

Quantifying song categories in Adelaide's Warbler (*Setophaga adelaidae*)

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Online supplementary material

Song Structure models

Song duration

lmer (Duration ~ Cluster + (1|Bird) + (1|Bird:Day)+(1|Song type within bird))

Number of notes

lmer (No. of notes ~ Cluster + (1|Bird) + (1|Bird:Day)+(1|Song type within bird))

Trill rate

lmer (Trill rate ~ Cluster + (1|Bird) + (1|Bird:Day)+(1|Song type within bird))

Frequency excursion (FEX)

lmer (FEX ~ Cluster + (1|Bird) + (1|Bird:Day)+(1|Song type within bird))

Bandwidth

lmer (Bandwidth ~ Cluster + (1|Bird) + (1|Bird:Day)+(1|Song type within bird))

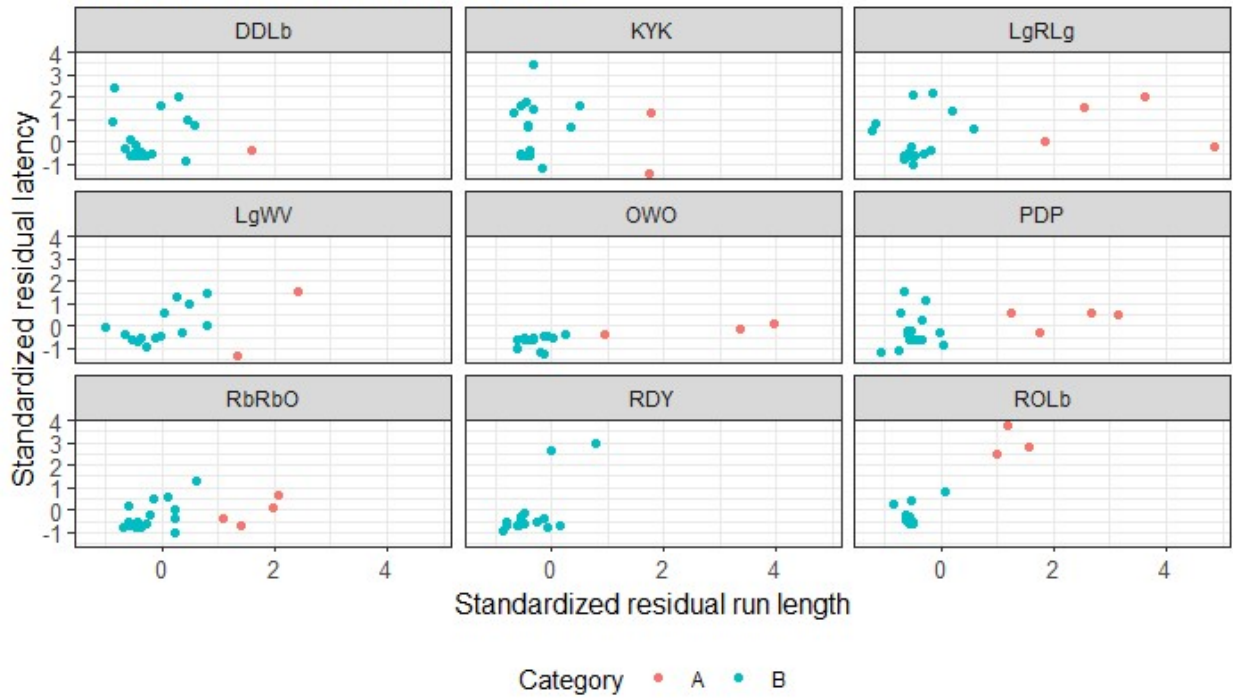
Minimum frequency

lmer (FMin ~ Cluster + (1|Bird) + (1|Bird:Day)+(1|Song type within bird))

