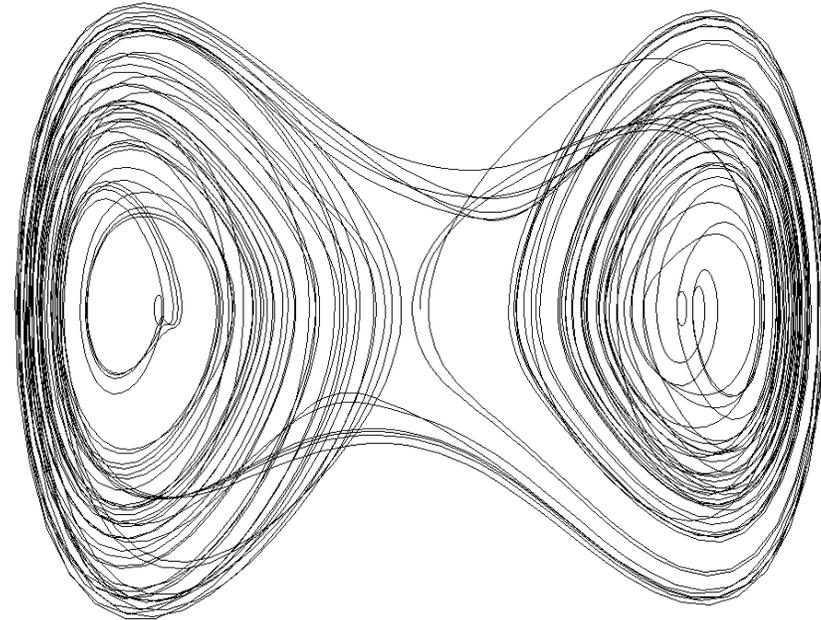


# Animal signals and emotion in music



**Greg Bryant**

UCLA Department of Communication Studies  
Center for Behavior, Evolution, and Culture

# Defining signals and cues

## *Signal*

Any act or structure that affects the behavior of other organisms, which evolved because of that effect, and which is effective because the receiver's response also evolved.



Maynard Smith, J. & Harper, D. (2003). *Animal Signals*. Oxford University Press, Oxford.

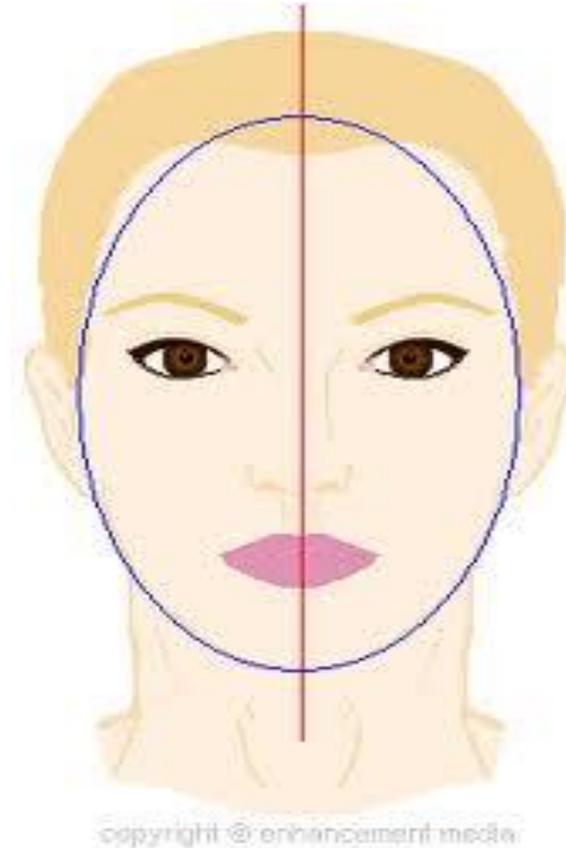
Scott-Phillips, T. C. (2008). Defining biological communication. *Journal of Evolutionary Biology*, 21, 387-395.

# Defining signals and cues

## *Cue*

Any feature of the world, animate or inanimate, that can be used by an animal as a guide to future action

Any act or structure that affects the behavior of other organisms, and is effective because the receiver's response evolved, but did not evolve because of that effect.

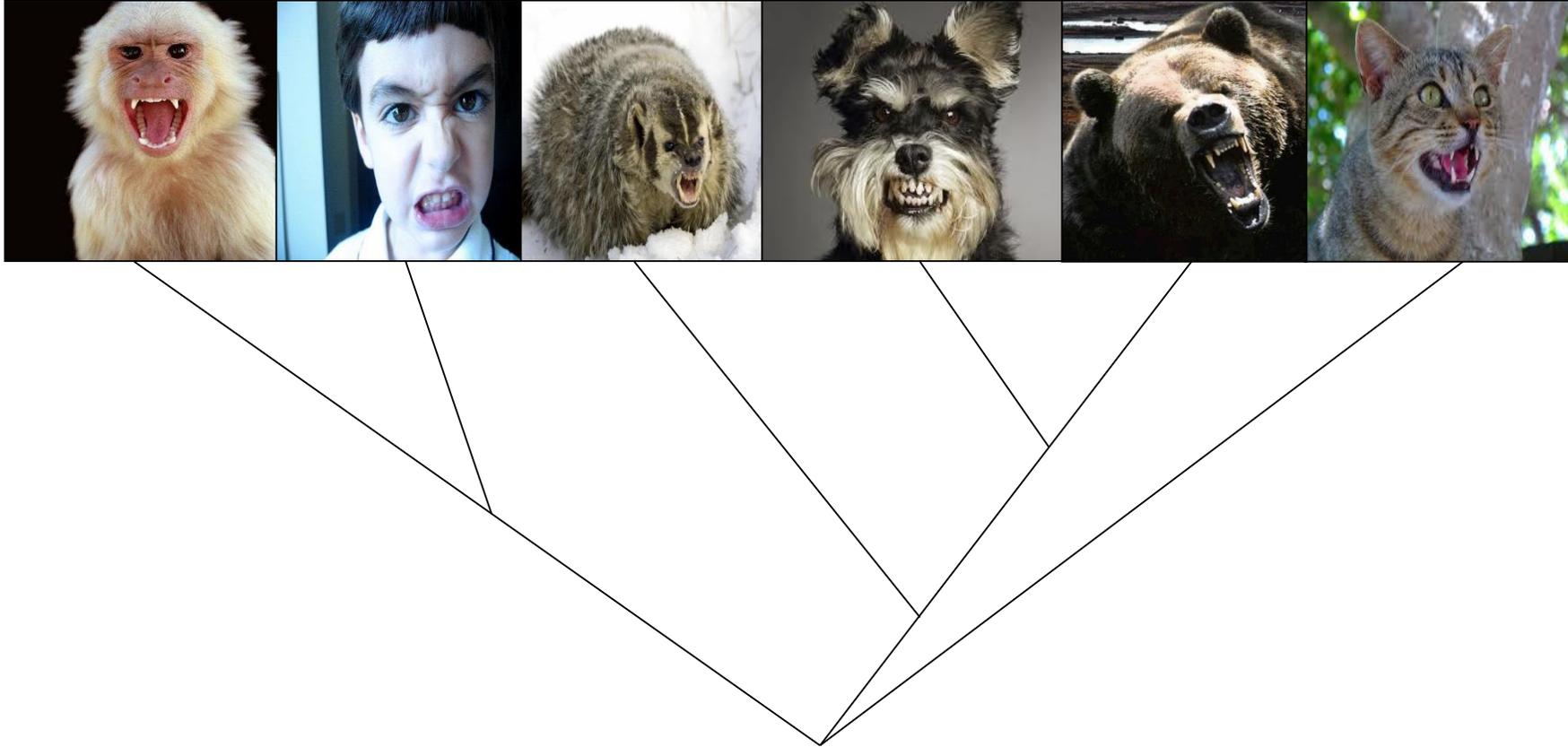


Maynard Smith, J. & Harper, D. (2003). *Animal Signals*. Oxford University Press, Oxford.

Scott-Phillips, T. C. (2008). Defining biological communication. *Journal of Evolutionary Biology*, 21, 387-395.

Emotional expressions are signals

# Phylogeny of emotion expressions



Many emotion signals are homologous across mammals

Signal forms are modified in species specific ways, but retain similar features because of similar functions

