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The Association of Feline Behavior to Acoustical Features of Kitten Directed Speech

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Abstract

This study observed the responses of adult cats to kitten directed speech (KDS) and adult human directed speech (HDS). Recordings of adult human vocalizations in human directed, adult cat directed and kitten directed speech scenarios were analyzed for their acoustic qualities. Acoustical analysis showed that there was little difference between feline adult directed speech (FADS) and human directed speech; as a result, playback experiments use only kitten directed and human directed speech. Analysis of kitten directed and human directed speech showed that minor difference in many features occurred, only harmonicity varied significantly. Videos of playback experiments provided data for the analysis of feline responses to the cats' owners and to strangers using kitten directed speech and human directed speech. The analysis showed that cats paid more attention to the kitten directed speech of strangers than owners.

Keywords: Cat *(Felis catus)*, Directed Speech

Introduction

Cats *(Felis catus)* are one of the most popular animals used for companionship in the United States. America Veterinary Association estimates that in the United States alone there are seventy-four million pet cats ("U.S. Pet Ownership Statistics"). Due to their rising popularity, behavioral scientists have become increasingly interested in how cats communicate with other cats and with humans. The cat's behavioral repertoire varies within interspecific and intraspecific relationships. Free living cats form colonies that consist of related females that sometimes engage in allo-mothering (Bradshaw 2016). Cats identify colony members using their acute sense of smell; in addition, they communicate using postural and vocal signals. They signal friendly approaches by raising their tails followed by rubbing against the other cat. Kittens solicit care from and gain the attention of adults by purring (Rochliz p.15-17). Body posture, ear position, mouth, bared teeth, staring, and vocalizations are used in combination to signal various emotional states (Jumelet, Bedossa and Deputte 2012) (Caffazzo and Natoli 2009) (Turner 2017) (Bennett, Gourkow and Mills 2017).

Selection has adapted the cat's social behavior to fit their role as a house pet. This intraspecific relationship is influenced by length of co-habituation, human and cat temperament, the age of the cat, and the sex of the human. Wedlet et al (2011) showed that cats with a wide behavioral repertoire and female caretakers formed stronger dyads. Cats tend to decrease the complexity of their behavior with age (Wedlet et al 2011).

Few studies have examined how humans talk to cats or how cat respond to this communication. However, the study of the canine-human relationship has inspired the investigations of the human-cat interaction. Dogs gazed at trusted humans to solicit help in solving problems (Merola 2015). Galvin (2016) described an increase in feline attentiveness in response to cues that communicated positive human emotions. Cats also appeared to use social referencing in making decisions about accepting unfamiliar items; they accepted and took comfort from these items when they were offered by trusted humans (Galvin and Vonk 2016). McComb et al. (2009) and Schreeve and Udell (2015) reported that cats meow more frequently in the presence of humans particularly their owners, especially when soliciting food. These cries are like those that kittens use to get their mothers' attention. McComb et al. (2009) discovered a purr embedded in the meow associated with food and attention solicitations that altered the communicative signal so that the cry was perceived as more urgent, like a baby's cry. Due to this embed purr, humans can successfully to distinguish a food-soliciting meow in a familiar cat (Turner 2016). Saito and Shinozuka (2013) composed a playback experiment to learn if a cat could recognize its owner's voice. The researchers concluded that cats recognize their owner's voice based on a habituation-dishabituation experiment using the voices of three strangers followed by the owner and, then, another stranger. They did not, however, address the salient vocal qualities of the human utterances (Saito and Shinozuka, 2013).

Humans habitually alter their speech when talking to infants and canines (*Canis lupus familiaris*) as compared to utterances directed to adults (Burnham et al 1998). Infant directed speech (IDS) or "motherese" appears in almost every human culture. Mothers and strangers tend to use higher pitch, exaggerated harmonics, and simple content when talking to infants. IDS includes longer pauses and shorter sentences (Fernand 1985) (Knoll 2015). IDS also uses high fundamental frequencies to gain a child's attention and lower fundamental frequencies to provide emotional support (Fernald 1985) (Burnham et al 1998). The simplification of speech to infants conveys the basic rules of language and helps to prune the necessary neural linguistic maps underlying the native language of mother and infant (Knoll 2015).