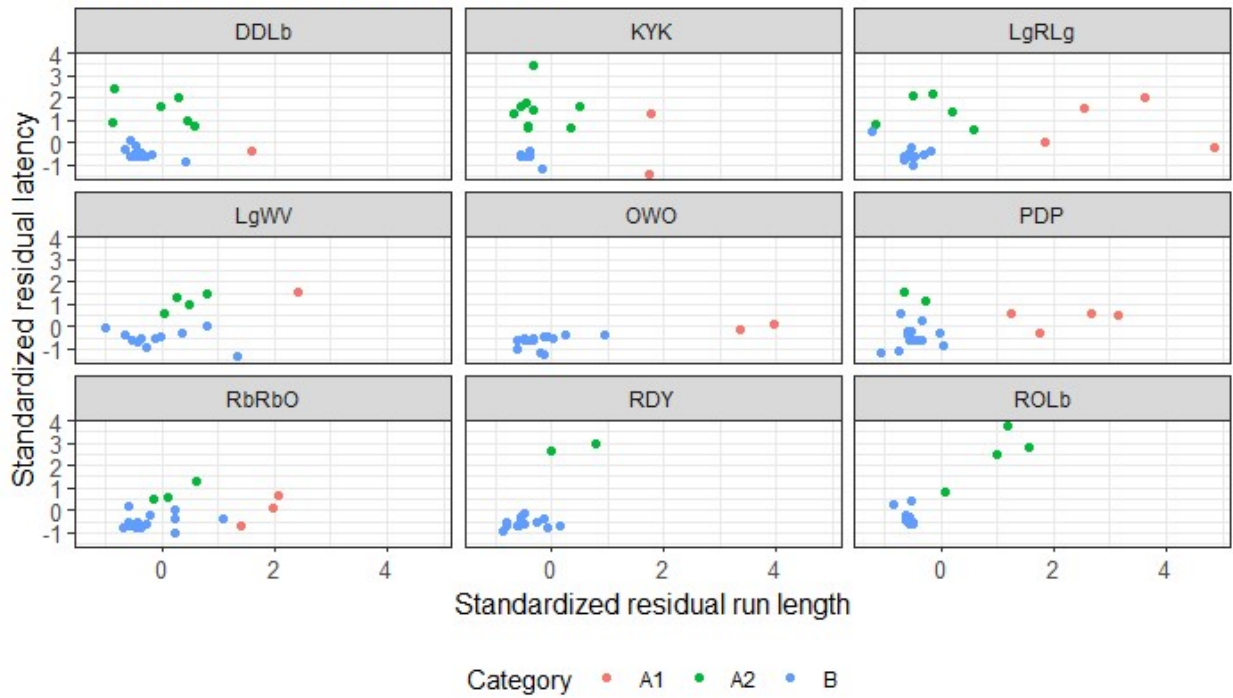
Maximum frequency

lmer (FMax ~ Cluster + (1|Bird) + (1|Bird:Day)+(1|Song type within bird))

