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A phonetic pilot study of chirp, chatter, tweet and tweedle in three domestic cats

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Abstract

This study collected 257 vocalisations from three domestic cats when they were watching birds through the window. The sounds were subdivided into the types chatter, chirp, tweet and tweedle, and analysed for duration and F_0. Variation was found within and between these types as well as within and between the three cats in both duration and F_0. A tentative taxonomy of prey-observing cat vocalisations is suggested based on words used for bird sounds.

Introduction

The domestic cat has an extensive and highly variable vocal repertoire, generally divided into three categories: sounds produced with the mouth closed, sounds produced with an opening–closing mouth, and sounds produced with the mouth held tensely open (Moelk, 1944; McKinley, 1982). Many descriptions of domestic cat vocalisations refer to the 16 phonetic patterns suggested by Moelk (1944). However, most of them fail to include the sounds uttered in the vicinity of prey, often referred to as chirp, chatter or other words for bird sounds. The majority of references to such sounds are found in articles about wild cats or on cat-related pages on the Internet, e.g. online dictionaries and articles. Wikipedia (2013) states that "Cats sometimes make chirping or chattering noises when observing prey". Researchers in the Brazilian Amazon have observed wild cats (margays) imitating the calls of tamarin monkeys to lure them within range when hunting. Observations of jaguars and pumas mimicking their prey have also been reported. According to Wildlife Conversation Society (2010) researcher Fabio Rohe "Cats are known for their physical agility, but this vocal manipulation of prey species indicates a psychological cunning that merits further study" (State Journal, 2010; Kelley, 2010).

Chirp and chatter

Chirp and chatter are said to be common vocalisations in some felids and in other small mammals, including the badger, guinea pig and rat. It has been suggested that wild cats are able to copy the calls of their prey, and that this hunting instinct is prevailed in the domestic cat. These sounds are usually elicited when a bird or insect catches the attention of the cat, e.g. by making a sound. The cat becomes riveted to the prey, and will start to chirp, tweet and chatter.

A *chirp* is a voiced short call said to be mimicking a bird or rodent chirp. Stoeger-Horwath and Schwammer (2003) found that juvenile cheetahs produce two distinct cries; chirping and churring, and describe chirping as "a high-intensity call of a bird". Ruiz-Miranda et al. (1998:7) found that chirp were the most common vocalisation in male cheetahs during separations. Acoustic analysis showed high individual variation, with significant differences between individuals in all acoustic measures of fundamental frequency and duration. Feuerstein and Terkel (2008:155) describe chirping as a "sound similar to a high-pitched phone ring, tone often rises near the end", which cats use during play.

Chatter or teeth chattering are very quick stuttering or clicking sounds with the jaws juddering. A Pawsonline (2013) online article argues that chattering is an involuntary, (e.g. at the sight of prey outside the window) enacting of a special type of juddering jaw movement used by the cat to kill its prey while reducing any risk of injury to itself.

Prey-observing cats may also use other types of sounds, which to the author's knowledge have not yet been studied in detail. This study is an attempt to learn more about chirp, chatter and similar sounds. In an earlier study (Schötz, 2012), 18 out of 538 collected cat vocalisations were identified as 'chatter', and an acoustic analysis showed a fairly large variation in F_0 and duration within this type. By recording and analysing a larger number of prey-observing domestic cat vocalisations, the aim is to identify different types and phonetic patterns, and the purpose is to investigate the variation within and between these types.

Words for bird sounds used for cat calls

Dictionaries contain numerous words for various bird sounds, and many of these have been used for also for cat vocalisations. *Table 1*

lists a selection of such words and descriptions, in this case taken from the online dictionary TheFreeDictionary (2013). The words with descriptions that also fitted the different types of prey-related cat vocalisations identified in this study are marked with bold typeface.

Table 1. Words used to describe bird and/or cat sounds (words used in this study for different types of prey-observing cat vocalisations in bold).

