

# Melody in Human–Cat Communication (Meowsic): Origins, Past, Present and Future



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# Introduction

- In December 2015 we received a 4 MSEK grant from Marcus and Amalia Wallenbergs Minnesfond, in response to our project application:

*Melody in human–cat communication (Meowsic)*

- Project applicants: Susanne Schötz, Lund University  
Joost van de Weijer, Lund University  
Robert Eklund, Linköping University
- Contrary to standard procedure, Lund University made an official press release about the project half a year prior to its official start-up meeting
- Resulted in an enormous media interest, internationally
- This presentation describes the project and how it came about



# The Origins (2010)

- In December of 2009 Eklund and his girlfriend Miriam Oldenburg worked as volunteers at the Dell Cheetah Centre\*, near the town Parys, South Africa
- Already the year before, whilst working as volunteers at the Amakhala Game Reserve in Paterson, South Africa, Eklund has realized that despite hundreds of books and thousands of papers on felids, very little was done on their vocalizations
- If felid vocalizations were mentioned in the literature, this was mainly in anecdotal form, often in footnotes, and almost always without any hard data to back it up
- Eklund read up on the topic and “came prepared” to Dell, bringing professional recording equipment

\* Deep thanks to Pieter and Estelle Kemp



# Caine the Magnificent

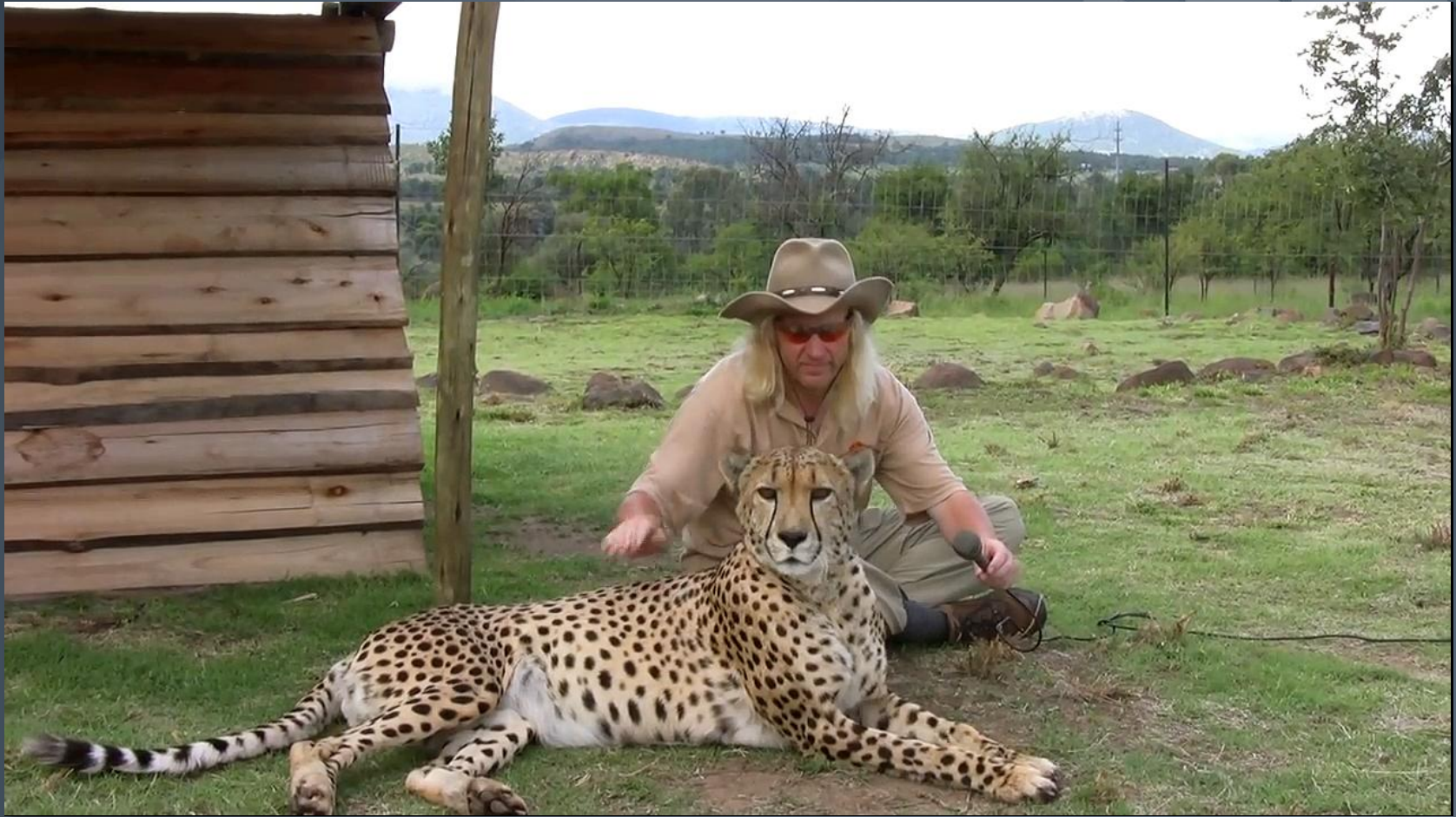
- At Dell, Eklund became friends with the huge (and very kind!) cheetah Caine – and recorded Caine’s impressive purring



