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THE INFLUENCE OF INDIVIDUAL FEATURES ON THE VOCALISATION OF CATS OF DIFFERENT BREED

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ABSTRACT

Vocal communication of cats includes a wide range of sounds from quiet purrs and trills to loud distress vocalizations. There is a surprisingly small number of papers devoted to cat vocalization. Importantly, all previous research has been conducted on cross-breed house cats. No one has ever tried to study the parameters of feline vocalization of pure breed cats. The purpose of this work was to check whether the individual features like sex, sterilisation, age, breed, and place of living influence their vocalisation. Vocal recordings from 20 adult Siberian cats, 10 Persian cats and 10 Neva Masquerade cats were collected and used in a phonetic study in order to test some recording and analysis methods. Cats' responses to behavioural stimuli (isolation - closing a cat in a cage for 3 minutes) were recorded. Vocalizations were manually segmented, with voiced and unvoiced vocalizations being differentiated. The recordings were processed using PRAAT, Raven Pro and Audacity software. The vocalizations were analysed and compared for duration, formants, pitch, jitter, shimmer and other acoustic parameters.

1. INTRODUCTION

Cat communication is the transfer of information by one cat that has an effect on the current or future behaviour of another animal, including humans. Vocal communication includes a wide range of sounds from quiet purrs and trills to loud distress vocalizations. Cats are said to have one of the widest 'vocabularies' of all carnivore species, and this may be related to the fact that in the natural environment vocal communication is important when they spend much active time in poor lighting conditions. Cats produce a range of vocalisations including yowls, snarls, hisses, and shrieks. Meows often include other elements, such as clicks and growls, which enable different calls to be distinguished, for example 'trills' as social greetings [1]. There is some evidence that cats are able to modify their vocalizations when communicating with people.

There is a surprisingly small number of papers devoted to cat vocalization. Importantly, all previous research has been conducted on cross-breed house cats. No one has ever tried to study the parameters of feline vocalization of pure breed cats. This issue is very interesting because we

cannot reject the hypothesis that the modifying effect of breeding selection also influenced the vocalization of animals. Selection increases interbreed differences and also affects the vocal behaviour of purebred cats. Current scientific research suggests that the diversity of behaviour in purebred cats, including different communication abilities, may be affected in behavioural problems of these breeds. A better understanding of how animals communicate their feelings is fundamental for all aspects of animal welfare [2].

The main purpose of this work was to check whether the individual features like sex, sterilization, age, breed, and place of living influence cats' vocalization.

2. MATERIALS AND METHODS

All the results presented in this research were made at the Faculty of Animal Breeding and Biology of the University of Agriculture in Krakow, at the Department of Genetics, Animal Breeding and Ethology - from March 2016 to April 2020.

Vocal recordings from 20 adult Siberian cats, 10 Persian cats and 10 Neva Masquerade cats were collected. Cats' responses to behavioural stimuli (isolation - closing a cat in a cage for 3 minutes) were recorded.



Photo 1. Siberian cat, recording in a transporter

2.1. Cat's breeds

Although cats have been with us for thousands of years, the breeding of purebred cats lasts just two hundred years. Genetically, behaviourally and phenotypically different breeds were selected for the study.

The Persian is the most popular pedigreed cat in North America, if not the world. These cats first became popular during the Victorian era, but they existed long before then. The first documented shows that ancestors of the Persians were imported into Italy from Iran (historically known as Persia in The West) around 1620 [3]. Recognized by the cat fancy since the late 19th century, it was bred first by the English, and then mainly by American breeders after the Second World War. The Persian cat belongs to the brachycephalic breeds - short-skulled ones. It is characterized by a round head with a wide and short nose, a convex forehead, full cheeks and a clearly flattened face. Unfortunately, the increasing deepening of the visceral skull, the so-called "peke face" (facial part similar to that of a Pekingese dog), is associated not only with aesthetic changes in the breed's traits, but also changes in health [4], including difficulty in breathing, hydrocephalus and numerous dental defects.

The Siberian cat is a centuries-old landrace (natural variety) of domestic cat in Russia [5] and recently developed as a formal breed whose standards were spread across the world over in the late 1980s. The Siberian personality is usually friendly and adventurous. This breed does especially well with people, other cats, and even dogs. Siberians enjoy the company of their family and make excellent companions with their calm attitude and quiet sounds. The genetic research conducted that Siberian cats are the breed that has been the least genetically modified and still has the highest genetic variability, comparable to wild cat populations that breed randomly.

