

Supplementary materials for

Encoding of Arousal and Physical Characteristics in Audible and Ultrasonic Vocalizations of Mongolian Gerbil Pups Testing Common Rules for Mammals

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Correlation plots and Pearson correlation coefficients (R) between the acoustic parameters of all calls.



Figure S2.

Plot showing the optimum number of clusters based on the Elbow figure produced by the Silhouette method (general unsupervised clustering; K-means model).

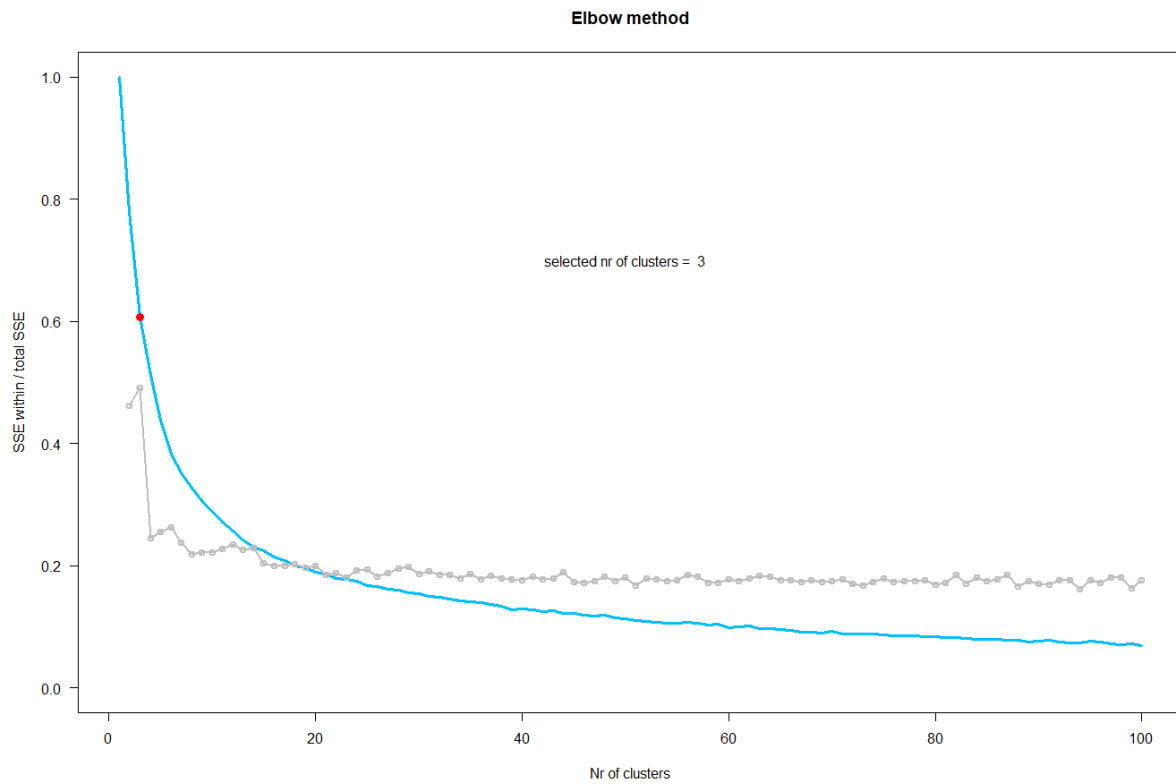


Figure S3.

Boxplots for (A) USV rate, (B) ADV and (C) USV-ADV rate for pups which produced the respective call type in each Age group. Boxplots represent lower and upper quartile, thick black line is the median, whiskers are non-outlier range, yellow dots represent number of vocalizations plotted as a beeswarm.