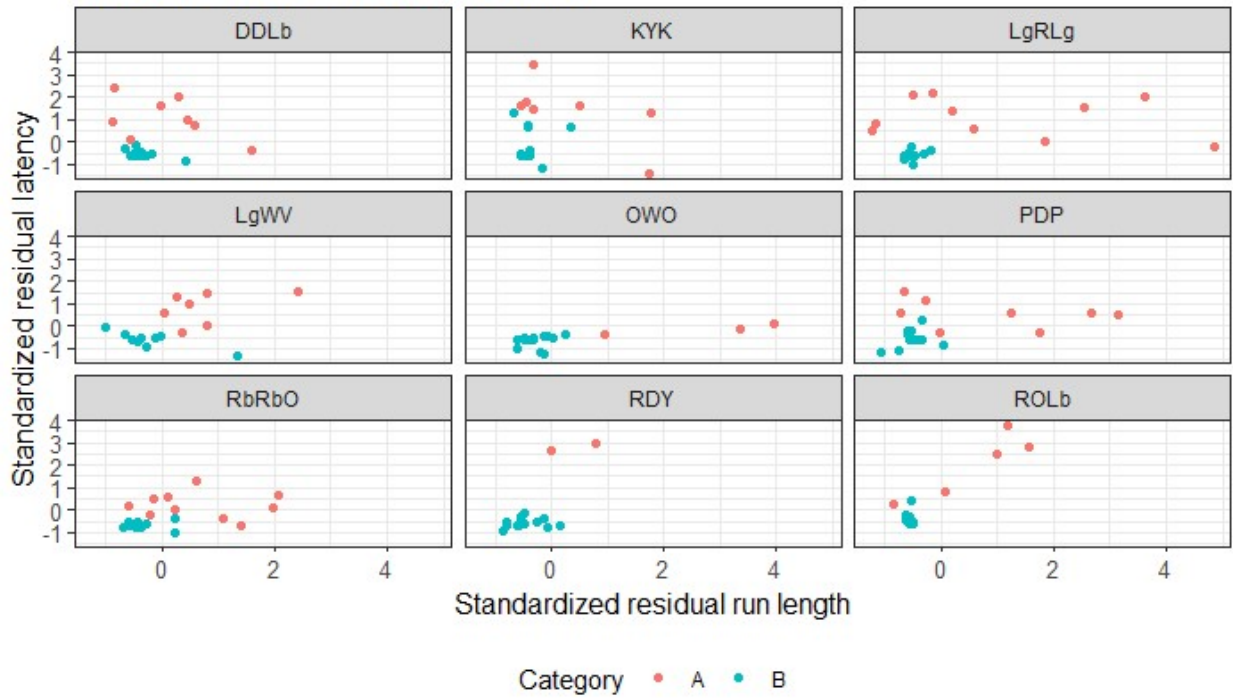
Categories for best one-variable scheme



Categories for best two-variable scheme



Categories for best three-variable scheme



Categories for best four-variable scheme

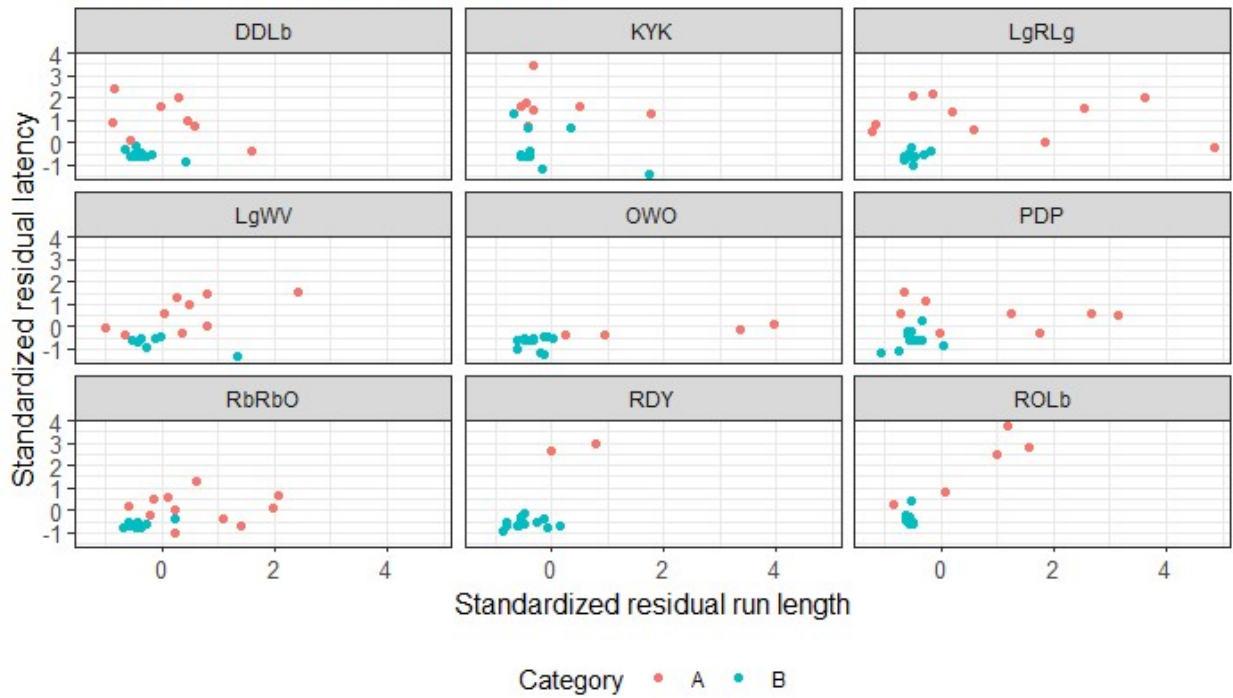


Figure S1. Scatterplots of the best clustering schemes for each unique number of variables, separated by individual. Individuals are denoted by abbreviated color-band combinations (e.g., DDLb, KYK).

Table S1: Song type sharing by individual birds based on categorisation of four best clustering schemes.

# of variables	# of song types shared in different categories	# of song types shared in the same category	mean±sd of shared B songs between two birds	mean±sd of shared A songs between two birds	t	p
4	20	21	3.31 ± 2.33	1.25 ± 1.34	5.57	<0.0001
3	20	21	3.31 ± 2.33	1.25 ± 1.34	5.57	<0.0001
2	24	17	3.61 ± 2.73	0.47 ± 0.65*	6.93	<0.0001
1	16	25	5.22 ± 3.03	0.22 ± 0.48	10.02	<0.0001

* For two-variable scheme, sharing of song types within A1 and A2 categories combined

Table S2: Effects of song categories on song structure. Estimated effects are relative to category A songs.

