

Title: Bats dynamically change echolocation parameters in response to acoustic playback

Running Title: Adaptations in response to acoustic playback

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Supporting information

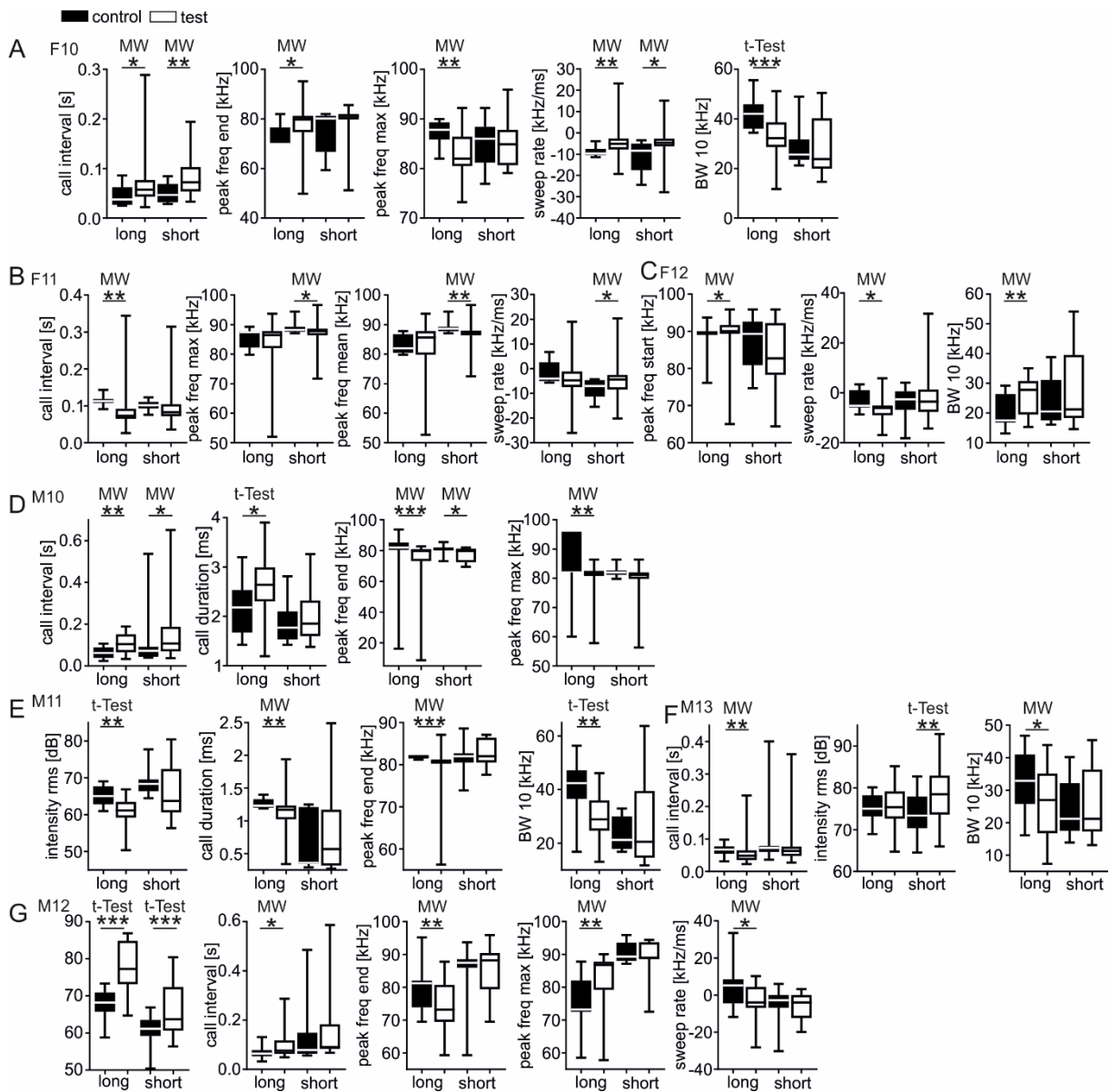


Figure S1 Individual specific call adaptations in response to playback stimuli

(A-G) Boxplots from seven individuals showing the call parameters that the bats changed in response to the playback stimulus. Calls recorded under control conditions (absence of playback stimulus) are indicated by black boxplots and white boxplots represent calls recorded under test conditions (presence of playback stimulus). Note that each bat changed different call parameters under test conditions. *BW* = bandwidth; *freq* = frequency; *MW* = mann-whitney test; * p < 0.05; ** p < 0.01; *** p < 0.0001.

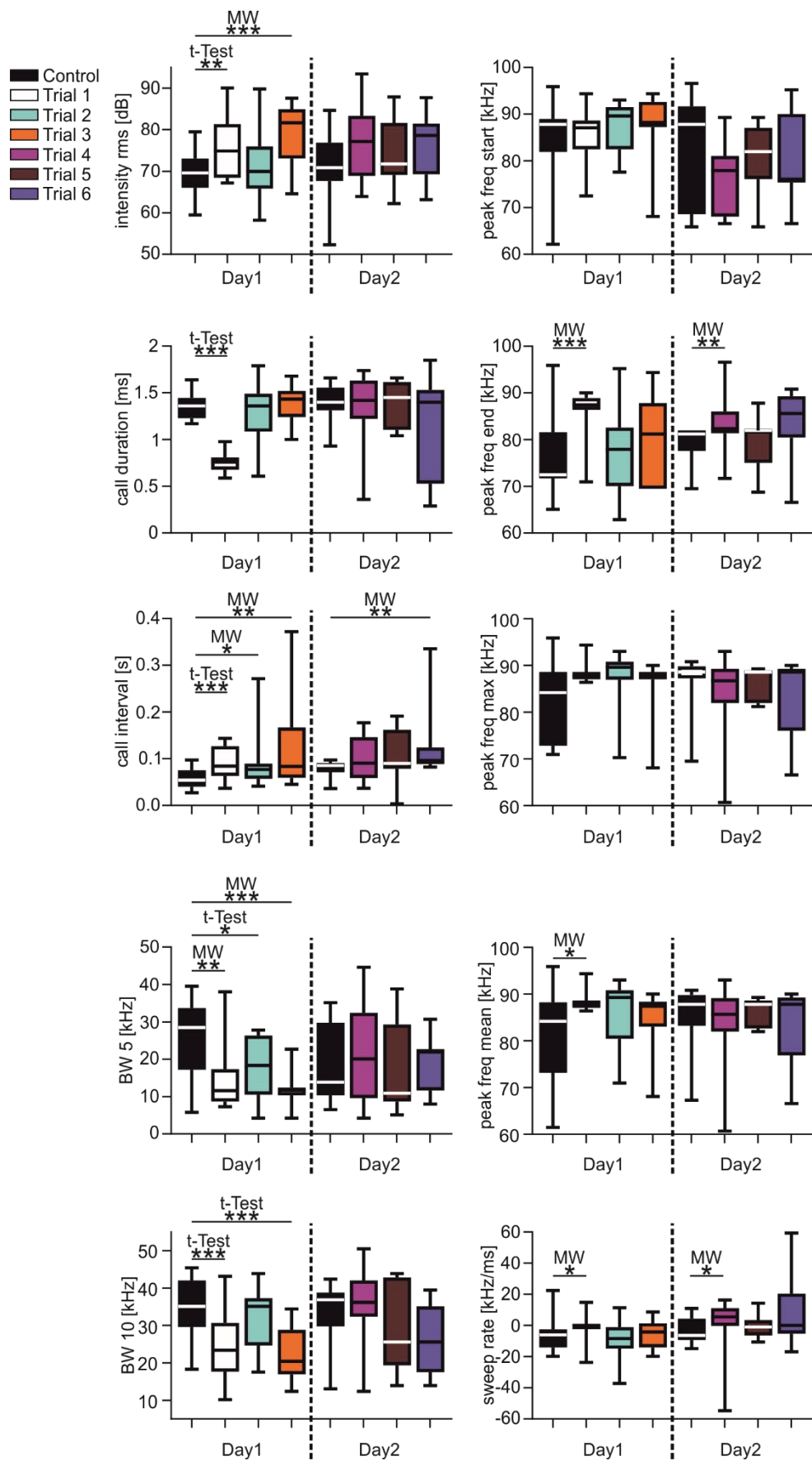


Figure S2 Bats switch adaptation strategies across trials and days

Figure S3 Bats switch adaptation strategies across trials

Call parameters are shown as boxplots for each trial (6 test trials and 1 control trial) from one bat (F10). For visualization, each trial is color coded. *BW* = bandwidth; *freq* = frequency; $p < 0.05$; ** $p < 0.01$