# Affective responses in tamarins elicited by species-specific music

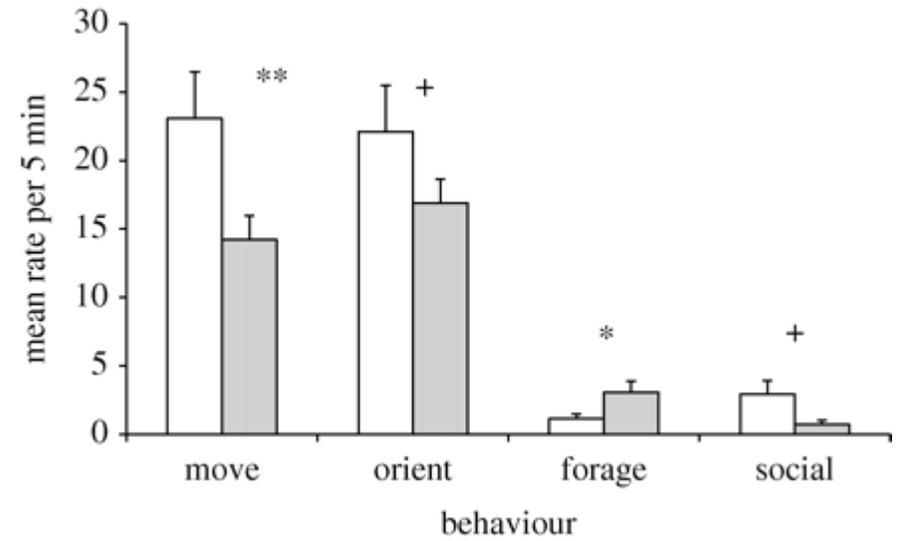
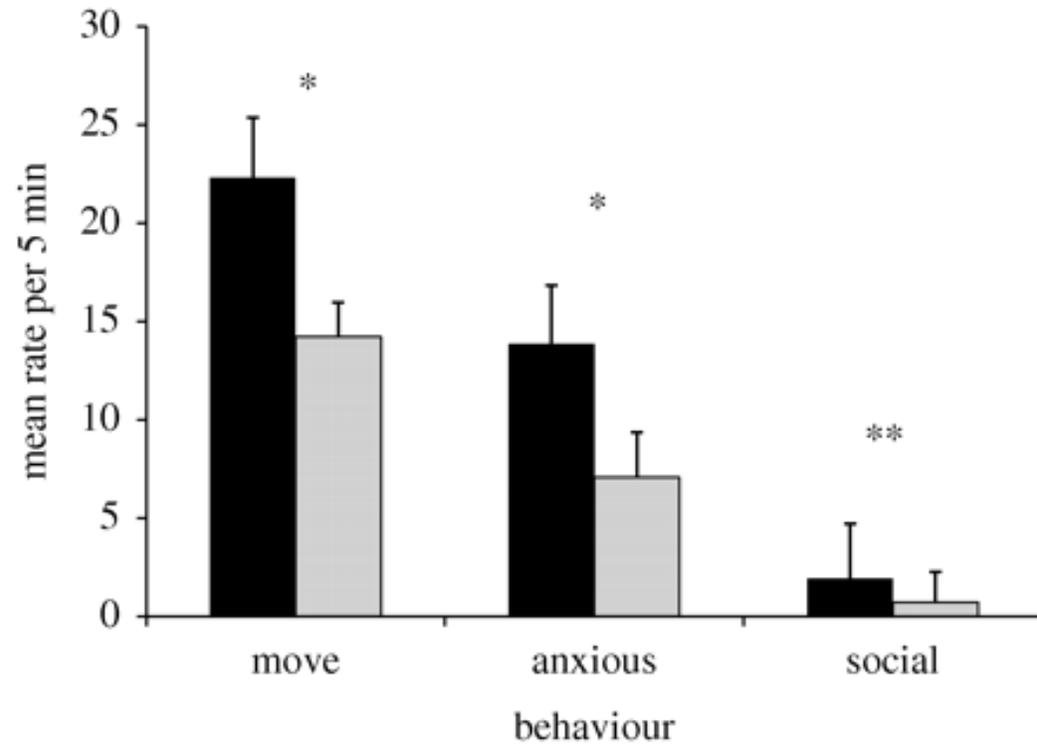
Compared with human music, Tamarins responded with increased arousal to tamarin threat vocalization based music, and with decreased activity and increased calm behaviour to tamarin affective vocalization based music.

Snowdon & Teie, 2009

Tamarin Serenade

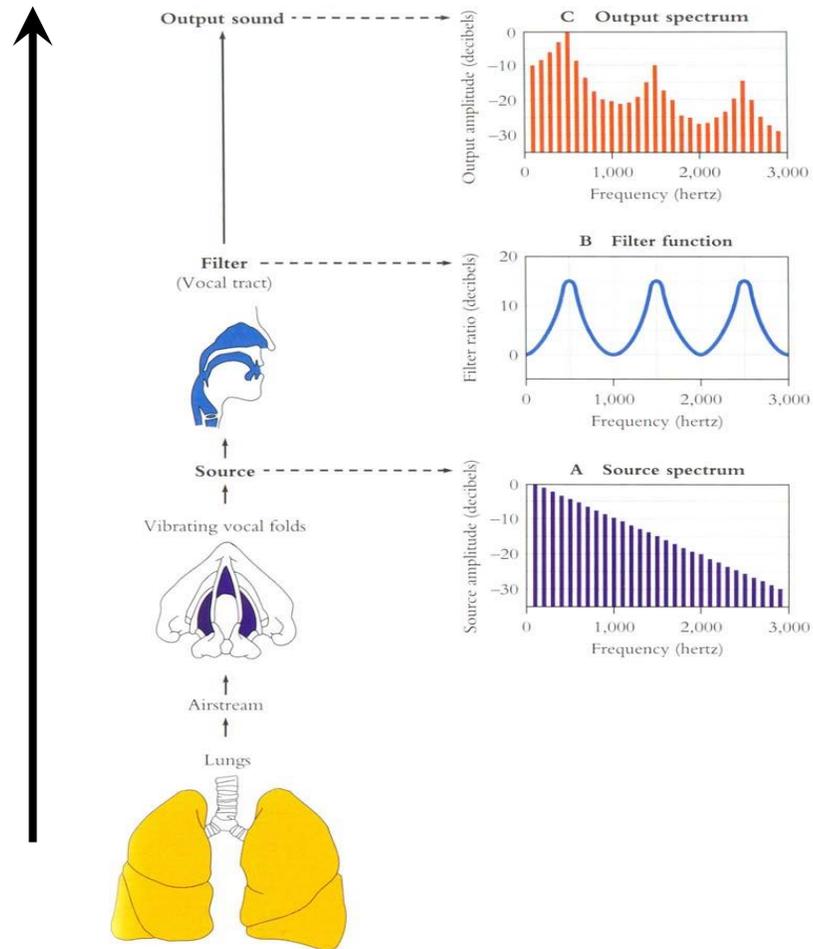


# Affective responses in tamarins elicited by species-specific music



# What are nonlinearities?

## Source-filter theory



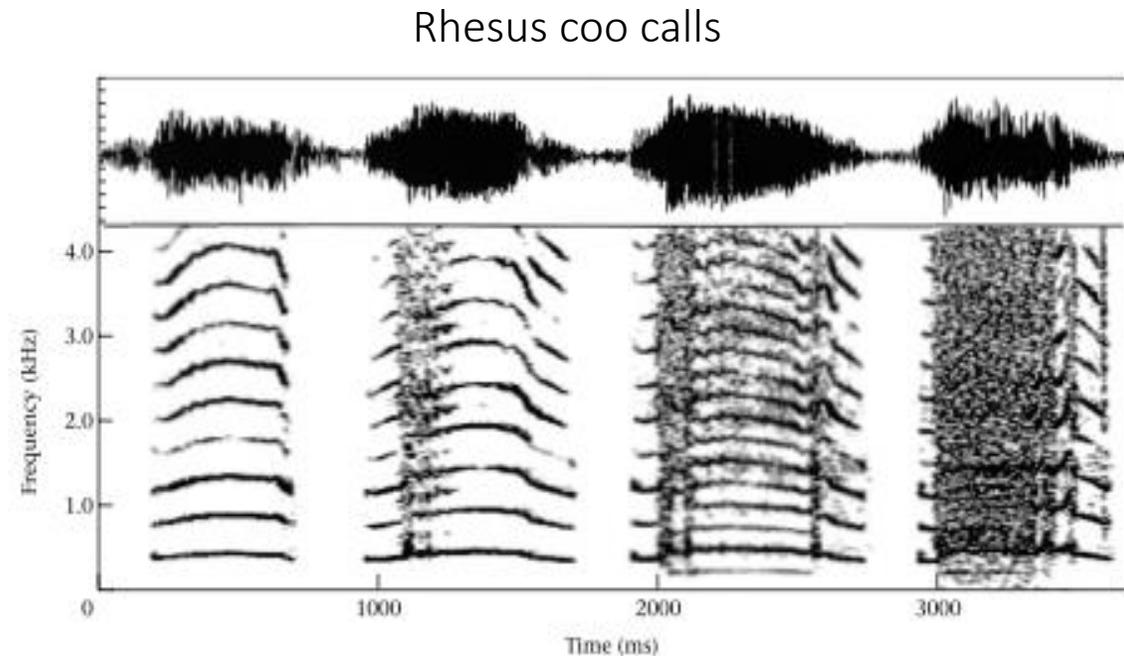
# What are nonlinearities?

