Patterns and variation in long-distance communication of simakobu monkeys (*Simias concolor*) on Siberut Island, Indonesia - a pilot study.

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ABSTRACT

Long-distance or loud calls are common among vertebrates, and have been described in many primate species. Because these calls are more commonly produced by males and are often contagious, they are hypothesized to function in between-group communication, interpreted as resource or mate defense. Since intra- and inter-individual variation in calls may convey information about the caller, such as condition, age, location, or rank, an analysis of this variation can provide insight into the functions of loud calls. Adult male simakobu (*Simias concolor*) produce loud calls in a variety of situations: spontaneous calls, contagious choruses, and in response to loud noise such as thunder. The current pilot study aims to test hypotheses about the function of loud calls in male competition in simakobu. Data were collected from Jun–Aug, 2005 on several unhabituated groups within the 4,000 ha primary forest reserve of the Siberut Conservation Project (SCP), northern Siberut, Indonesia. All vocalizations heard during the 271 hours spent in the forest were noted together with time, location and stimulus; and in all, 72 calls were recorded. Diurnal distribution of long-distance calls were analyzed, as well as the acoustic variation between callers and locations. Distinct differences especially in call duration and syllable number suggest that in simakobu calls might advertise more than just location. The main study will further investigate loud calls as honest signals of male quality.

BACKGROUND

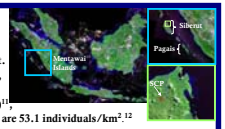
Loud Calls: **In many vertebrate species, males produce vocalizations that are considered long-distance calls, also known as long or loud calls, because they have the potential to function in extra-group communication among males. This hypothesized function is supported by the observation that long-distance calls frequently are contagious, in that calling by one animal stimulates others to counter-call[1,2] and that these calls are more commonly produced by males than females. In primates, loud calls have often been suggested to be important indicators of male quality, as they may convey information about an individual's age[3], condition[2], body size[4], rank[5], and willingness to defend mates or food.[6] Listeners may use this information to make decisions about whether to approach or avoid signalers. Analyzing the variation within and among signalers may provide insight into the function of loud calls as advertisements of quality. Furthermore, the function of dawn calls may differ from that of calls at other times of the day. Although most efficient call propagation is achieved during the morning[7], it is also at this time that callers' energy reserves are probably at their lowest levels.[8] Therefore, dawn calls may be the hardest to emit, making them particularly suitable to serve as honest indicators of a male's quality.[9]**

***Simakobu*: Adult male *Simias* frequently produce a loud, stereotyped vocalization or "type 1 loud call", the loudest parts of which are audible for >500 m.[1,10] Loud calls occur spontaneously, in response to other calls, or in response to loud sounds (e.g., thunder, tree fall).[1] In the Pagais (see map below), 40% of spontaneous calls were followed by another call.[1] Because loud calls were found to provoke loud calls, they were hypothesized to serve in communication among males, probably as a mechanism for group spacing.[1]**

OBJECTIVES

1. **To describe the diurnal patterns of loud calling by simakobu monkeys in the Peleonan forest, Siberut**
2. **To describe the patterns and variation in acoustic parameters of simakobu loud calls**
3. **To investigate the possible sources of variation among simakobu loud calls**

METHODS



***Study Area*: Indonesia's Mentawai islands, a small archipelago off Sumatra's west coast.**
***Study Site*: Peleonan Forest, located in Northern Siberut (0°58'-1°03'S - 98°48'-98°51'E), 40km² of mixed primary dipterocarp rainforest, rented by Siberut Conservation Project.**
***Study Species*: Simakobu (*Simias concolor*), medium-sized colobines (7.10kg ♀, 8.75kg ♂)[11] endemic to the Mentawai Islands, 1-male groups with 1+ adult females. At this site there are 53.1 individuals/km².[12]**

***Data collection*: Data were collected Jun–Aug 2005. All loud calls heard during 271 hours in the forest were noted (time, location, stimulus). Several calls were recorded *ad libitum* using a Marantz Professional Solid State Recorder PMD660 and Sennheiser Directional Microphone. A calling bout was defined as all calls that occurred within 5 minutes of each other.**

***Acoustic Analysis*: Calls were recorded at 44,100 Hz. For the spectral analysis, the sample frequency was reduced to 11,025 Hz to obtain a better frequency resolution. Avisoft-SASLab Pro was then used to conduct a fast Fourier transform (Hamming window; 1,024-pt FFT; time resolution: 5.8 ms; frequency resolution: 10.8 Hz) and the resulting spectra were submitted to a custom software program (LMA 8.4) to extract call parameters (below) from acoustic signals. The 'huh' and 'hoo' of each syllable were analyzed separately.**

Parameter	Description
mean syllable duration (sec)	mean duration of all syllables, each measured from its onset to the onset of the next
call duration (sec)	total call duration, measured from the onset of the first syllable to the onset of the last
syllable #	total number of syllables from the start to the end of the call
pf mean (Hz)	mean value of the frequency with the highest energy in all time segments
pf max (Hz)	maximum value of the frequency with the highest energy in all time segments
pf min (Hz)	minimum value of the frequency with the highest energy in all time segments
Fo mean (Hz)	mean value of the fundamental frequency in all time segments
Fo max (Hz)	maximum value of the fundamental frequency in all time segments
Fo min (Hz)	minimum value of the fundamental frequency in all time segments