Photograph by Miriam Oldenburg



# Hear and see him purr!



Behind the camera: Elizabeth (Lizzie) Duthie  
<http://www.youtube.com/watch?v=ZFvULxbN3NM>



# First paper: Fonetik 2010

- At the annual Swedish phonetics conference in 2010 Eklund and colleagues presented a paper\* comparing purring in Caine and Miriam's domestic cat, Misha
- The authors showed that F0 was more or less the same in the cheetah and the in the domestic cat, ~20 Hz, despite a 20-fold difference in weight
- Egressive and ingressive phases were analyzed for duration, (relative) amplitude and cycles per phase, but this and later studies have revealed huge individual variation



\* Eklund, Robert, Gustav Peters & Elizabeth D. Duthie. 2010. **An acoustic analysis of purring in the cheetah (*Acinomyx jubatus*) and in the domestic cat (*Felis catus*)**. In: *Proceedings of Fonetik 2010*, Lund University, 2–4 June 2010, Lund, Sweden, pp. 17–22.



## ... and then

- Fonetik 2010 was organized by Dr Susanne (“Sussi”) Schötz
- Watching Eklund’s presentation, Schötz got inspired (“can you do things this fun as a phonetician!?”)
- Back home that evening she recorded her own cat Vincent
- A few months later Schötz became caretaker of three other cats: Donna, Rocky and Turbo
- They were also subjected to recording sessions
- Schötz contacted Eklund, and collaboration was initiated

# Susanne and her cats



Please observe the neck-mounted (on the cat) camera





# The Past (2011–2013)

## More purring (2011)

- At Fonetik 2011 (KTH, Stockholm), Schötz & Eklund (2011) presented a paper on purring in (Sussi's) four cats
- The results added to the previously reported (Eklund, Peters & Duthie, 2010) characteristics of egressive/ingressive phases

## Lion roars (2011)

- At the same conference, Eklund and collaborators also presented two papers on lion roars (Eklund, Peters, Ananthakrishnan & Mabiza, 2011; Ananthakrishnan, Eklund, Peters & Mabiza, 2011), recorded in Zimbabwe and at Parken Zoo, Sweden\*

\* Deep thanks to Jennie Westander



# Beyond purring (2012–2015)

- In 2012 – although Eklund presented a paper on purring in cheetahs (Eklund, Peters, Weise & Munro, 2012a) – both Eklund and Schötz moved beyond purring
- Eklund presented a paper on agonistic vocalizations in cheetahs (Eklund, Peters, Weise & Munro, 2012b)
- Schötz presented a paper on a wider range of vocalizations in the domestic cat (Schötz, 2012)
- During the period 2012–2015 Schötz and her colleague Joost van de Weijer established themselves as the authorities on domestic cat vocalizations, building on previous work by Mildred Moelk (1944) whose taxonomy they extended