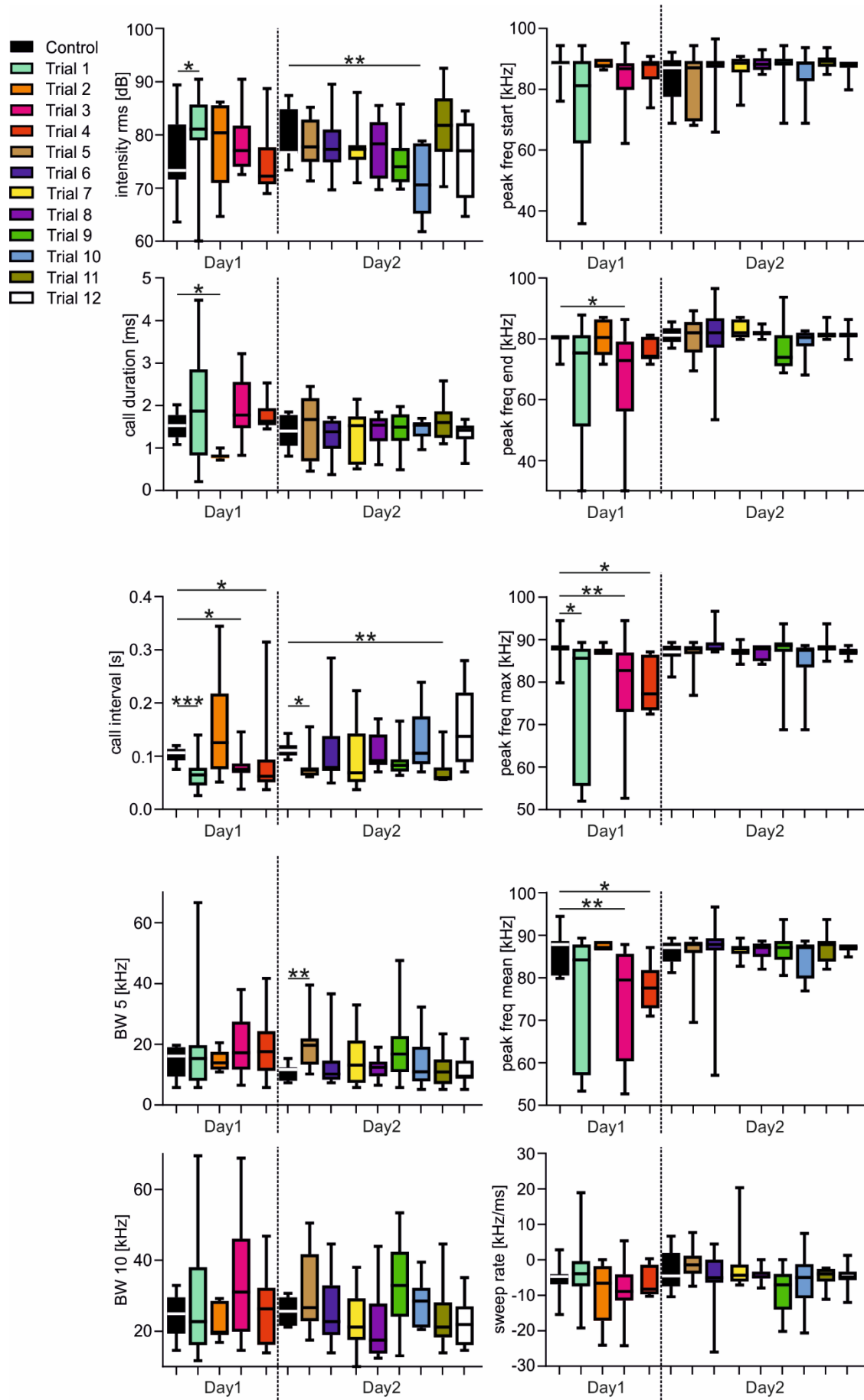


Figure S4 Bats switch adaptation strategies across trials and days

Call parameters are shown as boxplots for each trial (12 test trials and 2 control trials) across two days from one bat (F11). For visualization, each trial is color coded. *BW* = bandwidth; *freq* = frequency; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.0005$