	Duration (ms)	No. Notes	Trill Rate	FEX	Min. Freq. (Hz)	Max. Freq. (Hz)	Bandwidth (Hz)
4 variable scheme							
Fixed effects – Estimate							
Intercept	2094.8	24.88	11.88	65.77	3177.35	6131.28	2946.36
Category B	-121.7***	-1.997***	-0.28*	1.996*	-45.75	-14.03	40.94
Random effects –Variance							
Song Type	5508.1	2.82	0.29	15.82	16772.2	11848	17748
Bird:day	3953.0	0.99	0.15	6.12	5691.4	11277	7506
Bird	561.2	0.54	0.07	2.32	255.2	3769	1164
3 variable scheme							
Fixed effects – Estimate							
Intercept	2098.16	24.999	11.91	66.11	3178.41	6137.28	2951.89
Category B	-123.67***	-2.12***	-0.31*	1.44	-46.02	-22.22	32.1
Random effects –Variance							
Song Type	54.79	2.72	0.28	16.15	16805.2	11778	17819
Bird:day	3998	1.01	0.15	6.14	5767.1	11321	7519
Bird	691	0.52	0.06	2.25	283.1	3813	1293
2 variable scheme							
Fixed effects – Estimate							
Intercept	2100.28	25.00	11.896	66.12	3179.19	6153.69	2977.43
Category A2	-9.76	-0.39	-0.12	-0.46	13.79	3.85	-23.001
Category B	-119.56***	-1.92**	-0.24	1.48	-48.73	-45.02	1.226
Random effects –Variance							
Song Type	6420.6	3.25	0.30	16.00	16708.2	11711	18110
Bird:day	3733.9	0.98	0.15	6.18	5747.7	11207	7605
Bird	331.1	0.44	0.07	2.79	671.6	3981	1549
1 variable scheme							
Fixed effects – Estimate							
Intercept	2083.06	24.798	11.90	65.93	3176.47	6112.77	2939.01
Category B	-81.53**	-1.44**	-0.24	1.36	-34.38	10.29	40.95
Random effects –Variance							
Song Type	8149	3.59	0.30	16.39	17551.9	11995	17946
Bird:day	3684	0.94	0.15	6.16	5795.77	11272	7466
Bird	1011	0.83	0.08	1.81	28.01	3640	1345

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.0001$

Table S3: Mean and standard deviations of song structure variables from the best clustering scheme for each number of variables, one through four.

# of variables	category	duration	# of notes	trill rate	FEX	F min	F max	Frequency bandwidth
4	B	1989.02	23.15	11.67	66.89	3131.04	6086.59	2955.57
		±293.91	±4.24	±1.50	±12.14	±396.38	±519.93	±506.76
	A	2118.17	25.58	12.05	65.26	3201.30	6118.87	2917.57
		±290.69	±5.27	±1.59	±9.32	±396.01	±482.37	±454.67
3	B	1989.34	23.12	11.65	66.64	3136.05	6088.26	2952.23
		±293.64	±4.24	±1.51	±12.03	±394.59	±522.17	±507.87
	A	2119.66	25.70	12.09	65.87	3190.03	6115.27	2925.25
		±291.14	±5.24	±1.56	±9.70	±402.29	±475.84	±451.16
2	B	1990.96	23.18	11.67	66.60	3135.87	6082.76	2946.91
		±293.63	±4.30	±1.52	±11.99	±393.04	±520.66	±506.58
	A2	2119.55	25.37	11.95	66.15	3203.45	6152.64	2949.22
		±296.83	±5.20	±1.56	±9.55	±404.87	±467.29	±440.58
	A1	2119.76	25.82	12.15	65.79	3183.49	6113.15	2929.63
		±288.52	±5.22	±1.53	±9.94	±407.66	±485.03	±463.69
1	B	2008.06	23.49	11.72	66.68	3144.35	6096.60	2952.27
		±299.21	±4.51	±1.53	±11.68	±393.98	±512.29	±497.39
	A	2110.27	25.48	12.04	65.25	3183.67	6093.23	2909.54
		±282.09	±5.16	±1.55	±10.13	±411.77	±496.73	±468.03

Table SX: Mean average silhouette indices (ASIs) for song types within male with > 40 exemplars, versus those with 40 or fewer exemplars, and the results of a two-tailed, unpaired t-test.

# of variables	ASI (>40 songs)	ASI (\leq 40 songs)	t	P
4	0.452	0.316	4.63	<0.0001
3	0.578	0.424	4.08	<0.0001
2	0.659	0.581	2.05	0.042
1	0.756	0.784	-0.91	0.357