# Function and evolution of vibrato-like frequency modulation in mammals

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**Figure S1**

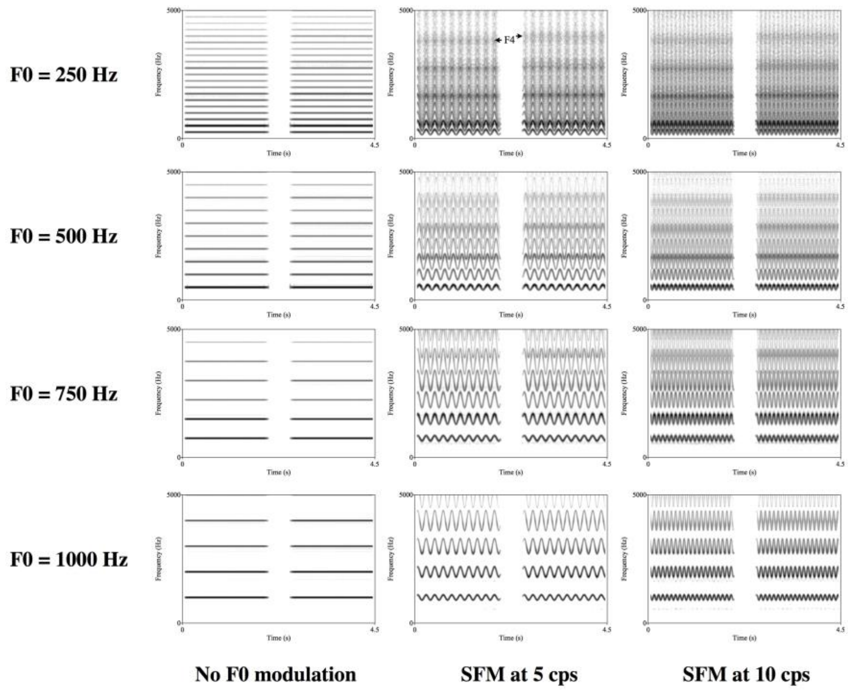


**Figure S1. Stimuli used in psychoacoustic tests.** The vocal stimuli were synthesised using scripts written by BDC that generated voice-like stimuli with or without SFM. Four different mean F0s (250, 500, 750 and 1000 Hz) and two levels of SFM rate (5 and 10 cycles per second) were presented to the participants. The stimuli were presented in pairs that had identical mean F0 and SFM cps, but either differed only in the value of the fourth formant (shifted up 3%, or down 3%, from its original value of 3850 Hz) or had exactly the same formant pattern. F4 denotes the position of the fourth formant, which has been shifted up 3% in all the stimuli presented. The mean F0 of the stimuli is given vertically and the level of F0 modulation is given the horizontally: cps = cycles per second. Also see Figure 2 in the main text.