Canine directed speech (CDS) shares certain characteristics with IDS such as shorter sentences, repetitiveness, higher pitch, and exaggerated harmonicity (Mitchell 2001). In CDS sentences are shorter and fundamental frequencies are as high as in IDS, even during interactions with unfamiliar dogs (Burnham et al 1998). Humans use CDS regardless of the age of the dog but more often with puppies. Ben-Aderet (2017) concludes that people adapt their speech to communicate with dogs and that puppies are highly responsive to these alterations (Ben-Aderet et al 2017). A comparable study of human communication with cats comparing a cat version of canine directed speech and infant directed speech (called from here on, "kitten directed speech") to HDS should be undertaken.

This study investigated the acoustics of speech directed to kittens (KDS), feline adults (FADS), and humans (HDS). The vocal features of the utterances were observed and playback experiments with adult cats were analyzed for the reaction to owner's KDS, owner's HDS, stranger's KDS, and stranger's HDS. Playback experiments differentiated the attentiveness of adult cats to speech with significantly different acoustic features used by their owner and by strangers. Several hypotheses guided the experimental design: (1) that KDS, would share similar characteristics to CDS, especially with regards to pitch; (2). that cats would be more attentive to KDS than HDS; and (3) that cats would pay more attention to strangers' utterances than their owners.

Materials and Methods

Preliminary Set up- Image Selection:

Images of 80 cats were extracted from the internet. They were equally classified as either "kitten" ($\leq$ 6 months) or "adult" ($\geq$1 years old). Coat colors were also equally selected with felines having either black, tabby brown, gray/ white, orange or multicolored fur. (Table 1).

With the selected images, a slide show (Microsoft Office PowerPoint) was created. The images were divided into 30 balanced sets containing photos of a kitten, adult cat and a control slide with no picture. The slides contained the phrase “Hi! Hello cutie! Who’s a good boy? Come here! Good boy! Yes! Come here sweetie pie! What a good boy!”

Table 1: Characteristics of the pictured felines presented to human speaker during recordings

Name	Age	Color
Picture 1	Adult	Brown Tabby
Picture 2	Kitten	Black
Picture 3	Adult	Brown tabby
Picture 4	Kitten	Brown tabby
Picture 5	Kitten	Orange
Picture 6	Adult	Brown tabby
Picture 7	Kitten	gray/white
Picture 8	Adult	Brown Tabby
Picture 9	Adult	Brown tabby
Picture 10	Kitten	Gray/white
Picture 11	Kitten	Multicolored
Picture 12	Adult	Brown Tabby
Picture 13	Adult	Brown Tabby
Picture 14	Kitten	Brown Tabby
Picture 15	Adult	Brown Tabby
Picture 16	Kitten	Black
Picture 17	Kitten	Orange
Picture 18	Adult	Orange
Picture 19	Kitten	Gray/white
Picture 20	Adult	Orange
Picture 21	Adult	Black
Picture 22	Kitten	Brown Tabby
Picture 23	Kitten	Black
Picture 24	Adult	Orange
Picture 25	Adult	Orange
Picture 26	Kitten	Multicolored
Picture 27	Adult	Orange

Picture 28	Kitten	Multicolored
Picture 29	Kitten	Brown Tabby
Picture 30	Adult	Orange
Picture 31	Kitten	Black
Picture 32	Adult	Orange
Picture 33	Adult	Orange
Picture 34	Kitten	Brown Tabby
Picture 35	Kitten	Gray/white
Picture 36	Adult	Black
Picture 37	Adult	Black
Picture 38	Kitten	Multicolored
Picture 39	Adult	Black
Picture 40	Kitten	Orange
Picture 41	Kitten	Gray/white
Picture 42	Adult	Black
Picture 43	Kitten	Orange
Picture 44	Adult	Black
Picture 45	Adult	Black
Picture 46	Kitten	Multicolored
Picture 47	Kitten	Multicolored
Picture 48	Adult	Black
Picture 49	Adult	Gray/white
Picture 50	Kitten	Black
Picture 51	Adult	Gray/white
Picture 52	Kitten	Orange
Picture 53	Kitten	Black
Picture 54	Adult	Gray/white
Picture 55	Kitten	Gray/white
Picture 56	Adult	Gray/white
Picture 57	Adult	Gray/white
Picture 58	Kitten	Brown Tabby
Picture 59	Kitten	Orange
Picture 60	Adult	Gray/white
Picture 61	Adult	Gray/white
Picture 62	Kitten	Brown Tabby
Picture 63	Adult	Gray/white
Picture 64	Kitten	Black
Picture 65	Kitten	Brown Tabby
Picture 66	Adult	Multicolored
Picture 67	Kitten	Multicolored