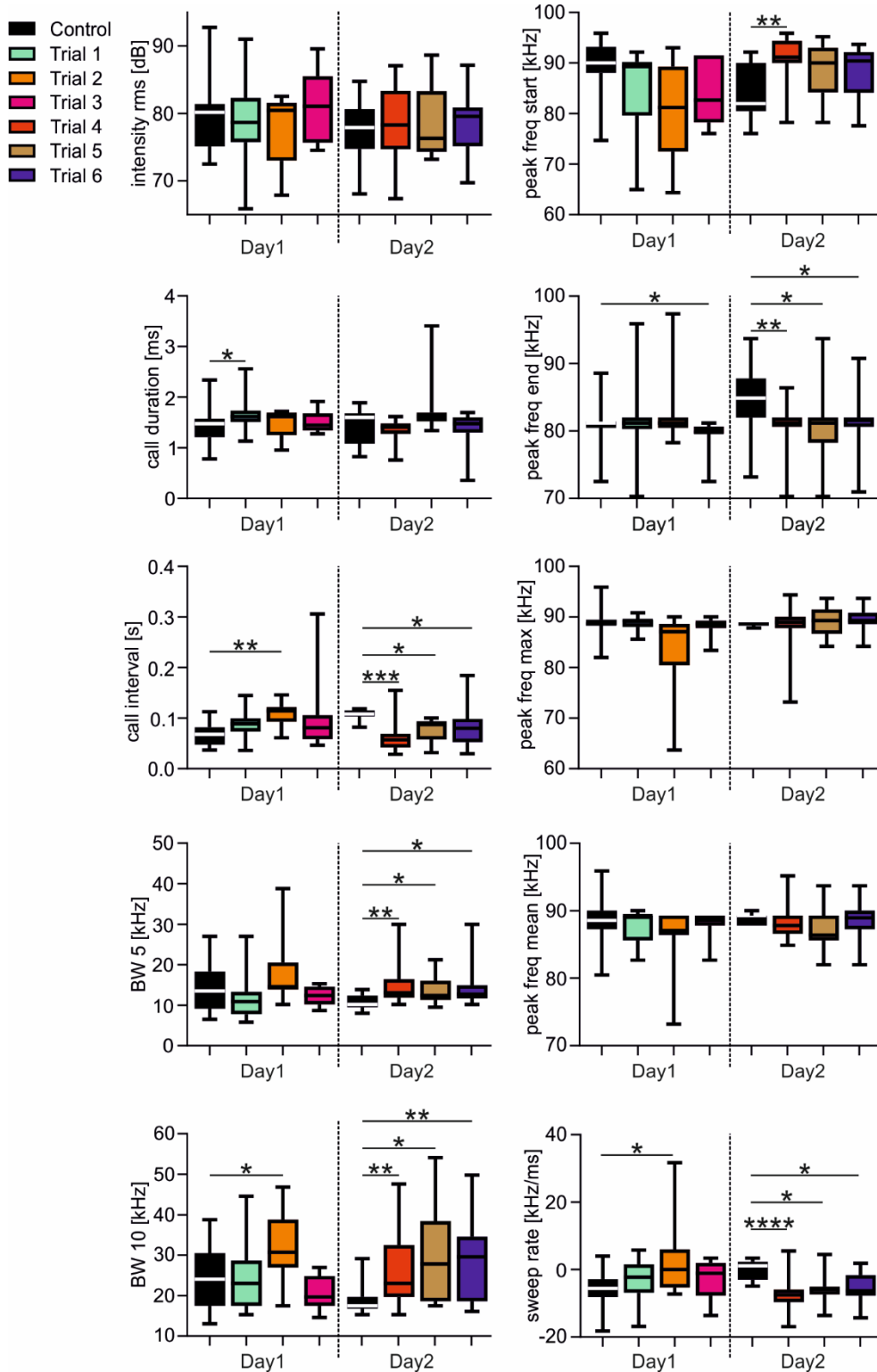


Figure S5 Bats switch adaptation strategies across trials and days

Call parameters are shown as boxplots for each trial (6 test trials and 2 control trials) across two days from one bat (F12). For visualization, each trial is color coded. BW = bandwidth; $freq$ = frequency; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.0005$, **** $p < 0.0001$

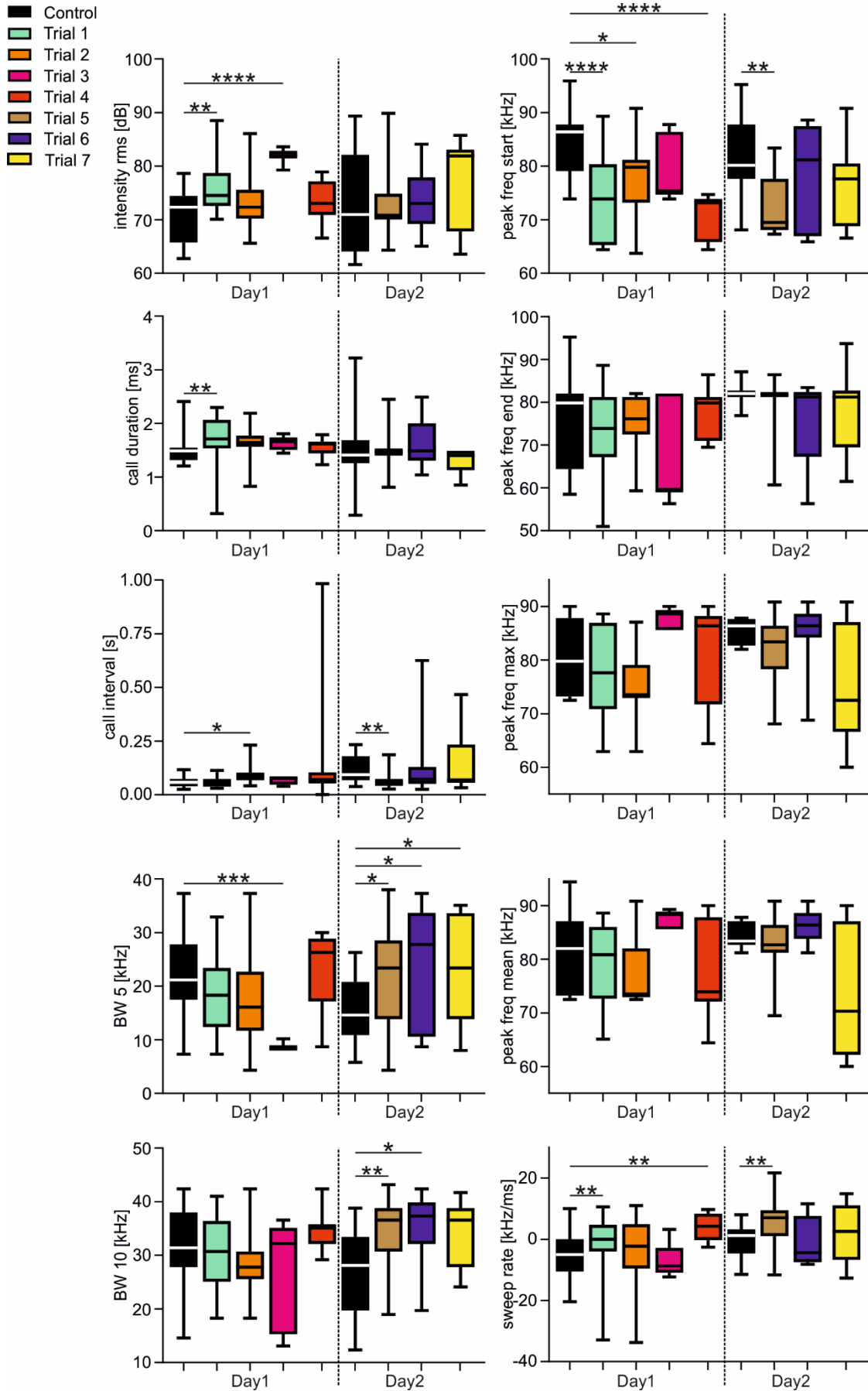


Figure S6 Bats switch adaptation strategies across trials and days

Call parameters are shown as boxplots for each trial (7 test trials and 2 control trials) across two days from one bat (M9). For visualization, each trial is color coded. BW = bandwidth; $freq$ = frequency; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.0005$, **** $p < 0.0001$