**Figure S2**

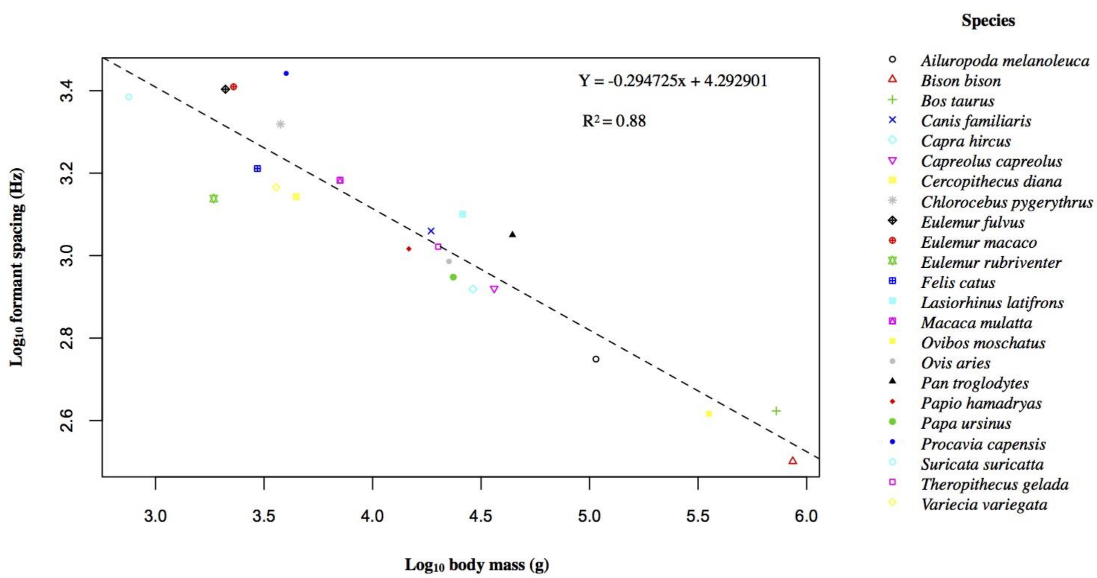


**Figure S2. Relationship between $\log_{10}$ formant spacing ($\Delta$F) and $\log_{10}$ body mass across 23 mammal species.** A non-phylogenetic Ordinary Least Squares (OLS) model without the species' typical habitat and social structure proved to be the best supported model (Table S5). The regression equation from this model was subsequently used to predict $\Delta$F.

