

Hello my name is Joyce Poole from ElephantVoices. Today I am going to try to give you a window into the information contained in the voices of African savanna elephants. I began studying elephants in Amboseli NP, Kenya in 1975. My early work focused on the behavior of males in the sexual and aggressive state of musth. I documented the postures and displays of musth males including a very low frequency vocalisation called a Musth-Rumble. My discovery in 1984 with Katy Payne that this and other African elephant Rumbles contain frequencies below the level of human hearing led to a long-term study of elephant communication during which I have focussed on vocalisations and other behaviors of free living elephants.



In the early 2000s my husband Petter Granli and I formed ElephantVoices with the aim of studying the voices and behavior of elephants as well as acting as a voice for elephants. We have worked together on elephant communication and conservation projects in Amboseli and Maasai Mara, Kenya and in Gorongosa, Mozambique. These projects have allowed us to observe how elephants with different histories and habitats behave.

# The Elephant Ethogram: A Library of African Elephant Behavior

**THE ELEPHANT ETHOGRAM**

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**Specific Searches**

Behaviors & Behavioral Constellations

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Calls (Acoustic-Vocal)

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Search based on first letter in name of behavior/constellation:

A|B|C|D|E|F|G|H|I|J|K|L|M|N|O|P|Q|R|S|T|U|V|W|X|Y|Z

**Free Text Search**

Search on any word. All behaviors and constellations with that word in the name or description will be listed, with number of video exemplars in parentheses.

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**BEHAVIORS**

Aggressive-Whoosh (3), Alarmed-Trumpet (4), As-Touched-Rumble (3), Baroo-Rumble (1), Begging-Rumble (5), Bonding-Chorus (3), Cadenced-Rumble (3), Coalition-Rumbling (3), Comment-Rumble (1), Contact-Rumble (3), Coo-Rumble (5), Croaking (2), Cry (1), Cry-Rumble (2), Estrous-Roar (3), Estrous-Song (3), Female-Chorus (2), Greeting-Rumble (4), Grumble-Rumble (12), Husky-Cry (13), Lets-Go-Rumble (5), Little-Greeting-Rumble (13), Mating-Pandemonium-Calling (3), Mouth-Rumble (3), Play-Trumpet (3), Pulsated-Trumpet (4), Roar-Rumble (1), Roar (12), Rumble-Cry-Rumble (3), Rumble-Roar-Rumble (1), Separated-Rumble (3), Snot (7), Social-Trumpet (3), Tusk-Like-Call (3), Trumpet-Blast (15), Squelch (1), V8-Rumble (4), Rumble-Roar (2), Rev (2), Call-Call-Rumble (2), Sneeze (2), Blow (2), Rumble (3), Trumpet (3), Bark (3), Mating (3), Estrous-Running-Rumble (1), Estrous-Rumble (1), Bonding-Rumble (1).

**49 entries matches your search**

**BEHAVIORAL CONSTELLATIONS**

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**35 entries matches your search**

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- Behavior - *unique movement or action* (N=273)
- Behavioral Constellation - *suite of Behaviors that typically occur together* (N=85)
- Context (N=23)

**Musth-Rumble**

A moderately long (1-4 seconds in duration), very low frequency, distinct rumble with a characteristically pulsating 'bul-out-out' or 'big-gulp-drip' quality, only produced by an adult male during his heightened sexual and aggressive period of musth. Known as a Mouth-Rumble, this call is associated with an increase in the rate of Ultra-Orbiting and a particular and frequent known as Ear-flapping. The calls of individual males are distinctive. Some males Mouth-Rumble out of short duration, while those of others are very long, some have a rising quality while others are more pulsated, or may sound like water gurgling through a deep barrel. The 'classic' Mouth-Rumble is a long, low, pulsated, local call with considerable overlying noise.

Males elephants tend to Mouth-Rumble in specific contexts such as: During aggressive interactions with other males, when approaching a group of females, prior to and immediately after a Mating when they Rub a tree with Terminal Branch Separation, when Drinking, Mud-Splashing, or Mud-Balancing, or in situations where they feel challenged. For example, the sound of another musth male, an approaching vehicle or even an airplane combined to often enough to trigger a musth male's Mouth-Rumble. Musth males also frequently Mouth-Rumble before or after Calving, when they are presumably responding to distant elephant calls or using calling to search for potential mates.

Musth males most often Mouth-Rumble when they are alone, less often when they are in the company of females and least often when they are Guarding an estrous female. Since musth males often follow after they Mouth-Rumble, it is likely that they use Mouth-Rumbles to advertise their heightened aggression and sexual drive to rival males and to potential mates. Females respond to the Mouth-Rumbles of musth males by Female-Chorusing, so calling may help a male to locate groups of females. Once a male has located an estrous female he may head further the herd for the desire to advertise his whereabouts.

References: Poole 1982: 32, 51; Poole 1987; Poole et al 1988; Poole 2011. [Full reference list](#)

This behavior occurs in the following contexts: Advertisement & Attraction, Aggression, Courtship

Video    Photo    Audio

**Mouth-Rumble**

Context: Advertisement & Attraction (7)

This was grazing with male companions on the edge of Amboseli National Park. He was not in musth but he Ear-Flapped at us a few times and these were associated with half-heard Mouth-Rumbles. In the clip he Ear-Flaps and gives a short Mouth-Rumble as he approaches our car. A few days later he was in full musth and had left his companions in favor of being alone. Amboseli, Kenya



**ElephantVoices**

During the last few years we have built and are populating an online fully searchable database called The Elephant Ethogram: A Library of African Elephant Behavior, which we hope to have publicly available later this year.

