An acoustic analysis of agonistic sounds in wild cheetahs

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Abstract

The cheetah ranks among the more vocal felids, and is above all a prominent purrer. However, the cheetah also produces a wide variety of other sounds, and this paper takes a closer look at a category of sounds produced by wild cheetahs, agonistic vocalizations, that can be divided into moaning, growling, hissing and spitting sounds.

Introduction

The cheetah is a prominent purrer, but only a few detailed studies have been devoted to the other sounds produced by this vocal felid. This paper focuses on one group of cheetah vocalizations, i.e. agonistic sounds, which include moans, growls, hisses and spits.

The Cheetah

The cheetah (*Acinonyx jubatus*) is probably best known for being the fastest land animal in the world with an estimated top speed of circa 112 km/h (Sunquist & Sunquist, 2002:23).

Contrary to a widespread misconception that the cheetah "is not a cat", it is a full-fledged felid, most closely related to the puma (*Puma concolor*) and the jaguarundi (*P. yaguarondi*) (O'Brien & Johnson, 2007:70). The cheetah is roughly the same size as a leopard (*Panthera pardus*) – with which it is often confused – but is of a lighter and more slender build, has a smaller head, smaller teeth, and is a poor climber. The cheetah is also distinguished by dark tear-marks in the facial fur running down its eyes, towards the muzzle.

Sexual dimorphism is not very pronounced in the cheetah: a male cheetah weighs 29–65 kg, is 172–224 cm nose-to-tail with a shoulder height of 74–94 cm; a female cheetah weighs 21–63 kg, and is 170–236 cm nose-to-tail with a height of 67–84 cm (Hunter & Hamman, 2003:141).

Although the cheetah is a relatively large carnivore, there are no records of a wild cheetah ever killing a human being (Hunter & Hamman, 2003:17).

Previous Research

While focused studies devoted to purring exist (cf. Eklund, Peters & Duthie, 2010), few detailed studies of other cheetah vocalizations have been carried out, although several sources list a variety of vocalizations produced by the cheetah, however most often without any detailed description and/or analysis.

Krausman & Morales (2005:4) mention "antagonistic vocalizations, purrs of contentment, a chirping sound made by a female to its young, and an explosive yelp that can be heard from 2 km away". Caro (1994) lists "churrs", "growls" and "yips", while Ruiz-Miranda et al. (1998) performed a detailed study of "eeaows", "chirps" and "stutters" in separation/reunion experiments. Sunquist & Sunquist (2002:27) list "yelps", "churrs" or "stutters", "gurgles", "growls", "moans" and "purrs". Besides purrs, Hunter & Hamman (2003:56) mention "yips" or "chirps", "churrs" or "stutters", "growls", "hisses" and "spits", and also "yowls" or "moans".

One of the more exhaustive studies of cheetah vocalizations is Stoeger-Horwath & Schwammer (2003) who studied vocalizations in juvenile cheetahs at the Schönbrunn Zoo. Drawing on Peters (1991) they list: "hissing", "purring", "chirping", "churring", "growling", "snarling", "hissing", "coughing", "bleating", "whirring", as well as sounds without any assigned name/term: "nyam, nyam, nyam", "ihn, ihn, ihn" and "prr, prr" (which is not a purr). Unlike many other studies, where the terms used are not given a detailed definition, Stoeger-Horwath & Schwammer (2003) include spectrograms and acoustic analyses which makes it possible to get a clear view of exactly what sounds are referred to.

The most exhaustive and detailed analysis of cheetah vocalizations published so far is Volodina (2000), who divides vocalization into the three classes: *pulsed* which includes "chirrs", "pr-prs", "gargles", "churtlings", "gurgling", "purring" and "growling"; *tonal*

which includes "miaowing", "chirping", "yelping" and "howling"; and *noisy* which includes "hissing". Volodina also mentions that sounds might also be both *transitional* and *intermediate*, something that was also pointed out already by Wemmer & Scow (1977:751). Moreover, Volodina also provides several spectrograms, a detailed acoustic analysis of the different sounds, as well as a discussion with regard to the communicative function of each specific sound. The cheetahs studied in Volodina (2000) were zoo animals.

As should be evident, terminology is in no way clearly defined or consistent, and quite often onomatopoeic in nature without acoustic confirmation.

Data Collection

Data were collected in December 2011 from wild cheetahs in their enclosures at the N/a'an ku sê Foundation, Windhoek, Namibia.