**Table S1. Acoustic, morphological and ecological data for all mammal species in the dataset**

| Species | Call type | Habitat | Context | Body mass (g) | Mean F0 (Hz) | ΔF (Hz) | predΔF/F0 ratio | References for acoustic data | Source of weight data |
|---|---|---|---|---|---|---|---|---|---|
| *Ailuropoda melanoleuca* | SFM | Terrestrial | Contact promoting | 107000 | 366 | **561** | 1.77 | [S1] | [S1] |
| *Ailurus fulgens* | SFM | Terrestrial | Contact promoting | 5000 | 3046 | 1595 | 0.52 | [S2] | [S3] |
| *Alces alces* | Other | Terrestrial | Sexual | 573785 | 125 | 394 | 3.15 | [S4] | [S3] |
| *Alopex lagopus* | Other | Terrestrial | Territorial | 4261 | 1283 | 1672 | 1.30 | [S5] | [S3] |
| *Arctocephalus australis* | SFM | Terrestrial | Contact promoting | 51750 | 871 | 801 | 0.92 | [S6] | [S3] |
| *Ateles geoffroyi* | Other | Arboreal | Various | 7627 | 1509$^{\$}$ | 1408 | 0.93 | [S7] | [S7] |
| *Bison bison* | Other | Terrestrial | Sexual | 863410 | 55 | **317** | 6.32 | [S8] | [S8] |
| *Bos taurus* | Other | Terrestrial | Contact promoting | 725000 | 117 | **420** | 3.15 | [S9] | Wikipedia |
| *Brachyteles hypoxanthus* | Other | Arboreal | Contact promoting | 9000 | 1723 | 1341 | 0.78 | [S7] | [S7] |
| *Callithrix geoffroyi* | Other | Arboreal | Contact promoting | 307 | 7353 | 3630 | 0.49 | [S7] | [S7] |
| *Callithrix jacchus* | Other | Arboreal | Feeding | 269 | 6957 | 3774 | 0.54 | [S7] | [S7] |
| *Callithrix kuhlii* | Other | Arboreal | Feeding | 271 | 4853 | 3766 | 0.78 | [S7] | [S7] |
| *Callithrix pygmaea* | SFM | Arboreal | Contact promoting | 133 | 9831^ | 4645 | 0.47 | [S10] | [S3] |
| *Callorhinus ursinus* | SFM | Terrestrial | Contact promoting | 149333 | 250# | 586 | 4.21 | [S11] | [S3] |
| *Canis familiaris* | Other | Terrestrial | Aggression | 18603 | 133 | **1148** | 8.17 | [S12] | [S12] |
| *Canis latrans* | SFM | Terrestrial | Contact promoting | 12197 | 725^ | 1226 | 1.69 | [S13] | [S3] |
| *Canis lupus dingo* | Other | Terrestrial | Various | 35280 | 1950$^{\$}$ | 897 | 0.46 | [S14] | [S3] |
| *Capra hircus* | SFM | Terrestrial | Contact promoting | 45162 | 223 | **829** | 3.74 | [S15] | Wikipedia |
| *Capreolus capreolus* | Other | Terrestrial | Territorial | 36346 | 175 | **833** | 5.08 | [S16] | [S3] |
| *Cebus apella* | Other | Arboreal | Fear | 2929 | 1826 | 1867 | 1.02 | [S7] | [S7] |
| *Cebus capucinus* | SFM | Arboreal | Feeding | 3036 | 7546 | 1848 | 0.24 | [S17] | [S3] |
| *Cercocebus atys* | Other | Arboreal | Feeding | 10553 | 129 | 1280 | 9.96 | [S7] | [S7] |
| *Cercopithecus campbelli* | Other | Arboreal | Various | 3600 | 658$^{\$}$ | 1757 | 2.67 | [S7] | [S7] |
| *Cercopithecus diana* | SFM | Arboreal | Contact promoting | 4445 | 1500$^{\#}$ | **1390** | 1.10 | [S18] | [S3] |
| *Cercopithecus mitis* | Other | Arboreal | Various | 5187 | 835$^{\$}$ | 1578 | 1.89 | [S7] | [S7] |
| *Cercopithecus mona* | Other | Arboreal | Sexual | 4566 | 534 | 1638 | 3.07 | [S7] | [S7] |
| *Cervus nippon* | Other | Terrestrial | Various | 34583 | 940^ | 902 | 0.96 | [S19] | [S3] |
| *Chlorocebus pygerythrus* | Other | Terrestrial | Alarm | 3768 | 330 | **2083** | 5.25 | [S20] | [S3] |
| *Crocuta crocuta* | Other | Terrestrial | Feeding | 58167 | 547 | 774 | 1.41 | [S21] | [S3] |
| *Enhydra lutris* | Other | Terrestrial | Various | 25848 | 888$^{\$}$ | 983 | 1.11 | [S22] | [S3] |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Equus caballus* | SFM | Terrestrial | Contact promoting | 479350 | 399 | 416 | 1.04 | [S23] | [S23] |
| *Equus przewalskii* | Other | Terrestrial | Contact promoting | 270000 | 296 | 492 | 1.66 | [S24] | [S3] |
| *Erythrocebus patas* | Other | Terrestrial | Contact promoting | 9740 | 212 | 1310 | 6.20 | [S7] | [S7] |
| *Eulemur fulvus* | Other | Arboreal | Group coordination | 2100 | 566 | **2532** | 3.64 | [S25] | [S26] |
| *Eulemur macaco* | Other | Arboreal | Contact promoting | 2289 | 75 | **2567** | 26.77 | [S25] | [S3] |
| *Eulemur rubriventer* | Other | Arboreal | Contact promoting | 1854 | 52 | **1375** | 41.09 | [S27] | [S3] |
| *Felis catus* | Other | Terrestrial | Contact promoting | 2947 | 609 | **1626** | 3.06 | [S28] | [S3] |
| *Felis chaus* | Other | Terrestrial | Contact promoting | 7600 | 440 | 1410 | 3.20 | [S29] | [S29] |
| *Felis margarita* | Other | Terrestrial | Contact promoting | 3000 | 580 | 1854 | 3.20 | [S29] | [S29] |
| *Felis nigripes* | Other | Terrestrial | Contact promoting | 1550 | 320 | 2252 | 7.04 | [S29] | [S29] |
| *Felis silvestris lybica* | Other | Terrestrial | Contact promoting | 4500 | 356 | 1645 | 4.62 | [S29] | [S29] |
| *Felis silvestris ornata* | Other | Terrestrial | Contact promoting | 3300 | 245 | 1803 | 7.36 | [S29] | [S29] |
| *Felis silvestris silvestris* | Other | Terrestrial | Contact promoting | 6500 | 335 | 1476 | 4.41 | [S29] | [S29] |
| *Geomys breviceps* | SFM | Terrestrial | Sexual | 139 | 2090 | 4587 | 2.19 | [S30] | [S3] |