[YouTube link at the end of the presentation](#)



# Affiliative vocalizations

- In 2012, Schötz collected 538 affiliative vocalizations from three domestic cats
- Auditive analyses categorized these vocalizations into five types that were analyzed for duration and F0
- Within each type duration was similar across all three cats
- F0 measurements (minimum, maximum and mean), were not similar, however, due to the large number of intonation patterns used in each vocalization type



# Prey-directed vocalizations

- Schötz (2013) collected 257 prey-directed vocalizations from three cats



Bird-watching. Figure 1 in Schötz (2013)

- The sounds were subdivided into chatter, chirp, tweets and tweedles , and were analyzed for duration and F0
- Variation in both duration and F0 was found both within and across all types and cats



# Human perception of cat vocalizations

- Schötz and van de Weijer (2014a, 2014b) examined human listeners' ability to classify domestic cat vocalizations
- Two recording settings:
  1. during feeding (food-related miaows) and
  2. while waiting to visit a veterinarian (vet-related miaows)
- F0-analysis showed that food-related miaows tended to have rising F0 contours, while vet-related miaows tended to have falling F0 contours
- Thirty human listeners judged 12 miaows (six of each type)
- Classification accuracy was significantly above chance



# Human perception (cont'd)

- Human listeners who reported previous experience with cats performed significantly better than listeners who did not report previous experience with cats
- The two food-related miaows with the highest classification accuracy showed clear rising F0 contours
- The two vet-related miaows with the highest classification accuracy showed clear falling F0 contours



# Human perception (further cont'd)

- Schötz (2014) conducted a pilot study where 36 human listeners classified 28 cat vocalizations into seven emotion categories
- Classification accuracy and between-listener agreement varies considerably between vocalizations
- Preliminary results suggest that cats vary their intonation to signal different emotions, and that humans perceive these vocalizations based on cues used to signal emotion in human speech
- Surprisingly, the chirr (trill) used by cats for affiliative greetings was often misjudged as anger



# Agonistic cat vocalizations

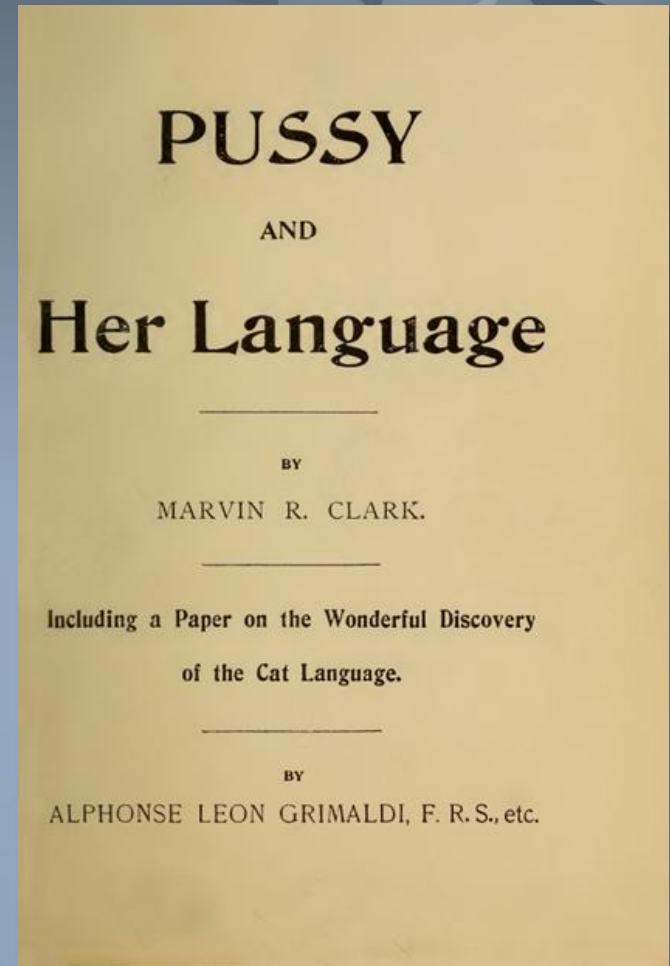
- Schötz (2015) recorded 468 agonistic cat vocalizations as one new cat was introduced into her home with her three resident cats
- Six main vocalization types were identified: growl, howl, howl-growl, hiss, spit and snarl
- Numerous other and merged vocalizations were also found
- An acoustic analysis showed differences within and across all types for duration, F0 and spectral centre of gravity