Word	Description(s)
chatter	a rapid series of short, inarticulate, speech-like sounds / a rapid rattling or clicking noise by striking together (the teeth)
chirring or churring	a sharp/shrill whirring or trilling/vibrant sound made by some insects and birds, such as the grasshopper and partridge
chirp	a short sharp/high-pitched sound made by small birds and certain insects
cheep	a faint shrill/short weak high-pitched sound like that of a young bird; a chirp
chitter	chiefly US twitter or chirp / twitter or chatter, as a bird
chirrup	a series of chirps / clucking and clicking sounds to urge on a horse
peep	a short, soft, high-pitched sound, like that of a baby bird; cheep / to speak in a hesitant, thin, high-pitched voice
pipe	a birdcall, to chirp or whistle, as a bird does, to utter in a shrill reedy tone
tweet	a weak chirping sound, as of a young or small bird; an imitation or representation of the thin chirping sound made by small or young birds (often reiterated)
twitter	a succession of light chirping or tremulous sounds; chirrup, a light tremulous speech or giggle; titter
tweedle	sing in modulation; play negligently on a musical instrument
warble	sing (a note or song, for example) with trills, runs, quavers or other melodic embellishments
quaver	speak or sing with a trembling voice; (esp. of the voice) to quiver, tremble, or shake

Material and method

Recording procedure

Video and audio recordings of 257 vocalisations were collected from the three domestic cats Donna, Rocky and Turbo (D, R and T; 1 female, 2 males, all 2.5 year old siblings from the same litter) when they were watching birds. The recordings took place in their home between December 2012 and March 2013. A remote-controlled video camera recorder with an electret condenser microphone (either a Sony DCR-PC100E with a Sony ECM-DS70P stereo microphone or a Sony HDR-CX730E with Sony ECM-CG50 shotgun microphone) was positioned on a tripod next to a large window. A variety of bird food was arranged outside (apples and bird seeds on the ground, bird feeders containing peanuts and fat ball nets on strings and poles). When the cats were vocalising at birds through the window, recording could be started from an adjacent room using the remote control without disturbing the cats. Additional recordings were done with an Apple iPhone 3G. *Figure 1* shows the set-up for the video camera with the shotgun microphone.

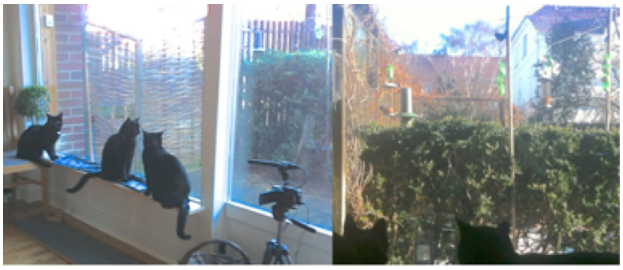

Figure 1. Recording set-up with bird food outside the window and video camera with shotgun microphone.

Preprocessing, segmentation and analysis

Audio files (wav, 44.1 kHz, 16 bit, mono) were extracted with *Extract Movie Soundtrack*. The waveforms were normalised for amplitude and the vocalisations segmented and labelled in *Praat* (Boersma & Weenink, 2013) using the labels chatter, chirp, tweet, and tweedle. Sequences of chirps and tweets were also labelled chirrups and twitter. Measures of duration and F_0 were obtained with a *Praat* script and manually checked.

Results

In this corpus, 97 vocalisation tokens were single sounds, and 49 were phrases of two or more sounds. The most frequent vocalisation type was chirp with 169 tokens. 30 tweedle, 22 chatter and 22 tweet sounds were also recorded. R was the most vocal cat with a total of 119 vocalisations, followed by T: 103 and D: 35 sounds. *Table 2* shows the number of vocalisations for each cat. The results of the acoustic analysis of the four vocalisations types are described below. Median values were very close to mean values, and therefore only mean values are presented here.

Table 2. Number of vocalisations of the three cats in the study by type (CHA = chatter, CHI = chirp, TWE = tweet, TWD = tweedle).