**Subharmonics:** the addition of 'bands' of energy between harmonics

**Deterministic chaos:** broadband energy

**Bi-phonation:** sidebands adjacent to the harmonic

**Warbles:** abrupt frequency transitions

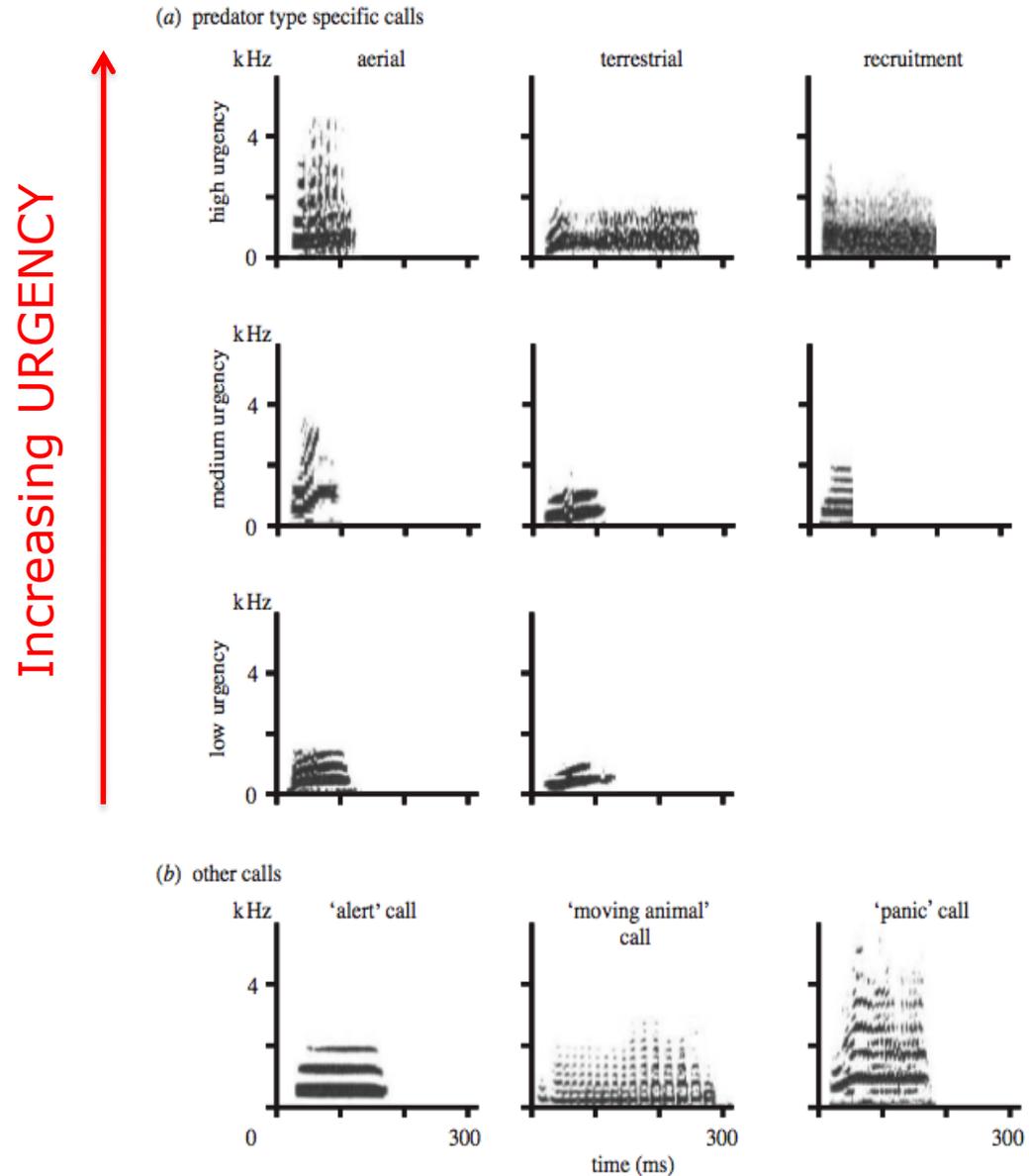


Fitch et al. 2002, *Anim. Behav.*

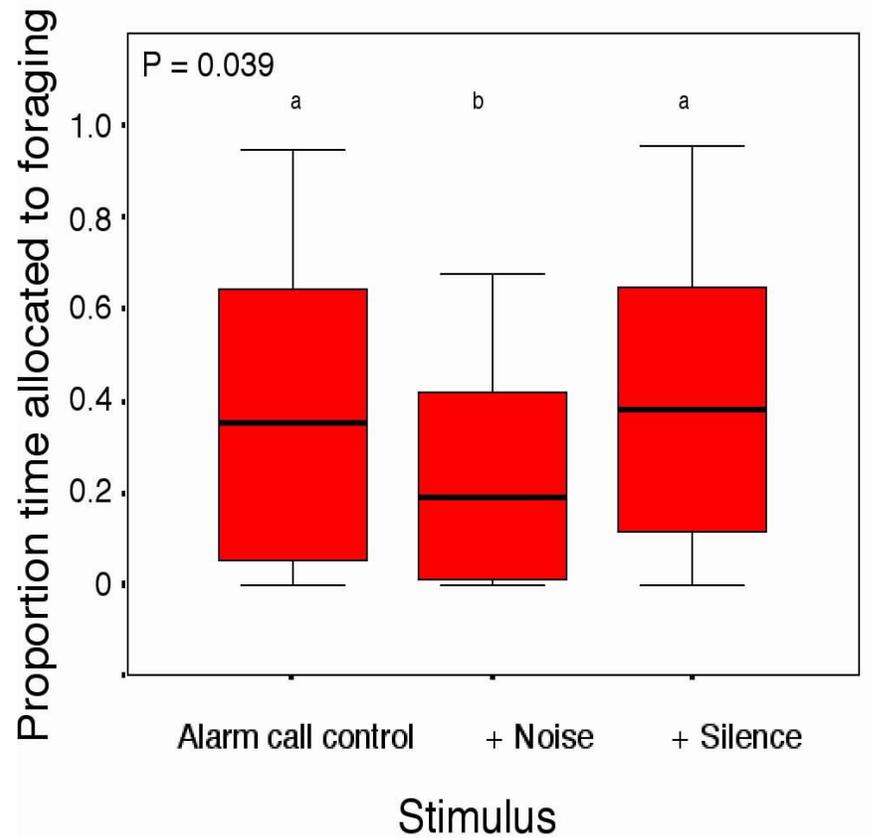


In meerkats,  
as urgency  
increases, calls  
become noisier

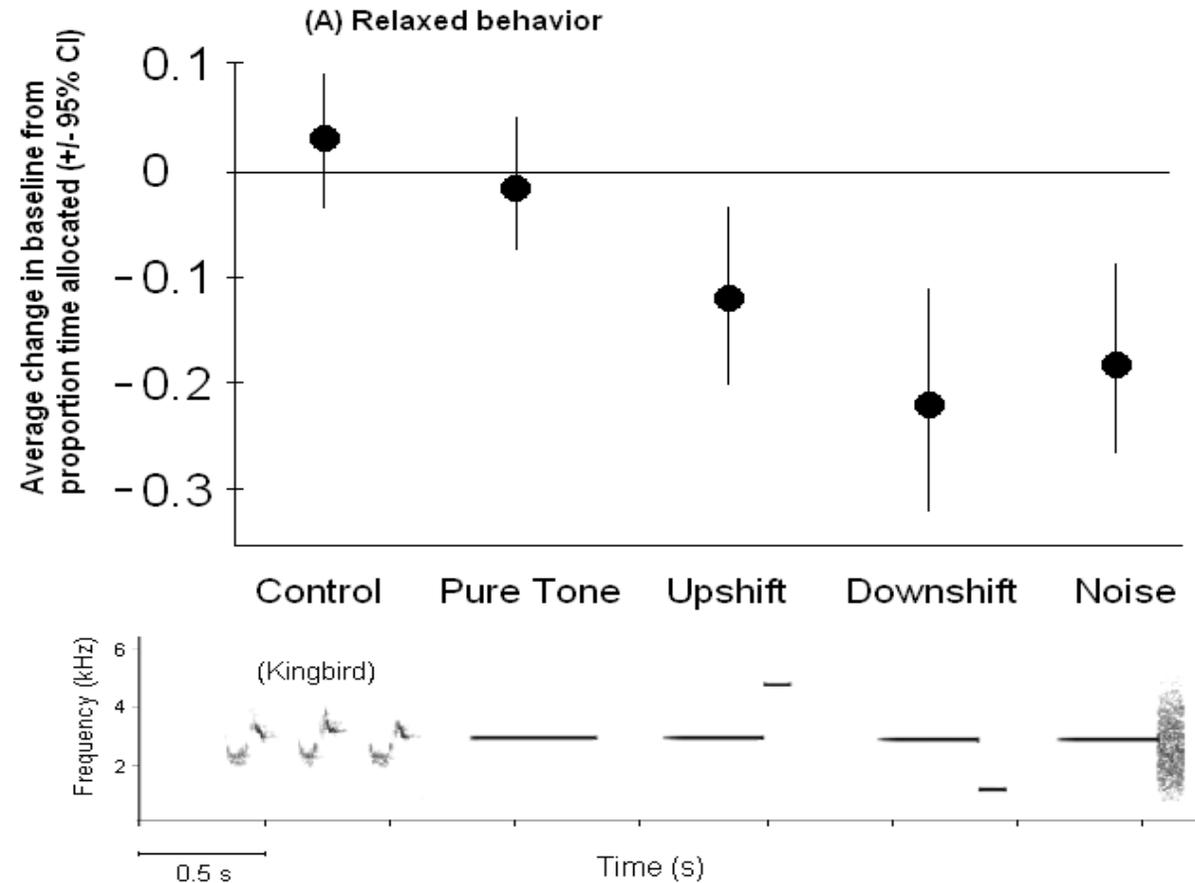
Manser 2001, *PRSB*



# Marmot alarm calls with noise added suppressed foraging compared to normal calls or calls with silence added



# Nonlinearities, specifically rapid downshifts and noise, decreased relaxed behavior in Caribbean great-tailed grackles



Nonlinearities may be evocative because they are directly tied to actual arousal creating an honest signal of fear



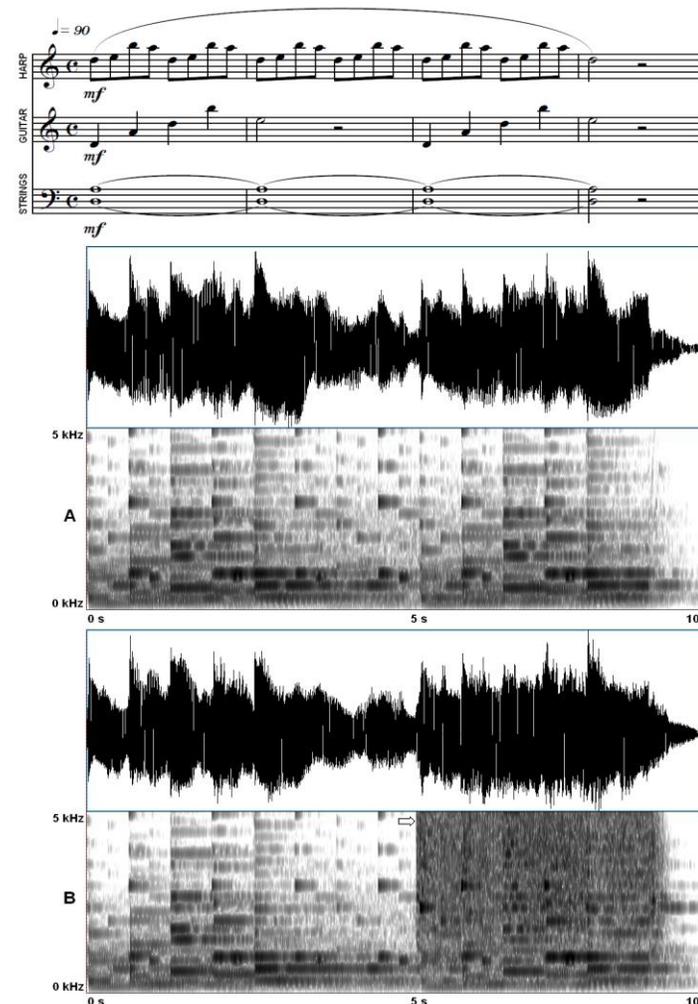
# Horror film soundtracks differentially contain nonlinear analogues

Specific types of nonlinear analogues are used to elicit fearful responses (noise in horror films), while others are used to elicit more dramatic emotional responses (abrupt frequency shifts)



# Can experimentally added nonlinear phenomena manipulate perceptions of arousal and valence?

- Experiment 1: Sound only
  - Music
  - Music + noise
  - Music + frequency up
  - Music + frequency down
- Experiment 2: Sound + Video
  - Music
  - Music + noise
  - Music + frequency up
  - Music + frequency down