Cheetahs

Study animals were six wild-caught cheetahs (registered with the *International Studbook Cheetah*) awaiting relocation and managed under minimum human contact conditions. The animals were maintained in two different multi-hectare enclosures featuring their natural habitat. The enclosures conformed to and exceeded the minimum requirements for captive cheetahs in Namibia as stipulated by the Ministry of Environment and Tourism.

All cheetahs were, however, semi-habituated to human contact at the time of sampling, i.e. they approached the enclosure fence for feeding but once fed did not seek human attention, immediately returning into natural cover deeper in the enclosures. The animals were not tame and could not be handled or approached within the enclosures.

The first sample group consisted of an adult female (*International Studbook Cheetah* no. 8167) estimated at 8–9 years of age and an approximate weight of 43 kg together with her two sub-adult 3.5 years old female cubs (*International Studbook Cheetah* nos. 8168 & 8169) which weighed approximately 31 kg at the time. This group had been in captivity for three years.

The second sample group consisted of a single sub-adult female (*International Studbook Cheetah* no. 8166) approximately 3.5 years of age, weighing 33 kg, and housed together with two younger sub-adult siblings (male no. 8172 and female no. 8173), aged approximately 2 years old, and with an estimated weight of 26 kg. The larger sub-adult female (no. 8166) had come to the facility 1.5 years before time of sampling, whilst the two younger cheetahs had arrived three months later.

Since the cheetahs vocalized in an overlapping way, whether or not they were in focus, it was not possible to assign each individual vocalization to a particular cheetah.

Equipment

The equipment used was a Canon HG-10 HD camcorder with a clip-on DM50 electret stereo condenser shotgun microphone with a frequency range of 150–15,000 Hz, and a sensitivity of –40 dB. Recording distance was between 1 and 3 m.

Data Post-Processing

Audio tracks were excerpted from the films with TMPGEnc 4.0 Xpress. Working audio format was 44.1 kHz, 16 bit, mono.

Results

Analysis Tools

Waveforms were created and analyzed with Cool Edit 2000/Pro 2.0, and both waveform and spectrogram analyses were carried out with WaveSurfer.

Statistics were calculated with SPSS 12.0.1.

Sequential Production

Wemmer & Scow (1977:751) pointed out that some sound transitions followed sequential patterns, where aggressive sounds constitute a good example. They observed that growling was often followed by howling (moaning) and that the agonistic sequence ended with spitting. This was confirmed in the present study, and the results will be presented in a sequential order that adheres to the order with which the sounds were most often produced.

Moaning

The term moaning corresponds to the "yowl" mentioned by Hunter & Hamman (2003:56), and is produced "when a threat is escalated" (ibid., loc. cit.), and with the cheetah adopting a "crouched" posture; see *Plate 1*. This vocalization is of variable duration, and is quite often intertwined with growling and hissing.

Plate 1. A typical cheetah moaning/growling pose. Photo by Miriam Oldenburg.

Plate 2. A typical cheetah spitting/paw-hitting pose. Film capture by the first author.

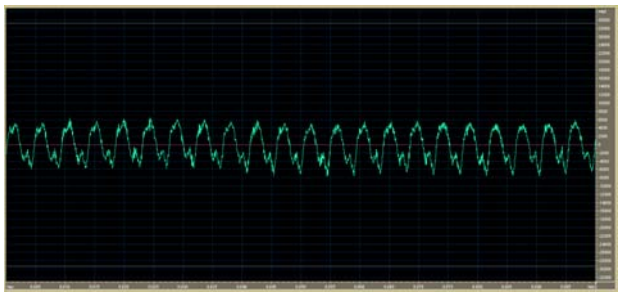

Figure 1. Moaning. Window = 100 ms; which gives an estimated frequency of around 220 Hz.

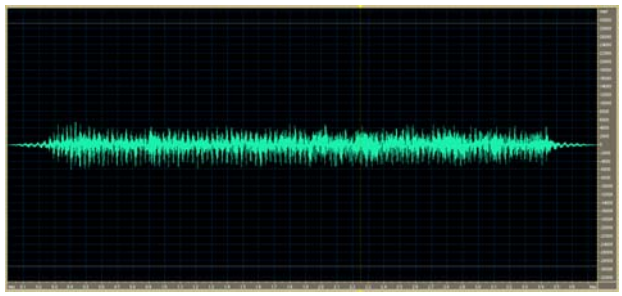

Figure 2. Growling. The stable and "pulsed" characteristics are clearly seen.

Although most of the moans/growls recorded were of the "mixed" variety mentioned in the literature, some clear-cut cases were also found; see *Figure 1*. Moans are very cyclical, with an average fundamental frequency that in our recorded material lies around 200 Hz.