Picture 68	Adult	Multicolored
Picture 69	Adult	Multicolored
Picture 70	Kitten	Orange
Picture 71	Kitten	Gray/white
Picture 72	Adult	Multicolored
Picture 73	Adult	Multicolored
Picture 74	Kitten	Orange
Picture 75	Adult	Multicolored
Picture 76	Kitten	Gray/white
Picture 77	Kitten	Black
Picture 78	Adult	Multicolored
Picture 79	Kitten	Multicolored
Picture 80	Adult	Multicolored

Part I: Recording of Human speech and analysis:

Each human participant (n= 25 [male, n=8; female n=17], ages 20-55) was recorded (Zoom H4n digital recorder, sampling frequency= 44100 Hz) speaking to a set on a Samsung tablet (Android OS). Participants were asked to read the phrases as though engaging with the cat or kitten. For the Control situation, the individual was asked to speak as though talking to a human (HDS). The speech sequence associated with the "adult" and "kitten slides", FADS and KDS respectively.

Next, we performed acoustic analyses of the speech sequences using a dedicated batch-processing script in PRAAT (version 6.0.04) with four distinct procedures (Boersma and Weenink 2012). The first procedure of the script characterized the fundamental frequency (F0; pitch) and the intonation (sound pattern produced by pitch variation) of the speech sequence. In a first step, the F0 contour was extracted using the "To Pitch" command, and the following parameters were extracted: %voiced (percentage of the signal that is characterized by a detectable pitch, a measure of the proportion of spoken content), total duration of the recording, mean F0, max F0, min F0 (the mean, maximum and minimum F0 calculated over the duration of the signal respectively) and F0CV (coefficient of variation of pitch over the duration of the signal). In a second step, two distinct smoothing algorithms were performed on the pitch contour. The first allowed a relatively broad bandwidth to suppress very short-term frequency fluctuation while preserving minor intonation events and the second allowed a narrow bandwidth to only characterize strong F0 modulation (major intonation events). Inflection points were counted (as each change in the sign of the contour's derivative) after each smoothing procedure, and divided by the total duration of the voiced segments in each recording, resulting in two distinct indexes of F0 variation (inflex25- wide pitch variation and inflex2- narrow pitch variation). A second procedure focused on the intensity contour and the characterization of the variability of the speech sequence's intensity by calculating intCV using the "To intensity 'y'" command in PRAAT. A third procedure focused on the periodic quality of the signal and measured the harmonicity (harmonics to noise ratio)(1), an index of jitter (rapid modifications of the pitch) (2) and an index of shimmer (rapid modifications of the amplitude)(3)(Boersma and Weenink 2012). A final procedure characterized the first (lowest) five formant frequencies of the speech sequence. Formant frequencies were measured using the Linear Predictive Coding Burg algorithm in PRAAT with a time step of 0.05sec, a maximum formant value of 5500 Hz, a window length of 0.1 s, and a pre-emphasis from 50 Hz. The mean formant frequencies (F1, F2, F3, F4, F5) were then calculated across the total duration of each speech sequence.

$$\text{Harmonicity} = 10 * \log 10\,(\text{energy of the signal} \div \text{noise}) \tag{1}$$

$$\text{Jitter} = \text{the absolute difference in consecutive periods} \div \text{period average} \tag{2}$$

$$\text{Shimmer} = \text{the absolute difference in consecutive amplitudes} \div \text{amplitude average} \tag{3}$$

To test for differences in speech quality between the four recording conditions, we used linear mixed effect models with acoustic variables as dependent measures (fixed effects: recording condition –control, kitten, adult cat- and speaker's gender; random effects: speaker identity and presentation order of the pictures). P values were obtained with likelihood-ratio tests comparing the fit of full models with reduced models lacking the fixed effect. To compare between the recording conditions, this analysis was followed by post-hoc multiple comparison tests (function glht in multcomp R package).