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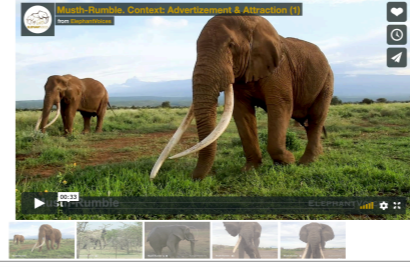
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Video (3)
Photo (3)
Audio (3)

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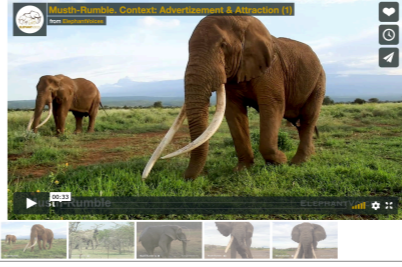
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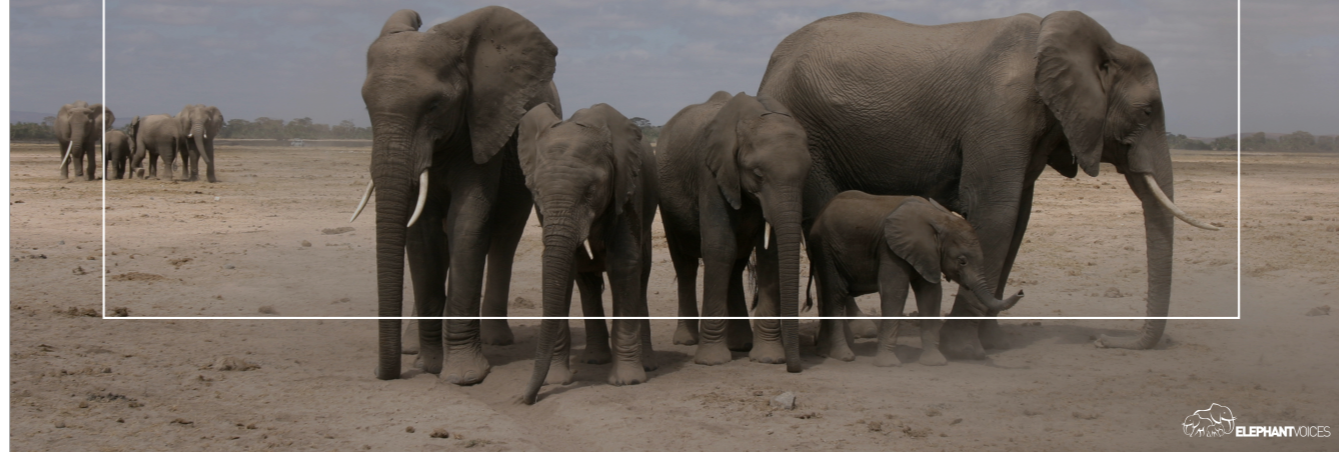
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- Rituals around birth, death, greeting, mating, etc



What do we know about African elephant  
acoustic communication?





# What do we know about African elephant acoustic communication?

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- Trunk-call types: Trumpets, Nasal-Trumpets, Snorts, novel or imitated calls (e.g. Berg 1983, Leong et al. 2003, Stoeger-Horwath et al 2007, Poole 2011)



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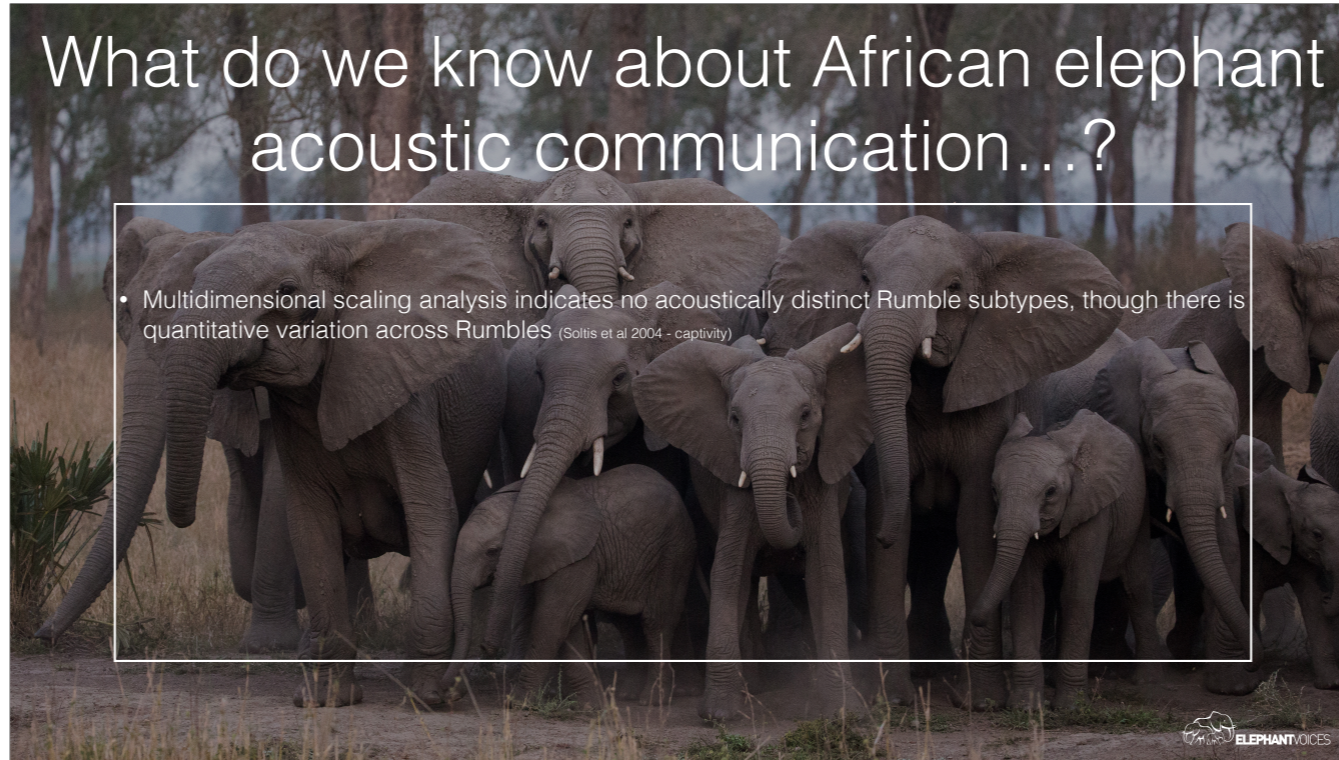
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- The most common call type is the Rumble making up ~90% of calls among free-ranging African savanna elephants (Poole 2011)

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- African elephants have distinctive referential alarm calls for humans and African honey bees (Soltis et al 2014) - a discovery supporting the existence of Rumble sub-types.