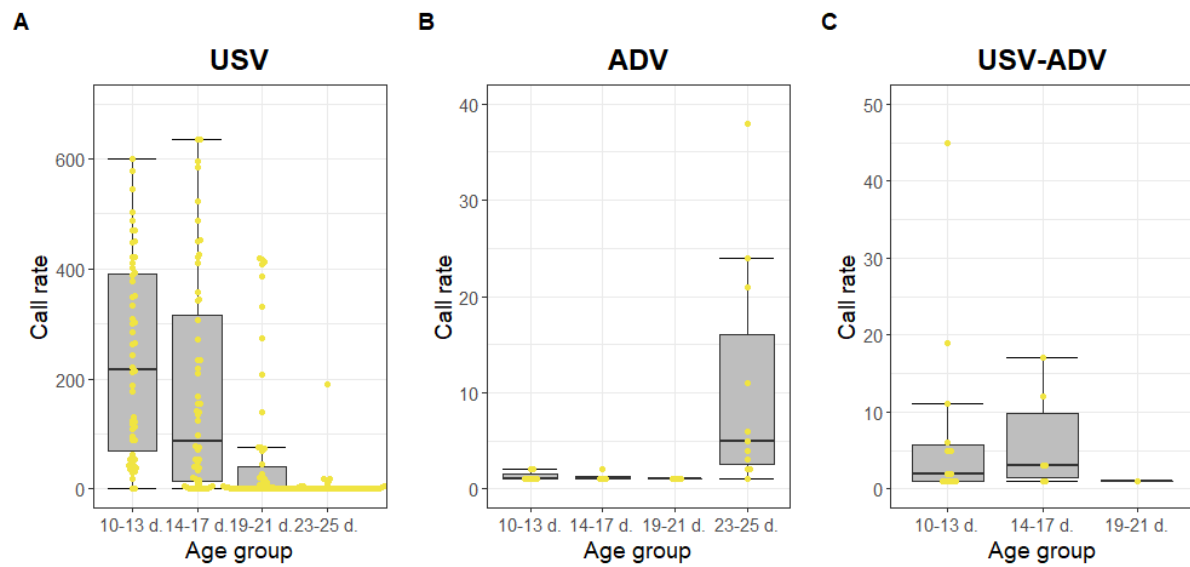


Table S1.

Results of the LME models testing the effect of Arousal on USV acoustic parameters; df = 653, SE: standard error; Bold: $p < 0.05$

Parameter	Estimate	SE	t-value	p-value
Time-related parameters				
Duration	8.14	2.28	3.57	<0.001
TimeminF0	2.26	0.92	2.46	0.014
TimemaxF0	3.88	2.24	1.73	0.084
Source-related parameters				
MinF0	-1.13	0.22	-5.07	<0.001
MaxF0	-1.61	0.33	-4.91	<0.001
BandF0	-0.44	0.32	-1.40	0.161
MeanF0	-1.08	0.21	-5.13	<0.001
SDF0	-0.25	0.09	-2.80	0.005
SlopeF0	14.04	12.17	1.15	0.249
Filter-related parameters				
CoG	-1.05	0.21	-4.97	<0.001
SD	0.39	0.15	2.57	0.011
Ske	0.53	0.19	2.85	0.005
Kur	-5.66	3.74	-1.51	0.131
Tonality-related parameters				
Voiced	0.50	0.51	0.97	0.332
Hnr	-2.69	1.12	-2.42	0.016
Entropy	0.03	0.01	2.87	0.004

Table S2

Results of the LME models testing the effect of Body weight on USV and ADV acoustic parameters.
SE: standard error; Bold: $p < 0.05$

	USV (df = 653)				ADV (df = 47)			
Parameter	Estimate	SE	t-value	p-value	Estimate	SE	t-value	p-value
Time-related parameters								
Duration	-4.25	0.52	-8.12	<0.001	4.80	1.99	2.41	0.020
TimeminF0	0.01	0.21	0.03	0.976	4.31	1.91	2.26	0.029
TimemaxF0	-4.40	0.51	-8.60	<0.001	0.57	0.68	0.84	0.408
Source-related parameters								
MinF0	-0.59	0.05	-12.53	<0.001	-0.04	0.07	-0.57	0.574
MaxF0	-0.44	0.08	-5.60	<0.001	0.14	0.11	1.29	0.204
BandF0	0.09	0.07	1.26	0.209	0.19	0.11	1.77	0.083
MeanF0	-0.55	0.05	-11.33	<0.001	0.03	0.08	0.39	0.697
SDF0	0.05	0.02	2.31	0.021	0.06	0.03	1.68	0.099
SlopeF0	38.99	2.53	15.39	<0.001	-2.49	1.89	-1.32	0.195
Filter-related parameters								
CoG	-0.35	0.05	-6.77	<0.001	-0.01	0.13	-0.09	0.928
SD	0.15	0.04	4.23	<0.001	-0.04	0.06	-0.60	0.550
Ske	-0.09	0.04	-2.11	0.035	-0.04	0.05	-0.78	0.437
Kur	-0.90	0.89	-1.01	0.311	-0.15	0.65	-0.24	0.812
Tonality-related parameters								
Voiced	0.15	0.11	1.32	0.187	-1.59	0.53	-2.98	0.005
Hnr	0.13	0.27	0.47	0.638	-0.24	0.76	-0.32	0.750
Entropy	0.00	0.00	1.09	0.277	0.00	0.00	1.33	0.191

Table S3.