| *Gorilla gorilla* | Other | Terrestrial | Group coordination | 109909 | 264 | 641 | 2.43 | [S31] | [S3] |
| *Heterocephalus glaber* | Other | Terrestrial | Group coordination | 41 | 4100 | 6557 | 1.60 | [S32] | [S3] |
| *Homo sapiens* | Other | Terrestrial | Various | 71900 | 162$ | 727 | 4.48 | [S33] | [S33] |
| *Hydrochoerus hydrochaeris* | SFM | Terrestrial | Contact promoting | 48700 | 1945 | 815 | 0.42 | [S34] | [S3] |
| *Hylobates klossii* | Other | Arboreal | Sexual | 5792 | 811 | 1527 | 1.88 | [S7] | [S7] |
| *Hylobates lar* | Other | Arboreal | Sexual | 5457 | 968 | 1554 | 1.61 | [S7, 35] | [S3] |
| *Hylobates moloch* | Other | Arboreal | Sexual | 6120 | 951 | 1503 | 1.58 | [S7] | [S7] |
| *Hylobates muelleri* | Other | Arboreal | Sexual | 5847 | 839 | 1523 | 1.82 | [S7] | [S7] |
| *Hylobates pileatus* | Other | Arboreal | Sexual | 5495 | 778 | 1551 | 1.99 | [S7] | [S7] |
| *Indri indri* | Other | Arboreal | Sexual | 8896 | 637 | 1346 | 2.11 | [S36] | [S3] |
| *Lasiorhinus latifrons*** | Other | Terrestrial | Mild distress | 26000 | - | **1260** | - | [S37] | [S3] |
| *Lemur catta* | Other | Arboreal | Group coordination | 2549 | 626 | 1945 | 3.11 | [S38] | [S3] |
| *Lycaon pictus* | SFM | Terrestrial | Greeting call | 20643 | 1526 | 1050 | 0.69 | [S39] | [S3] |
| *Macaca fascicularis* | Other | Terrestrial | Sexual | 4369 | 179 | 1660 | 9.27 | [S7] | [S7] |
| *Macaca fuscata* | Other | Terrestrial | Contact promoting | 10342 | 763 | 1287 | 1.69 | [S7] | [S7] |
| *Macaca mulatta* | Other | Terrestrial | Contact promoting | 7086 | 215 | **1524** | 6.71 | [S7] | [S7] |
| *Marmota flaviventris* | Other | Terrestrial | Alarm | 3967 | 1302 | 1707 | 1.31 | [S40] | [S3] |
| *Meles meles* | Other | Terrestrial | Various | 11869 | 348*$ | 1236 | 3.55 | [S41] | [S3] |
| *Mesocricetus auratus* | Other | Terrestrial | Sexual | 97 | 36150 | 5095 | 0.14 | [S42] | [S3] |
| *Microcebus murinus* | SFM | Arboreal | Sexual | 78 | 19200 | 5436 | 0.28 | [S43] | [S43] |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Microcebus rufus* | Other | Arboreal | Sexual | 43 | 21800^ | 6479 | 0.30 | [S44] | [S26] |
| *Mungos mungo* | SFM | Terrestrial | Alarm | 1364 | 2000[#] | 2339 | 1.86 | [S45] | [S3] |
| *Mus musculus* | Other | Terrestrial | Sexual | 20 | 62338 | 8145 | 0.13 | [S46] | [S3] |
| *Nasalis larvatus* | Other | Arboreal | Aggression | 14659 | 136 | 1162 | 8.57 | [S7] | [S7] |
| *Neophoca cinerea* | SFM | Terrestrial | Contact promoting | 170275 | 534 | 564 | 1.06 | [S47] | [S3] |
| *Odobenus rosmarus* | Other | Terrestrial | Contact promoting | 828000 | 118 | 354 | 3.00 | [S48] | [S3] |
| *Odocoileus virginianus* | Other | Terrestrial | Sexual | 88914 | 209 | 683 | 3.27 | [S4] | [S3] |
| *Ovibos moschatus* | Other | Terrestrial | Aggression | 354884 | 92 | **414** | 4.96 | [S49] | [S3] |
| *Ovis aries* | SFM | Terrestrial | Contact promoting | 22500 | 181 | **968** | 5.67 | [S50] | [S3] |
| *Pan troglodytes* | Other | Terrestrial | Various | 44127 | 247[$] | **1122** | 3.40 | [S7] | [S7] |
| *Papio hamadryas* | Other | Terrestrial | Contact promoting | 14699 | 72 | **1039** | 16.14 | [S51] | [S3] |
| *Papio ursinus* | Other | Terrestrial | Group coordination | 23550 | 84 | **887** | 12.10 | [S52] | [S52] |
| *Phodopus sungorus* | Other | Terrestrial | Aggression | 32 | 58925 | 7068 | 0.12 | [S53] | [S3] |
| *Pongo pygmaeus* | Other | Arboreal | Alarm | 56882 | 46 | 779 | 16.93 | [S7] | [S7] |
| *Procavia capensis* | Other | Terrestrial | Sexual | 4000 | 1280 | **2766** | 1.33 | [S54] | [S3] |
| *Propithecus diadema* | Other | Arboreal | Contact promoting | 6230 | 1229 | 1495 | 1.22 | [S55] | [S3] |
| *Pteronotus parnellii* | Other | Terrestrial | Navigation | 12 | 63500 | 9437 | 0.15 | [S56] | [S56] |
| *Pteronura brasiliensis* | SFM | Terrestrial | Aggression | 26000 | 347 | 981 | 2.83 | [S57] | [S3] |
| *Pteropus poliocephalus* | SFM | Arboreal | Contact promoting | 719 | 3000 | 2825 | 0.94 | [S58] | [S3] |
| *Rattus rattus* | Other | Terrestrial | Contact promoting | 275 | 2500 | 3749 | 1.50 | [S59] | [S59] |
| *Saguinus oedipus* | Other | Arboreal | Contact promoting | 456 | 1856 | 3230 | 1.74 | [S7] | [S7] |
| *Saimiri sciureus* | SFM | Terrestrial | Contact promoting | 760 | 7500^ | 2779 | 0.37 | [S60] | [S3] |
| *Suricata suricatta* | Other | Terrestrial | Contact promoting | 753 | 556 | **2427** | 4.96 | [S61] | [S3] |
| *Sus scrofa* | Other | Terrestrial | Various | 95700 | 133[$] | 668 | 5.01 | [S62] | [S62] |
| *Tamias striatus* | SFM | Terrestrial | Alarm | 104 | 7000 | 498 | 0.71 | [S63] | [S3] |
| *Theropithecus gelada* | Other | Terrestrial | Sexual | 20075 | 111 | **1051** | 9.54 | [S64] | [S3] |
| *Tupaia belangeri* | Other | Terrestrial | Various | 200 | 3343^ | 4118 | 1.23 | [S65] | [S3] |
| *Varecia variegata* | Other | Arboreal | Group coordination | 3600 | 222 | **1464** | 7.91 | [S66] | [S3] |
| *Vulpes vulpes* | Other | Terrestrial | Various | 5077 | 748[$] | 1588 | 2.12 | [S67] | [S3] |