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- Several sub-types: Protest-Trumpet, Alarm-Trumpet, Trumpet-Blast, Trump, Pulsated-Trumpet, Nasal-Trumpet, Social-Trumpets
- Depending on the type, trumpets are used to intimidate or express: alarm, surprise, annoyance, protest, intense level of social arousal, such as during a Bonding-Ceremony or Social Play

- Protest-Trumpet (annoyance, protest): Mother as infant is pushed by young male
- Alarm-Trumpet (alarm, surprise): Separated and alarmed Ejac, aged 2, as his mother calls to him
- Trumpet-Blast (anti-predator): Ambuscadora when charging us
- Trump (social play): A young male challenging us during social play
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- Social-Trumpets (high social arousal): Family members at an elephant birth

# Trumpet

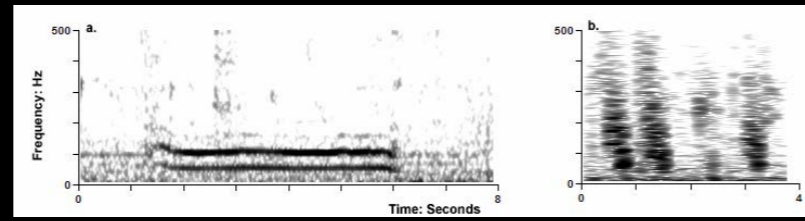
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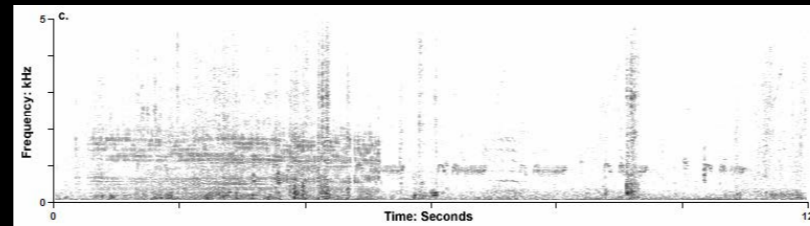
# Novel Calls/Vocal Learning

Truck-Like

Squelch



Croaking



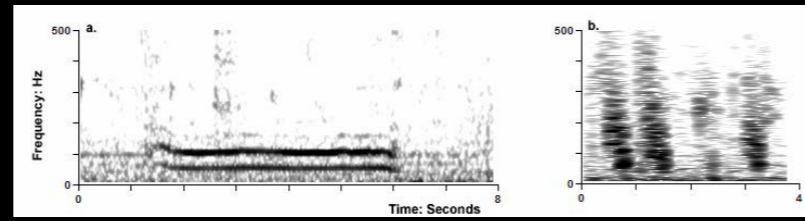
Poole et al 2005



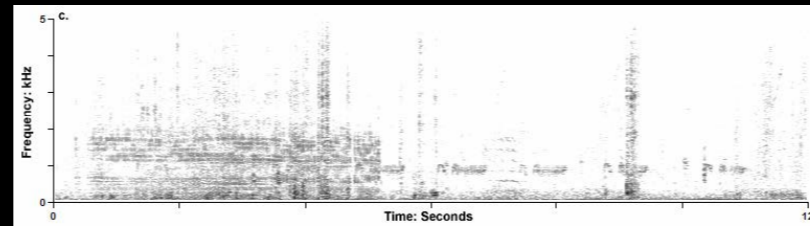
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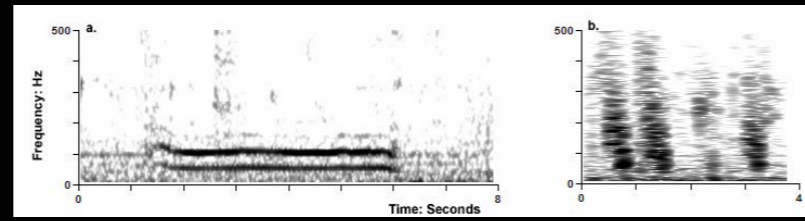
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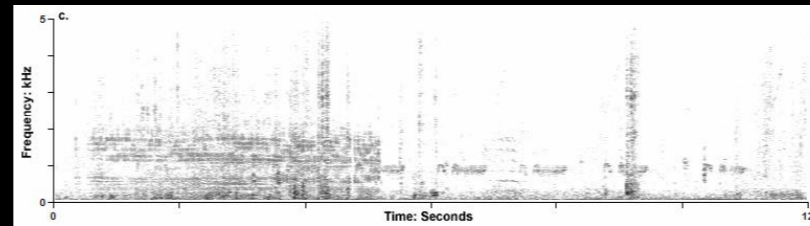
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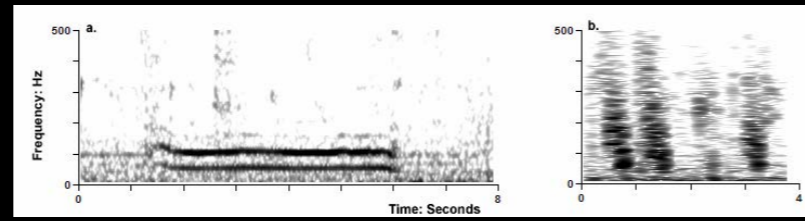
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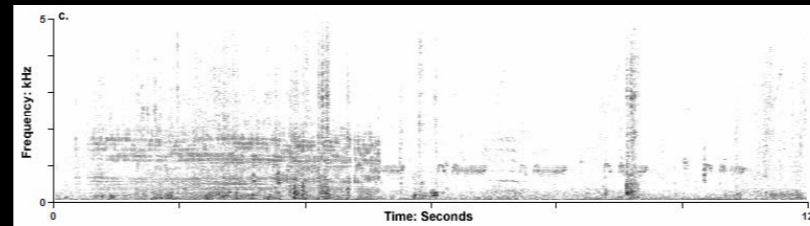
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# An Asian elephant imitates trainer



Kosik an Asian elephant in Korean Zoo imitates human speech, matching Korean formants and fundamental frequency in such detail that Korean native speakers can readily understand and transcribe the imitations - Stoeger et al 2012, Stoeger & Manger 2014



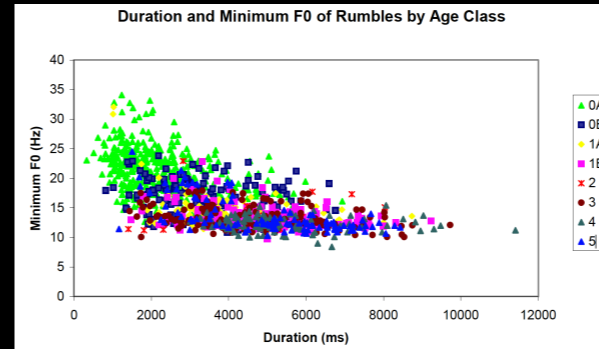
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# Rumble