# Tongue-in-cheek

- Eklund (2015) presented a paper on Grimaldi's decoding of Cat Language, as reported in Clark (1895)
- Clark establishes that “the intelligence of the Cat is equal to that of man”
- Includes word lists, word order, prosodic inflection, the number system used by cats (which is base-ten, by the way) etc
- Curiously, cats have a word for cooked meat: *bleeme-bl*





# The Present (2015–2016)

- In January 2015 Schötz, Eklund and van de Weijer wrote an application for a project grant
- Aim: to combine the findings in our earlier studies, with focus on prosody in human–cat vocal interaction
- The project received funding from the Marcus and Amalia Wallenbergs Minnesfond in December 2015
- First official start-up meeting in August 2016
- The project objectives are outlined on the following slides



# The Future (2016–)

- The purpose of the project is to:
- Study communication between humans and domestic cats
- Specifically, we will study how prosody influences vocal communication between the species
- This includes voice, melody/intonation and speaking style
- The project will carry out the following major studies



# Basics

- We will record the cats and their human care-takers in their homes in everyday interactive situations (feeding, greeting etc)
- Both video and audio
- $N =$  at least 30 cats from two different regions, or possibly three
- Goal: an annotated and searchable corpus with high-quality sound and video recordings
- Auditory and acoustic analyses will be performed
- Develop a prosodic typology of cat vocalizations





# I: Prosody in cat vocalizations (1)

- Starting points: previous results and theories
- Previous studies (Moelk, 1944 and own work) suggest that cats vary the intonation, voice quality, rhythm and duration in different contexts to signal different emotions
- However , still no larger systematic acoustic study
- We will explore a number of features in order to learn how cats modulate their prosody when interacting with humans



# I: Prosody in cat vocalizations (2)

- Three main research questions:
  1. What are the most common types of vocalizations and how do they differ prosodically?
  2. Which types are used in different contexts or situations?
  3. How do humans perceive this prosodic variation?
- Our hypotheses are:
  1. Cats “semi-consciously” use distinct prosodic patterns in different contexts to adjust, emphasize or alter the meaning of a vocalizations
  2. Similar types of prosodic variation are used by different/most cats
  3. Experienced human listeners are able to interpret this variation



## II: Cat perception of human prosody (1)

- As has been shown by Burnham, Kitamura and Vollmer-Conna (2013), pet-directed speech shares many of the characteristics of infant-directed speech (“motherese”)
- However, we do not know whether pets, like infants, are more drawn to this kind of speech
- Plan: a discrimination experiment in which we expose cats to audio samples of pet-directed and adult-directed speech
- Both natural and resynthesized stimuli
- First: what behavioral responses can be used?
- Candidates: head, eye, ear and body movement

## II: Cat perception of human prosody (2)



- Second: are any of these responses suggestive of preferences for either pet-directed or adult-directed speech
- We will also investigate whether there is a preference for adult or children voices or whether familiar and unfamiliar voices elicit different behaviors
- To minimize stress levels the sessions will take place in the cats' home environment, using a specially built mobile box
- This box will be cleaned carefully between sessions!
- The recordings will be scored by two independent judges in order to obtain objectivity and reliability of the results





# III: Dialects in cats?

- Our project has received vast media attention, internationally
- Often one of the recurring points has been whether cats have dialects, e.g. BBC Quiz of the Week's News (second question):  
<http://www.bbc.com/news/magazine-35935380>
- Given that we will record cats at different locations in Sweden, where human prosody is clearly distinct, our data could reveal whether human care-taker prosody also shows up in cat prosody
- Far-fetched?
- ... wait for it...