Cat	*CHA*	*CHI*	*TWE*	*TWD*	*Total*
D	3	19	6	6	*35*
R	7	70	19	22	*119*
T	12	80	9	2	*103*
Total	*22*	*169*	*34*	*30*	*257*

Chirp (CHI) and chirrup

A chirp can be described phonetically as a glottal stop [ʔ] followed by a short, often harsh or raspy vowel, e.g. [ə], [e] or [ɛ], produced with an open mouth. Chirps were either single [ʔə] or reiterated [ʔɛʔɛʔɛ...]. Each chirp was fairly short with a mean duration of 0.15 sec. F_0 varied from 229 to 1199 Hz, with a mean F_0 of 661 Hz. Numeric values for chirps are shown in *Table 3*. Sequences of chirps were labelled *chirrups*, and the individual sounds were analysed together with the single chirps.

Table 3. Mean durations, as well as minimum, maximum and mean F_0 of chirp vocalisations (CHI).

Cat	*meanDur*	*minF_0*	*maxF_0*	*meanF_0 (sd)*
D	0.15 s	623 Hz	944 Hz	797 (92) Hz
R	0.14 s	229 Hz	1071 Hz	698 (157) Hz
T	0.17 s	253 Hz	1199 Hz	589 (173) Hz
All	*0.15 s*	*229 Hz*	*1199 Hz*	*661 (194) Hz*

Chatter (CHA)

Chatter sounds were produced with a tensely open mouth, often in sequences. They are phonetically similar to unaspirated voiceless palatal or velar plosives [k̟̄]. The mean duration of individual chatter sounds was 0.03 seconds. As the chatter recorded in this study was mostly voiceless, no measures of F_0 were obtained. Figure 2 shows the waveform, broadband spectrogram and F_0 contour of an example phrase consisting of two sequences of chatter followed by chirps.

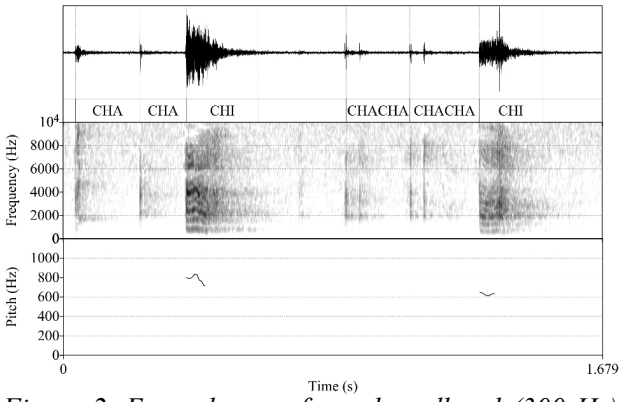

Figure 2. Example waveform, broadband (300 Hz) spectrogram and F_0 contour of two sequences of chatter (CHA) followed by chirps (CHI).

Tweet (TWE) and twitter

Tweets were produced as soft weak chirps, often without any clear initial [ʔ] and with varying vowel qualities, e.g. [wi] or [ɦɛu]. Sequences of tweets were labelled twitter, and the individual sounds analysed together with the single tweets, as they were similar in duration and phonetic quality. *Table 4* shows the numeric values for tweet, which had a mean duration of 0.20 sec. F_0 ranged from 306 to 939 Hz, and the mean F_0 was 635 Hz.

Table 4. Mean durations, as well as minimum, maximum and mean F_0 of tweet (TWE).

Cat	*meanDur*	*minF_0*	*maxF_0*	*meanF_0 (sd)*
D	0.18 s	533 Hz	939 Hz	840 (128) Hz
R	0.19 s	306 Hz	937 Hz	596 (104) Hz
T	0.22 s	514 Hz	648 Hz	586 (26) Hz
All	*0.20 s*	*306 Hz*	*939 Hz*	*635 (132) Hz*

Tweedle (TWD)

A tweedle sounded like a prolonged chirp or tweet, often with some voice modulation, like tremor or quaver, e.g. [ʔəɛəɯə]. The mean duration of tweedle was 0.51 sec, mean F_0 was 578 Hz, ranging from 147 to 936 Hz. *Table 5* shows the duration and F_0 results for tweedle. An example waveform, spectrogram and F_0 contour of a phrase consisting of one tweedle and three tweets is shown in *Figure 3*.