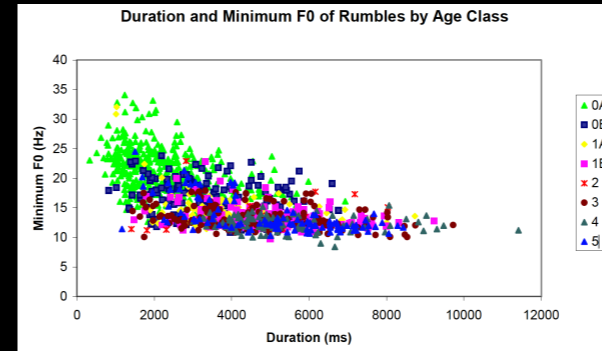
Rumble duration & minimum F0  
by age class



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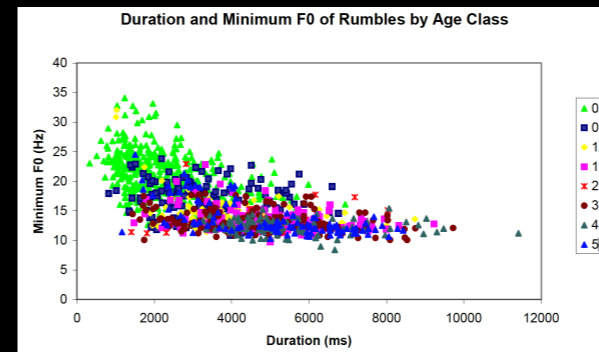
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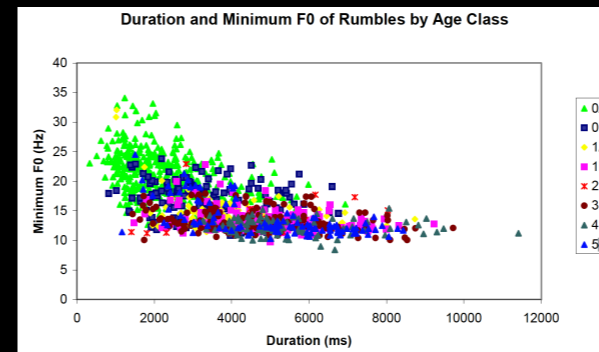
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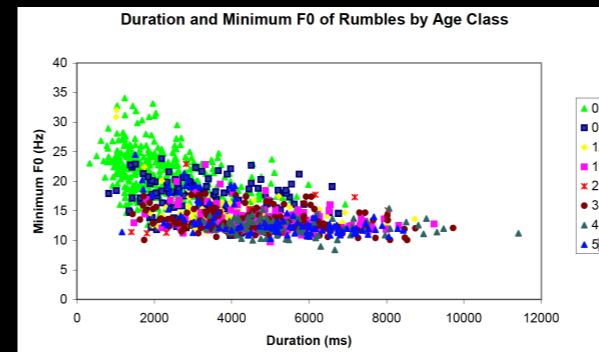
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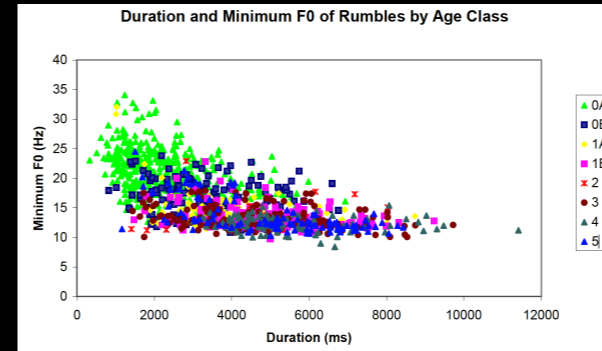
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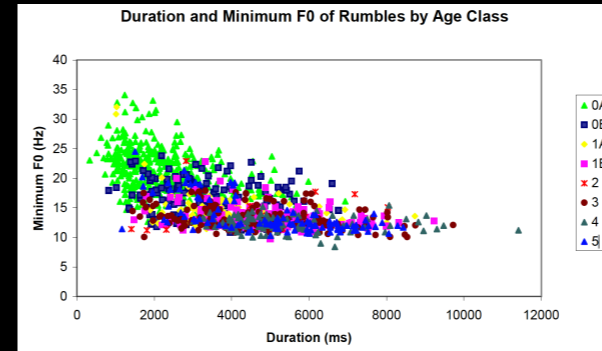
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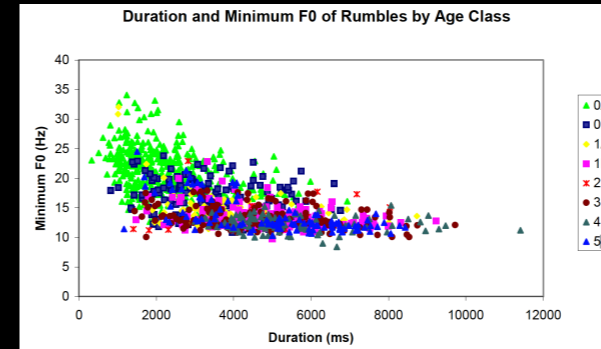


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(Poole 2011)

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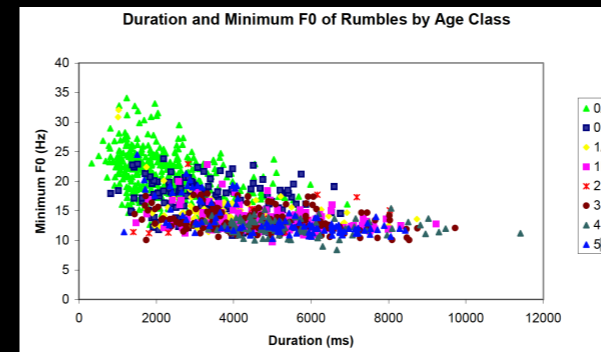
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- Can recognise voices of close associates up to 2.5 km away

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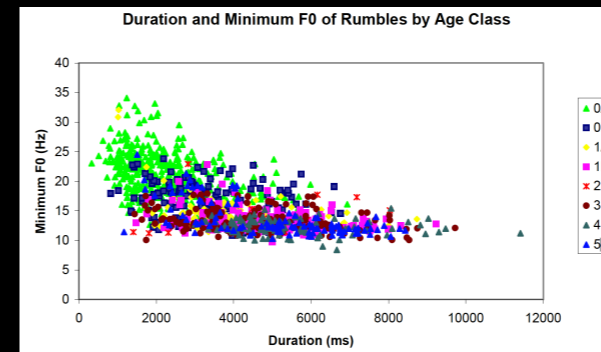
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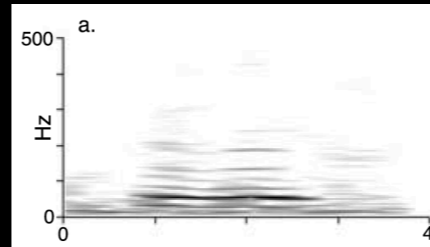
- Can recognise voices of close associates up to 2.5 km away
- Recognise voices of at least 200 other adult elephants

