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Human Perception of Emotions from *Canis familiaris* Barks: An Auditory-Perceptual Study

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Abstract:- This study investigates how experience and gender influence the perception of emotions in dog barks. Drawing from Morton's structural-motivational rule and previous research on mammalian vocalizations, we aimed to discern whether humans, especially those experienced with dogs, can accurately identify emotions such as stranger, anger, lonely, and play in dog barks. Using recordings of Indian Lesser Spitz barks in various contexts, we conducted auditory-perceptual experiments with two groups: experienced listeners (with more than 2-3 years of pet dog experience) and non-experienced listeners. Participants listened to bark sequences and identified the corresponding emotions. Results revealed that experienced listeners consistently outperformed non-experienced ones in identifying emotions, except for 'play,' where no significant difference was observed. Gender did not significantly affect emotion perception. Interestingly, 'anger' was most accurately identified across both groups, followed by 'stranger,' 'play,' and 'lonely' emotions. Analyzing open-ended responses, we found that acoustic cues such as pitch and inter-bark intervals strongly influenced emotional perception. 'Stranger' barks were described as low-pitched, while 'anger' barks had shorter inter-bark intervals. 'Lonely' barks were characterized by high pitch and longer inter-bark intervals than 'play' barks. These findings suggest that experience plays a crucial role in accurately perceiving emotions in dog barks, aligning with the concept of a common mammalian heritage in emotional communication. Gender differences were negligible in this context. Understanding the acoustic cues underlying emotional expression in dogs enhances our comprehension of canine behavior and has implications for fields like animal welfare and neuroscience. Further research could delve deeper into the mechanisms underlying emotional perception in non-verbal communication across mammalian species.

Keywords:- *Emotions, Canis Familiaris, Human Perception, Emotion Perception.*

I. INTRODUCTION

Emotions reflect the internal status of an organism and help a second person evaluate the internal status of his fellow organism. Emotions can be expressed or comprehended through variations in various acoustic parameters of vocal signals, such as frequency (Tonality, Noise, Mean Pitch, and Frequency Modulation), amplitude (Relative Amplitude and Abrupt Onset), and duration (Pulse Duration and Pulse Repetition) as reported by Lord, Feinstein, and Coppinger (2009). According to Waldman (1972), an animal's emotional state can be analogous to human emotions. Morton (1977), based on bird and mammalian vocalizations, hypothesized that low-pitch (atonal) vocalizations signal aggressive intentions, in contrast to high-pitch (tonal) vocalizations signaling friendly and submissive intentions.

Dogs (*Canis familiaris*) are integral to many households and are aptly referred to as man's best friend. Earlier studies have proved that dogs emit acoustically different barks in different situations, suggesting that emotional changes in dogs are reflected in barking vocalizations (Feddersen-Petersen, 2000; Yin, 2002; Pongracz et al., 2005). A similar study on the vocalization system of wolves revealed that acoustic features of vocalizations vary with intentions or internal state (Schassburger, 1993). Further, Linnankoski et al. (1994) interestingly reported that humans could identify the emotions of a macaque from its vocalizations. Pongracz et al. (2005) investigated the effect of acoustic parameters of dog barks on human listeners, and results revealed that barks recorded in different situations had distinctive acoustic patterns regarding harmonic-to-noise ratio, fundamental and peak frequency and inter-bark intervals conveying emotional information for human listeners.

Pongracz et al. (2005) proposed the possibility of a common mammalian heritage in the acoustic communication of emotions. The common mammalian heritage theory postulates that during the evolution of species from lower-order to higher-order organisms, the basic principles of acoustic processing schemes might also have been transferred.

All people (including children) make everyday judgments of emotions when listening to their fellow beings, even though they may be inexperienced. One might be using the same perceptual schemes for perceiving emotion intensity in non-human vocalizations (e.g., dog barks), which is used for perceiving emotion in human infant cries and in adult speech.