Neva Masquerade is a very intelligent and curious colorpoint variation of the Siberian cat breed. Like the Siberian cat, the Neva Masquerade breed origins from Russia and it is named after the river Neva in St. Petersburg, where it first was developed somewhere around the late-1970s / early-1980s. Neva Masquerades were the result of cross breeding between Siamese and Siberians in Russia. Some sources claim other breeds such as Birman, Himalayan and Balinese were bred into the Neva Masquerade as well, but that remains unclear.

2.2. Sound recording and processing method

All cats were recorded in a quiet home environment using a condenser shotgun microphone RODE NTG-1 and a handy recorder ZOOM H4Pro. Vocalizations were manually segmented, with voiced and unvoiced vocalizations being differentiated, using Audacity software. Raven Pro software was used for visualising spectrograms to help with manual segmentation. The segmented recordings were analysed using PRAAT, extracting a number of parameters. The preliminary results were checked manually for correctness with spectrograms. Among others, following parameters were extracted from the recordings:

- $F0$ – mean fundamental frequency

- $F1, F2, F3$ – mean first, second, third formant frequency
- $Energy\ q1, Energy\ q3$ – frequency of a first and third quartile of energy spectrum
- $Percentage\ of\ voiced\ frames$ – as reported by Praat Pitch object
- $Kurtosis$ – kurtosis of the energy spectrum
- $Peak$ - the frequency associated with the maximum energy density.
- $Max\ amp\ abs\ time$ – time of a peak of maximum amplitude (in seconds)
- $Max\ amp\ rel\ time$ – time of a peak of maximum amplitude relative to the length of a recording

2.3. Statistical analysis

Before the analysis, recordings which exhibited outlying values in any of the parameters were discarded.

To determine whether a parameter exhibits different average value in different conditions (be it cat breed, age, or other factor), a following procedure was applied:

1. Average values from each cat separately to get one value per cat (unless indicated otherwise in the Results section)
2. Group the results according to the condition
3. Check normality of each results group using a Shapiro-Wilk test
4. Test for equality of means of the result groups. Depending on the result of normality test and the number of groups, use a following test:
 - a. If the normality test didn't reject the normality hypothesis for any of groups:
 - i. If there are 2 groups of results, use Welch t-test
 - ii. If there are more than 2 groups of results, use Kruskal-Wallis test
 - b. If the normality test rejected the hypothesis of normality for any of groups:
 - i. If there are 2 groups of results, use Mann-Whitney U-test
 - ii. If there are more than 2 groups of results, use Kruskal-Wallis test.

All statistical tests were performed with the statistical significance level of 0.95.

3. RESULTS

The studies have shown that the some vocal parameters of cats depend on breed, sex, sterilisation and age.

3.1. Association between breed and vocal parameters

Averaged data per cat was used for comparison. Extreme data and unvoiced recordings were deleted.

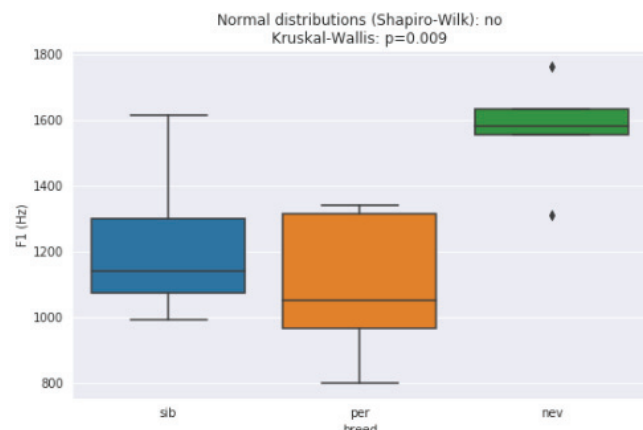


Figure 2. Association between breed and F1 (first formant) (Hz)