(McComb, 2003)

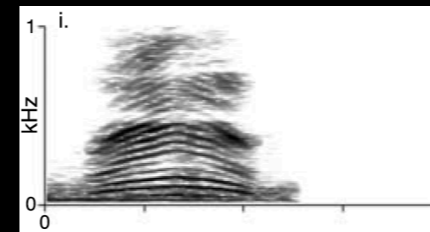
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# Oral versus Nasal Rumbles



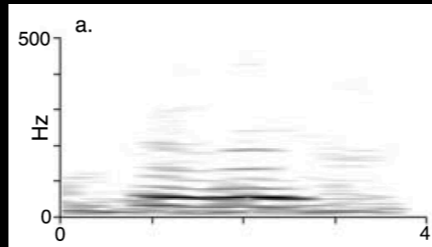
a. Begging-Rumble  
(nasal-rumble) by Ella's  
1 year calf



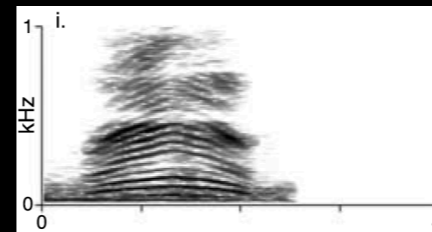
i. Baroo-Rumble (oral-  
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1 year infant after  
being pushed away  
from an infant by  
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# Oral versus Nasal Rumbles

- Oral-rumbles emitted from the mouth while nasal-rumbles emitted from the trunk



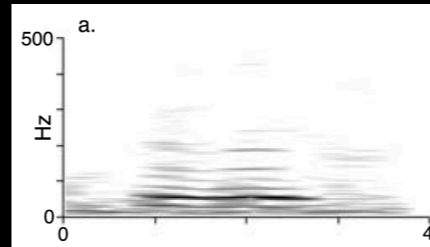
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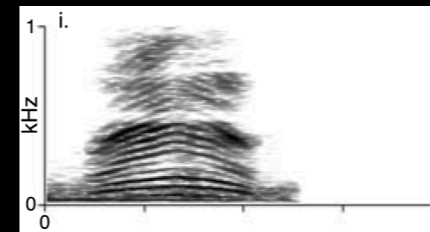
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- Oral rumbles are associated with higher formants and a shorter vocal tract (0.7 m) and nasal rumbles with lower formants and a longer vocal tract (2 m)



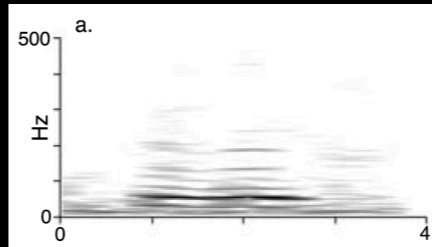
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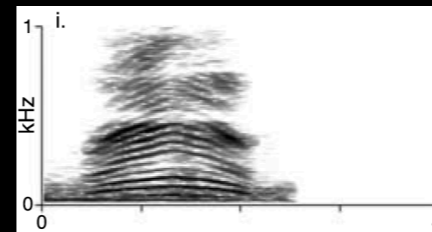
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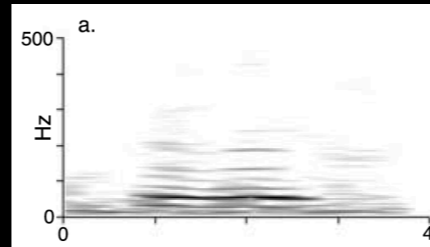


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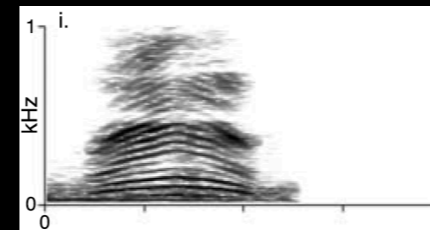
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Stoeger et al 2014



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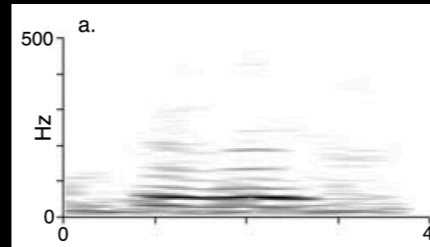
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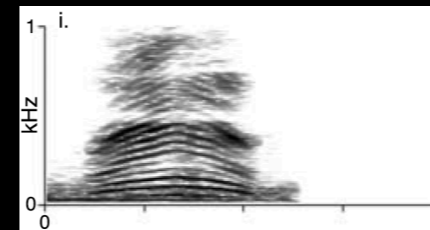
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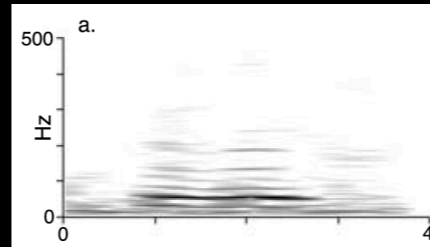


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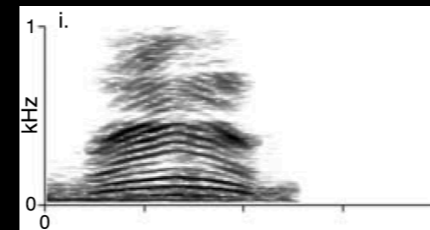
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# Rumble Sub- or Context-Types

Elephants produce a wide variety of rumble forms that are associated with behavioral context