The present study conducted an auditory-perceptual experiment to explore humans' ability to identify emotions from dog bark. Under the perceptual analysis of emotions, the aim of the present study was threefold: (i) The primary aim was to investigate the influence of experience and gender in

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the perception of 4 target emotions: stranger, anger, lonely, and play (happy). (ii) The secondary aim of the study was to find the order of identification of emotions, i.e., which emotion is perceived most accurately and vice versa. (iii) The tertiary aim of the study was to determine the possible implication of the "common mammalian heritage" model in the perception of emotion using the present findings.

II. METHODS

A. Participants

Two groups of individuals participated in the study. Group 1 included twenty experienced listeners, ten males and ten females in the age range of 18-24 years (mean age=21.0 years) who had a minimum of 2-3 years of experience with pet dogs of any breed, and the second group included twenty non-experienced listeners, ten males and ten females in the age range of 18-24 years (mean age=20.6 years) who did not have any experience with dogs.

B. Recording of Stimulus

A three-year-old female dog from the Indian Lesser Spitz (*Canis familiaris)* variety participated in the study. This breed's characteristic feature is that it is a watchdog known for excessive barking. Bark recordings were collected in four contexts at the owner's home. All barks were recorded by the experimenters directly. The four contexts were;

- *Stranger*: The experimenter was a stranger to the dog and would arrive at the house gate in the owner's absence. The owner was asked to stay inside the house during bark recordings. Dog barking was elicited and recorded during the experimenter's appearance at the house's gate for 1-2 minutes.
- *Lonely*: The owner tied the lash of the dog to a tree at one corner of the house and walked away, out of sight of the dog. The recorder was kept at a distance of 0.5-1 meter, and dog barks were recorded for 1-2 minutes.
- *Play*: The owner was asked to play a usual game with the dog, such as catching the ball. The experimenter recorded barks elicited at a distance of 0.5-1 meter for 1-2 minutes.
- *Anger*: The owner was asked to stand near the dog, and one of the experimenters pretended to be hitting the owner. The barks elicited were recorded at a distance of 0.5-1 meter for 1-2 minutes.

Recordings were made directly by the experimenters with a built-in omnidirectional microphone (frequency range 16 Hz-12000 Hz) of a Sony Walkman digital media player (NWZ-E443, Sony Corp, China). During the recording of the barks, the distance between the dog and the recorder was maintained at 0.5-1 meter constantly, and barks emitted during each context were recorded for 1-2 minutes. Two visits were made on two different days, and two sets of recordings were made for each of the four contexts.

C. Auditory-Perceptual Experiment

Barks of 15 seconds that accurately represented the target emotions (four in number: Anger, stranger, lonely, and play) were selected perceptually by three experimenters of this study. Stimuli were assembled using Adobe Audition software version 3.0 (Adobe Systems, Incorporated) by adding 30 seconds of silence after each 15 seconds of bark as response time for human listeners. Three bark sequences were made, each consisting of barks from four different contexts arranged randomly.

The bark sets were copied into a compact disk (CD) and played on a computer via Philips SHP2000 headphones (frequency response: 15-22000Hz) to the participants. The listeners had to listen to each bark set and identify the context in which it was recorded. The listeners' responses were collected using a quaternion forced choice condition in which they had to put a tick mark (√) in the box corresponding to the context. The experimenter handled the player. The bark sequence sets were played back individually to the listeners, who were allowed to listen to each set only once. However, a particular context bark from a bark set was repeatedly played back at the listeners' request. After listening to 3 bark sets, the listeners were asked to mention the unique features that distinguished one emotion from the others in an open-choice manner.

III. RESULTS

The results of the present study are discussed under four headings: (a) Experienced versus non-experienced listeners, (b) Experienced males versus experienced females, (c) Non-experienced males versus non-experienced females, and (d) Order of identification of emotions.

A. Experienced versus Non-Experienced Listeners

Experienced listeners identified all four emotions more correctly than non-experienced listeners. The emotion 'anger' was identified correctly and accurately by almost all experienced listeners, followed by the emotion 'stranger' and 'lonely.' The emotion 'play' was least identified by the experienced listeners, though it was correctly identified by 75% of the participants. Table 1 shows the percentage of correct identification of emotions by experienced versus non-experienced listeners.