***Data Analysis*: Chi-square analysis was used to test for a non-random distribution of calls throughout the day. Mann-Whitney U tests were used to compare calls at different times of the day (dawn vs. post-dawn), as well as in different contexts (spontaneous vs. following a loud sound). Only two variables were found to vary with context (pf mean was lower and call duration longer following a loud sound), and were not included in the multivariate analyses. For multivariate analyses, only 'hoo's from a syllable in the first half of the call were included. Cluster and PCA analyses were used to explore variation between callers' locations. All statistical tests were carried out with SPSS 11.0.**

RESULTS

1

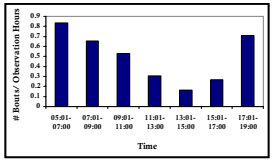


Fig 1. Diurnal distribution of 81 spontaneous loud call bouts. The distribution is significantly non-uniform, with an excess of calls produced in the morning hours and at dusk.
(X^2 = 75.5, d.f. = 6, p<0.05)

1

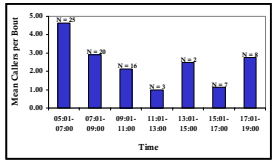


Fig 2. Diurnal distribution of the number of callers participating in 81 spontaneous loud call bouts. The distribution is significantly non-uniform, with an excess number of callers participating in dawn bouts.
(X^2 = 18.9, d.f. = 6, p<0.05)

2

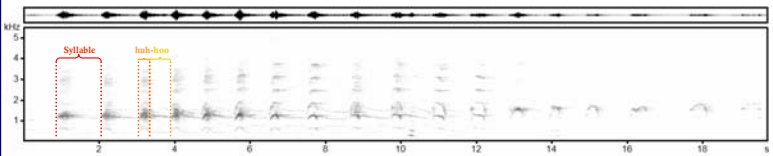


Fig 3. Spectrogram of a complete loud call (22.7 seconds, 18 syllables), depicting 'syllables' as well as the 'huh' and 'hoo' elements.

2

Table 1. Means and standard errors of acoustic parameters

Parameter		Mean	S.E.
Fo max (Hz)	Huh	674	12.00
	Hoo	421	13.13
Fo min (Hz)	Huh	543	10.90
	Hoo	357	14.27
Fo mean (Hz)	Huh	620	9.95
	Hoo	386	12.80
pf max (Hz)	Huh	1896	82.09
	Hoo	1662	65.30
pf min (Hz)	Huh	1037	35.11
	Hoo	871	39.67
pf mean (Hz)	Huh	1391	31.43
	Hoo	1242	34.10
Mean Syllable Duration (sec)		1.20	0.02
Call Duration (sec)		17.95	1.08
Mean Syllable #		15.61	0.88

3

Table 2. Variation in temporal characteristics of calls as a function of context and time of day

Variable		Syll. Duration	Call Duration	# Syllables
Context	spontaneous	n.s.	shorter (p<0.1)	n.s.
	stimulus	n.s.	longer (p<0.1)	n.s.
Time	dawn	n.s.	shorter (p<0.1)	fewer (p<.05)
	post-dawn	n.s.	longer (p<0.1)	more (p<.05)

3

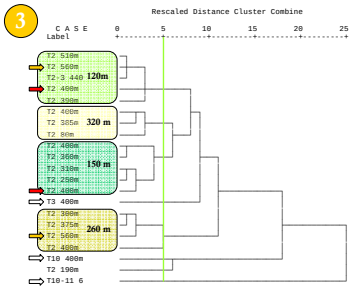


Fig 4. Hierarchical cluster analysis (UPGMA) indicating 4 major clusters (colored boxes) of calls and the maximum distance between calls in each cluster. Two pairs (like-colored arrows) of callers from a single bout known to be different individuals do not cluster together. Three calls recorded from different transects in the forest (white arrows) do not cluster with any of those recorded on Transect 2.

3

Table 3. Results of PCA analysis, showing the first two components and the original variables exhibiting eigenvectors >0.5.