## IV: Language learning (1)

- That animals exhibit language learning and dialectal variation (two sides of the same coin) has been observed since Aristotle, who reported dialectal variation in bird (Zirin, 1980)
- That animals can both learn and use prosody outside their innate vocalizations has recently been shown in a couple of remarkable papers
- Lamario et al (2016) on the orang-utan, who managed to learn and mimic human speech prosody
- Vester et al (2016) identified six dialects in Norwegian fin whales (and that was just in northern Norway)



## IV: Language learning (2)

- Ridgway et al. (2012) reported on a Beluga whale who, on his own time and volition, adapted its vocalizations to be able to speak to human divers
- The whale's attempt to address the human divers was far outside its normal frequency range, revealing clear adaptation



Free stock photo from [imgsplanet.com](https://www.imgsplanet.com)



# Ethical considerations

- No ethical committee decision is needed to film care-takers and their cats in their natural environment
- There are, however, other ethical considerations
- In order to evoke prosodic modulation we plan to perform certain manipulations , like brushing a cat first gently, then more and more intensively until we reach a “that’s enough” level, or hang food in front of the cats without giving it to them
- Our last wish is to annoy our feline friends
- Ergo: judgment call!



# Project benefits: cats

- What possible benefit to cats might there be here?
- The better we understand how cats signal their mental states, the better we can adapt to their needs
- Both social and medical gains here
- Also: veterinarians linked to the project



# Project benefits: humans

- Humans benefit from having pets around
- Case in point: hospice for the elderly and retirement homes
- The better humans can understand their cats, the better the relationship will be for both parties



# Project benefits: scientists

- Recent research has revealed impressive communicative skills in animals, hitherto thought impossible (see previous slides for but a few examples)
- Also, inter-species communication is also a field very much in its infancy
- Both these fields can act as windows into language from a wider perspective, e.g. language learning (mentioned above) and even – dare we say? – the emergence of languages in humans
- Psycholinguist tied to the project



# External collaboration

- Meowsic collaborates with a group of consultant experts:

## **Elin Hirsch**

PhD student in Applied Ethology,  
Centre for Feline Behaviour and Welfare,  
Department of Animal Environment and Health,  
Swedish University of Agricultural Sciences

## **Ann-Charlotte Sandberg**

Veterinarian  
Landskrona Smådjursklinik, Sweden

## **Gisela Håkansson**

Professor of General Linguistics,  
Lund University

## **Gustav Peters**

Retired Curator  
Forschungsmuseum Alexander Koenig  
Bonn, Germany

## **John Ohala**

Emeritus Professor of Linguistics,  
Berkeley University of California

## **Jennie Westander**

Head of Research  
Kolmården Zoological Park, Sweden





# Parallel projects (1)

- The research team is also active in three related projects
- Schötz & van de Weijer collaborates with Elin Hirsch and Maria Andersson at the Swedish University of Agricultural Science and the Centre for Feline Behavior and Welfare
- Multi-disciplinary study of prosody, behavior and welfare in the domestic cat
- The project goal is to develop a web-based toolbox with descriptions and examples
- To be used by humans wanting to assess cat welfare



## Parallel projects (2)

- Eklund collaborates with Dr Florian Weise and Stuart Munro at the N/a'an ku sê Foundation, Windhoek, Namibia
- Project officially sanctioned by the Namibian Government
- Recording of vocalizations in cheetahs and African Wild Dogs
- Project goal is to gain knowledge of mental states in the said animals and how those are signaled in vocalizations
- Improve husbandry and animal welfare
- High-quality video and audio recordings made in December 2013 – now subject to analysis



# Parallel projects (3)

- Eklund is also collaborating with Dr Andrew Kitchener and Georg Hantke, National Museums Scotland, Edinburgh
- Project goal is to perform post mortems on all species of cats with focus on laryngeal structures and other structures of value for analyses of vocalizations
- Work in progress





# Media attention (1)

- Enormous international media interest (press, radio, TV, web)
- Not surprising: 600 million cats in the world!
- More than 30 interviews (Schötz, Eklund)
- In June 2016, we knew about at least 100 articles...
- ... but we don't know about languages ungoogleable to us
- For example, Eklund asked friends in Taiwan about mentions of Meowsic in Chinese media
- Immediate hits were found