- Control
- Trial 1
- Trial 2
- Trial 3
- Trial 4
- Trial 5
- Trial 6

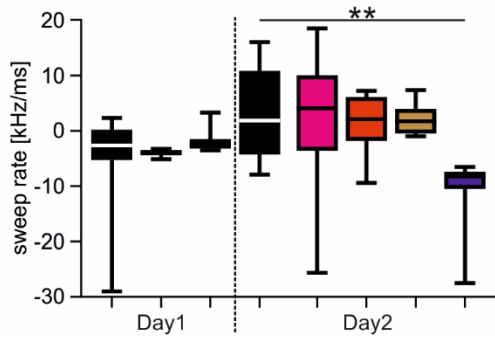
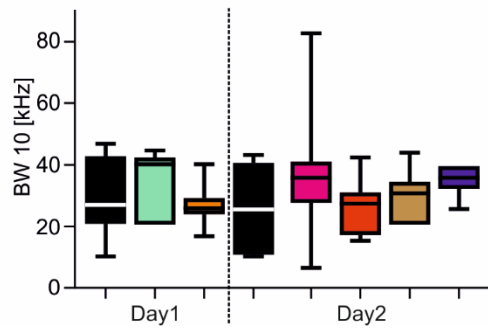
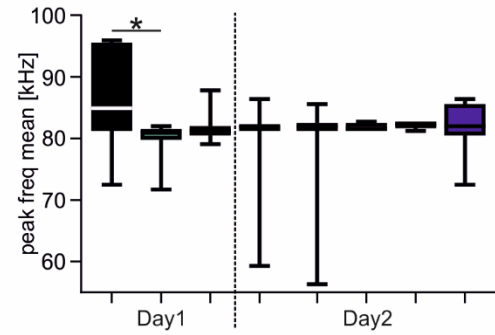
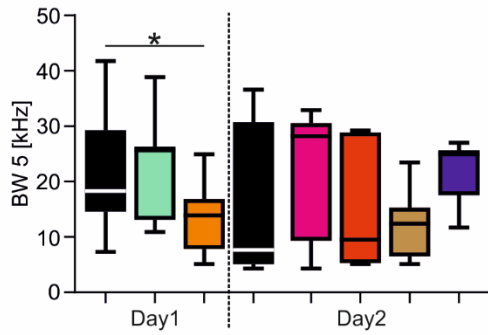
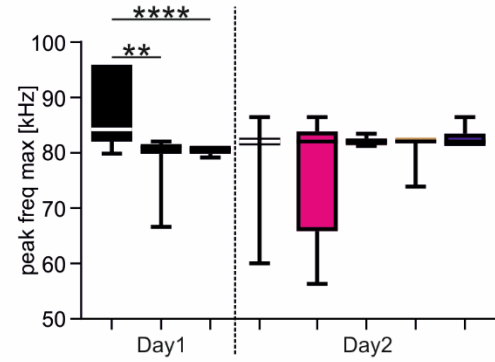
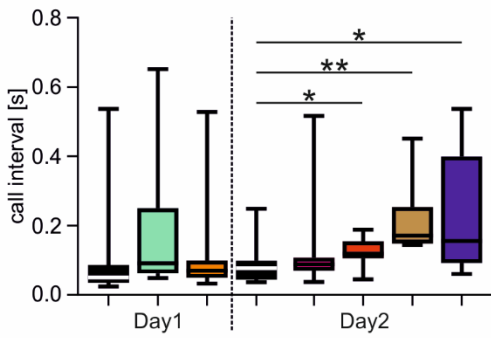
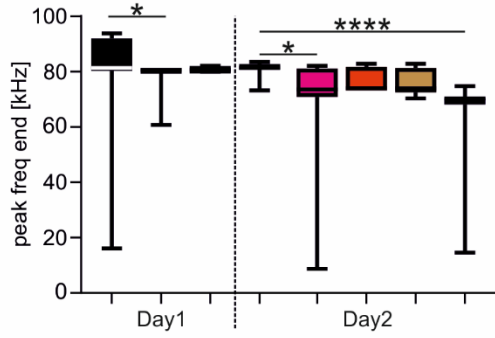
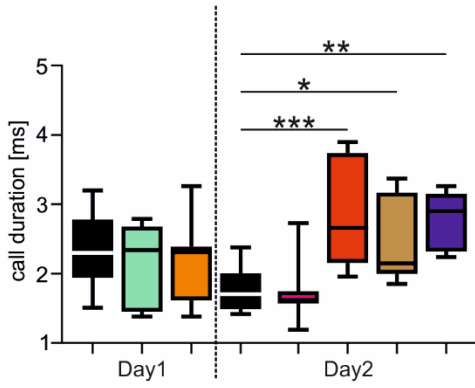
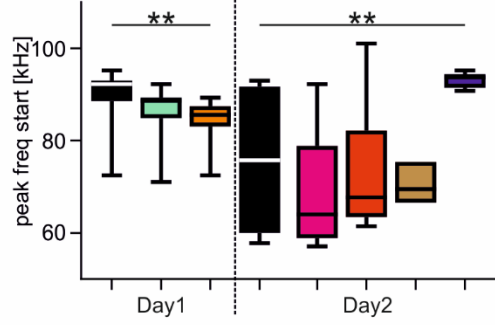
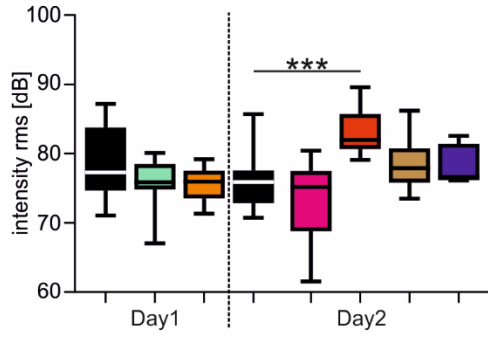


Figure S7 Bats switch adaptation strategies across trials and days

Call parameters are shown as boxplots for each trial (6 test trials and 2 control trials) across two days from one bat (M10). For visualization, each trial is color coded. *BW* = bandwidth; *freq* = frequency; *

$p < 0.05$; ** $p < 0.01$; *** $p < 0.0005$, **** $p < 0.0001$

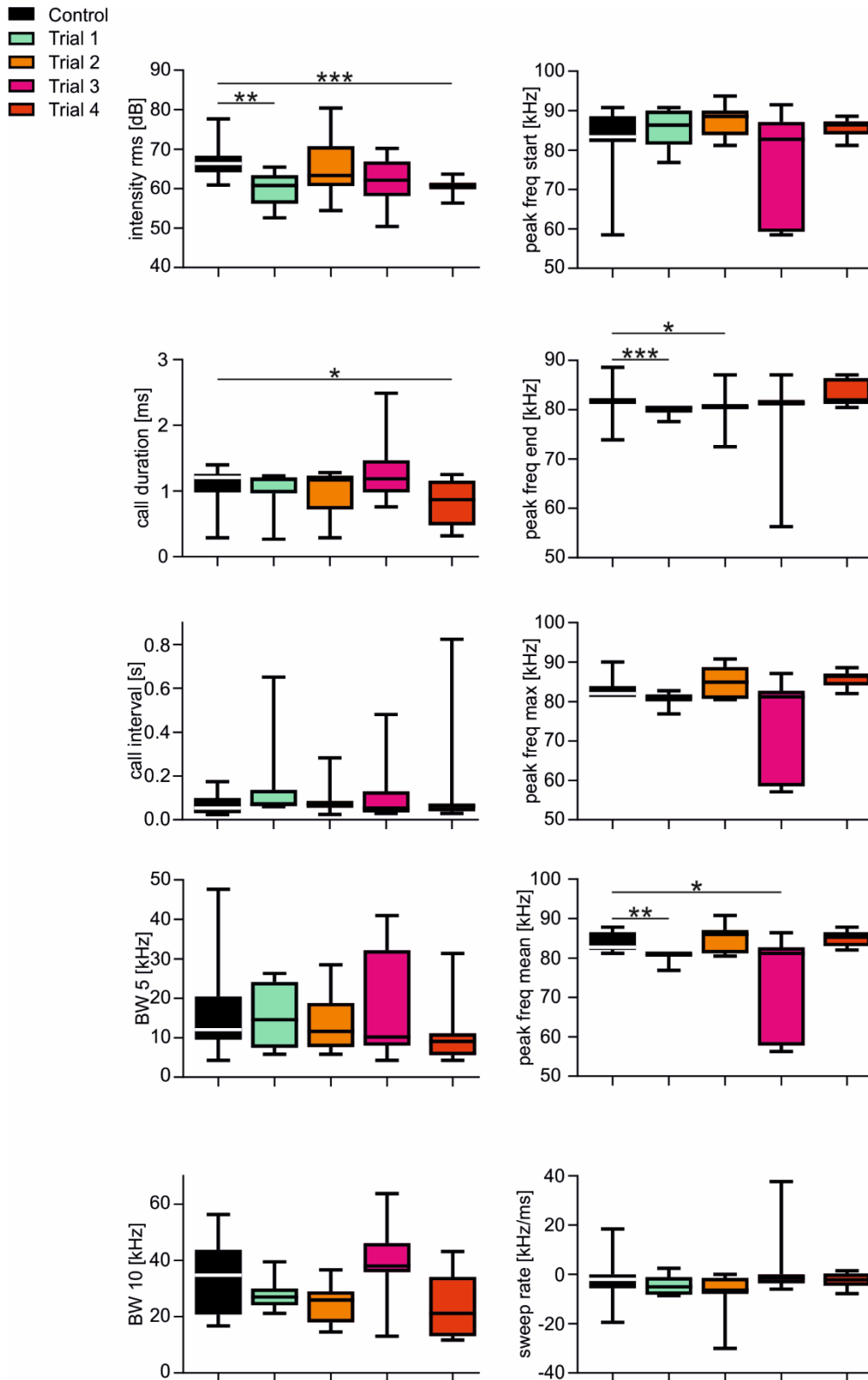


Figure S8 Bats switch adaptation strategies across trials and days

Call parameters are shown as boxplots for each trial (4 test trials and 2 control trials) from one bat