Table 5. Mean durations, as well as minimum, maximum and mean F_0 of tweedle (TWD).

Cat	*meanDur*	*minF_0*	*maxF_0*	*meanF_0 (sd)*
D	0.63 s	528 Hz	936 Hz	820 (61) Hz
R	0.50 s	147 Hz	785 Hz	530 (180) Hz
T	0.29 s	409 Hz	552 Hz	496 (29) Hz
All	*0.51 s*	*147 Hz*	*936 Hz*	*578 (194) Hz*

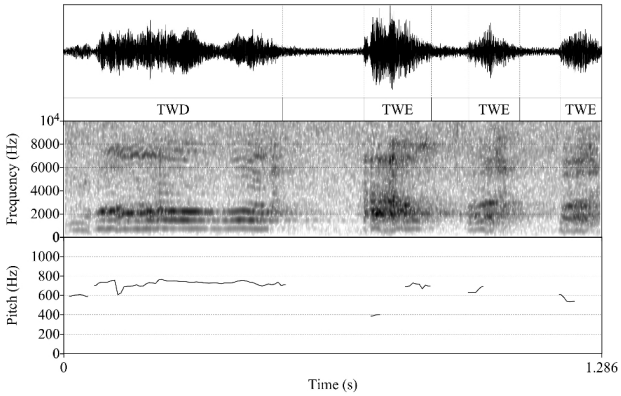

Figure 3. Example waveform, broadband (300 Hz) spectrogram and F_0 contour of a tweedle (TWD) followed by a sequence of three tweets (TWE).

Discussion and future work

The three cats of this study mainly chirped in the vicinity of prey (birds outside the window). Some chirps rose in tone toward the end (cf. Feuerstein & Terkel, 2008), but level or falling F_0 contours were equally common, suggesting that cats are able to vary the intonation of chirp sounds as much as other vocalisation types (see e.g. Schötz, 2012).

Table 6. Tentative taxonomy of prey-observing cat vocalisation types based on words for bird sounds.

feature / **sound**	*voice*	*pitch*	*loudness*	*length*	*rate*	*modulation/reiteration*	*other descriptions or comments*
chatter	unvoiced	-	-	short	rapid	rapid series or rattling	sometimes used for voiced sounds too
chirp	voiced	high	sharp	short	-	-	-
chirrup	voiced	high	sharp	short	-	series	clicking sounds used to urge on a horse
tweet	voiced	high	weak	short	-	often reiterated	-
twitter	voiced	light	light	long	-	succession of tremulous sounds	titter, nervous giggle
tweedle	voiced	-	-	long	-	modulation	-

Several other distinct phonetic patterns were identified within the same behavioural context of this study, which motivated a subdivision into further types. Just like chirp and chatter, words generally used for bird sounds could be used for the additional types as well. This study used the types chatter, tweet (weak chirp), and tweedle (long modulated tweet) for single sounds, and chirrup and twitter for sequences of chirps and tweets. Phrases consisting of two or more types were also not uncommon. Based on the analysis of the recordings of this study, a tentative taxonomy of the sound types and their corresponding features is suggested, as shown in *Table 6*.

Within each type, there was considerable inter- and intra-cat variation in F_0 (except for the voiceless type chatter), and also some variation in duration. This is in line with Ruiz-Miranda et al. (1998), who found significant differences between chirps in cheetahs, with Schötz (2012), where large variation in three other vocalisation types was observed, and also with Moelk (1944:185), who found that the vocal repertoire of the domestic cat is characterised by "an indefinitely wide variation of sound and of patterning".

The results of this pilot study should be regarded as tentative, due to the often limited number of tokens analysed of each type. Future work includes a larger study of similar and also other types of vocalisations collected from a larger number of cats.

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