**壹讀**

科學家正在研究貓是否也有自己的方言

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說話帶口音的貓聽起來像那些異想天開的兒童故事裡的角色，不過瑞典科學家最近真的在研究國內不同地方的貓叫起來帶不帶「方言」。此外他們還在研究主人的聲音是否會影響它們「喵」的方式。如果這項研究最終獲得成功，這個來自隆德大學的團隊可能會出一本貓叫「字典」。

「貓似乎總是不斷地有意識地改變它們叫聲地語調和旋律，或許是為了傳達某種特定的信息，或者是為了改變或者增加某種訊息和情緒地緊迫性」，該項目的負責人，語言學教授 Susanne Schötz 說。 「我們想知道國內的貓在多大程度上受到人類所講的語言和方言的影響，因為看起來貓發出的叫聲好像確實有輕微的不同，很像方言。」



這個項目名為「Meowsic」（「人與貓溝通中的旋律」的英文簡寫），將在未來5年中進一步展開實施。Schötz 解釋說她和她的團隊將會使用語音分析的方法比較來自斯德哥爾摩和隆德這兩個不同的地區中貓的叫聲，也會與人類的方言進行對比分析，最終研究是否不同地域的貓講著不同的方言。他們將會側重研究人與貓發聲的語調，聲音，風格間的相互影響。

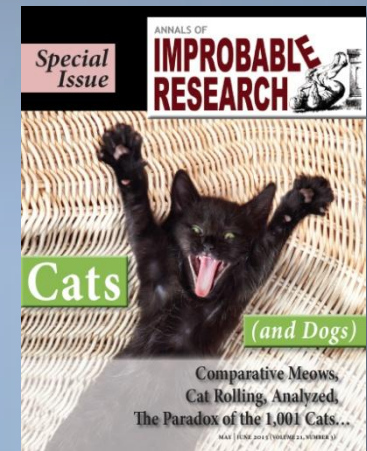


# Media attention (2)

- Just listing a few:

National Geographic, The Washington Post, The Guardian, BBC 5 Live, The Telegraph, Daily Mail, Der Spiegel, as well as Swedish radio, TV and press, Norwegian radio and online all over the world, including Chile, China and Vietnam

- We take special pride in having our previous research (prior to Meowsic) covered in a special issue of *Annals of Improbable Research* (the people behind the IG Nobel Prizes), 2015, volume 21, no. 3, Special Issue on Cats (and Dogs), pp. 6–8





# Acknowledgements

- Above all: Marcus and Amalia Wallenbergs Minnesfond
- Lund University Humanities Lab
- We are also very grateful to all our consultants for their support and participation in the project
- We would also like to thank all our cat informants
- Thanks are extended to a plethora of interested journalists
- And everyone around the world who sends us encouraging emails on a daily basis!



# The research team

Susanne Schötz



Robert Eklund



Joost van de Weijer



# Project-related publications

Schötz and Schötz & de Weijer and Schötz & Eklund have so far published the following papers on cat vocalizations:

- Schötz, S., R. Eklund & J. van de Weijer. 2016 (proceedings pending). Melody in Human–Cat Communication (Meowsic). Origins, Past, Present and Future. *Proceedings of Fonetik 2016*, 13–15 June 2016, KTH, Stockholm, Sweden.
- Schötz, S. 2015. *Agonistic Vocalisations in Domestic Cats: A Case Study*. *Proceedings of Fonetik 2015*, Lund University, 85–90.
- Schötz, S. & J. van de Weijer. 2014a. A Study of Human Perception of Intonation in Domestic Cat Meows. *Proceedings of Speech Prosody 2014*, Dublin, 874–878.
- Schötz, S. & I. van de Weijer. 2014b. A Study of Human Perception of Intonation in Domestic Cat Meows. *Proceedings of Fonetik 2014*, Department of Linguistics, Stockholm University, 89–94.
- Schötz, S. 2014. A pilot study of human perception of emotions from domestic cat vocalisations. *Proceedings of Fonetik 2014*, Department of Linguistics, Stockholm University, 95–100.
- Schötz, S. 2013. A phonetic pilot study of chirp, chatter, tweet and tweedle in three domestic cats. *Proceedings of Fonetik 2013*, 14–16 June 2013, Linköping University, Sweden, 65–68.
- Schötz, S. 2012. A phonetic pilot study of vocalisations in three cats. *Proceedings of Fonetik 2012*, Department of Philosophy, Linguistics and Theory of Science, University of Gothenburg, 45–48.
- Schötz, S., & R. Eklund. 2011. A comparative acoustic analysis of purring in four cats. *Proceedings of Fonetik 2011*, Speech, Music and Hearing, KTH, Stockholm, TMH-QPSR, Vol. 51, 9–12.