(M11). For visualization, each trial is color coded. *BW* = bandwidth; *freq* = frequency; * $p < 0.05$; ** p

< 0.01 ; *** $p < 0.0005$

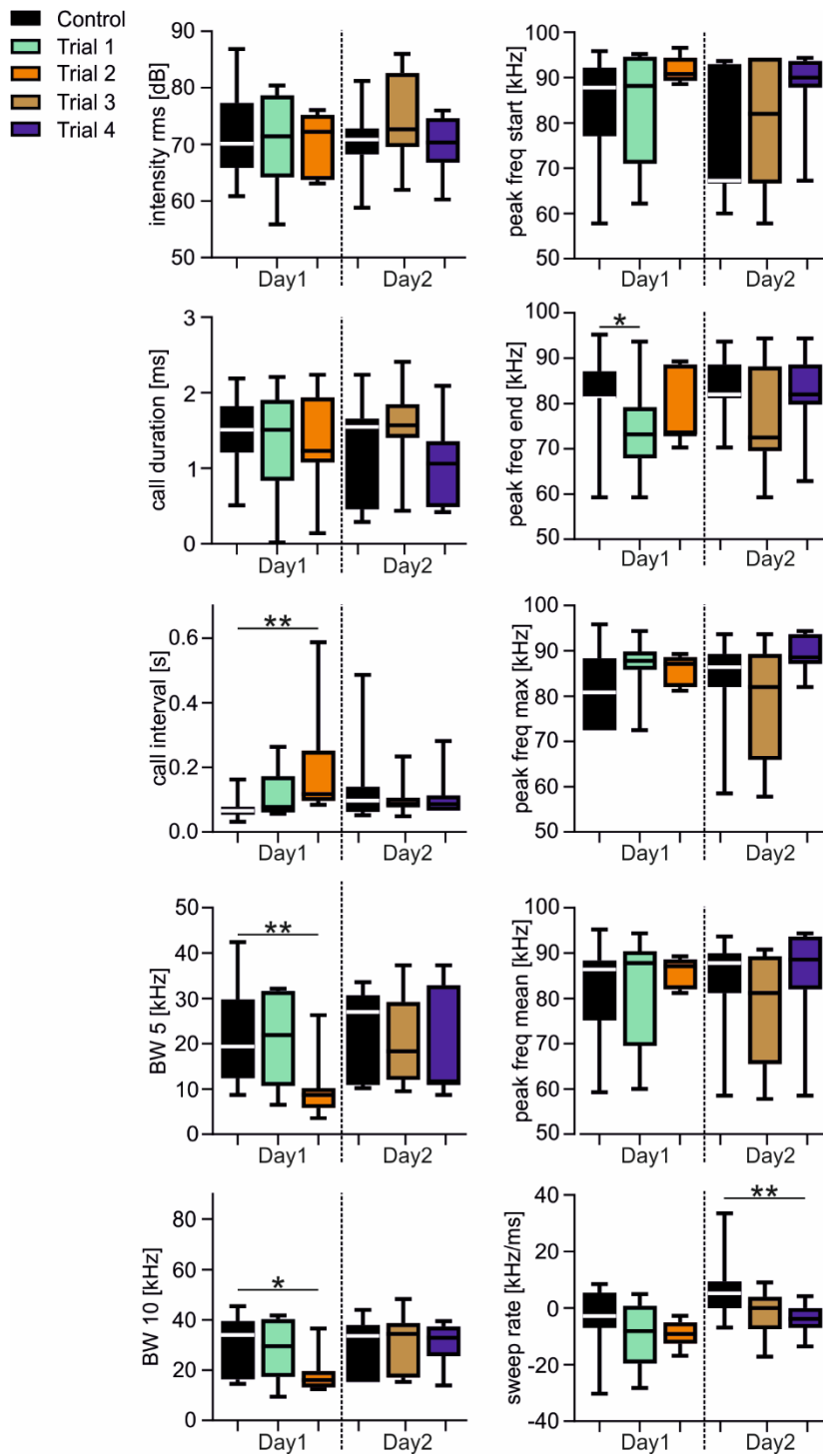


Figure S9 Bats switch adaptation strategies across trials and days

Call parameters are shown as boxplots for each trial (6 test trials and 2 control trials) across two days from one bat (M12). For visualization, each trial is color coded. *BW* = bandwidth; *freq* = frequency; * $p < 0.05$; ** $p < 0.01$

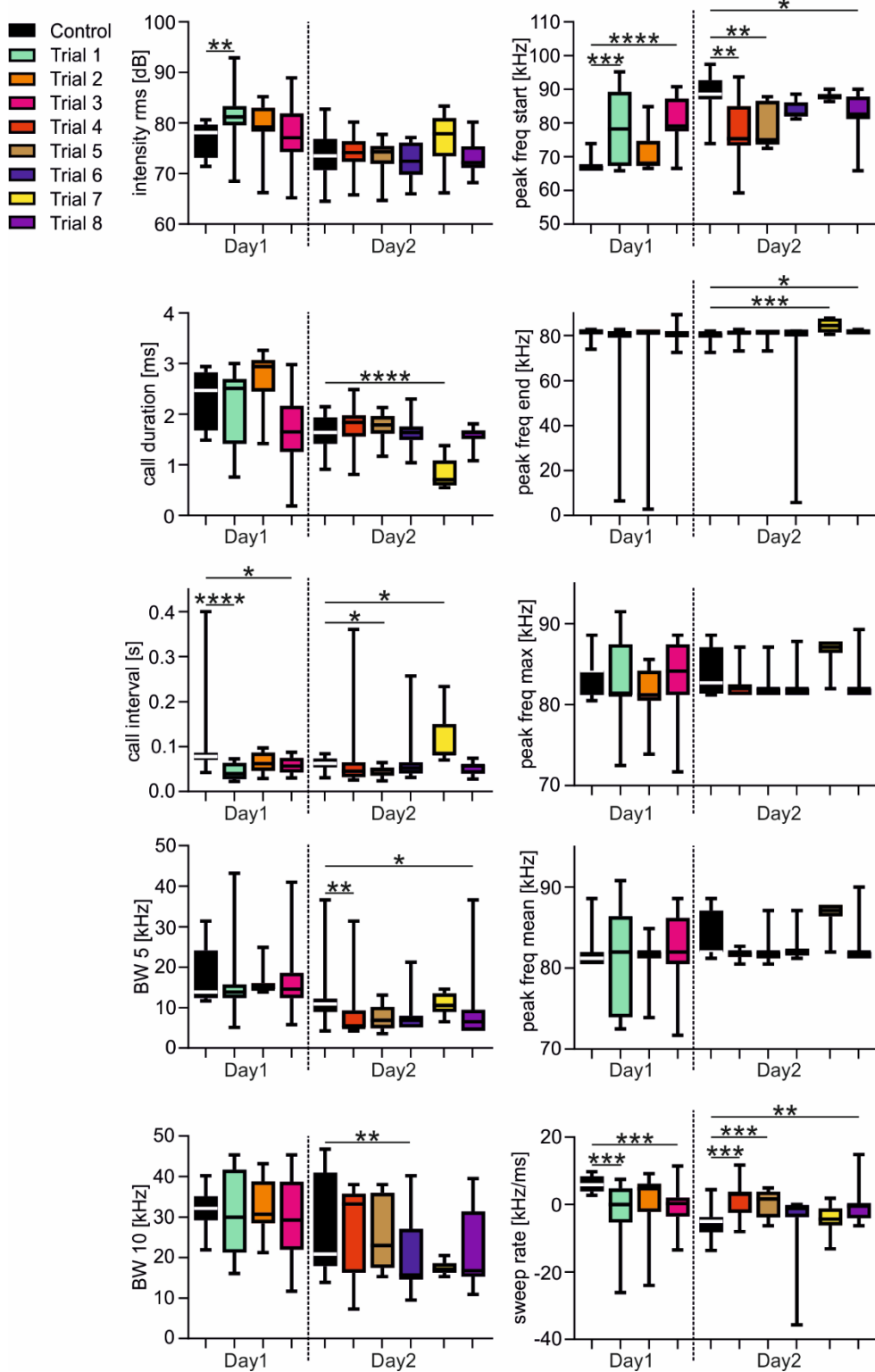


Figure S10 Bats switch adaptation strategies across trials and days

Call parameters are shown as boxplots for each trial (8 test trials and 2 control trials) across two days from one bat (M13). For visualization, each trial is color coded. BW = bandwidth; $freq$ = frequency; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.0005$, **** $p < 0.0001$