# Experiment details

**Experiment 1:** N = 42 (23 F, 19 M)

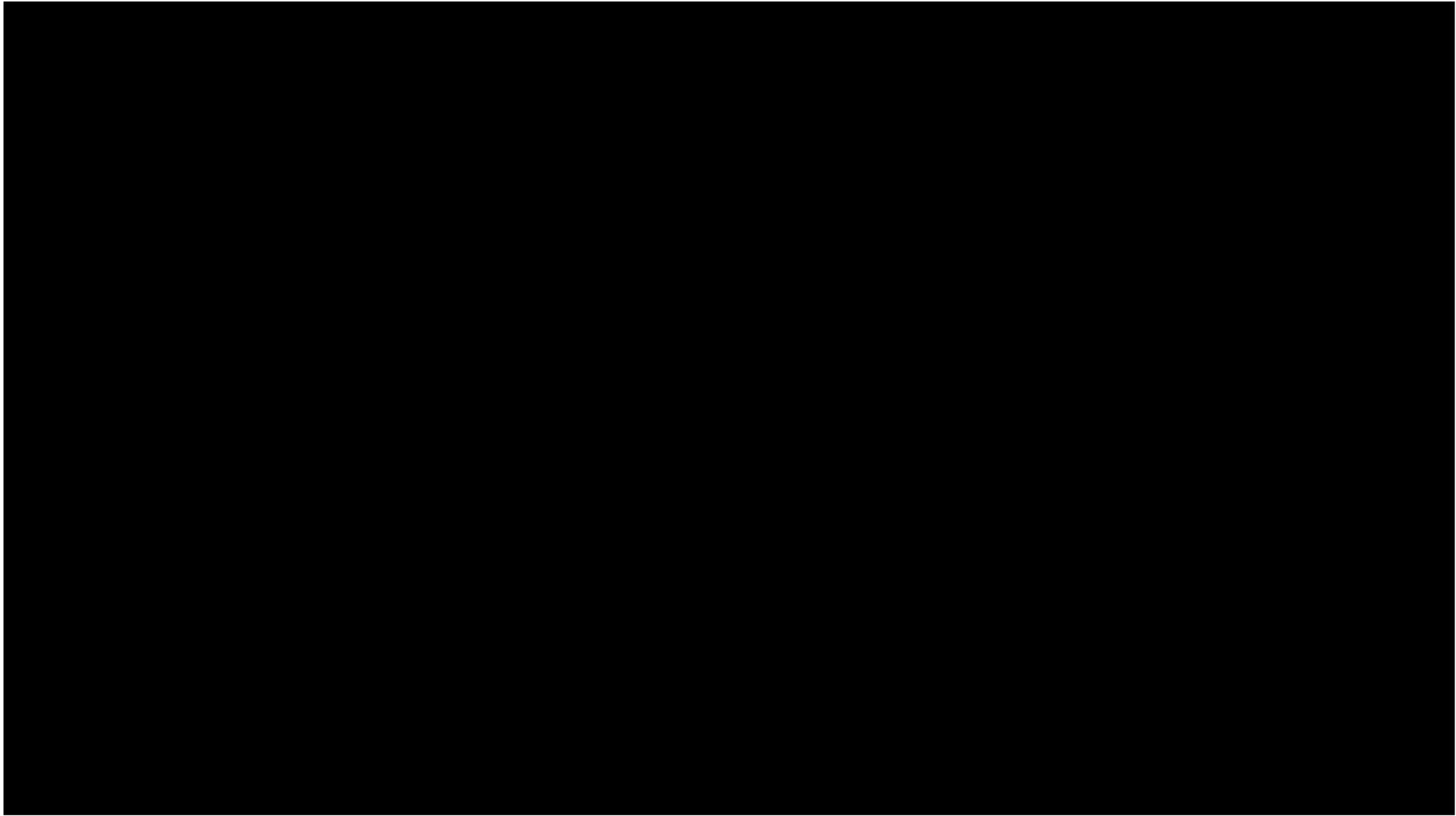
- 12, 10-sec 'emotionally neutral' compositions
- Nonlinearity added at 5 sec mark
- 6 fillers with no nonlinearities added

**Experiment 2:** N = 42 (27 F, 15 M)

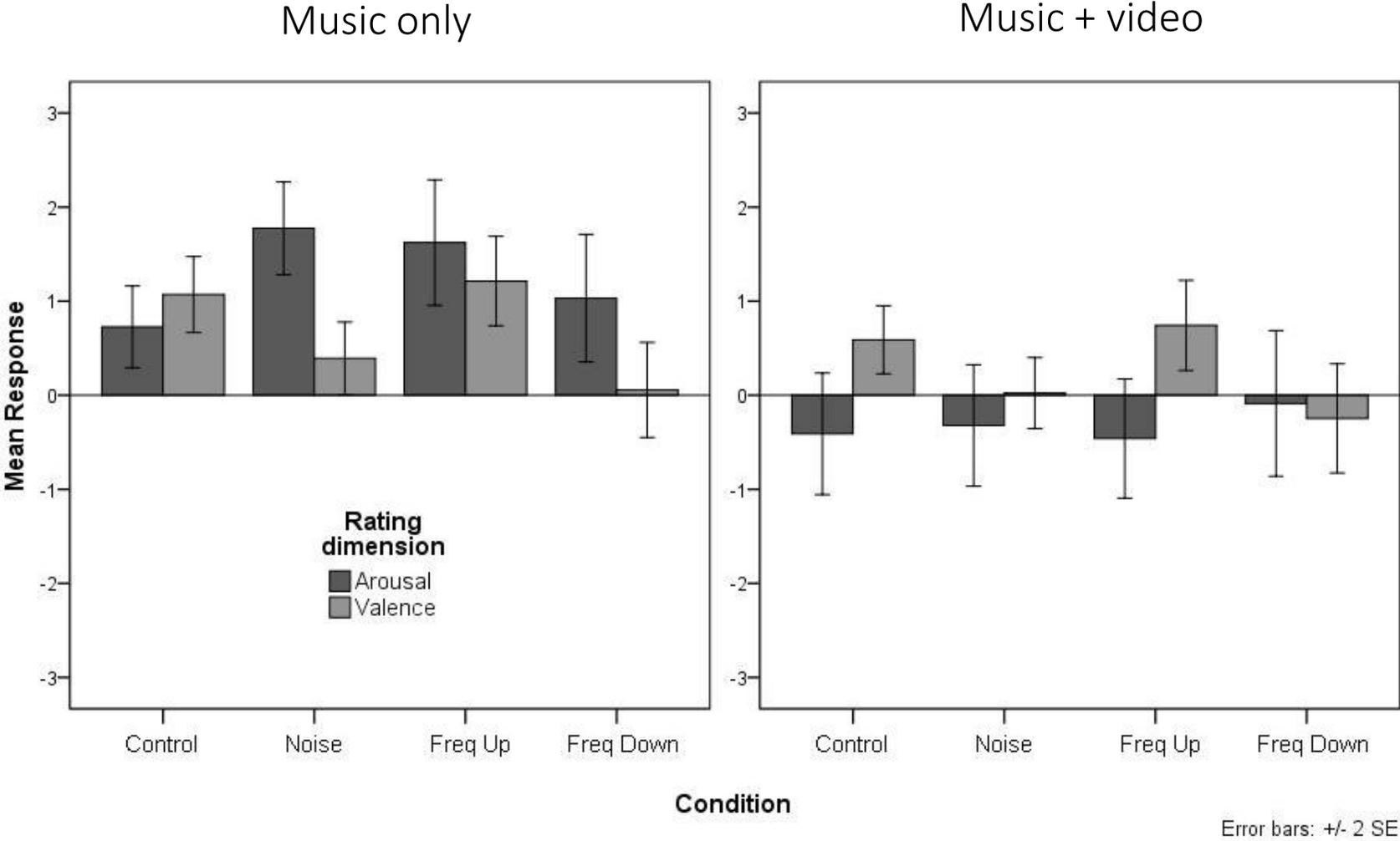
- Same music
- 18 videos of 'benign' activity occurring at 5-sec mark

Asked subjects to rate stimuli on -5 to +5 scale

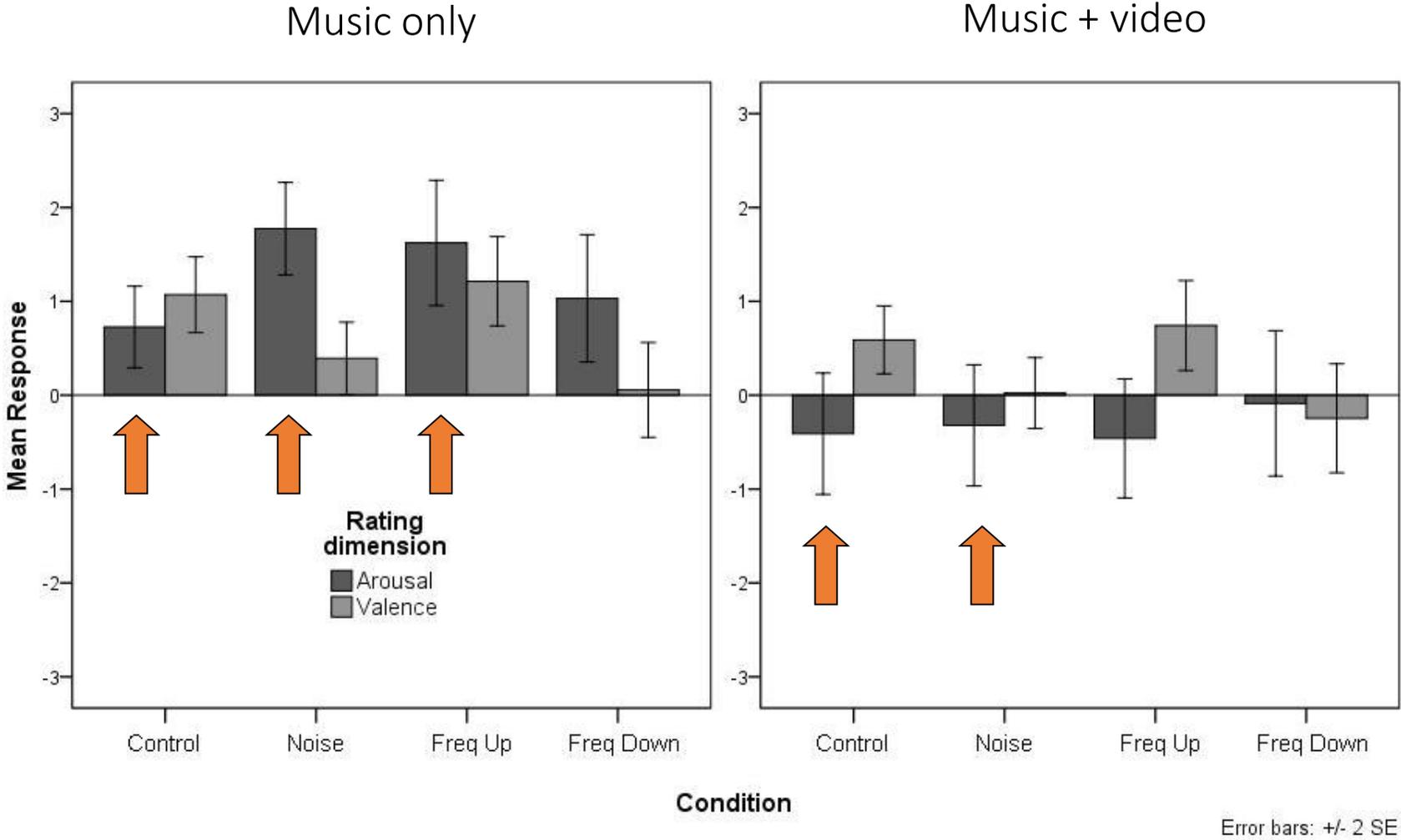
- Arousal: how emotionally stimulating or active
- Valence: how positive or negative (i.e., happy or sad)