** the southern hairy-nosed wombat (*Lasiorhinus latifrons*) was used in the formant model but does not have a measureable F0 in its "harsh cough" vocalizations. **ΔF** = derived from published data, normal font = ΔF predicted from body mass using the formant model (Figure S2). Data on species habitat were taken from the Encyclopedia of Life website (http://eol.org/). Data on species social structure were taken from the Animal Diversity Website (http://animaldiversity.org/). $Average F0 from vocal repertoire. ^ F0 calculated as the mid point between reported minimum and maximum values. #F0 values measured from a published spectrogram using a clear ruler to extrapolate from the axes. Also see Figure 3 in the main text.

**Table S2. Results from the ten best supported PGLS regression models fitted to explain variance in $\log_{10}$ harmonics to formants ratio with call type across 92 mammal species.**

| Model | (Intercept) | Call type | Habitat | $\log_{10}$ male body mass | Social structure | df | logLik | AICc | Delta | Weights |
|---|---|---|---|---|---|---|---|---|---|---|
| BM + λ | -0.34 | + | - | 0.16 | - | 5.00 | -44.40 | 99.50 | 0.00 | 0.32 |
| BM + λ | 0.20 | + | - | - | - | 4.00 | -45.93 | 100.32 | 0.81 | 0.21 |
| BM + λ | -0.39 | + | - | 0.16 | + | 6.00 | -45.03 | 103.04 | 3.54 | 0.05 |
| BM + λ | 0.18 | + | - | - | + | 5.00 | -46.73 | 104.16 | 4.66 | 0.03 |
| BM + λ | -0.42 | + | + | 0.15 | - | 7.00 | -44.73 | 104.80 | 5.30 | 0.02 |
| BM + λ | 0.06 | + | + | - | - | 6.00 | -45.94 | 104.86 | 5.36 | 0.02 |
| BM + ρ | -0.33 | + | - | 0.17 | - | 5.00 | -48.66 | 108.03 | 0.05 | 0.28 |
| BM + λ | -0.46 | + | + | 0.16 | + | 8.00 | -45.51 | 108.75 | 9.25 | 0.00 |
| BM + λ | 0.04 | + | + | - | + | 7.00 | -46.80 | 108.93 | 9.43 | 0.00 |
| BM + ρ | 0.27 | + | - | - | - | 4.00 | -50.82 | 110.11 | 2.13 | 0.10 |

