Supplemental Information

Artoo-Detoo: What imitating a Star Wars droid reveals on allospecific vocal imitation in parrots and starlings

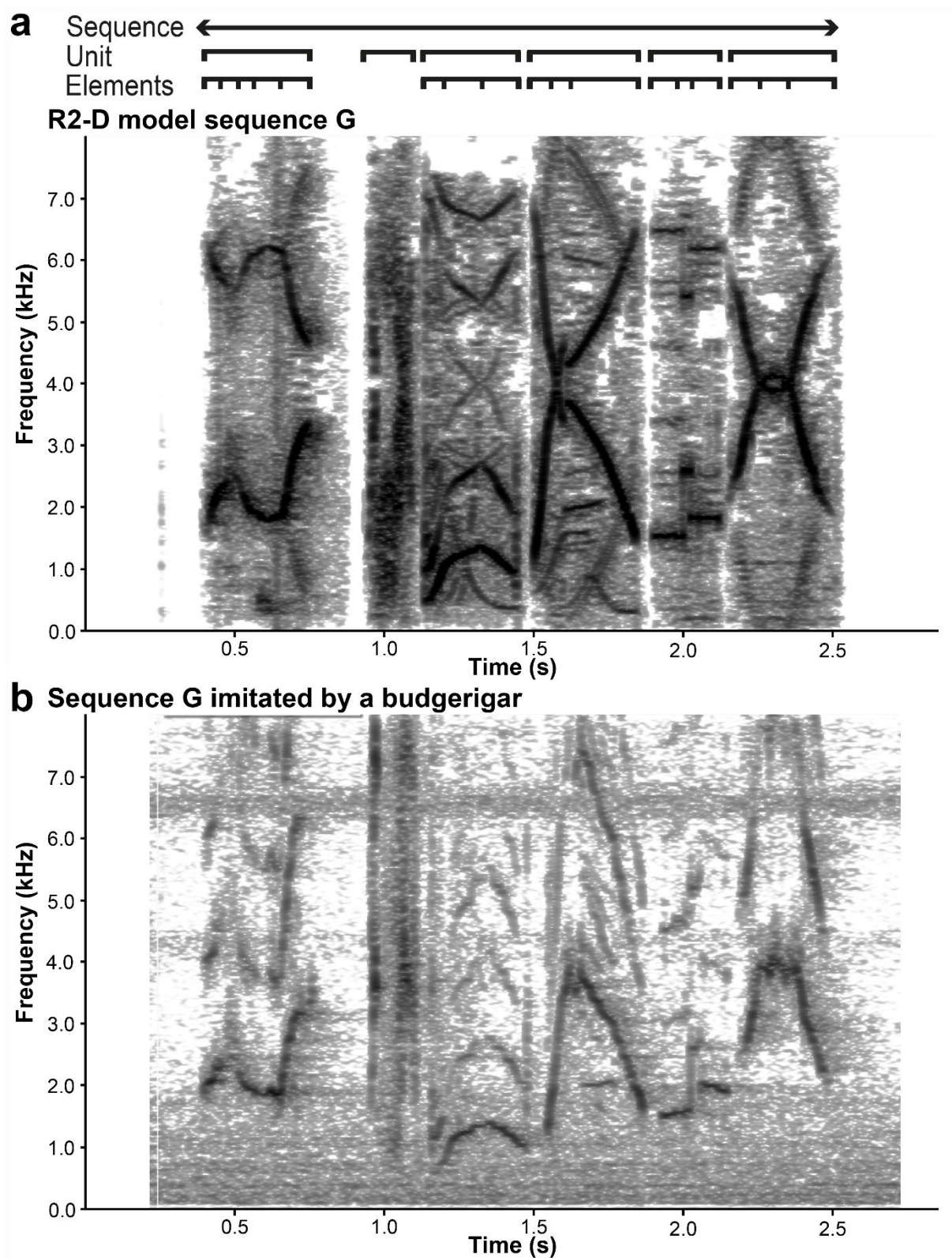Nick C.P. Dam, Henkjan Honing, Michelle J. Spierings