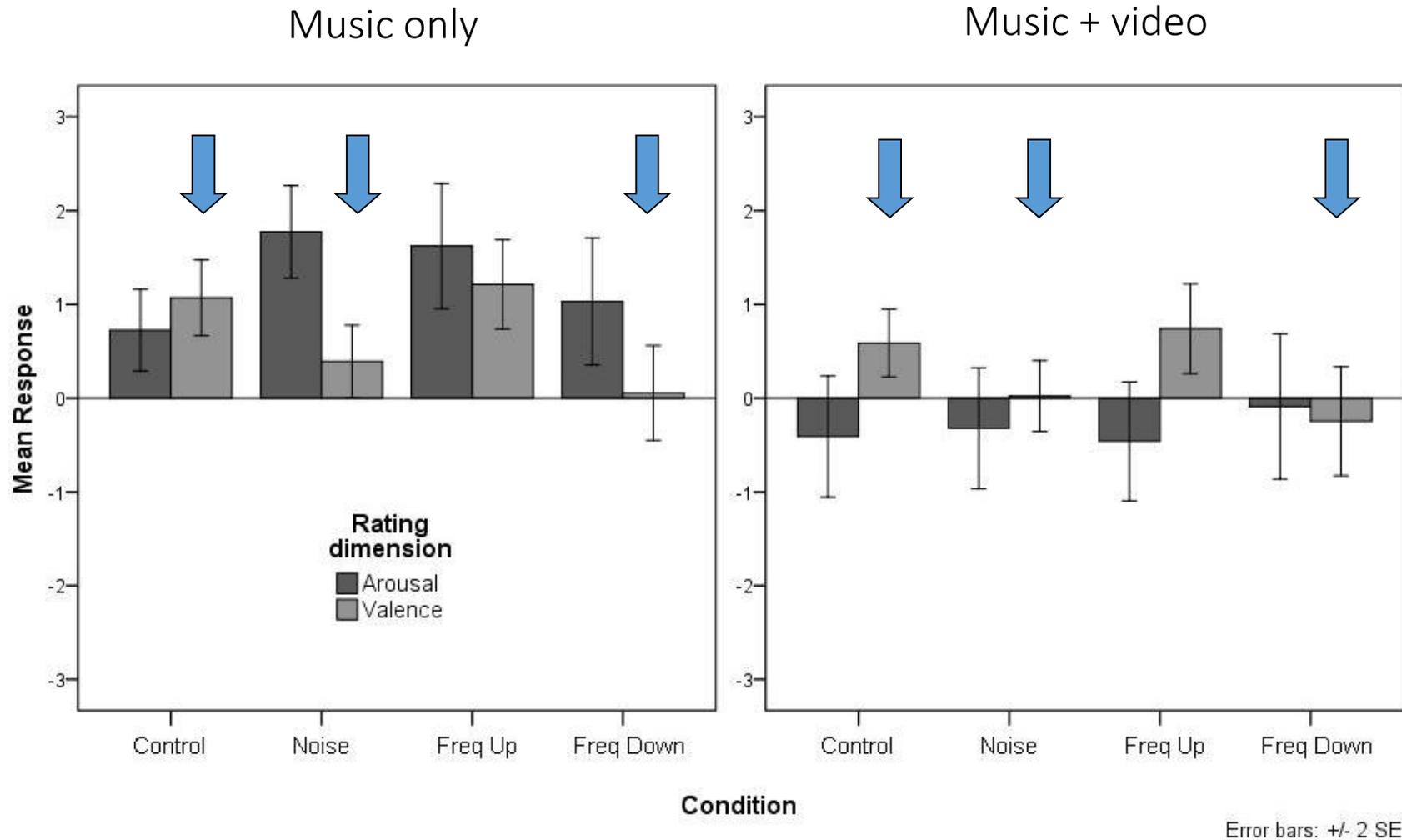
# Arousal increased by noise and frequency-up in music only but not in music + video



# Arousal **increased** by noise and frequency-up in music only but not in music + video



# Positive valence reduced by noise and frequency-down in both experiments



# Psychophysiological measures

Facial EMG

Heart rate

Skin conductance

Respiration



# Psychophysiological measures

## *Facial EMG*

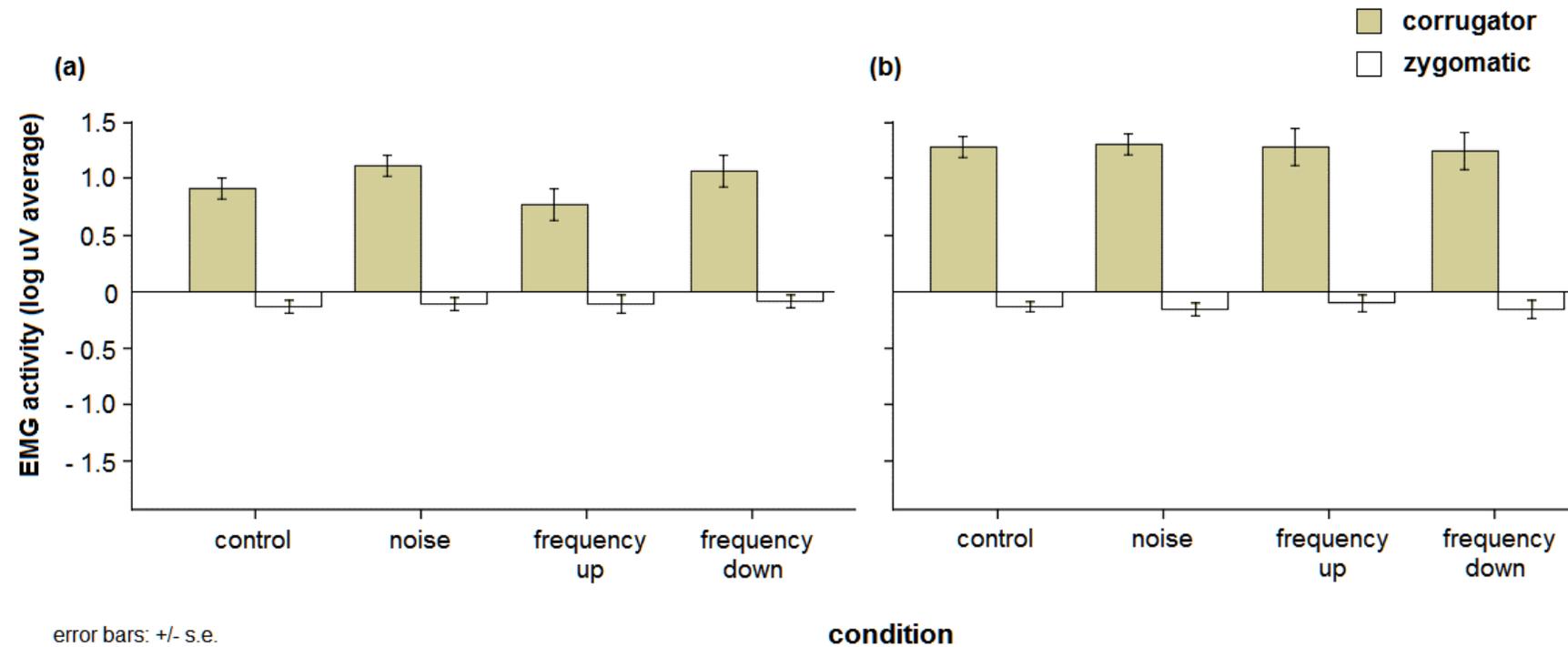
Recorded corrugator supercilii muscle and zygomaticus major muscle reactions using two pairs of 4mm unshielded Biopac electrodes + ground.

Signals were amplified and filtered using a BioNext Biopotential Amplifier with 60 Hz notch filtering, connected to a PC with BioLab Acquisition Software to digitize the signal.