The PGLS regression models are ordered by AICc value so that the best supported model (with the lowest AICc value) is first in the list. "+" denotes factor included in the model and statistically significant independent variables are indicated with asterisks (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). BM + λ = Brownian motion + Pagel's lambda model, BM + ρ = Brownian motion + Grafen's rho model.

**Table S3. Acoustic measures for SFM calls**. Data on mean F0 and F0 modulation extent were taken from the same source. Also see Figure 3 in the main text.

| Species | Context | Mean F0 (Hz) | F0 modulation extent (Hz) | % F0 modulation | pred∆F/F0 ratio | Source of recordings | N | SFM acoustics |
|---|---|---|---|---|---|---|---|---|
| *Ailuropoda melanoleuca* | Contact promoting | 365 | 101 | 28 | 1.54 | | 245 | [S1] |
| *Ailurus fulgens* | Contact promoting | 1450 | 442 | 30 | 1.1 | CS, AT | 6 | Data not available |
| *Arctocephalus australis* | Contact promoting | 871 | 353 | 41 | 0.92 | | 276 | [S6] |
| *Callithrix pygmaea* | Contact promoting | 9831 | 3264 | 33 | 0.47 | | 12 | [S10] |
| *Callorhinus ursinus* | Contact promoting | 139 | 40 | 29 | 4.21 | ML | 20 | Data not available |
| *Canis latrans* | Contact promoting | 778 | 271 | 35 | 1.58 | AT, ASA | 15 | Data not available |
| *Capra hircus* | Contact promoting | 223 | 49 | 22 | 3.72 | | 88 | [S15] |
| *Cebus capucinus* | Feeding | 6163 | 2258 | 37 | 0.3 | AT | 5 | Data not available |
| *Cercopithecus diana* | Contact promoting | 1163 | 312 | 27 | 1.2 | ASA | 13 | Data not available |
| *Equus caballus* | Contact promoting | 494 | 126 | 26 | 0.84 | AT | 7 | Data not available |
| *Geomys breviceps* | Sexual | 2090 | 966 | 46 | 2.19 | | 30 | [S30] |
| *Hydrochoerus hydrochaeris* | Contact promoting | 1495 | 1007 | 67 | 0.55 | CW | 13 | Data not available |
| *Lycaon pictus* | Greeting call | 1506 | 579 | 38 | 0.7 | ASA | 8 | Data not available |
| *Microcebus murinus* | Sexual | 22000 | 12050 | 55 | 0.25 | | 138 | [S43] |
| *Mungos mungo* | Alarm | 1260 | 611 | 48 | 1.86 | ASA | 11 | Data not available |
| *Neophoca cinerea* | Contact promoting | 534 | 180 | 34 | 1.06 | | 61 | [S47] |
| *Ovis aries* | Contact promoting | 256 | 28 | 11 | 3.79 | AT | 16 | Data not available |
| *Pteronura brasiliensis* | Aggression | 300 | 55 | 18 | 3.27 | ML | 3 | Data not available |
| *Pteropus poliocephalus* | Contact promoting | 3000 | 2000 | 67 | 0.94 | | 27 | [S58] |
| *Saimiri sciureus* | Contact promoting | 2689 | 1006 | 37 | 1.03 | ASA | 5 | Data not available |
| *Tamias striatus* | Alarm | 1211 | 435 | 36 | 4.12 | AT | 8 | Data not available |

CS = Cao et al 2016 Anim. Biol. 66, 145-155 supplementary material
AT = Animal Trax audio CD (Hollywood Edge, CA, USA)
ASA = Berlin Animal Sound Archive (http://www.animalsoundarchive.org/tsa/content_16_en.html)
ML = Macaulay Library (https://www.macaulaylibrary.org/)
CW = Capybara World website (https://capybaraworld.wordpress.com/)