Fig. S1 Birds imitated R2-D2 sequences in the same order as the original model sounds. a) Example of the original R2-D2 sequence "G". R2-D2 model sounds are always produced in sequences that consist of units which are made up of one or more elements. b) A budgerigar imitating sequence "G" in the exact same order as the original sounds even though the mirrored spectral contour is missing.
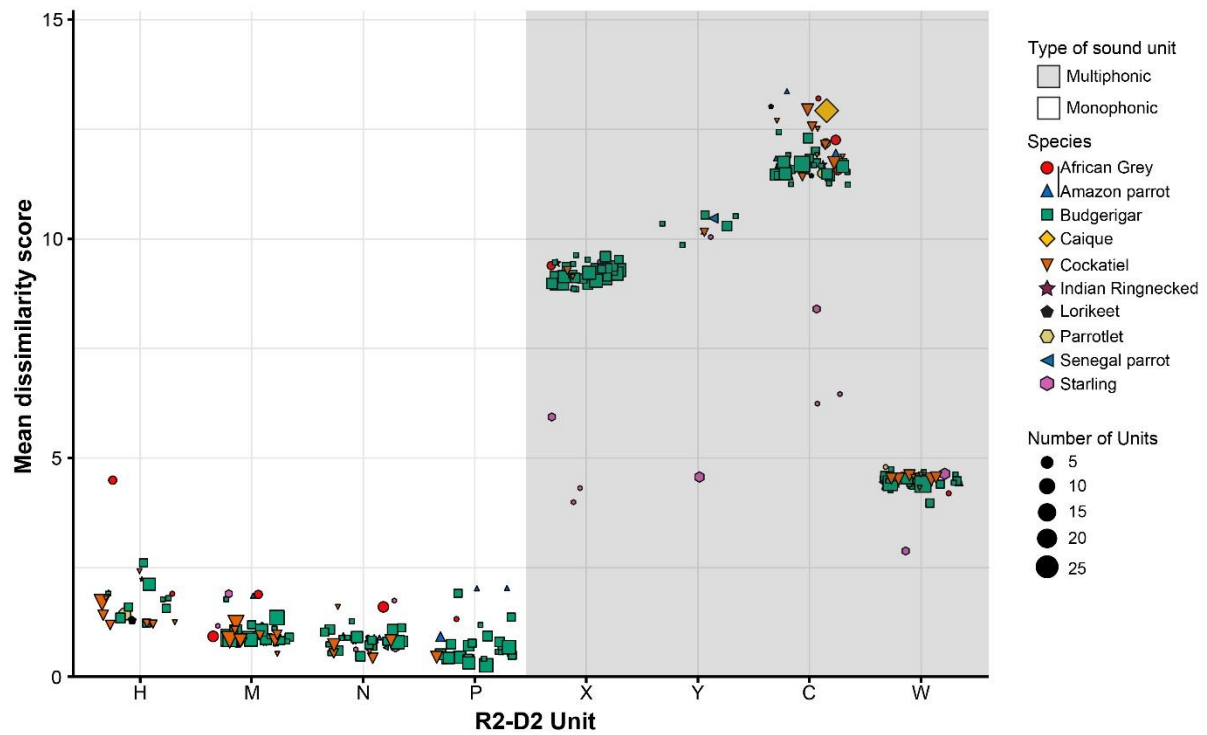
Fig. S2 Imitation accuracy of R2-D2 units varied between individuals within species**.** Mean dissimilarity scores per unit for each individual are shown. Dissimilarity scores varied between each unit but also within each species. Colors and shapes indicate the different species. Scores in the white and grey background correspond to monophonic and multiphonic units, respectively. Sizes of dots are related to the number of imitated units per individual.
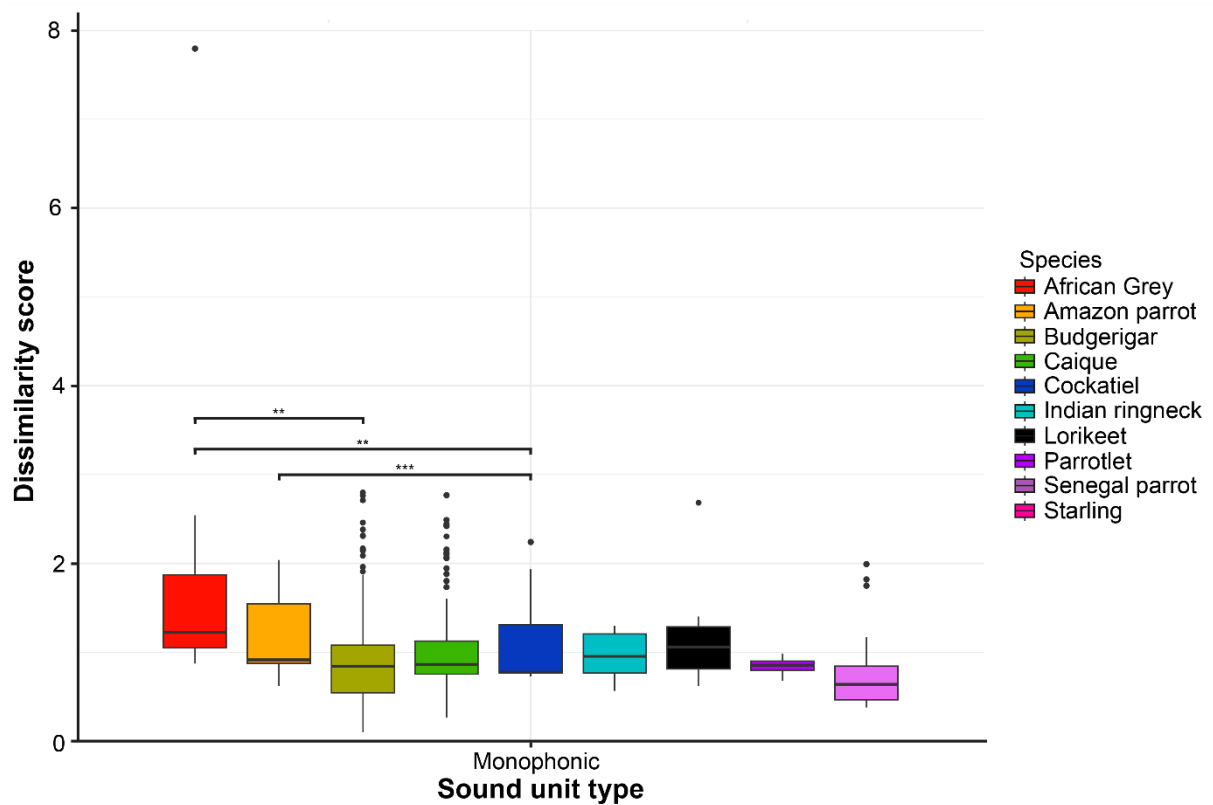
Fig. S3 Parrots and starlings vary in how accurately they imitate monophonic units. Medians, inter-quartile ranges as well as minima and maxima are represented by horizontal lines, boxes and whiskers, respectively. Dissimilarity scores were combined for all monophonic and all multiphonic units separately. Colors correspond to dissimilarity scores for each species. Stars indicate significance levels (** P < 0.01, *** P < 0.001).