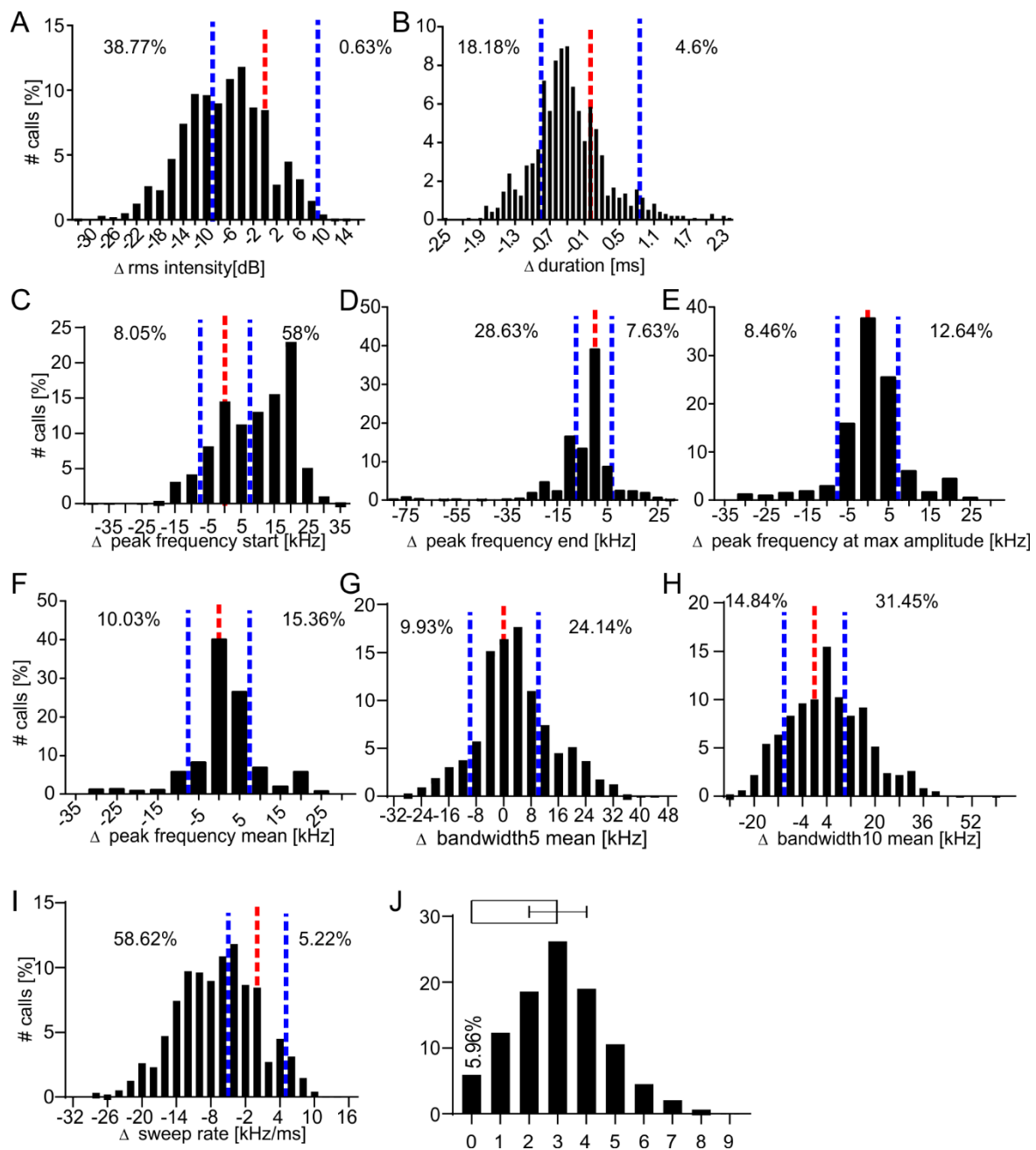


Figure S11 Comparison between emitted echolocation calls and playback calls

(A-I) Histograms demonstrating the differences of the echolocation calls from the playback calls for different call parameters (intensity (A), duration (B), peak frequency start (C), peak frequency end (D), peak frequency max (E), peak frequency mean (F), bandwidth 5 (G), bandwidth 10 (H), sweep rate (I). Red vertical dashed lines indicate the zero line. Calls at the zero line were equal to the playback stimulus with respect to the call parameter. Blue vertical dashed lines indicate lower and upper thresholds for defining the calls to be different from the playback calls. For each tested call parameter, the percentage of calls that are below or above the thresholds are indicated in each plot.

(J) Histogram summarizing how many call parameters were different from the control call of the bat that was recorded beforehand and used as interfering playback. Only 5.96% of the calls had a call design similar to the control call. A summary bar with standard deviation is shown on top of the histogram.

Supple Table 1 P-values from the statistics comparing call parameters across subsequent pendulum swings (control trials) from nine bats. Across subsequent control trials, bats did not change call duration, intensity, starting peak frequency (P F start), sweep rate, terminal peak frequency (P F end), maximum peak frequency (P F max), mean peak frequency (P F mean), bandwidth 5 (BW 5), and bandwidth 10 (BW10) (indicated by blue cells). Four bats (F9, F10, F11, and M12) varied significantly the call intervals across subsequent trials (indicated by red cells). Namely, they increased the call intervals which may indicate a habituation to the pendulum. For **F8, F11, F12, M9, M10, M11, and M12**, p-values result either from an one-way ANOVA (if data follow a Gaussian distribution based on D'Agostino-Pearson omnibus normality test) or from a Kruskal-Wallis test (if data do not follow a Gaussian distribution). For **F9 and F10**, p-values result either from an unpaired t-test (if data follow a Gaussian distribution based on D'Agostino-Pearson omnibus normality test) or from a Mann-Whitney test (if data do not follow a Gaussian distribution).