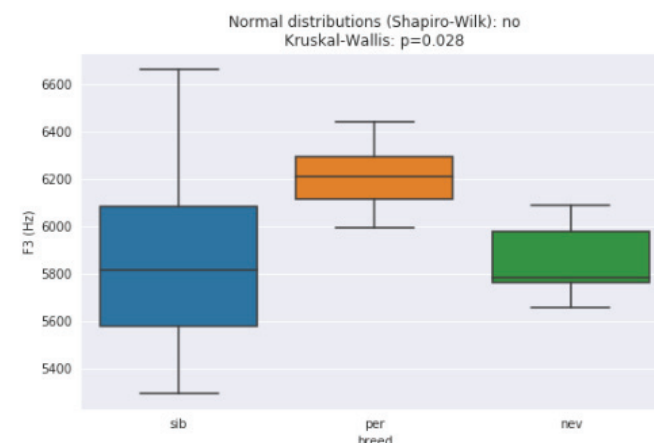


Figure 2. Association between breed and F3 (third formant) (Hz)

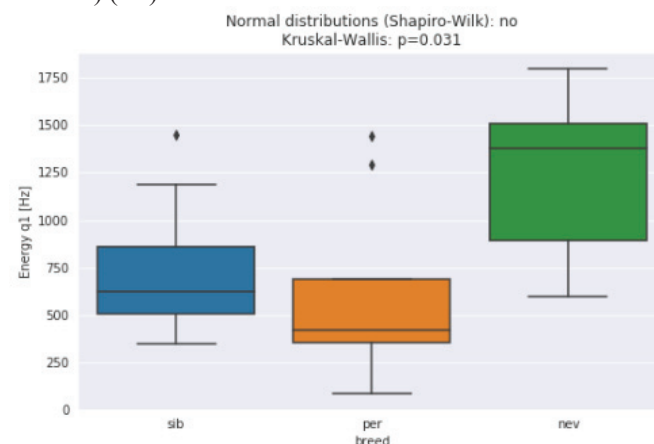


Figure 3. Association between breed and first energy quartile (Hz)

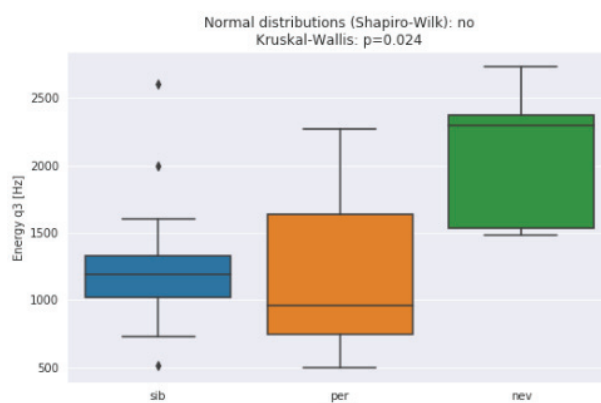


Figure 4 Association between breed and third energy quartile (Hz)

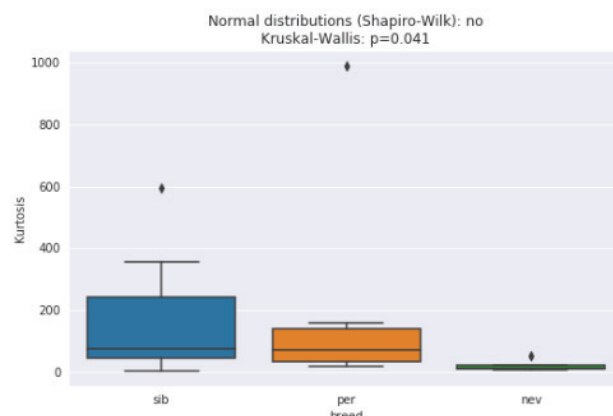


Figure 5 Association between breed and energy spectrum kurtosis

The results of these tests (Kruskal-Wallis, $p < 0.05$) show the existence of a significant relationship between vocal parameters such as F1 (Hz) [fig.1], F3 (Hz) [fig.2], Energy q1 [fig.3], Energy q2 [fig.4] and Kurtosis [fig.5] associated with breed. No relationship was found between breeds and other parameters like: F0 (Hz), F2 (Hz), F4 (Hz), maximum F0 (Hz), maximum F0 in time (s), minimum F0 (Hz), minimum F0 in time (s), F0 standard deviation (Hz), F0 range (Hz), F0 range (semitones), F0 absolute slope (Hz/s), F0 absolute slope (Hz/s), F0 relative Jitter, Shimmer, mean HNR (harmonic to noise ratio) (dB), maximum HNR (dB), maximum amplitude absolute time (s), percentage of voiced frames, harmonic ratio (dB), peak (Hz)

3.2. Association between individual features and vocal parameters

All recordings of the tested breeds were analysed together. Averaged data per cat was used for comparison. Extreme data and unvoiced recordings were deleted.