# Psychophysiological measures

## Facial EMG

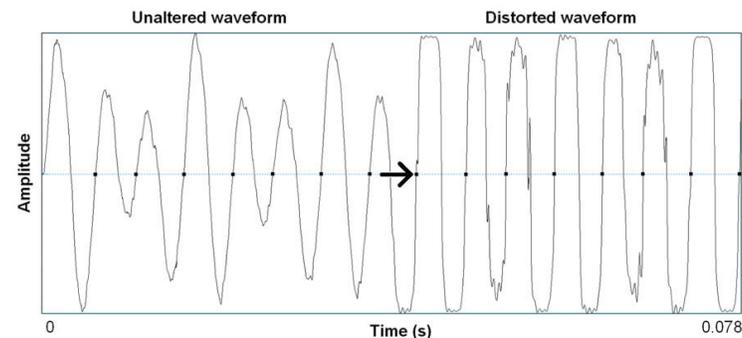


# Nonlinearities in modern music

Composers and musicians incorporate nonlinear phenomena into music for emotional effects

Musical genres geared toward generating arousal in listeners have deeply incorporated sound features such as distortion and rapid amplitude and frequency shifts

Cultural evolution of the sound of arousal through sensory manipulation

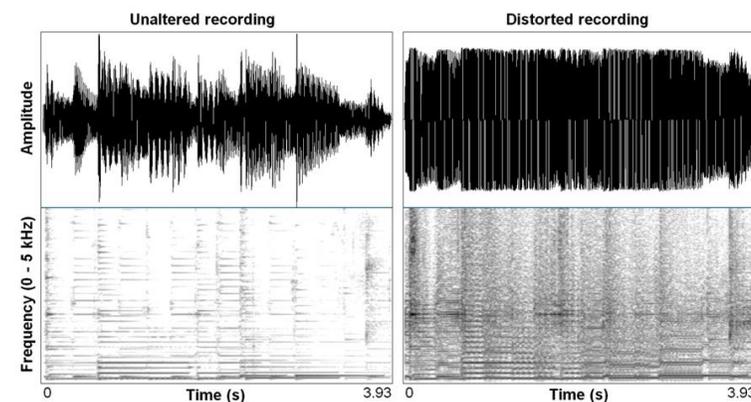


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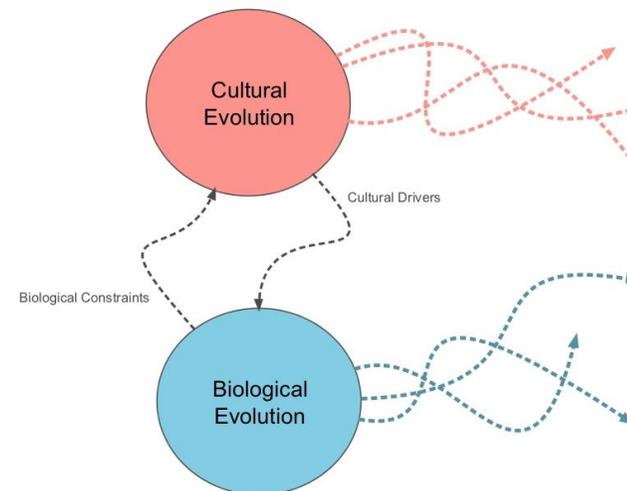


# Nonlinearities in modern music

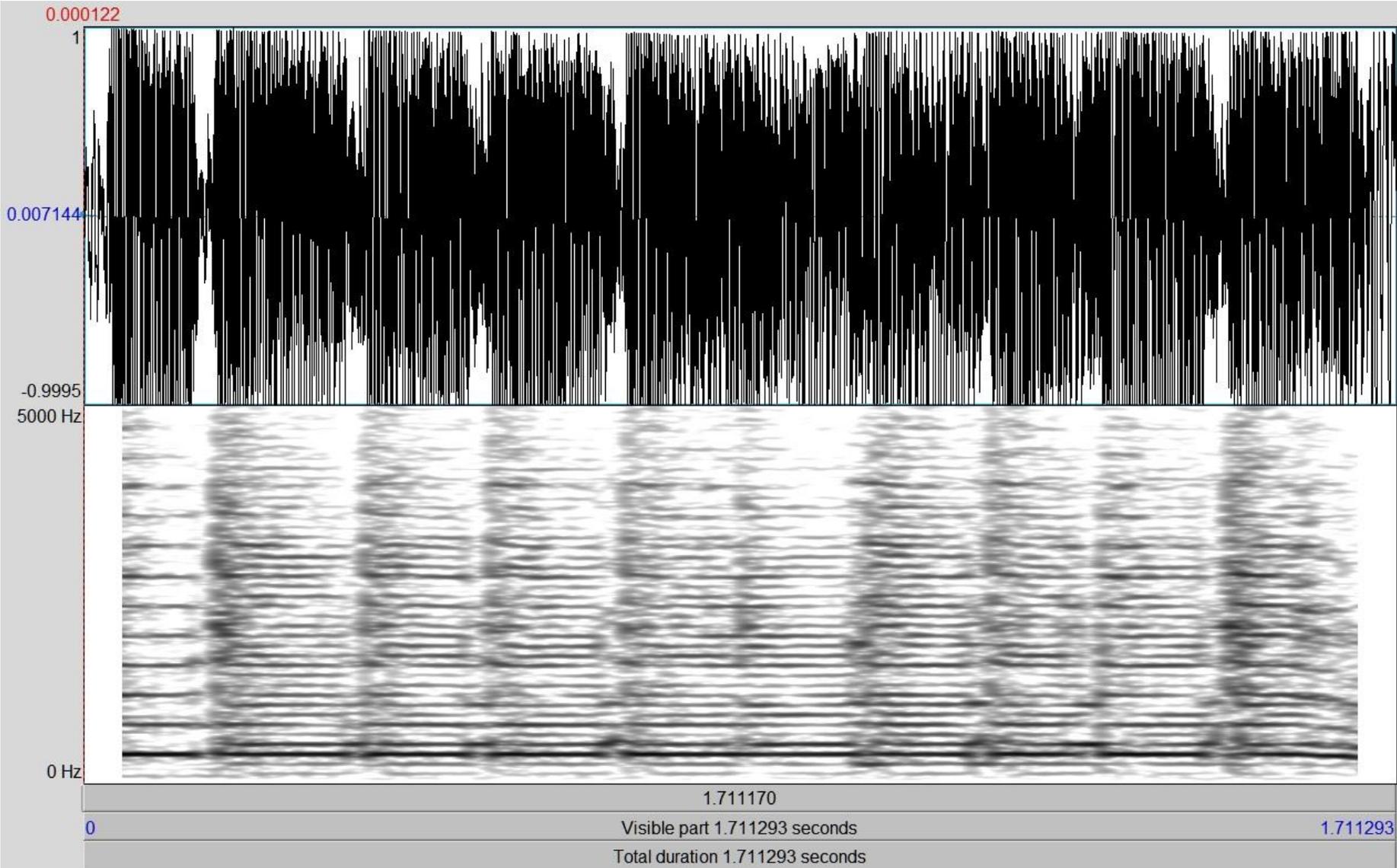
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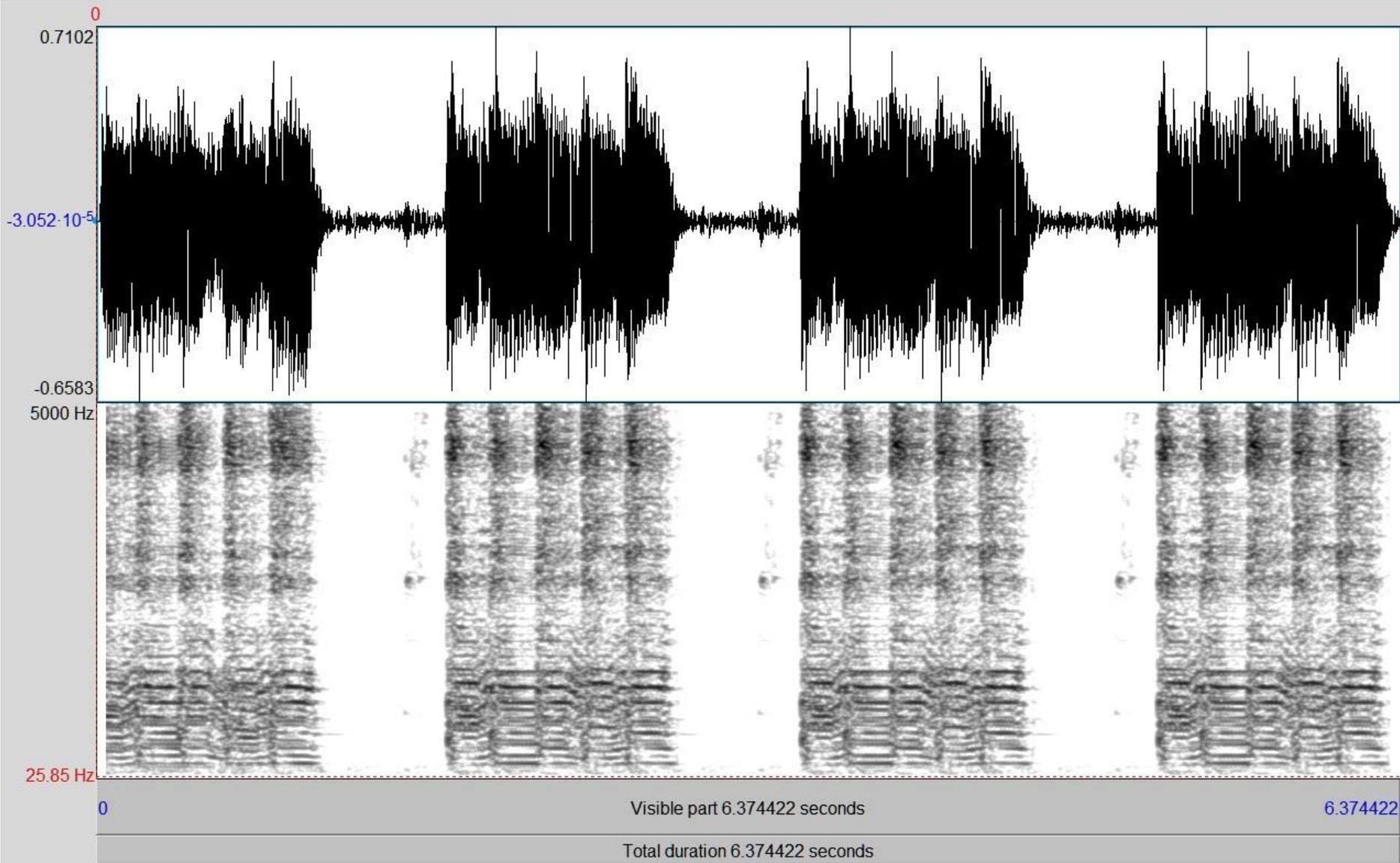
Cultural evolution of the sound of arousal through sensory manipulation