Part II: Playback experiments on Cats and analysis

Twelve fixed pet cats belonging to the human participants of part one were selected ([male= 7, females= 4] age >1 year old). All cats were non-aggressive and curious cats. Any fearful or easily stressed cats were eliminated.

All experiments were performed in a room preferred by the felines within their homes (New York, USA). Preparation for the playback trials included mounting a camera (Cannon Powershot SX720) to a 40-inch-tall tripod and placing a speaker (Bose Sound Link Color Bluetooth) within the camera's view and in a spot which would produce the best sound quality. A camera test was done prior to taking measurements of the room's dimensions, distances of the camera to speaker, speaker to nearest furniture, speaker to center of room, and camera to center of room.

The cat was placed in the middle of the testing room by the owner. The camera was put to record and both the owner and experimenter exited the room. A 20 second behavioral baseline was recorded. After ensuring the cats was still in frame a 10 second waiting period occurred. This small period allowed for the cat to return to baseline behaviors. If the cat was not within frame, the owner moved the cat prior to the waiting period. The first vocal playback recording was then presented. On average, the playbacks included a 2 second silence period in the beginning and end of each trial and 4 seconds of utterances. The playbacks were presented in a balanced manner and included a total of 4 per subject: owner kitten directed speech (OKDS), owner human directed speech (OHDS), stranger kitten directed speech (SKDS) and stranger human directed speech (SHDS). All recordings were unique and specific for each subject. Owners and strangers were of the same gender and similar in age.

Table 2: Individual characteristics of felines tested during playback experiments

Name	Age (In Years)	Sex	Coat color
Nema	2.5	Female	Black medium haired
Tiger	3.5	Male	Brown tabby short haired
Mason	2	Male	Brown tabby short haired
Kiera	1.5	Female	Brown tabby short haired
Maxie	2.5	Female	Black with white long haired
Karl	6	Male	Black tuxedo short haired
General Jack	1.5	Male	White with gray short haired
Tiger Tyson	3.5	Male	Brown tabby short haired
Eva	1	Female	Brown long haired
Frida	7	Female	Cream long haired
Javier	3	Male	Brown tabby short haired
Flapjack	2	Male	Black with white markings short haired
Flapjack Companion	8	Female	Black and white short haired
Maxie Companion	4	Male	Black long haired

A 20 second behavioral response was recorded after each vocalization. After the first, second and third playback, the experimenter checked the cat's position and behavior. If the cat displayed any signs of stress, the playbacks were ended and the cat could leave the testing room. One trial included all 4 playback sessions and any companion cat that came into camera frame.

The videos were analyzed using Griffin VC 2 (Singh and Ragir 2014). For coding, each cat was identified along with behavioral events, degrees of intensities and attentiveness, coding of the direction of movement Vis a Vis the speaker- toward or away, along with the identification of the utterances also took place (Table 3). The videos were categorized into nine different interludes: a 20 "Pre-play back" period (pre-PB), four vocal playback sessions ("PB"); followed by a "Post playback" section ("Post PB"). Each PB and Post PB varied in recording length but since cats stopped responding after 20 seconds, a combined 20 second PB and Post PB analysis was done.

Table 3: Ethogram used for Coding

Subjects

Label	Name	Comments
Nema	Nema	Female
Tiger	Tiger	Male
Mason	Mason	Male
General Jack	Jack	Male
Karl	Karl	Male
Flapjack	Flapjack	Male
Tiger Tyson	Ty	Male
Maxie	Maxie	Female
Kiera	Kiera	Female
Eva	Eva	Female
Javier	Javier	Male
Frida	Frida	Female
Co	Companion	The companion of the cats

Events

Label	Name	Comments
E	Ear movement	
T	Tail movement	
H	Head Turn	
W	Walk	
R	Run	
J	Jump	
L	Lie down	Prone or on sides
G	Self-groom	

GA	Gaze	
S	Sit	
TO	touch	Touching the speaker

Owner-Stranger

Label	Name	Comments
OM	Owner-male	Cat's owner and male
SM	Stranger-male	Stranger to the cat and male
OF	Owner-female	Cat's owner and female
SF	Stranger-female	Stranger to the cat and female