Results of the LME models testing effects for Age group on acoustic parameters of USVs and ADVs. For USVs results of the Anova of the LME model are represented comparing Age group 10-13 d., 14-17 d. and 19-21 d. For ADVs results of the LME model are represented comparing the combined Age groups 10-21 d. with Age group 23-25 d. If the predictor had more than two levels, we reported the results of the ANOVA of the model. If the predictor had only two levels, we reported the estimates and standard error together with the results of the t-test. SE: standard error; Bold: $p < 0.05$

	USV (df = 2)		ADV (df = 47)			
Parameter	χ^2	p-value	Estimate	SE	t-value	p-value
Time-related parameters						
Duration	130.04	<0.001	67.16	23.07	2.91	0.006
TimeminF0	2.17	0.338	60.42	22.45	2.69	0.010
TimemaxF0	161.27	<0.001	11.38	9.49	1.25	0.219
Source-related parameters						
MinF0	50.54	<0.001	0.03	0.73	0.04	0.967
MaxF0	60.52	<0.001	3.88	1.34	2.88	0.006
BandF0	44.32	<0.001	3.76	1.35	2.79	0.008
MeanF0	122.06	<0.001	1.63	0.94	1.74	0.088
SDF0	40.42	<0.001	0.92	0.44	2.06	0.045
SlopeF0	219.48	<0.001	-23.85	21.34	-1.12	0.269
Filter-related parameters						
CoG	70.30	<0.001	1.52	1.57	0.97	0.337
SD	0.99	0.608	0.81	0.92	0.88	0.384
Ske	7.59	0.022	-1.32	0.53	-2.48	0.017
Kur	0.82	0.663	-1.20	5.67	-0.21	0.833
Tonality-related parameters						
Voiced	19.58	<0.001	-16.51	7.17	-2.30	0.026
Hnr	12.61	0.002	-1.45	5.53	-0.26	0.794
Entropy	2.70	0.259	0.01	0.01	0.85	0.398

Table S4.

Results of the LME models testing the effect of Individual on USV and ADV acoustic parameters. SE: standard error; Bold: $p < 0.05$

	USV (df = 25)		ADV (df = 12)	
Parameter	χ^2	p-value	χ^2	p-value
Time-related parameters				
Duration	235.32	<0.001	66.67	<0.001
TimeminF0	92.11	<0.001	61.62	<0.001
TimemaxF0	276.12	<0.001	21.26	0.047
Source-related parameters				
MinF0	384.13	<0.001	80.42	<0.001
MaxF0	463.74	<0.001	26.78	0.008
BandF0	245.66	<0.001	31.27	0.002
MeanF0	668.63	<0.001	39.74	<0.001
SDF0	255.46	<0.001	34.93	<0.001
SlopeF0	304.50	<0.001	84.94	<0.001
Filter-related parameters				
CoG	726.77	<0.001	39.71	<0.001
SD	492.55	<0.001	22.62	0.031
Ske	290.34	<0.001	47.65	<0.001
Kur	239.05	<0.001	111.72	<0.001
Tonality-related parameters				
Voiced	114.42	<0.001	37.65	<0.001
Hnr	195.61	<0.001	258.49	<0.001
Entropy	366.30	<0.001	36.83	<0.001

Table S5.

Results of the LME models testing the effect of Sex on USV and ADV acoustic parameters. SE: standard error; Bold: $p < 0.05$

	USV (df = 18)				ADV (df = 6)			
Parameter	Estimate	SE	t-value	p-value	Estimate	SE	t-value	p-value
Time-related parameters								
Duration	8.75	5.21	1.68	0.110	-18.11	29.68	-0.61	0.564
TimeminF0	-0.29	1.67	-0.17	0.864	-14.78	28.00	-0.53	0.616
TimemaxF0	9.37	5.19	1.81	0.088	-17.10	6.94	-2.46	0.049
Source-related parameters								
MinF0	-0.42	0.54	-0.77	0.452	-2.25	0.57	-3.99	0.007
MaxF0	1.30	1.03	1.26	0.223	-1.73	1.45	-1.19	0.278
BandF0	1.82	0.78	2.32	0.032	0.04	1.56	0.26	0.805
MeanF0	0.45	0.82	0.55	0.591	-2.46	0.78	-3.15	0.020
SDF0	0.48	0.23	2.10	0.050	0.31	0.48	0.63	0.550
SlopeF0	54.02	28.59	1.89	0.075	25.87	25.29	1.02	0.346
Filter-related parameters								
CoG	0.51	0.89	0.58	0.571	-4.74	0.96	-4.93	0.003
SD	-0.13	0.44	-0.29	0.773	-1.38	0.71	-1.96	0.098
Ske	-0.82	0.54	-1.51	0.148	0.89	0.42	2.10	0.080
Kur	-12.54	9.43	-1.33	0.200	-4.40	9.61	-0.46	0.663
Tonality-related parameters								
Voiced	1.00	0.95	1.05	0.308	-3.00	6.12	-0.49	0.641
Hnr	2.39	2.46	0.97	0.344	-20.82	12.62	-1.65	0.150
Entropy	-0.03	0.03	-0.79	0.442	0.01	0.01	0.42	0.691