Animal ID	F8	F9	F10	F11	F12	M9	M10	M11	M12
N calls/ trial	19,17,1 4	20,12	25,11	20,14,1 7,19	12,17,1 4	24,21,1 4	15,15,1 8	18,16,2 6	20,13,1 2
Interval	0.63	0.002	0.0002	0.004	0.5	0.09	0.9	0.5	0.0012
Duration	0.17	0.26	0.37	0.15	0.24	0.66	0.64	0.11	0.06
Intensity	0.53	0.83	0.17	0.31	0.26	0.08	0.1	0.16	0.06
P F start	0.1	0.13	0.57	0.12	0.21	0.6	0.11	0.12	0.81
Sweep rate	0.27	0.96	0.89	0.39	0.39	0.97	0.07	0.23	0.21
P F end	0.96	0.18	0.59	0.8	0.31	0.66	0.49	0.39	0.72
P F max	0.13	0.32	0.95	0.1	0.57	0.46	0.05	0.06	0.71
P F mean	0.08	0.73	0.31	0.18	0.3	0.78	0.09	0.38	0.42
BW5	0.07	0.81	0.07	0.1	0.07	0.94	0.47	0.12	0.37
BW10	0.32	0.78	0.15	0.46	0.4	0.69	0.84	0.62	0.58

Supple Table 2 Changes of the call parameters induced by the presence of playback stimuli. Calls were grouped into long (*l*) and short (*s*) delay calls. In contrast to table 2, supple table 2 indicate the exact p-values in its cells. Blue and red cells indicated non-significant ($p > 0.05$) and significant ($p < 0.05$) differences. p-values result either from an one-way ANOVA (if data follow a Gaussian distribution based on D'Agostino-Pearson omnibus normality test) or from a Kruskal-Wallis test (if data do not follow a Gaussian distribution). F = female; M = male; l = long delay calls; p f = peak frequency; s = short delay calls

Animal ID (n calls control/n calls test)	F8 (21/34;20/48)		F9 (33/95;13/51)		F10 (10/64; 12/28)		F11 (12/96; 10/62)		F12 (12/46; 17/47)		M9 (30/57; 17/37)		M10 (22/32; 13/27)		M11 (13/30; 9/11)		M12 (19/30; 12/22)		M13	
	l	s	l	s	l	s	l	s	l	s	l	s	l	s	l	s	l	s	l	s
Interval	0.002	0.0002	0.24	0.77	0.03	0.008	0.002	0.07	0.19	0.76	0.56	0.31	0.003	0.05	0.22	0.2	0.03	0.17	0.006	0.18
Duration	0.02	0.68	<1x10 ⁻⁴	0.001	0.54	0.45	0.73	0.53	0.59	0.28	0.03	0.4	0.01	0.51	0.004	0.97	0.83	0.62	0.35	0.16
Intensity	0.06	0.0006	0.17	0.003	0.06	0.55	0.07	0.3	0.98	0.47	0.002	0.84	0.11	0.33	0.001	0.32	<1x10 ⁻⁴	0.0007	0.97	0.03
P F start	0.93	0.06	0.03	<1x10 ⁻⁴	0.53	0.25	0.51	0.33	0.04	0.62	<1x10 ⁻⁴	0.06	0.31	0.07	0.43	>0.99	0.74	0.21	0.53	0.14
Sweep rate	0.89	0.0003	0.0001	0.06	0.007	0.02	0.08	0.04	0.02	0.8	0.005	0.67	0.46	0.3	0.07	0.28	0.03	0.46	0.7	0.22
P F end	0.59	0.005	0.38	0.06	0.01	0.09	0.07	0.12	0.07	0.67	0.13	0.84	0.0006	0.016	0.0007	0.56	0.003	0.87	0.85	0.11
P F max	0.75	0.68	0.0008	0.0078	0.002	0.92	0.67	0.04	0.33	0.45	0.15	0.25	0.002	0.1	0.85	0.44	0.007	0.73	0.55	0.83
P F mean	0.65	0.42	0.0006	0.008	0.41	0.66	0.56	0.005	0.89	0.2	0.52	0.19	0.11	0.49	0.13	0.62	0.89	0.54	0.6	0.54
BW5	<1x10 ⁻⁴	0.79	0.66	0.01	0.24	0.46	0.44	0.43	0.21	0.34	0.88	0.01	0.72	0.22	0.44	0.54	0.77	0.2	0.2	0.51
BW10	0.008	0.19	0.51	0.0006	0.0005	0.34	0.4	0.75	0.005	0.2	0.08	0.02	0.95	0.89	0.001	0.7	0.92	0.63	0.01	0.77

1 Supple Table 3 P-values from the statistics comparing calls emitted in the pendulum across different
2 days. Between days, bats vary different call parameters. Each trial of one bat was recorded at a
3 different day. For **F8, F11, F12, M9, M10, M11, and M12**, p-values result either from an one-way
4 ANOVA (if data follow a Gaussian distribution based on D'Agostino-Pearson omnibus normality test)
5 or from a Kruskal-Wallis test (if data do not follow a Gaussian distribution). For **F9** and **F10**, p-values
6 result either from an unpaired t-test (if data follow a Gaussian distribution based on D'Agostino-
7 Pearson omnibus normality test) or from a Mann-Whitney test (if data do not follow a Gaussian
8 distribution).

Animal ID	F1	F2	F3	F5	F7	M1	M3	M4	M6	M7
N calls/ trial	14,13	20,21,16	15,10,16	16,13,16	19,20,26	12,10,21	21,18	11,14,11	17,18,16	13,20
Interval	0.54	0.17	0.004	0.07	0.0003	<1x10 ⁻⁴	0.73	0.65	0.09	0.25
Duration	0.36	<1x10 ⁻⁴	<1x10 ⁻⁴	0.24	<1x10 ⁻⁴	<1x10 ⁻⁴	<1x10 ⁻⁴	0.002	<1x10 ⁻⁴	<1x10 ⁻⁴
Intensity	0.002	<1x10 ⁻⁴	0.27	0.0003	0.004	<1x10 ⁻⁴	0.11	<1x10 ⁻⁴	0.39	0.17
P F start	0.002	0.78	0.005	0.0001	0.46	<1x10 ⁻⁴	0.26	0.0005	<1x10 ⁻⁴	<1x10 ⁻⁴
Sweep rate	0.016	0.49	0.2	0.0002	0.35	0.68	0.11	0.002	0.044	0.0001
P F end	0.009	0.15	0.26	<1x10 ⁻⁴	0.46	<1x10 ⁻⁴	0.96	0.19	<1x10 ⁻⁴	0.11
P F max	0.0001	0.86	0.002	0.0004	0.66	0.0003	0.002	0.0004	0.001	<1x10 ⁻⁴
P F mean	0.0005	0.56	0.0005	<1x10 ⁻⁴	0.46	0.0001	0.002	0.0003	<1x10 ⁻⁴	0.0003
BW5	0.032	0.0004	0.0061	0.0004	<1x10 ⁻⁴	0.61	0.39	<1x10 ⁻⁴	0.37	0.58
BW10	0.004	<1x10 ⁻⁴	0.0053	0.25	<1x10 ⁻⁴	0.22	0.004	0.006	0.41	0.24

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10

11 Supple Table 4 P-values from the statistics comparing changes of call parameters across trials. Red
 12 cells represent p-values < 0.05. Blue cells represent p-values > 0.05