Direction

Label	Name	Comments
AS	Away from speaker	
TS	Toward speaker	

States

Label	Name	Comments
OFF	Off camera	Subjects not within camera frame
ON	On camera	Subject within camera frame
D	Disengaged	Disengaged to playback
A	Attentive	Attentive to playback
PB	Playback begins	Beginning of playback
PBE	Playback ends	End of playback

Intensity and speech

Label	Name	Comments
R	Rapid	Modifier of locomotion events
M	Moderate	Modifier of locomotion events
S	Slow/gentle	Modifier of locomotion events
AD	HDS	Human directed speech
KT	KDS	Kitten directed speech

Video analysis included calculations of behaviors and attentiveness. If the cat had a companion, the companion was analyzed separately and labeled as “Companion”. The total behaviors were then split into those pertaining to the cat being attentive or disengaged and also divided based on whether the session was OKDS, OHDS, SKDS or SHDS. Aside from analyzing the events for each cat, the portion of time spent attentive in each state was calculated using the time stamps provided by the Griffin VS 2 observation log. The observation logs for each cat were downloaded into separate excel files for analysis.

For statistical significance, three 2-way Analysis of Variance (ANOVA) were completed (IBM SPSS Statistics, version 24). Each ANOVA looked at the cats' attentiveness for either the vocal playback section, Post vocal playback section or the whole playback session ($p<.05$). Additionally, a k-related test was run for each ANOVA to verify any significance. Then, a bivariate correlation was used to look at each of the four playbacks and any order effects that may have occurred. An additional correlation was considered for total session activeness, versus the length of the vocal playback section. Lastly, interactions were tested using two t-tests; one for SKDS vs OKDS and another for SHDS vs OHDS.

Results

(i) Cat-directed speech shows higher harmonicity than control speech

The recordings and their respective analysis demonstrated that speech directed to cats differs from the control speech directed to adult humans. However, the extent of these differences remained limited, especially when speaking to an adult cat. The main acoustic feature that differed between control and KDS was harmonicity, χ^2 (2, N=25) =22.9, $p\leq .001$ (periodic quality of the signal): KDS sequences thus showed a higher ratio of harmonics to noise in the signal and a clearer quality (Figure 1). In women, the percentage of the signal that is characterized by a detectable pitch also increased during KDS. Pitch was only marginally affected by recording conditions and speakers did not significantly modify their pitch χ^2 (2, N=25) =6.65, $p\geq .05$ when speaking to cats. Other important acoustic features like the pitch variation over time (F0CV) and the mean format frequencies were not (F2-F5) or only slightly (F1) affected by recording condition. There was no significant interaction between speaker's gender and recording condition, except for sequence duration where men χ^2 (2, N=25) =8.43, p≤ .001 slowed down their speech rate in front of cats.

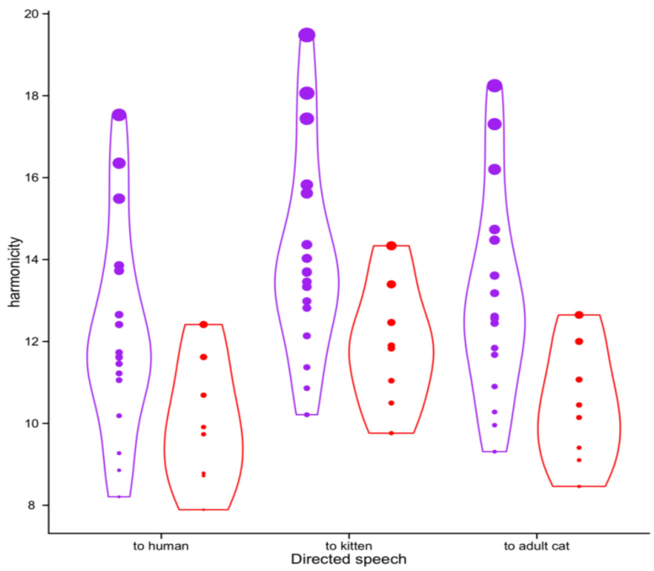

Figure 1. Influence of recording condition on speech quality. X-axis = recording conditions (directed speech to human adult, kitten and adult cat respectively). Y-axis = degree of acoustic periodicity of the recorded speech sequence (parameter *harm*, ratio of harmonics to noise in the signal) (in red: men speakers, n = 8; in purple: women speakers, n = 17). Each dot represents a single recording of the same speech sequence from different human adult speakers (each speaker was recorded in each of the three recording conditions; see main text for description of the recorded speech sequence). The size of dots is proportional to the percentage of the signal that is characterized by a detectable pitch (parameter *%voiced*).

ii) Playback video recordings showed an overall higher attentiveness to Kitten Directed speech, especially in a stranger's voice.

