inside age categories these features may reflect asymmetries in animal self-esteems: if they estimate themselves as being stronger or weaker and more or less self-reliant in comparison with their social partners.

The use of different sounds is dependent on the social role

In order to estimate the effects of the asymmetries in behavioural roles between social partners on production of a certain call type, we compared vocal performances in two kinds of social unions in the cheetah. The first kind of social union was courting male and female in oestrus; the second one was mother and cubs. We counted overall numbers of calls recorded from animals during their living in each of these kinds of unions and percentages of different sound types have been occurred in them. The males produced significantly more pulsed chirr sounds than females; the same females performing a behavioural role of a mother produced significantly more pulsed chirr sounds than cubs. For high-pitched tonal sounds the picture was just reversed.

As so far a social asymmetry is related with differences in subjective self-esteems between partners, one can suppose, that these preferences in usage of certain vocal structures are related with different emotions. These difference can be characterised as subjective strongness or weakness of one partner in comparison with another one, or as their self-reliance or diffidence. In both the unions in our study, the

changes in environment were more predictable for the more stronger animal (first kind of union) or more stronger and experienced (second kind of union) animal. And in both the kinds of unions the three times higher proportion of pulsed chirr sounds was produced by a stronger animal, whereas a weaker animal produced more high-pitched tonal sounds. These data support a hypothesis about relations between pulsed sound structure in the chirr and self-confidence, whereas the high-pitch tonal structure is probably related with a state of diffidence, or unsure of themselves.

Relations between the sound structures and internal states: pulsed versus tonal

An occurrence in the cheetah vocal repertoire of transitional sounds, where the pulsed part changes the tonal part or vice versa, gives us an opportunity to observe, how the external events immediately evoke changes in animal's internal state and consequently changes in their sounds. For example, a mother who suddenly had noticed an observer who had been standing nearby during her playing with cubs, immediately changed the chirr calling into chirr with tonal initial component (see transitional call in the centre of the scheme).

Purring is closely related with relaxed, comfort, friendly behaviour in the cheetah, when external events are highly predictable. Therefore, we can suggest, that the purring cheetah is in self-confident state.

Gurgling did occur during friendly reunions between well-familiar cagemates, in well-known environment, out of relations with sexual activity. These conditions were well predictable for both animals. Therefore, this call type was also related with self-confident internal state.

Growling and howling more difficult to interpret in terms of confidence and diffidence. We recorded cheetah howling in relation with territorial behaviour (during introduction of a new member into a group or during approach of humans to a male in semi-natural environment). From one side, a calling animal was self-confident, as being an owner, but from the other side, some unpredictability also took place. So, the place of howling among "diffident" vocalizations is conditional enough.

Growling cheetah threats in a close distance to an opponent. During this vocalization the probability of a flee is low, therefore is high the predictability of the caller's behaviour for himself and for others. In some cases, we have been recording cubs responses to approach of a keeper in order to take them on hands for veterinary manipulations. The sequences of changes in vocal types in connection with shortening of a distance from the keeper consisted of an aggressive demonstration with hissing and strike of a paw at a floor, then growling, and then miaowing. So, we suppose that the growling is uttering by the more self-confident animal, then the miaowing.

Therefore, as a whole, pulsed structure reflects higher self-confidence of an animal, than the tonal one, in the cheetah.