



VOCAL CUES TO DISCOMFORT IN MAMMALS: Application for estimating welfare in captivity

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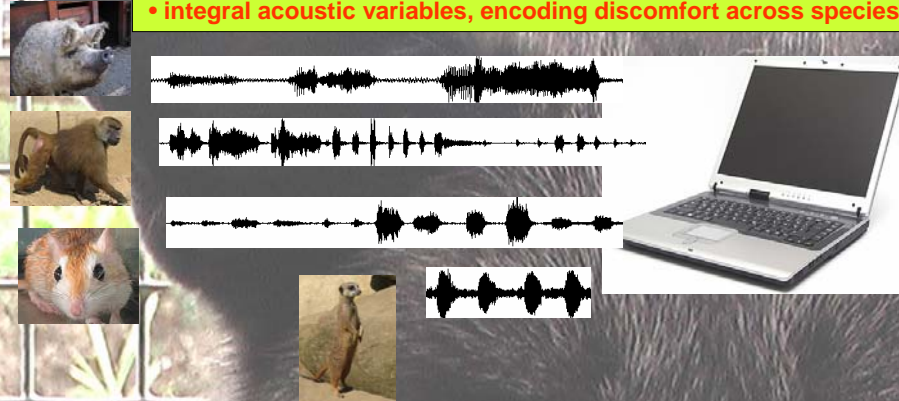
Negative emotional arousal impairs animal welfare. Many mammals respond vocally to discomfort, so the acoustic variables can be measured in automated mode to create systems for real time estimating the degree of discomfort.

Increase of discomfort and acoustic variables: meta-analysis

But: different mammals - different calls!

For creating automated systems of vocal-based welfare monitoring, is necessary:

- measuring discomfort-related features in calls of any structure
- integral acoustic variables, encoding discomfort across species

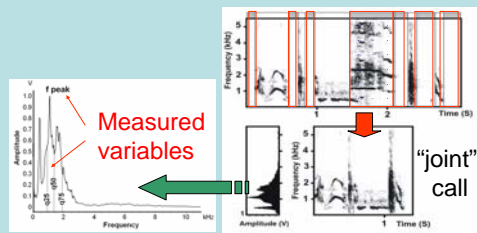


Universal variables:

The increase in proportion of time spent vocalizing and the shift of call energy towards higher frequencies may be integral vocal characteristics of short-term welfare problems in captive mammals.

Preparing a "joint" call:

removal of silent spaces and alien noises



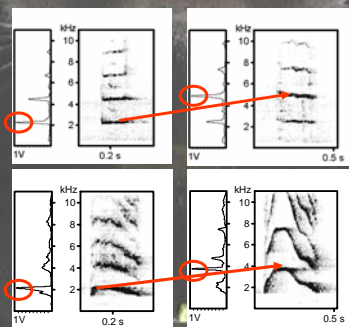
"Joint calls are appropriate for analysis of calls independently on their structure, either tonal or noisy.

Proposal algorithm of automated discomfort estimation



1. Splitting of continuous recording to fragments;
2. Checking of start and end of each calls;
3. Removal of silent spaces and strikes, formation of a joint call;
4. Measuring duration of the joint call (= time spent vocalizing);
5. Measuring peak frequency and quartiles of the joint call;
6. Comparison with previous and following joint calls.

Shift of energy to higher frequency bands (Pallid gerbil)



Discomfort increase

Fundamental frequency modulation (Great gerbil)

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

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Duration	
No increase	Baboon – Rendall 2003
	Common marmoset - Schrader, Todt 1993
	Domestic piglets - Weary, Frazer 1995
decrease	Meercat - Manser 2001
	Lynx – Chaadaeva 2005
	Great gerbil – Volodin et al. 1994
without change	Pallid gerbil – Volodin et al. 2009
	Common marmoset - Newman, Goedecking 1992
	Guinea pig – Monticelli et al. 2004
without change	Great gerbil – Volodin et al. 2009
	Tree shrew - Schehka et al. 2007
	Domestic piglets - Weary et al. 1998
without change	Silver fox – Gogoleva et al. 2010

Call rate	
Yes! increase	Baboon – Rendall 2003
	Domestic piglets - Weary, Fraze, 1995
	Domestic dog - Pongracz et al. 2005
Yes! increase	Silver fox – Gogoleva et al. 2010
	Brandt vole - Nikolskii, Sukhanova 1992
	Yellow-bellied marmot - Blumstein, Armitage 1997
Yes! increase	Great gerbil – Volodin et al. 1994
	Nikolskii, Sukhanova 1992
	Pallid gerbil – Volodin et al. 2009

Time spent vocalizing	
Yes! increase	Great gerbil – Volodin et al. 1994
	Silver fox – Gogoleva et al. 2010

Peak frequency and quartiles	
Yes! increase	Saimiri - Fichtel et al. 2001
	Barbary macaque - Fischer et al. 1995
	Common marmoset - Schrader, Todt 1993
Yes! increase	Newman, Goedecking 1992
	Tree shrew - Schehka et al. 2007
	Domestic piglets - Weary, Fraser 1995
Yes! increase	Weary et al. 1998
	Taylor, Weary 2000
	Lynx – Chaadaeva 2005
Yes! increase	Domestic dog - Pongrácz et al. 2005
	Silver fox – Gogoleva et al. 2010
	Great gerbil - Volodin et al. 2009
Yes! increase	Pallid gerbil – Volodin et al. 2009
	Human - Ruiz et al. 1996

Fundamental frequency BUT – only in tonal calls	
???	Baboon - Rendall 2003
	Pigtailed macaque - Gouzoules, Gouzoules 1989
	Common marmoset - Schrader, Todt 1993
???	Newman, Goedecking 1992
	Tree shrew - Kirchhof et al. 2001
	Schehka et al. 2007
???	Brown lemur - Fichtel, Hammerschmidt 2002
	Cattle - Watts, Stookey 1999
	Domestic dog - Pongracz et al. 2005
???	Brandt vole – Nikolskii, Sukhanova 1992
	Great gerbil - Nikolskii, Sukhanova 1992
	Volodin et al. 1994, 2009
???	Pallid gerbil – Volodin et al. 2009
	Guinea pig - Monticelli et al. 2004
	Human - Protopapas, Lieberman, 1995;
???	Bachorowski, Owren, 1995;
	Ruiz et al. 1996; Porter et al. 1986;
	Furlow 1997; Scherer 2003;
???	Papousek 1992; Scheiner et al. 2002

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