Table 1 Percentage of Experienced and Non-Experienced Listeners Who Gave >50% of Correct Identification of Emotions

Emotions	Group 1 (%)	Group 2 (%)	Z	p
Stranger	90	30	3.8730	0.0001*
Lonely	80	40	2.5830	0.0098*
Play	75	70	0.3541	0.7233
Anger	100	80	2.1082	0.0350*

A test of equality of proportion was conducted to find the statistically significant difference in the correct identification of emotions (>50%) between the two groups. The statistical analysis results revealed that the experienced listeners identified the emotions more accurately than non-experienced listeners. This was significant at 0,05 significance level for the emotions' stranger', 'lonely,' and 'anger.' There was no statistically significant difference between the experienced and non-experienced listeners for the emotion 'play.'

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B. Gender Effect on Experienced Listeners

Experienced female listeners identified two target emotions, 'stranger' and 'play,' correctly than experienced male listeners. On the other hand, emotions like 'lonely' and 'anger' were identified similarly by both experienced males and experienced females. The equality of proportions test results revealed no statistically significant difference between experienced males and females in correctly identifying target four emotions. Table 2 shows the percentage of experienced male and female listeners correctly identified the four target emotions.

Table 2 Percentage of Experienced Male and Female Listeners Who Gave >50% of Correct Identification of Emotions

Emotion	Males (%)	Females (%)	Z	p
Stranger	80	100	1.4907	0.1360
Lonely	80	80	0	1
Play	70	80	0.5164	0.6056
Anger	100	100	-	-

C. Gender Effect in Non-Experienced Listeners

Non-experienced female listeners correctly identified two target emotions, 'stranger' and 'lonely,' unlike non-experienced male listeners. On the other hand, emotion like 'play' was identified correctly by most non-experienced male listeners compared to non-experienced female listeners. The equality of proportions test results revealed no statistically significant difference between non-experienced males and females in correctly identifying target four emotions. Table 3 shows the percentage of non-experienced male and female listeners correctly identified the four target emotions.

Table 3 Percentage of Non-Experienced Male and Female Listeners Who Gave >50% of Correct Identification of Emotions

Emotion	Males (%)	Females (%)	Z	p
Stranger	20	40	0.9759	0.3291
Lonely	20	60	1.8257	0.0679
Play	80	60	0.9759	0.3291
Anger	80	80	0	1

D. Order of Identification of Emotions

The rank of emotions identified from most to least accurately identified was evaluated using the Friedman non-parametric test among experienced and non-experienced listeners. The Friedman test results found a significant difference in the rank of identification of emotions between the groups. Table 4 shows the results of the Friedman test for the order of identification of emotions (mean values were mentioned in parentheses).

Table 4 Friedman Test Results for Rank of Identification of the Emotions

Ranks	1	2	3	4	p
Experienced listeners	Anger (3.08)	Stranger (2.50)	Play (2.23)	Lonely (2.20)	0.001*
Non-experienced listeners	Anger (3.35)	Play (2.63)	Lonely (2.13)	Stranger (1.90)	0.000*

Table 4 indicates that the order of identification of emotions from best to least was anger, stranger, play, and lonely for experienced listeners and anger, play, lonely, and stranger for non-experienced listeners. Also, the Wilcoxon signed rank test was done to find out which emotion pair was better identified.

Table 5 shows the Wilcoxon signed rank test results for pair-wise comparison of emotions for experienced and non-experienced listeners. Wilcoxon signed rank test revealed that the emotion pairs like 'lonely-stranger,' 'anger-stranger,' 'anger-lonely,' and 'anger-play' significantly differ ($p<0.05$) among experienced listeners. The pairs' play-stranger', 'anger-stranger,' 'anger-lonely,' and 'anger-play' showed significant identification differences among non-experienced listeners ($p<0.05$).

Table 5 Results of Wilcoxon Signed Rank Test for Pair-Wise Comparison

Emotion pairs	Experienced listeners		Non-experienced listeners	
	Z	P	Z	P
lonely - stranger	-1.633	.102	-1.026	.305
play - stranger	-.682	.495	-2.553	.011*
anger-stranger	-2.232	.026*	-3.625	.000*
play - lonely	-.736	.461	-1.586	.113
anger - lonely	-2.716	.007*	-2.819	.005*
anger - play	-2.558	.011*	-2.252	.024*

Listeners were asked to describe the perceptual characteristic of each bark in an open-ended fashion that cued them to differentiate one type of emotion from the other. The listeners described "stranger" emotion as low pitch bark and "anger" bark as having short inter-bark intervals. "Play" and "lonely" bark were described as high-pitch barks, out of which "lonely" bark had more inter-bark interval and high tonality than "play" bark.