# Project-related publications (cont'd)

Eklund and colleagues have so far published the following papers on cheetah, lion and cat vocalizations (papers co-authored by Schötz omitted; see previous slide):

Eklund, Robert. 2015. Grimaldi's "Discovery of the Cat Language": A theory in need of revival (or perhaps not?) In: *Proceedings from Fonetik 2015. Working Papers 55/2015*, 8–10 June 2015, Centre for Languages and Literature, General Linguistics/Phonetics, Lund University, Lund, Sweden, ISSN 0280-526X, pp. 27–30.

Eklund, Robert & Gustav Peters. 2013. A comparative acoustic analysis of purring in juvenile, subadult and adult cheetahs. In: Robert Eklund (ed.), *Proceedings of Fonetik 2013, the XXVIth Swedish Phonetics Conference, Studies in Language and Culture, no. 21*, 12–13 June 2013, Linköping University, Linköping, Sweden. ISBN 978-91-7519-582-7, eISBN 978-91-7519-579-7, ISSN 1403-2570, pp. 25–28.

Eklund, Robert, Gustav Peters, Florian Weise & Stuart Munro. 2012a. A comparative acoustic analysis of purring in four cheetahs. In: *Proceedings from FONETIK 2012*. Gothenburg, Sweden, May 30–June 1, 2012, pp. 41–44.

Eklund, Robert, Gustav Peters, Florian Weise & Stuart Munro. 2012b. An acoustic analysis of agonistic sounds in wild cheetahs. In: *Proceedings from FONETIK 2012*. Gothenburg, Sweden, May 30–June 1, 2012, pp. 37–40.

Ananthakrishnan, Gopal, Robert Eklund, Gustav Peters & Evans Mabiza. 2011. An acoustic analysis of lion roars. II: Vocal tract characteristics. In: *Quarterly Progress and Status Report TMH-QPSR, Volume 51, 2011. Proceedings from Fonetik 2011*. Royal Institute of Technology, Stockholm, Sweden, 8–10 June 2011, pp. 5–8.

Eklund, Robert, Gustav Peters, Gopal Ananthakrishnan & Evans Mabiza. 2011. An acoustic analysis of lion roars. I: Data collection and spectrogram and waveform analyses. In: *Quarterly Progress and Status Report TMH-QPSR, Volume 51, 2011. Proceedings from Fonetik 2011*. Royal Institute of Technology, Stockholm, Sweden, 8–10 June 2011, pp. 1–4.

Eklund, Robert, Gustav Peters & Elizabeth D. Duthie. 2010. An acoustic analysis of purring in the cheetah (*Acinonyx jubatus*) and in the domestic cat (*Felis catus*). In: *Proceedings of Fonetik 2010*, Lund University, 2–4 June 2010, Lund, Sweden, pp. 17–22.



# Web resources

Meowsic Project website:

<http://meowsic.info>

Dell Cheetah Centre homepage:

<http://www.dccafrica.co.za/>

Eklund records the cheetah Caine:

<http://www.youtube.com/watch?v=ZFvULxbN3NM>

Agonistic vocalizations in cheetahs:

<http://www.youtube.com/watch?v=bBlf5g2Fp1U&feature=youtu.be>

Eklund's purring website:

<http://purring.org>