Animal ID (calls/trial)	Trial (Day)	Intensity	Duration	Interval	Sweep rate	P F start	P F end	P F max	P F mean	BW5	BW10
F8 (25, 16, 14, 12, 16, 16, 13, 11)	1 (1st)	0.047	<1x10 ⁻⁴	0.008	0.048	0.1	0.0014	0.7	0.144	0.002	0.0008
	2 (1st)	0.73	0.51	0.07	>0.99	0.77	>0.99	0.02	0.08	0.13	0.52
	3 (1st)	0.001	0.99	0.005	>0.99	0.93	0.81	>0.99	>0.99	0.002	<1x10 ⁻⁴
	4 (2nd)	0.13	>0.99	0.8	0.034	>0.99	0.036	0.95	>0.99	>0.99	0.63
	5 (2nd)	0.72	>0.99	0.33	>0.99	0.37	>0.99	>0.99	>0.99	>0.99	0.73
	6 (2nd)	0.23	>0.99	0.036	0.19	>0.99	0.12	>0.99	>0.99	>0.99	0.33
F9 (28, 15, 10, 15, 17, 23, 18, 34, 16, 16)	1 (1st)	0.36	>0.99	>0.99	>0.99	0.011	>0.99	>0.99	0.11	0.47	0.47
	2 (1st)	0.03	0.4	0.54	0.03	0.002	>0.99	0.006	0.12	0.63	0.08
	3 (1st)	>0.99	0.58	>0.99	0.22	0.029	0.46	0.003	0.02	>0.99	>0.99
	4 (1st)	>0.99	0.001	>0.99	0.11	0.0076	>0.99	<1x10 ⁻⁴	0.0001	0.02	0.02
	5 (1st)	>0.99	0.03	>0.99	0.18	0.0027	0.18	0.045	0.021	>0.99	>0.99
	6 (2nd)	0.005	>0.99	>0.99	0.001	>0.99	0.001	0.74	>0.99	>0.99	0.18
	7 (2nd)	0.54	>0.99	0.05	0.57	>0.99	0.256	0.39	>0.99	0.1	0.21
	8 (2nd)	0.037	>0.99	0.05	0.03	>0.99	0.004	0.79	0.8	0.62	0.96
F10 (22, 13, 10, 22, 16, 15, 16)	1 (1st)	0.11	0.12	0.17	0.004	>0.99	0.3	0.2	0.89	>0.99	>0.99
	2 (1st)	0.08	0.01	0.38	0.009	>0.99	>0.99	0.002	0.17	>0.99	>0.99
	3 (1st)	>0.99	>0.99	0.87	0.03	0.07	0.53	0.1	>0.99	0.3	0.22
	4 (1st)	0.36	>0.99	0.1	0.03	0.47	0.25	0.04	0.18	>0.99	0.64
	5 (1st)	>0.99	>0.99	0.67	0.22	>0.99	0.05	>0.99	0.71	>0.99	>0.99
	6 (1st)	>0.99	>0.99	0.01	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
F11 (13, 23, 7, 20, 8, 9, 16, 13, 11, 14, 15, 10, 9, 11)	1 (1st)	0.05	0.86	<1x10 ⁻⁴	>0.99	0.07	0.63	0.02	0.32	>0.99	>0.99
	2 (1st)	>0.99	0.05	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	3 (1st)	0.65	0.56	0.04	>0.99	0.61	0.04	0.006	0.006	0.73	0.71
	4 (1st)	>0.99	>0.99	0.04	>0.99	>0.99	0.84	0.01	0.05	>0.99	>0.99
	5 (2nd)	0.99	0.98	0.02	0.5	>0.99	>0.99	>0.99	>0.99	0.03	>0.99
	6 (2nd)	0.98	0.99	0.91	>0.99	>0.99	>0.99	0.78	>0.99	>0.99	>0.99
	7 (2nd)	0.93	0.99	0.1	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	8 (2nd)	0.97	0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	0.95
	9 (2nd)	0.2	0.99	0.37	>0.99	0.88	0.9	>0.99	>0.99	0.47	>0.99
	10 (2nd)	0.005	0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	11 (2nd)	0.96	0.94	0.007	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	12 (2nd)	0.32	0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
F12 (18, 14, 11, 11, 11, 24, 17, 16)	1 (1st)	>0.99	0.05	0.23	0.42	0.42	>0.99	>0.99	>0.99	0.23	>0.99
	2 (1st)	>0.99	0.55	0.001	0.04	0.07	>0.99	0.17	0.49	0.38	0.04
	3 (1st)	>0.99	>0.99	0.5	0.84	0.73	0.14	>0.99	>0.99	>0.99	0.43
	4 (2nd)	0.87	0.12	<1x10 ⁻⁴	<1x10 ⁻⁴	0.002	0.02	>0.99	>0.99	0.002	0.007
	5 (2nd)	0.9	0.62	0.02	0.01	0.1	0.006	>0.99	0.38	0.02	0.01
	6 (2nd)	0.88	>0.99	0.02	0.01	0.2	0.02	0.99	>0.99	0.03	0.007
M9 (23, 24, 15, 7, 9, 24, 23, 9, 7)	1 (1st)	0.008	0.005	>0.99	0.04	<1x10 ⁻⁴	0.87	>0.99	>0.99	>0.99	>0.99
	2 (1st)	>0.99	0.07	0.03	>0.99	0.01	0.92	0.47	>0.99	0.88	0.41
	3 (1st)	<1x10 ⁻⁴	0.46	>0.99	>0.99	0.07	0.25	0.07	0.07	0.0009	>0.99
	4 (1st)	>0.99	>0.99	0.94	0.006	<1x10 ⁻⁴	0.92	>0.99	>0.99	>0.99	0.77
	5 (2nd)	>0.99	>0.99	0.003	0.02	0.0012	>0.99	0.25	>0.99	0.03	0.002
	6 (2nd)	>0.99	>0.99	0.95	0.92	0.36	0.88	>0.99	0.68	0.03	0.01
	7 (2nd)	>0.99	0.69	>0.99	0.68	0.55	>0.99	0.06	0.14	0.05	0.14
M10 (17, 7, 14, 18, 12, 12, 7, 7)	1 (1st)	0.6	0.92	0.09	0.17	0.14	0.05	0.0057	0.03	>0.99	>0.99
	2 (1st)	0.24	0.66	0.4	0.76	0.001	0.5	<1x10 ⁻⁴	0.18	0.05	0.75
	3 (2nd)	>0.99	>0.99	>0.99	>0.99	0.93	0.03	>0.99	>0.99	0.2	0.85
	4 (2nd)	0.0001	0.0003	0.02	>0.99	>0.99	0.48	>0.99	>0.99	>0.99	>0.99
	5 (2nd)	0.59	0.03	0.001	>0.99	>0.99	0.23	>0.99	>0.99	>0.99	>0.99
	6 (2nd)	0.96	0.001	0.03	0.003	0.0045	<1x10 ⁻⁴	>0.99	>0.99	0.6	0.73
M11 (22, 8, 12, 11, 10)	1 (1st)	0.003	>0.99	0.15	0.58	>0.99	0.0008	0.09	0.003	>0.99	0.9
	2 (1st)	0.61	0.87	>0.99	0.29	0.32	0.03	>0.99	>0.99	>0.99	0.17
	3 (1st)	0.09	>0.99	>0.99	>0.99	>0.99	>0.99	0.57	0.01	>0.99	>0.99
	4 (1st)	0.0006	0.05	>0.99	>0.99	>0.99	>0.99	0.35	>0.99	0.2	0.12
	1 (1st)	0.86	0.88	0.22	0.26	0.94	0.049	0.12	>0.99	>0.99	>0.99
	2 (1st)	0.8	0.84	0.001	0.06	0.22	0.71	0.44	>0.99	0.005	0.025

M12 (20, 10, 7, 11, 13, 11)	3 (2nd)	0.28	0.27	>0.99	0.07	0.96	0.14	0.67	0.97	>0.99	0.97
	4 (2nd)	0.67	0.61	>0.99	0.009	0.16	0.95	0.23	0.94	>0.99	0.97
M13 (15, 29, 11, 24, 20, 20, 14, 16, 12, 15)	1 (1st)	0.001	0.87	<1x10 ⁻⁴	0.0002	0.0003	0.84	>0.99	>0.99	>0.99	>0.99
	2 (1st)	0.31	0.34	0.71	0.12	0.43	>0.99	0.7	>0.99	>0.99	>0.99
	3 (1st)	>0.99	0.1	0.05	0.0008	<1x10 ⁻⁴	>0.99	>0.99	0.96	>0.99	>0.99
	4 (2nd)	>0.99	>0.99	0.55	0.002	0.0002	0.85	0.33	0.14	0.006	>0.99
	5 (2nd)	>0.99	>0.99	0.05	0.004	0.0015	0.8	0.19	0.07	0.08	>0.99
	6 (2nd)	>0.99	>0.99	>0.99	0.35	0.12	>0.99	0.2	0.17	0.06	0.01
	7 (2nd)	0.08	<1x10 ⁻⁴	0.02	>0.99	>0.99	0.0001	0.07	0.08	>0.99	0.09
	8 (2nd)	>0.99	>0.99	>0.99	0.03	0.11	0.01	0.63	0.1	0.04	0.21

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