IV. DISCUSSION

The results of the present study indicated that experienced listeners could identify the emotions' anger, stranger, and lonely' (negative emotions) better than non-experienced listeners. This finding is in agreement with the results of the Pongracz et al. (2005) study, where people with different experiences with dogs were asked to describe the emotional content of several artificially assembled bark sequences based on five emotional states (aggressiveness, fear, despair, playfulness, and happiness). Pongracz et al. reported that experienced dog owners could correctly identify the target emotions more than the non-experienced. Also, the

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findings of the present study are in consonance with earlier findings of behavioral and neuro-imaging studies for parents' and non-parents perception of emotions from human infant cry, the results of which reveal that parents perform better than non-parents (Green et al., 1987 & Seifritz et al., 2003).

The identification of the emotion 'play' (a positive emotion) was unaffected by the listeners' experience. According to the most widely held view, the right hemisphere dominates the left hemisphere in the perception and expression of emotions (Strauss & Moscovitch, 1981; Campbell, 1978; Chaurasia & Goswami, 1975; Safer, 1981). Seifritz et al. (2003) found that in the right amygdala and interconnected limbic regions, non-parents showed relatively more robust activation for positive emotions, and parents showed relatively stronger activation for negative emotions.

Among the experienced and non-experienced listeners, regardless of gender, ' anger' was the best-identified emotion. This may be better understood because 'anger' is an expression signaling the hostile intentions of perceived persons (Hortsmann, 2003). Therefore, it is possible that in human evolutionary history, perceiving anger and preparing for a possible attack was more profitable than underestimating signals of potential danger and not anticipating the attack. In contrast, underestimating the expression of happiness would not have such negative consequences (Biele et al., 2006).

Statistically significant gender differences were not evident in the identification of emotions in the present study. Similar findings were reported by Westbrook (1976) in the perception of emotions in 49 males and 51 females, with no gender difference. Leger et al. (1996) reported no gender difference in human infant cry perception in adults. It should be admitted, however, that in some studies on human emotion perception, gender differences were observed, suggesting that gender effects are dependent upon procedural variables that can influence subjects' performance (Biele et al., 2006).

Earlier studies on human infant cry perception in adults have demonstrated that adults can discriminate between cries emitted widely discrepant circumstances (e.g., birth and pain cries) (Wasz-Hockert et al., 1968). However, Gustafson and Harris (1990) reported poor performance in perceiving more closely related ones (i.e., hunger vs. pain cry). Similar findings were found in the present study, where the listeners could discriminate between barks with discrepant characteristics but not between those with closely related characteristics.

Results of the present study hint that the emotion perception from dog bark points to the fact that humans can perceive emotions from the vocalizations of mammals based on perceptual-acoustic characteristics. This was evident from the earlier studies on infant cry perception. Vocalizations of mammals (human infants, dogs, wolves, and macaques) in different circumstances have been proven to have different acoustic characteristics (in earlier studies). All these may indicate that we might use the same 'perceptual processing schemes' for perceiving emotions in various vocalizations. Also, the role of a "common mammalian heritage" in acoustic communication, as mentioned by Pongracz et al. (2005), is evident, especially in the perception of emotions.

Both the experienced and non-experienced listeners described that the unique cues of emotions were in accordance with Morton's Structural-motivational rules (1977), which articulates that the pitch, inter-bark intervals, and tonality were found to have solid cues for the perception of emotions in dog barks for human listeners.

V. CONCLUSION

The results showed that communication between humans and dogs is based on the basic principles of mammalian communication (perceptual processing schemes) and follows Morton's structural-motivational rules. Interestingly, the results generally aligned with earlier studies on infant cry perception and animal communication, emphasizing the role of "common mammalian heritage" in the acoustic communication of emotions.

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