Rumble Sub-Type	nasal rumble	oral rumble	Distinguished by		
			Context & associated behavior	sound quality	measurement
• As-Touched-Rumble			✓	✓	✓
• Baroo-Rumble			✓	✓	✓
• Begging-Rumble	✓		✓	✓	✓
• Bonding-Rumble			✓	✓	✓
• Cadenced-Rumble	✓		✓	✓	✓
• Coalition-Rumbling		✓	✓	✓	✓
• Comment-Rumble	✓		✓	✓	✓
• Contact-Rumble	✓	✓	✓	✓	✓
• Coo-Rumble	✓		✓	✓	✓
• Estrous-Rumble	✓		✓	✓	✓
• Estrous-Running-Rumble	✓		✓	✓	✓
• Female-Chorus-Rumble	✓		✓	✓	✓
• Greeting-Rumble	✓		✓	✓	✓
• Grumble-Rumble			✓	✓	✓
• Lets-Go-Rumble	✓		✓	✓	✓
• Little-Greeting-Rumble	✓		✓	✓	✓
• Mating-Pandemonium-Rumbling			✓	✓	✓
• Musth-Rumble	✓		✓	✓	✓
• Separated-Rumble	✓		✓	✓	✓
• V8-Rumble		✓	✓	✓	✓

\* archetypal



# Patterns of Calling - Single/isolated call

e.g. Musth rumble



Other examples: V8-Rumble, Grumble-Rumble, Comment-Rumble, Trumpet, etc



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A distinctive pulsated rumble given by males in the heightened sexual & aggressive state of musth; associated with particular behaviors: Ear-Wave, Trunk-Dragging, Urine-Dribbling, Foot-Scuffing and answered with Female-Chorus by nearby females.  
Given:



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- in response to other low frequency sounds (including approaching airplanes, cars)
- when drinking, mud splashing, marking



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Given:

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- when drinking, mud splashing, marking
- when approaching a group of females
- immediately prior to mating.



Other examples: V8-Rumble, Grumble-Rumble, Comment-Rumble, Trumpet, etc



# Patterns of Calling- *Bout of single calls*

e.g. Grumble-Rumble



Other examples: Let's-Go-Rumble, Begging-Rumble, Separated-Rumble, etc



# Patterns of Calling- *Bout of single calls*

e.g. Grumble-Rumble

•An undulating Rumble of medium duration with an audibly detectable and distinctive complaining or whining tone. Typically heard when the calling elephant has been thwarted or "mistreated" in some manner. May escalate to a Baroo-Rumble. Not associated with Ear-Flapping.



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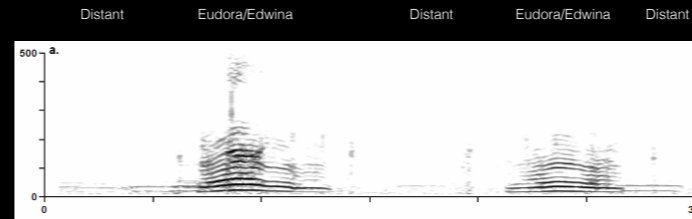
Other examples: Let's-Go-Rumble, Begging-Rumble, Separated-Rumble, etc



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*Antiphonal calling by two or more individuals*

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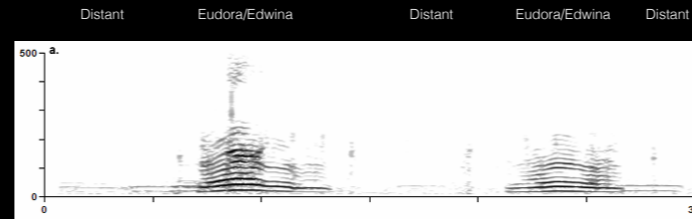




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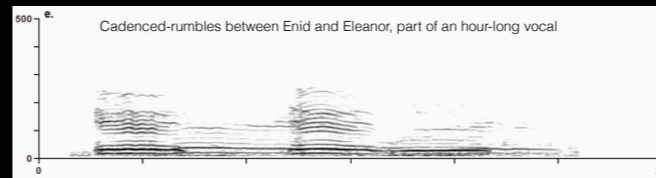
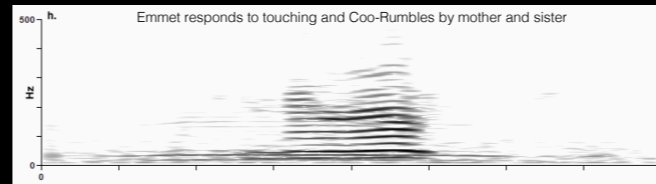
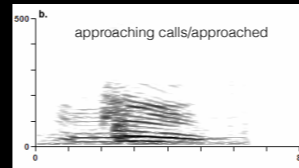
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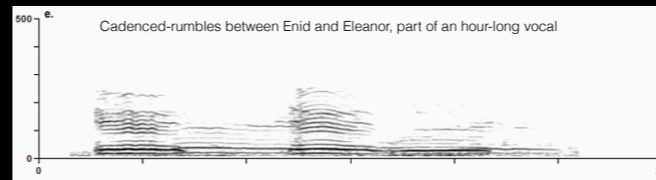
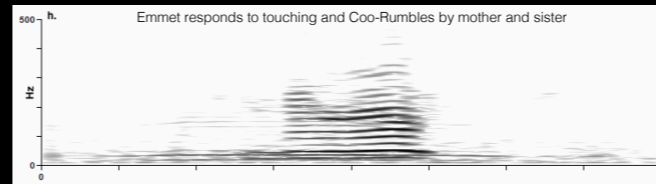
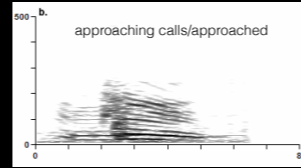
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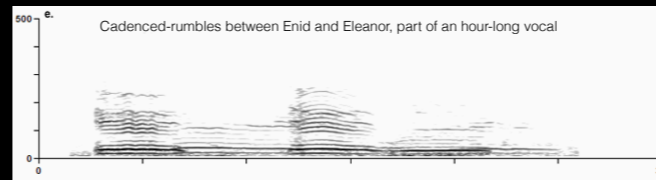
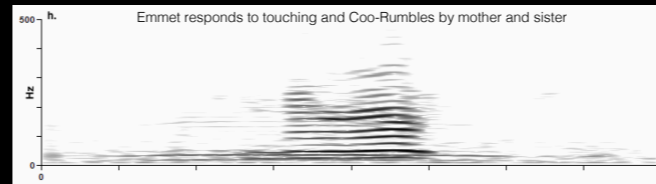
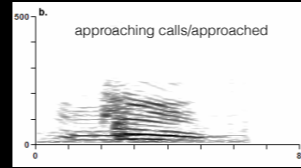


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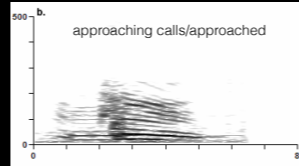