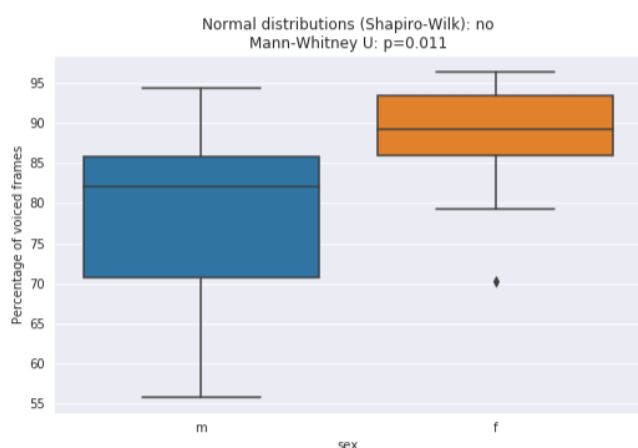


Figure 6. Association between sex and percentage of voiced frames

The result of this test (Mann-Whitney U, $p < 0.05$) shows the existence of a significant relationship between sex of cats and percentage of voiced frames [fig.6].

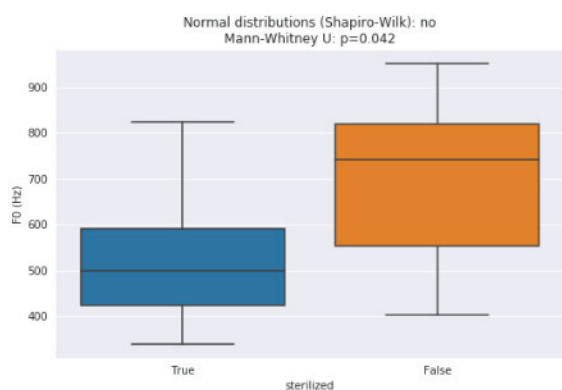


Figure 7. Association between sterilization and F0 (Hz)

The results of Mann-Whitney U tests show the existence of a significant relationship between cats sterilization and following vocal parameters: F0 (Hz) [fig.7], F1 (Hz), Peak (Hz). No relationship was found between cats sterilization and other parameters mentioned earlier (chapter 3.1)

The research has shown that age also affects vocal parameters: a significant relationship has been found between cats age and following parameters: F0 (Hz), max F0 (Hz), max amp abs time (s), max amp rel time.

No relationship was found between other individual features like: place in hierarchy, number of cats in cattery and voice parameters.

4. CONCLUSIONS AND DISCUSSION

The study has shown that some vocal parameters of cats depend on their breed and individual features.

Neva Masquerade (NEM) cats had higher F1 (Hz), Energy q1 (Hz) and Energy q3 (Hz) than Persians (PER) and Siberians (SIB). Comparative studies to date show that high values of energy quartiles are associated with negative emotions such as fear [6]. Based on these

results, it can be hypothesized that cats of the NEM breed are the most terrified during isolation test. SIB had the highest kurtosis. It can be therefore hypothesized that Siberian cats have the most diverse sounds, extreme, deviating from the average.

The differences between SIB and NEM seem surprising. For many years treated as sister breeds and mixed with each other, they differ in some parameters. It is difficult to say whether these differences were created in the years since the breeds were officially separated or even earlier as a result of crossbreeding of Siberian cats with other point breeds.

The results of these studies showed that sex only affects the percentage of voiced frames – it is higher in females than in males (without breed division).

Sterilisation influences cats' vocalisation too. Cats after sterilisation (both sexes) had higher F0 (Hz), F1 (Hz), Peak (Hz). This may be due to the fact that cats after castration have a reduced hormonal balance. They are more calm and composed.

In age studies, the cats (all breeds) were grouped into three groups: less than 3 years old, 3 to 7, older than 7 years old. There were 7 cats in the first group, 26 in the second one, and 9 in the third one. Group one (< 3) had the highest F0 (Hz) and Max F0 (Hz). The highest parameter in young cats can be caused by the fact that young cats use high sounds to communicate the need for care for themselves. Perhaps high sounds are used for mother-child communication, and over time they change into lower ones.

All results are just the beginning of the research. Tip on what to look for in further studies. Communication of cats is a very difficult and hard to study topic due to the small access to the recording of cat sounds. The research will be continued. Future work includes a larger study of vocalisation of cats of different breeds.

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