Growling

Growls are non-periodic sounds of variable duration, often intertwined with moaning and hissing, and are uttered when the cheetah is "at danger" (Hunter & Hamman, 2000:56), and are also often produced with the cheetah crouched.

Wemmer & Scow (1977:754) described growl duration as "[v]ariable but usually long and repeated". Although they are mainly non-periodic, "pure" growls constitute a fairly regular and consistent sound; see *Figure 2*.

Hissing

Hissing also constitutes a vocalization of variable duration, often intertwined with moaning and growling, as pointed out by Wemmer & Scow (1977:751). This sound is characterized by strong non-periodic noise across the entire frequency range; see *Figure 3*.

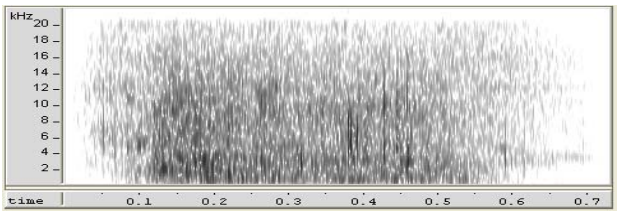

Figure 3. Hissing. The mild onset and tapering off is clearly visible. Note the white noise characteristics of this sound. Window dur. 0.7 s.

Hissing was relatively infrequent (N=15) in our data, and occurred both prior to or immediately after a spit/paw-hit event.

Spitting

Spitting occurs in most felids (Peters, 1991) and is very prominent in the cheetah. In the cheetah, spitting normally follows a sequence of moaning/growling/hissing, and is frequently, and characteristically, accompanied with the cheetah aggressively hitting its front paws to the ground; see *Plate 2*.

Often the cheetahs retreated a few meters immediately after the spit/paw-hit, but the animals frequently returned and started the agonistic sequence all over again.

Wemmer & Scow (1977:754) described the duration of spits as "fixed". Our data indicate that the spit can be divided into distinct phases, as is shown in *Figure 4*.

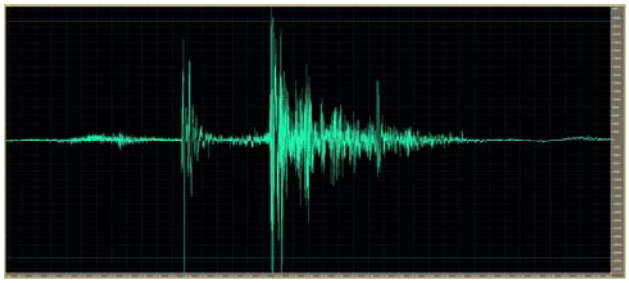

Figure 4. Waveform showing the four different phases of the spits: a build-up, a first explosion, an intermediate silent phase and the final explosion, including a "fade-out" section. Window dur. 390 ms.

Our data contains 29 cases of spits, including two or three cases of half-hearted productions. Durational statistics broken down for the different phases are shown in *Table 1*.

Table 1. Statistics for spitting phases.

Phase	Buildup	Expl. 1	Silence	Expl. 2	Total
N samples	16	24	26	29	29
Min dur (ms)	10	10	20	35	60
Max dur (ms)	90	30	80	175	300
Mean dur (ms)	36.7	15.63	50.0	89.0	166.9
St. dev.	19.9	5.8	17.3	31.6	63.2

As is shown in *Table 1* not all phases were consistently produced, but most "full-fledged" spits did contain four very distinct phases.

Discussion and Conclusions

The cheetah's agonistic sound repertoire basically is the "standard" felid repertoire occurring during agonistic interactions in these carnivores. Cheetahs use their agonistic sounds in intra- and interspecific communication, in the latter case especially towards other (and larger) carnivores present in their natural habitat, to many of which the cheetah is physically inferior. Several agonistic sounds and their combinations/intergradations are used to express different stages of antagonism.

However, the literature is characterized by a dearth of studies of cheetah vocalizations and their occurrence and function. Knowledge about these vocalizations is important and can help in the management and husbandry of cheetahs. Different agonistic sounds can occur in specific and different behavioural contexts, some being accompanied by specific body postures and movements. Correct interpretation of agonistic signals could both help prevent accidents and also reduce stress on the animals.

More material is needed to clearly establish the true nature of all these sounds, with regard both to production mechanisms (especially concerning the transitional forms) and the context in which they are produced. The present study is an attempt to deepen our understanding of agonistic vocalizations, from both a contextual and acoustical perspective.

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