The data, expressed as proportions of time that the animal was attentive during the 20-second observation period, showed no significant main effects for Person, $F(1,13) = 1.108$, $p > .05$, $\eta^2_{partial} = .079$, or for Speech, $F(1,13) = 1.424$, $p > .05$, $\eta^2_{partial} = .099$, but there was a significant interaction of Person X Speech, $F(1,13) = 5.816$, $p = .031$, $\eta^2_{partial} = .309$, shown in

Figure 2. As a follow-up to the interaction, simple effects tests were used to examine the Owner vs. Stranger difference, holding the type of Speech constant. With KDS, there was significantly more attention when the Speaker was a Stranger ($M = 50.36$, $SD = 36.06$**)** than when the Speaker was the Owner **(**$M = 26.12$, $SD = 29.79$), $t(13) = 2.503$, $p = .026$. However, with HDS, there was more attention when the Speaker was the Owner ($M = 33.71$, $SD = 35.55$) than when the Speaker was a Stranger ($M = 23.2$, $SD = 29.88$**),** but this difference was not statistically significant, $t(13) = 1.078$, $p > .05$. A Pearson correlations showed the only significant association between the order of presentation (1^{st}, 2^{nd}, 3^{rd}, 4^{th}) and the proportion of attention in the 20-second observation period to be a negative correlation between the position of OKDS and SKDS, $r (13) = -.562$, $p = .036$. No other order effects existed.

As noted earlier, the playback durations of the stimuli differed in length. Two post hoc analyses looked at attention during the playback portion and during the post-playback portion of the observation period. Both analyses showed an interaction of Person X Speech, but only the interaction for the post-playback portion approached significance ($p = .046$), before adjustment for multiple tests. Pearson correlations showed no significant association between playback length and attention in any of the four conditions (all p's > .170).

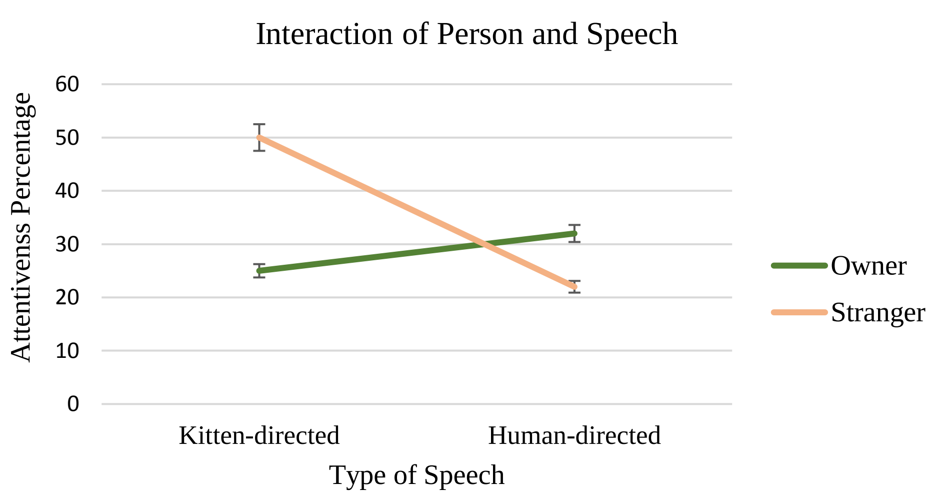

Figure 2 Attentiveness for the four total playback sessions. X-axis= The Speech condition (Kitten directed speech and Human directed speech respectively). Y-axis= Estimated Means for attentiveness of subjects (in red: Vocals from owner; in purple: Vocals of Stranger, n=14). 95%CI