Component	Eigenvalue	%Variance Explained	Correlated Variables	Eigenvector
1	3.09	44.09	Fomean	0.98
			Fomax	0.95
			Fomin	0.94
2	1.51	21.53	Pfmax	0.77
			Mean Syll Dur	0.67
			N Syllables	-0.67

DISCUSSION

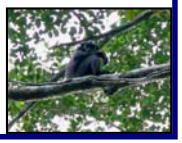
1 **Although it is not possible to determine the function of simakobu monkeys' loud calls from this pilot study, the high frequency of calling in the early morning as well as the high number of participants in these bouts (Figs. 1-2), suggest that dawn calls play an important role in communication between simakobu males. Calls produced at dawn also tend to have fewer syllables and to be shorter in duration than those produced at other times of day (Table 2). These results are consistent with the hypothesis that energy reserves are lowest at this time, making the calls more costly for males to produce. For listeners, this may be the best time to gain honest information about the condition and/or quality of signalers.**

2 **Simakobu monkeys produced loud calls of several repeated syllables, each with distinct 'huh' and 'hoo' elements. The 'huh's, presumably produced on exhalation[1], were louder, and were characterized by higher fundamental and peak frequencies; while the 'hoo's, likely produced on inhalation, were less loud and characterized by lower frequencies. Among calls analyzed, there was greater variance in frequency characteristics than in temporal ones, and this was particularly true for peak frequencies, suggesting that these parameters may have the most potential to convey information about individual identity.**

3 **The results of the multivariate analyses suggest that the acoustic parameters measured in this study can be used to discriminate between individual males (Fig. 4). After removing those variables that exhibited contextual differences, calls recorded from similar locations clustered together on the basis of their temporal and frequency characteristics, while those calls known to have been sampled from different individuals did not cluster with the others. In particular, differences in the fundamental frequency accounted for most of the variation in the dataset (Table 3). This parameter has been shown to vary with body size[13] and rank[5] in baboons, and thus, may reflect differences in quality between vocalizing males. This analysis suggests that eight different males were sampled, though this cannot be confirmed, as animals could only rarely be observed vocalizing. If these differences do reflect individual variation, as in other primates[13], loud calls may allow males to recognize one another over long distances. Such recognition may be adaptive for the males if they have differentiated relationships with their neighbors.**

FUTURE DIRECTIONS

This pilot study serves as the initial stage of dissertation work that aims to be the first long-term study of habituated groups of *Simias concolor* on Siberut. The results presented here provide hints to the function of loud calls in simakobu monkeys, but much remains to be learned. The first objective of continued work is to habituate these animals, so that calls can be recorded from closer distances and vocalizing animals can be observed and identified. Preliminary results suggest that some parameters measured here may reflect inter-individual variation, and increased sample sizes, individual identifications and improved recording quality will permit further investigation into these and other acoustic parameters that may allow animals to recognize one another.
The observation that dawn calls differ from those heard later in the day in syllable number and call duration, characteristics that could reflect energy availability, suggests that calling may bear some cost. Although it is yet unclear what these costs are, listeners could potentially assess a male's condition, quality and/or fighting ability by attending to his mode of delivery (e.g., syllable number and calling rate). Additional work will explore the relationship between variation in quality between males in the population, such as home range quality and female group size, together with variation in the acoustic features of their loud calls, such as measures of the fundamental frequency. Playback experiments to test the salience and importance of these features to both male and female listeners are planned. The main study will also explore the strategies used by males to defend and maintain access to a group of females, while considering the role of loud calls as signals to advertise competitive abilities.



REFERENCES

1. Tenaza RR 1989. Intergroup calls of male pig-tailed langurs (*Simias concolor*). Primates, 30:199–206.
2. Steenbeek, R, P Assink, SA Wich 1999. Tenure related changes in wild Thomas's langurs II: loud calls. Behaviour, 136: 627-650.
3. Fischer, J, DM Kitchen, RM Seyfarth, DL Cheney 2004. Baboon loud calls advertise male quality: acoustic features and their relation to rank, age, and exhaustion. Beh Ecol Soc, 56:140-48.
4. Fitch, WT 1997. Vocal tract length and formant frequency dispersion correlate with body size in rhesus macaques. J Acoust Soc Am, 102:1213-1222.
5. Kitchen, DM, RM Seyfarth, J Fischer, DL Cheney 2003. Loud calls as indicators of dominance in male baboons (*Papio cynocephalus ursinus*). Behav Ecol Soc, 53: 374-384.
6. Whitehead, JM 1988. The effect of the location of a simulated intruder on responses to long-distance vocalizations of mantled howling monkeys, *Alouatta palliata palliata*. Behavior, 73-103.
7. Waser, P M, CH Brown 1986. Habitat acoustics and primate communication. Am J Primatol, 10: 135-154.
8. Cowlishaw, G 1996. Sexual selection and information content in gibbon song bouts. Ethology, 102: 272-284.
9. Maynard Smith, J 1991. Honest signalling: the Philip Sydney game. Anim Behav, 42:1304-1305.
10. Gautier, JP, A Gautier 1977. Communication in Old World Monkeys. In: How Animals Communicate (Ed. TA Sebeok), Indiana Un. Press, Bloomington, pp. 890-964.
11. Rowe, N 1996. The Pictorial Guide to the Living Primates. Pogonias Press, East Hampton, New York, p. 205.
12. Waltert, M, C Abegg, T Ziegler, S Hadi, D Priata, K Hodges. Density and abundance of primates in the Peleonan Forest, N Siberut, Indonesia, submitted to Am J Primat.
13. Fischer J, K Hammerschmidt, DL Cheney, RM Seyfarth 2002. Acoustic features of male baboon loud calls: influences of context, age, and individuality J Acoust Soc Am, 111:1465–1474.

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