Table S1 Spectral-temporal weightings for dynamic time warping in Luscinia

Spectral-temporal parameter	Weighting
Time	5
Peak frequency	1
Fundamental frequency	1
Peak frequency change	0.25
Fundamental frequency change	0.25
Gap between elements	0.5
Peak frequency normalized	1
Fundamental frequency normalized	1
Frequency bandwidth[a]	0.25

[a] Only used for unit "C" due to complexity of the unit

Table S2 Results Linear Mixed Model

Fixed effect	Estimate	SE	Min. estimate	Max. estimate	T-value	P-value
Intercept	0.057	0.080	-0.1000	0.214	0.708	0.481
Starling: Starling	0.469	0.327	-0.170	1.108	1.433	0.154
Type: Multiphonic	0.141	0.066	0.012	0.269	2.140	**0.033**
Starling*Multiphonic	-3.240	0.293	-3.815	-2.648	-11.042	**< 0.001**

Table S3 Result of Post-Hoc test

Fixed effect	Estimate	SE	Min. estimate	Max. estimate	T-value	P-value
No-starling Monophonic – Starling Monophonic	-0.469	0.328	-1.318	0.380	-1.431	0.482
No-starling Monophonic – No-starling Multiphonic	-0.141	0.066	-0.310	0.029	-2.136	0.143
No-starling Monophonic – Starling Multiphonic	2.630	0.284	1.892	3.369	9.271	**< 0.001**
Starling Monophonic – No-starling Multiphonic	0.328	0.328	-0.521	1.178	1.001	0.749
Starling Monophonic – Starling Multiphonic	3.099	0.286	2.362	3.837	10.820	**< 0.001**
No-starling Multiphonic – Starling Multiphonic	2.771	0.284	2.032	3.510	9.759	**< 0.001**