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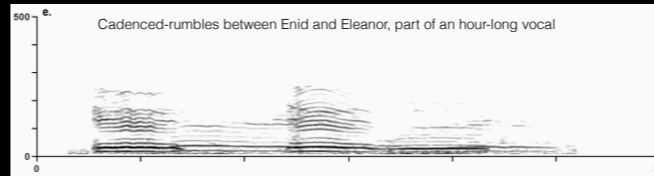
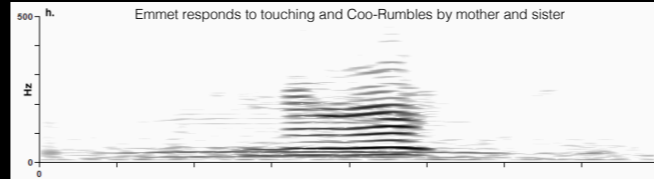
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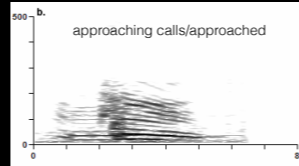


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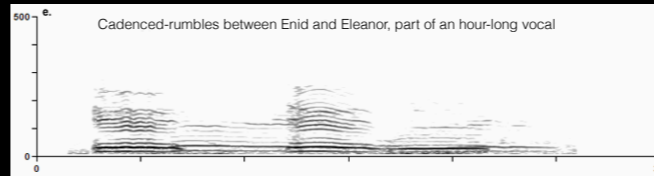
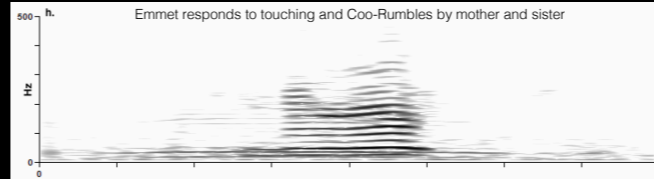
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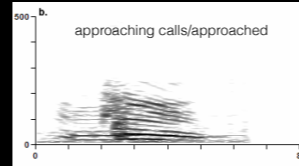


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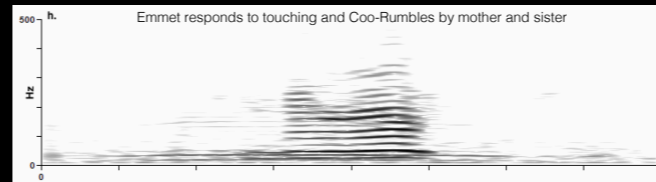
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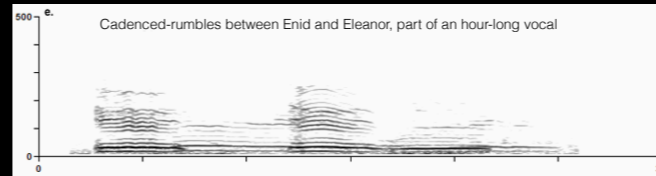
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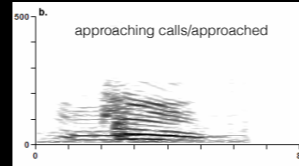


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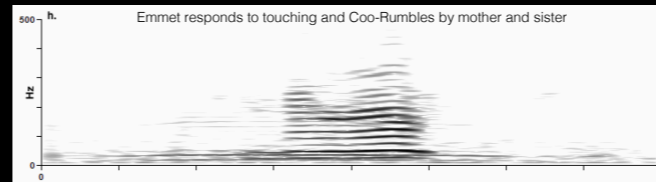
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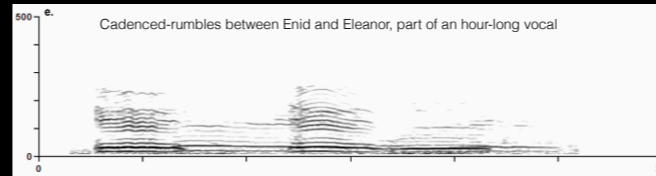
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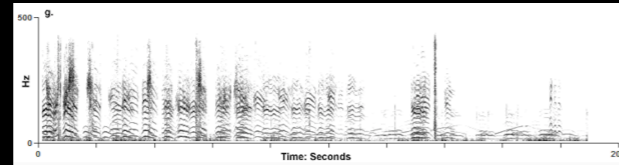
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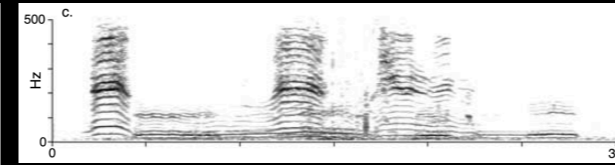


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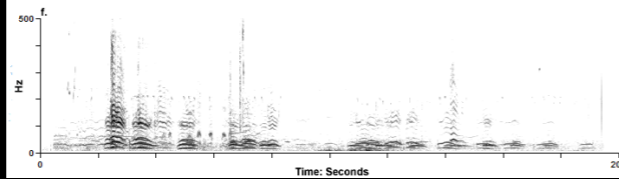
## Chorused calling by numerous individuals



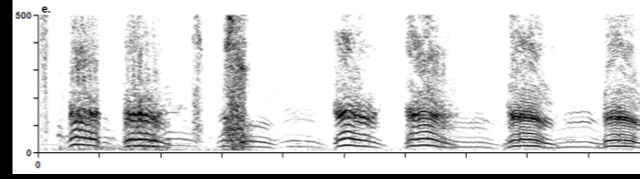
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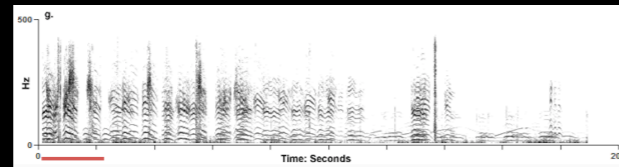


**Coalition-Rumbles: e)** Pounced on by a lion Amy's infant Roars; Amy and others face the lion and with powerful overlapping oral-rumbles call for help from more distant family members.