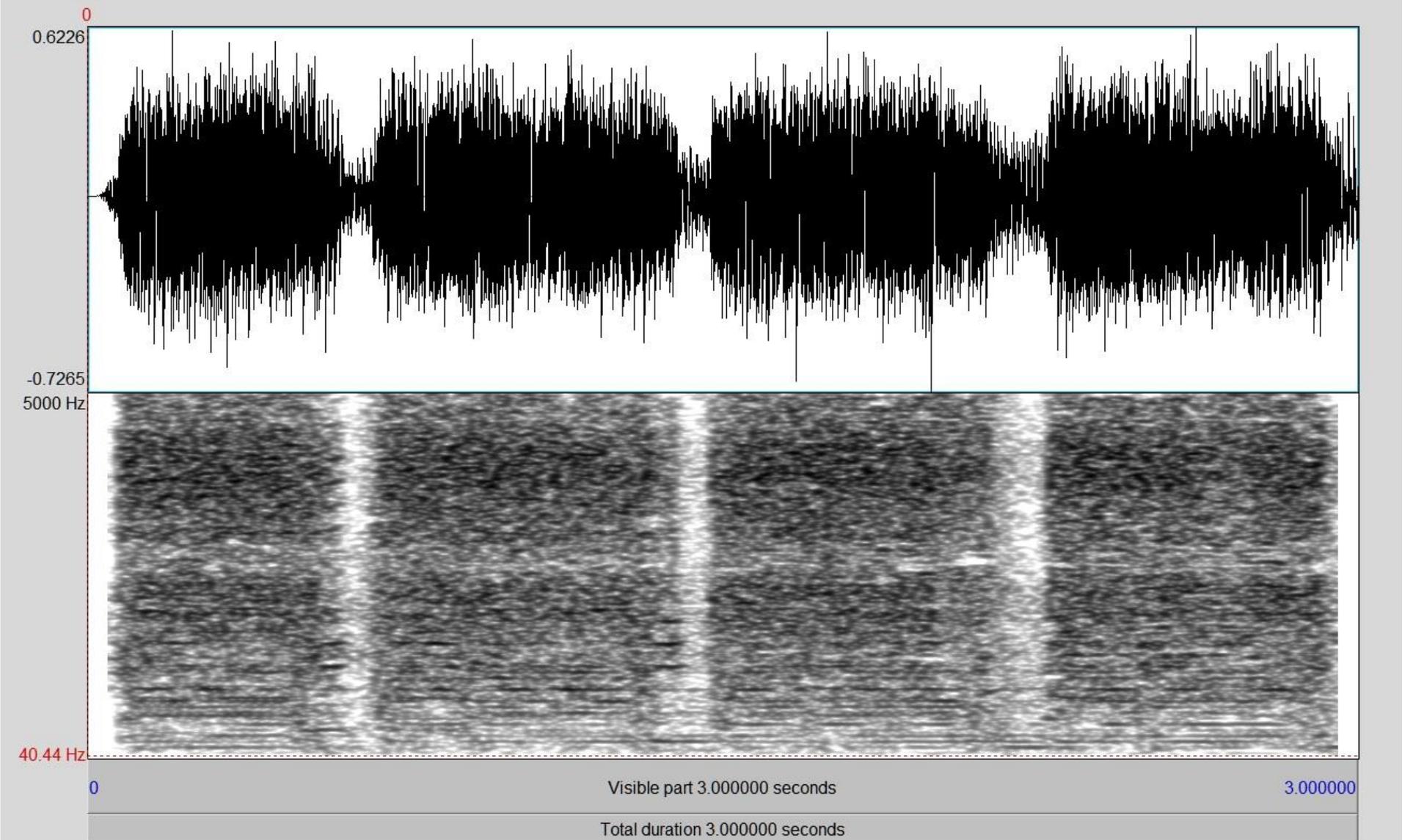
Goree Carter - Rock Awhile (1949)



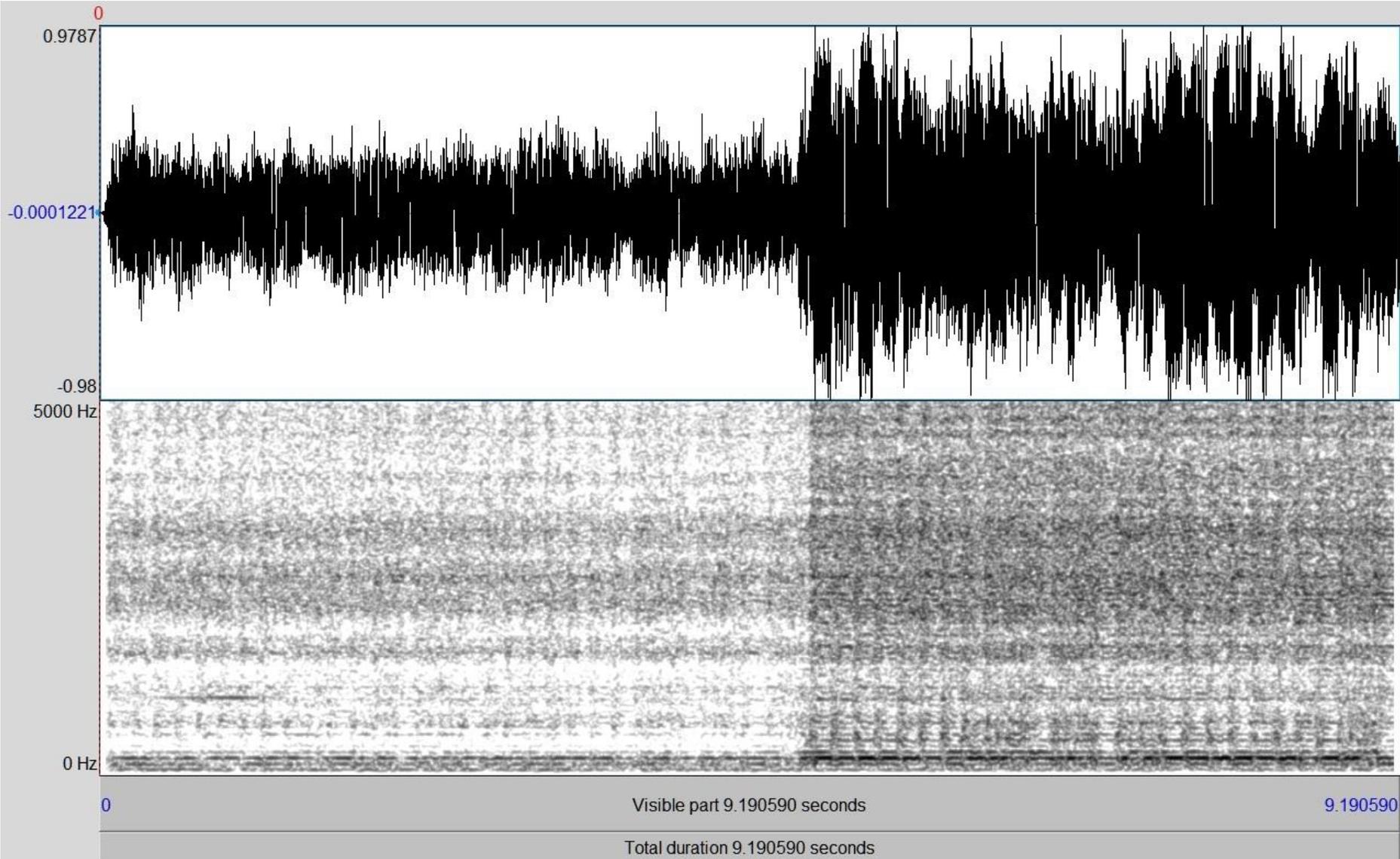
Kinks – You Really Got Me (1963)



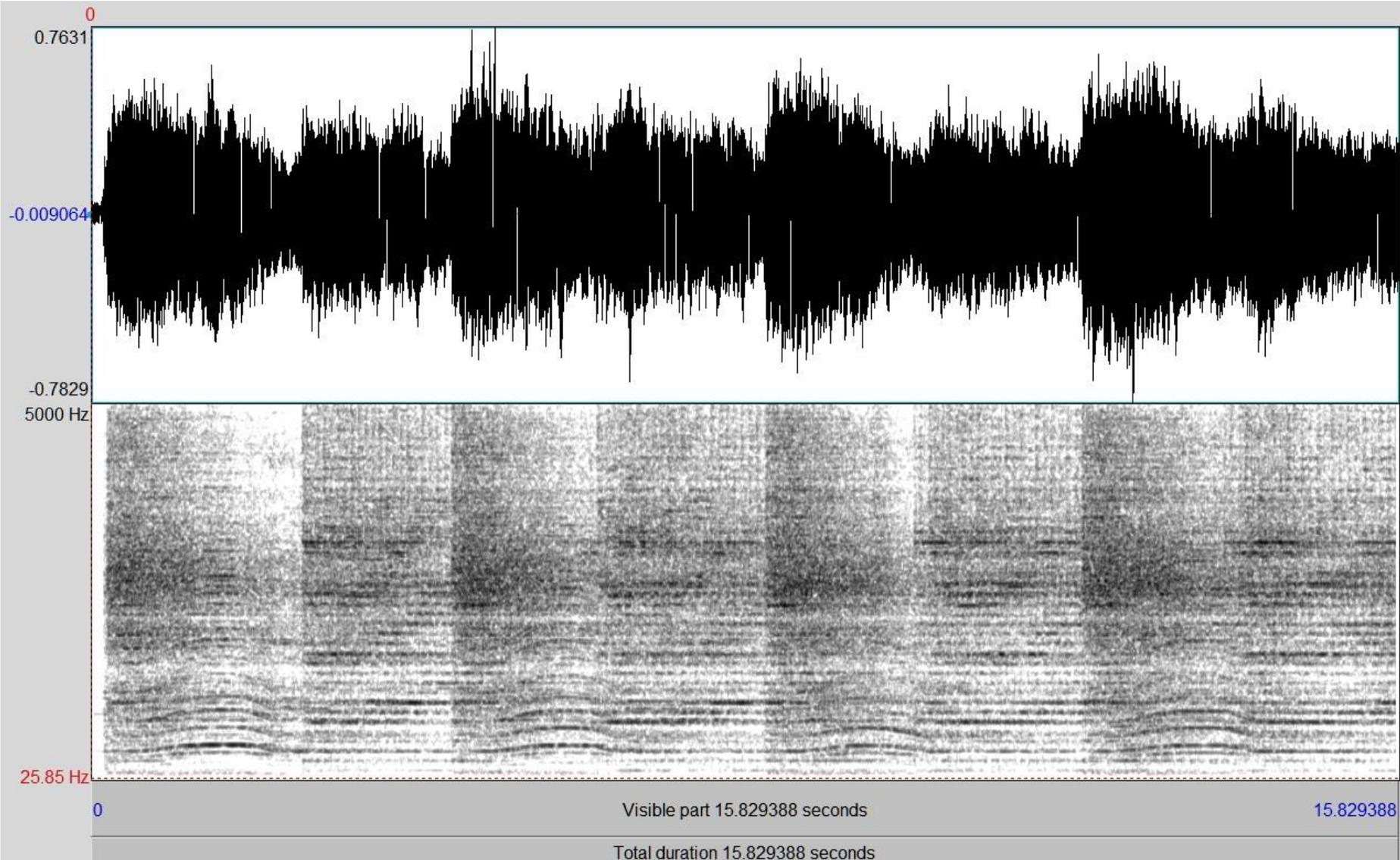
Sex Pistols – I Wanna Be Me (1979)