**Table S4. Results from the ten best supported PGLS regression models fitted to explain variance in $log_{10}$ harmonics to formants ratio with % F0 modulation in SFM calls across 21 mammal species.**

| Model | (Intercept) | $Log_{10}$ harmonics to formant ratio | $Log_{10}$ male body mass | Social structure | Habitat | df | logLik | AICc | Delta | Weights |
|---|---|---|---|---|---|---|---|---|---|---|
| BM | 56.11 | + | -3.05 | -13.25 | + | 6.00 | -64.04 | 146.09 | 0.00 | 0.33 |
| BM | 46.74 | + | - | -12.53 | + | 5.00 | -66.58 | 147.16 | 1.07 | 0.19 |
| BM | 57.34 | - | -4.16 | -14.30 | + | 5.00 | -66.71 | 147.43 | 1.34 | 0.17 |
| BM | 53.63 | + | -2.64 | -13.49 | - | 5.00 | -67.08 | 148.17 | 2.08 | 0.12 |
| BM + λ | 55.77 | + | -2.88 | -11.92 | + | 7.00 | -63.28 | 149.18 | 0.00 | 0.34 |
| BM | 45.88 | + | - | -12.77 | - | 4.00 | -69.48 | 149.47 | 3.38 | 0.06 |
| BM | 54.89 | - | -3.74 | -14.52 | - | 4.00 | -69.74 | 149.97 | 3.88 | 0.05 |
| BM + ρ | 48.95 | + | - | -17.99 | + | 6.00 | -65.99 | 149.98 | 0.00 | 0.34 |
| BM + λ | 58.16 | - | -4.38 | -12.84 | + | 6.00 | -65.99 | 149.98 | 0.80 | 0.23 |
| BM | 42.18 | - | - | -14.21 | + | 4.00 | -69.80 | 150.11 | 4.02 | 0.04 |

The PGLS regression models are ordered by AICc value so that the best supported model (with the lowest AICc value) is first in the list. "+" denotes factor included in the model and statistically significant independent variables are indicated with asterisks (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). BM = pure Brownian motion model, BM + λ = Brownian motion + Pagel's lambda model, BM + ρ = Brownian motion + Grafen's rho model.

**Table S5. Results from the ten best supported PGLS regression models fitted to explain variance in $\log_{10}$ formant spacing with $\log_{10}$ body mass across 23 mammal species.**

| Model | (Intercept) | $\mathrm{Log}_{10}$ male body mass | Social structure | Habitat | df | logLik | AICc | Delta | Weights |
|---|---|---|---|---|---|---|---|---|---|
| OLS | 4.29 | -0.29 | - | - | 3.00 | 17.51 | -27.76 | 0.00 | 0.90 |
| BM + $\lambda$ | 4.38 | -0.31 | - | - | 4.00 | 18.10 | -25.98 | 0.00 | 0.88 |
| BM + $\rho$ | 4.29 | -0.29 | - | - | 4.00 | 17.64 | -25.06 | 0.00 | 0.91 |
| OU | 4.29 | -0.29 | - | - | 4.00 | 17.51 | -24.80 | 0.00 | 0.92 |
| OLS | 4.28 | -0.29 | + | - | 4.00 | 16.34 | -22.45 | 5.31 | 0.06 |
| BM + $\lambda$ | 4.26 | -0.29 | - | + | 5.00 | 17.25 | -20.96 | 5.02 | 0.07 |
| OLS | 4.30 | -0.30 | - | + | 4.00 | 15.57 | -20.91 | 6.85 | 0.03 |
| BM + $\lambda$ | 4.36 | -0.31 | + | - | 5.00 | 16.95 | -20.37 | 5.61 | 0.05 |
| BM + $\rho$ | 4.27 | -0.28 | + | - | 5.00 | 16.47 | -19.41 | 5.65 | 0.05 |
| OU | 4.28 | -0.29 | + | - | 5.00 | 16.34 | -19.14 | 5.65 | 0.05 |

The PGLS regression models are ordered by AICc value so that the best supported model (with the lowest AICc value) is first in the list. "+" denotes factor included in the model and statistically significant independent variables are indicated with asterisks (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). OLS = non-phylogenetic (ordinary least squares) model, BM + $\lambda$ = Brownian motion + Pagel's lambda model, OU = Ornstein-Uhlenbeck model. BM + $\rho$ = Brownian motion + Grafen's rho model.

## Supplemental references


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