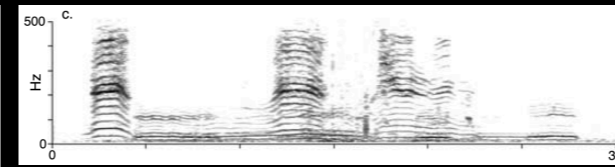
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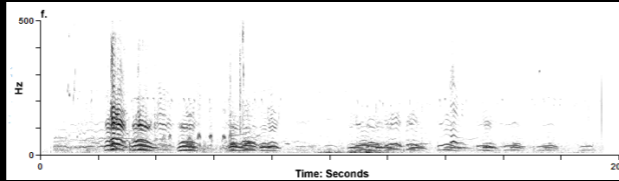
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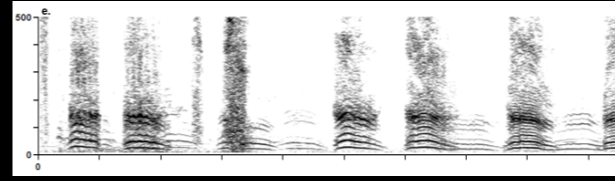
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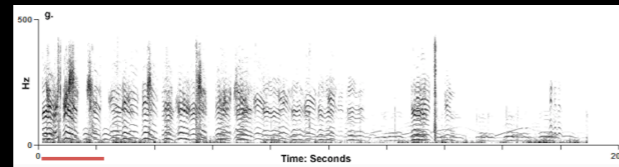


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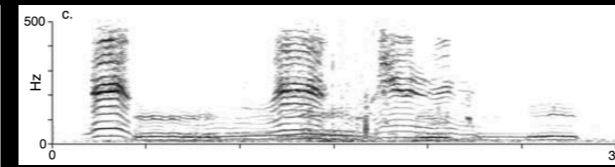
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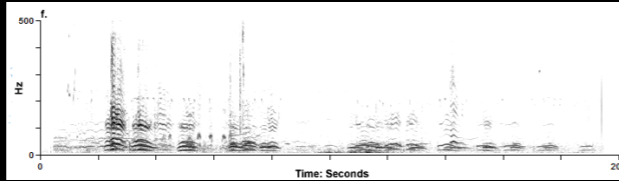
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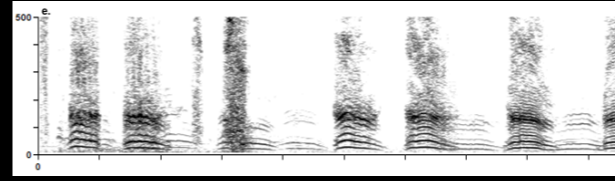
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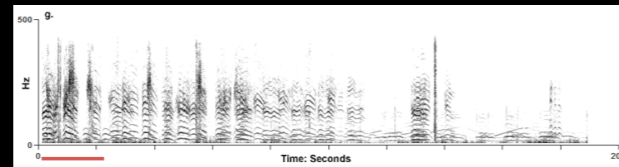


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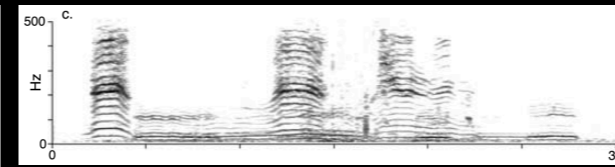
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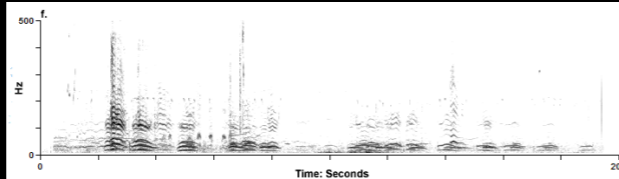
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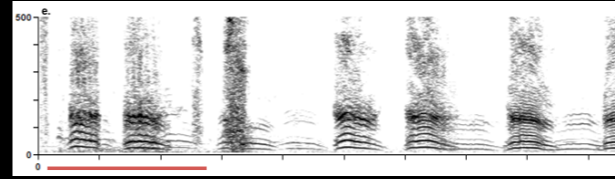
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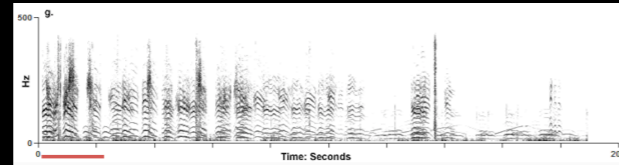


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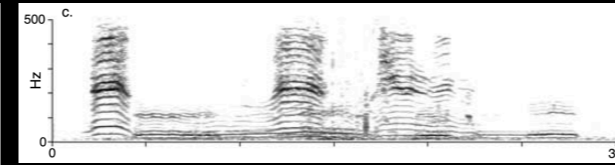
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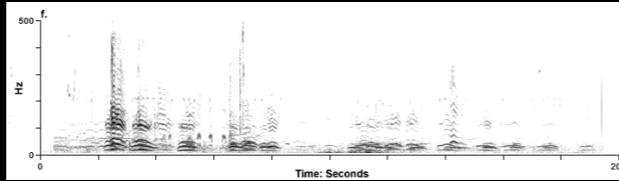
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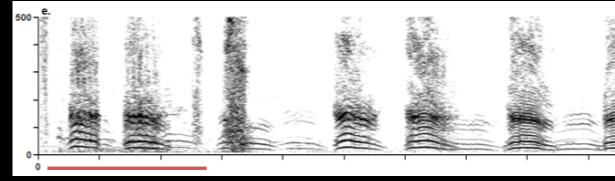
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- We know that elephants use vocal referential signals. We observe elephants to coordinate movement and actions, apparently discuss with one another, negotiate, make plans, reconcile conflicts, sympathise with one another. While rumble context-types are highly variable (e.g., reflecting arousal and individual identity), and in some cases may be only subtly different, the elephants show by their consistent behavior that they are able to discriminate emotion and meaning in these graded calls.

Can machine learning help us to decipher what, specifically, they are able to say to one another?

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- I have defined a large number of call sub-types based on sound quality behavioral context and measurement.

Can machine learning confirm these sub-types? For instance, is a Greeting-Rumble different from a rumble given in a different sort of Bonding-Ceremony? Can a Begging-Rumble be consistently discerned from a Separated-Rumble or a Let's-Go-Rumble from a Cadenced-Rumble?

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- Wind noise and overlapping calls pose particular challenges to the automated analyses of elephant calls  
Can computer technology isolate individual calls in a chorus or those contaminated with wind or other low frequency noise.



# Big Thank yous to:

- Simons Institute for the Theory of Computing
- JRS Biodiversity Foundation
- National Geographic
- Crystal Springs Foundation
- The Marshall Frankell Foundation
- WildiZe Foundation
- The Amboseli Trust for Elephants
- Kenya Wildlife Service
- The Gorongosa Project
- Bob Poole Films
- Off the Fence