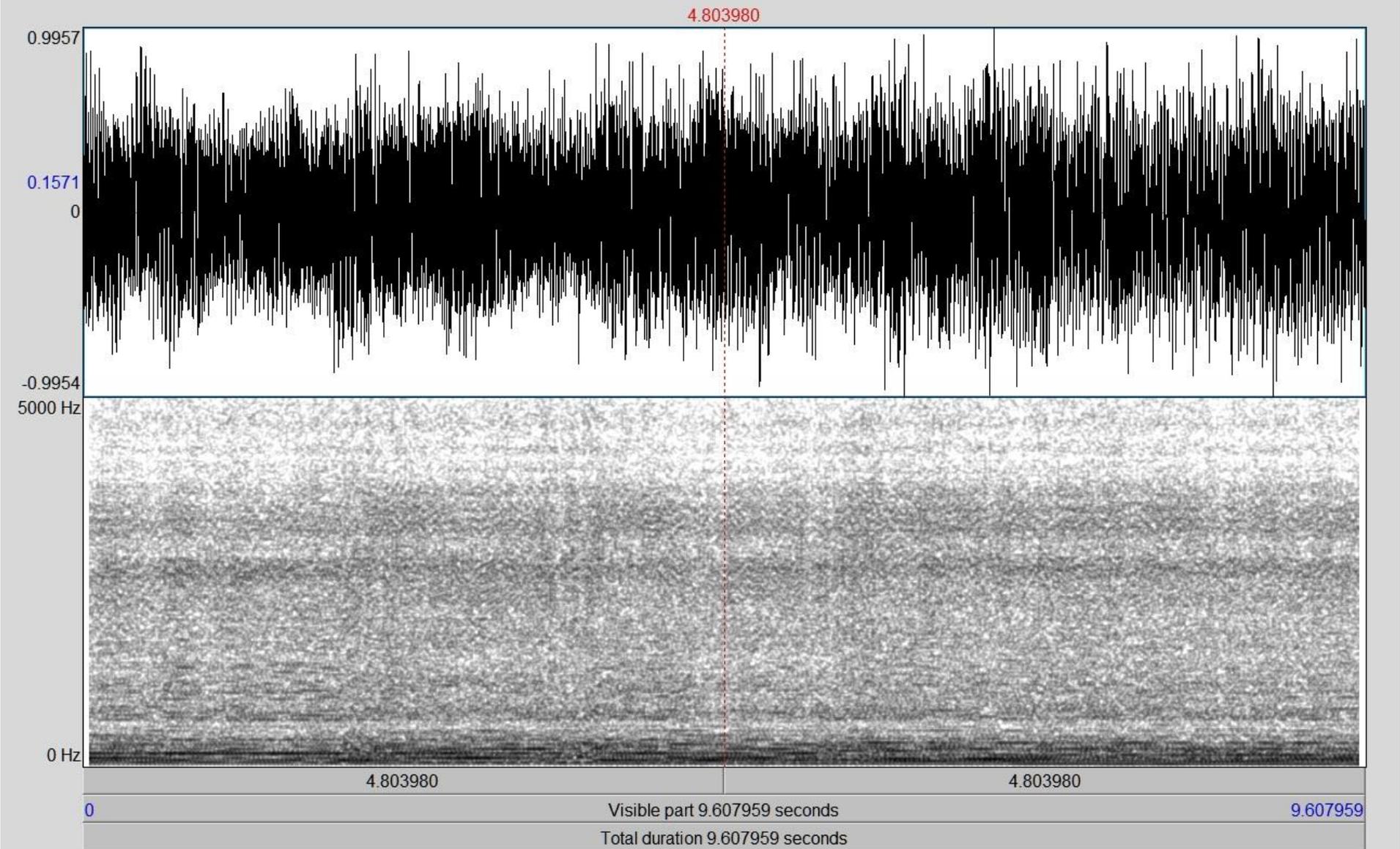
Slayer – Chemical Warfare (1984)



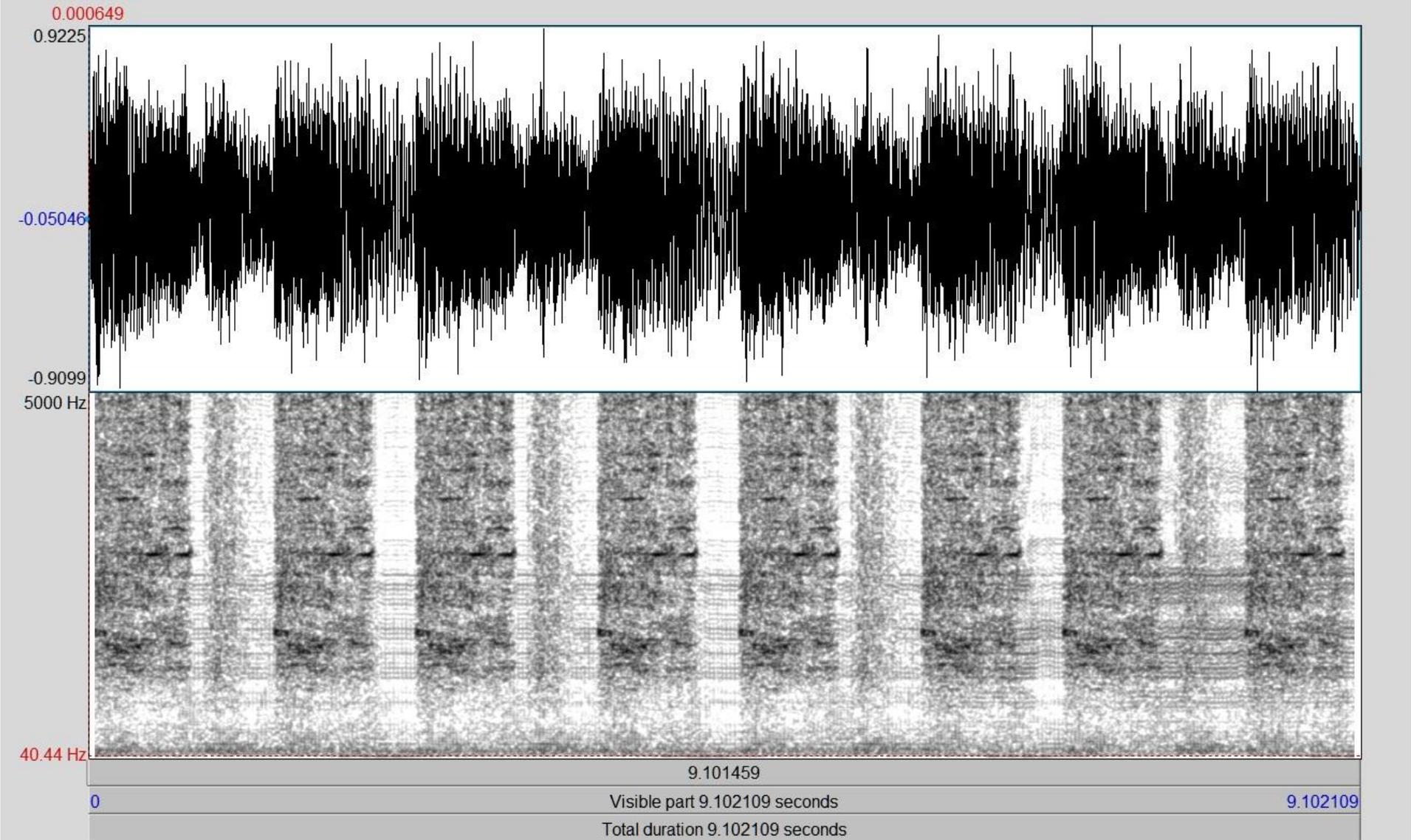
Sonic Youth – Marilyn Moore (1986)



# Sunn – Defeating Earth's Gravity (1999)



Wolf Eyes – Always Wrong (2009)



# Conclusions

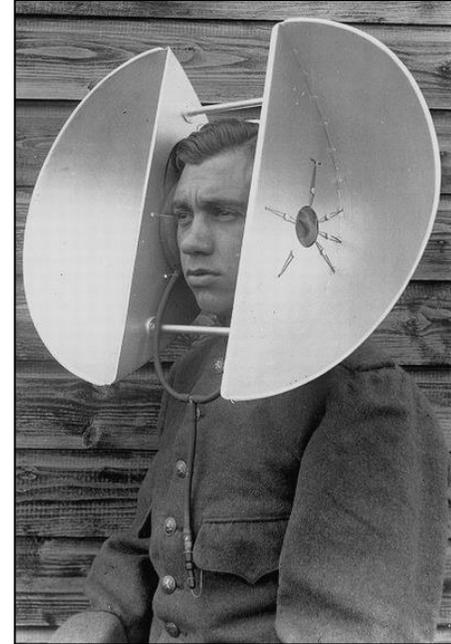
Nonlinearities are generally evocative in animals and humans

Multiple modalities may suppress otherwise evocative stimuli

Music cognition researchers might benefit from taking an evolutionary approach to understanding the evocativeness of music

Principles of vocal signaling are highly relevant to music production and perception

Cultural evolution can tap into sensory biases and spread evocative musical features



# Acknowledgements

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