Discussion

In pursuance of better understanding feline behavior toward humans, vocal utterances were recorded from subjects who were exposed to three different speech scenarios: human, cat, kitten. The only significant gender effect was that men used slower speech during KDS and FADs than in HDS. Females used a slightly higher pitch during KDS but not in FADS and HDS. These findings vary with the hypothesis, given that it was predicted that pitch would be one of the most significant differences between KDS and HDS. The use of slower speech and slightly higher pitches can be linked to characteristics of IDS and IDS. For infants, such vocal qualities allow them to learn and understand a language (Knoll 2105). Simple words are often paired with both qualities. Since mothers use a higher pitch to interact with their child, we can predict that woman will use higher pitches with kittens (Knoll 2015). Men produced a broader pitch change when their KDS and FADS was compared to HDS. Males are attempting to produce higher pitch qualities to mirror the ones that females naturally have. When compared to CDS, the slight increase of KDS pitch may be due to the positive utterances (What a good boy!) and the question (Who’s a good boy?) within the scripted phrase. Or humans talking to dogs these utterances cause a higher pitch but Ringrose (2015) concluded that ultimately it was the social norm that led to CDS (Ringrose 2015). Perhaps it is a form of social norm for which KDS differs and has significantly higher harmonics. The quality of the acoustic signal is due to harmonicity which compared the strength of the signal to the noise ratio. With a greater harmonicity, KDS has a clearer signal than the other signals (HDS and FADS). A clearer utterance in KDS, CDS and IDS allows for the speaker to attract and hold the attention of the listener. Slow, short utterances and clear speech used with infants help them disambiguate the meaning to words and rules that govern their function in sentences. The production of harmonics comes from the vocal folds; something that leads to pitch variations, which exaggerates the contrasts within the utterances- characteristics of KDS, CDS and IDS (Pisanski et al 2016). The differences between canine and cat directed speech could be linked to the unique relationship each specie shares with their owners (Ben-Aderet et al 2107).

Cats' attentiveness varies depending on whether being addressed by a stranger or their owner speaks to them; one of the hypotheses that motivated the study. Attentiveness lasted significantly longer for SKDS than any other speech. Again, this supports the hypothesis. SKDS may allow for a cat to gather as much information as possible from the person they are interacting with, which can lead to the recognition of the person and appropriate responses to an unfamiliar human. For infants, this information leads to vocal recognition and language acquisition. However, the higher attentiveness may be simply a response to the novelty of a stranger speaking in the cat's home. Hearing the utterance for the first time may peak the cat's curiosity of the person's location and/or intentions. Additionally, a cat's hearing range is wide: 500Hz to 22KHz (Heffner and Heffner 1985). With such a wide scale and a wider pitch variation in KDS than HDS, cats may be attentive to the utterance with more variation.

A greater pitch variation paired with curiosity may explain why cats tend to be more alert for SKDS. Cats selectively respond to an owner's voice because they already know enough about the owner to ignore meaningless phrases. This allows for both owner and cat to function properly in their dyad. Although information is processed differently puppies still use CDS to further their interactions with humans. They approach humans more often and for longer periods of time than adult dogs (Ben-Aderet et al 2017). In cats, approach behaviors for KDS are rare and responses are done at a distance.

The study did reveal some limitations- first was the calculated use of scripted human vocalizations and the second, the use of pictures rather than live kittens. By using a script, vocal qualities could be analyzed but may not mimic what would be spoken to a house. Several of the human speakers remarked in the artificiality of the utterance. The use of spontaneous utterances might lead to more authentic KDS qualities. In addition, live cats rather and photographs, might produce more realistic KDS. A potential problem in the playback experiment laid in the difficulty of accessing the effect of the variation in shape, size and acoustics of the room in which the cats were tested. These considerations might be addressed in any future studies regrading cats responses to kitten directed speech and adult feline directed speech.

Conclusion

In conclusion, humans tend to apply certain qualities of IDS and CDS to KDS. Harmonics and broad pitch changes are important in KDS. Women continue to use some pitch alterations, to communicate with non-verbal individuals. Adult cats also respond SKDS to grasp as much information as possible, the way an infant would. Finally, the ability to form a way to interact with a non-speaking companion and for the companion to respond, allows the special human-cat dyad to develop.

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