

Fig. S1. (A) Honey bee foragers were trained to the feeder (F) from the hive (H) over two days. (B) Google Image of the training path of the bees. The feeder locations are indicated in red. (C) Feeder was presented along with a multicolored umbrella along the training path. The vegetation along the road offered good optic flow.

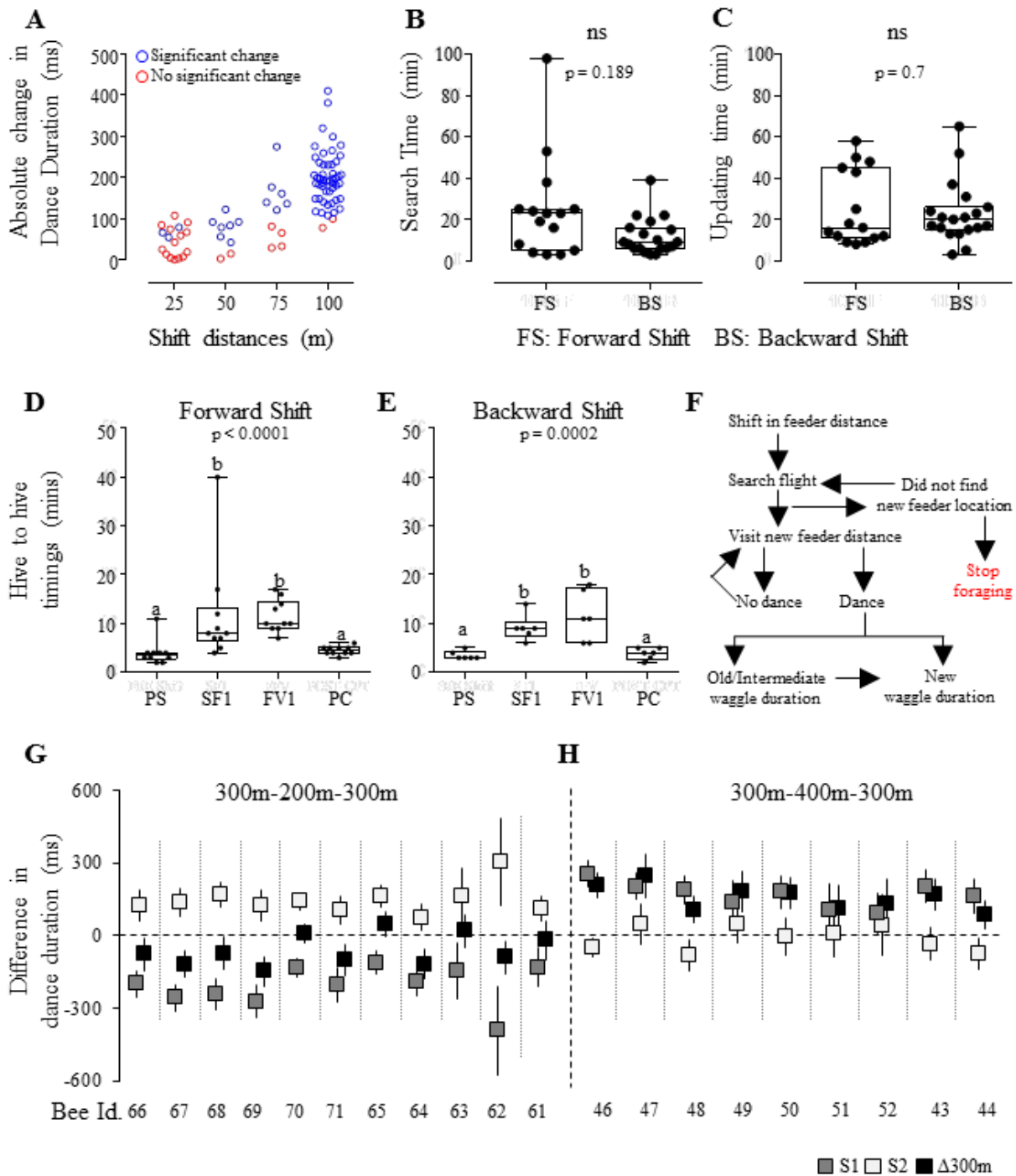


Fig. S2. (A) Change in waggle dance duration for individual bees (n=84) following shift in feeder by different distances. The percentage of bees showing significant difference in waggle duration following single feeder shift increased with the length of the feeder moved. For feeder shift distance of 25 m: 18% of the tested bees (3 out of 17) showed a significant change in waggle run duration; 50 m: 78% (7 out of 9), 75 m: 60% (6 out of 10) and 100 m: 95.8% (46 out of 48). Only at 100m did more than 95% of the bees show a significant difference in waggle duration.

(B) Time taken to find the feeder at the new distance (search time) and (C) update waggle duration from the first visit to the new feeder distance (updating time). In the forward and backward shift experiments, foragers took similar time to find the feeder at the new location (Mann Whitney U test:  $p = 0.189$ ). The time to update waggle dance duration after reaching the new feeder location was also not different (Mann Whitney U test:  $p = 0.7$ ).

(D and E) Durations of search flights forward and backward shift respectively. The durations of search flight were on average longer than foraging flights in both cases. We compared the hive to hive timings of individual foragers (FS: n=10, BS: n = 6), for the foraging trip preceding the shift (Pre Shift), the first search flight (SF1), the first feeder visit at the new location (FV1) and the first foraging trip after the change point (Post CPT). The hive to hive timings for the SF1 and FV1 were significantly longer in comparison with the Pre Shift and Post Shift foraging trip time for forward shift (Friedman test: n= 10,  $p < 0.0001$ , Friedman Statistic =22.48) as well as for backward shift (Friedman test: n= 6,  $p = 0.0002$ , Friedman Statistic =15.00) experiments.

(F) Flow chart of flight and dance activities after the feeder shift. Individual responses in the double shift experiment.

(G and H) Estimated difference in waggle dance duration after both shifts in Backward-Forward (BF) shift experiment and Forward-Backward (FB) shift experiment respectively. In BF, all individuals (n = 11) show a significant change in waggle duration after both shifts. Seven individuals (out of 11) show a slight but significant difference in waggle dance duration at the same feeder distance before the first shift and after the second shift. In FB, 8 out of 9 individuals showed a significant change in waggle dance duration after the first shift, but only 3 showed a significant change after the second shift. All 9 individuals showed a significant difference in their waggle dance duration at the same feeder distance before the first shift and after the second shift.

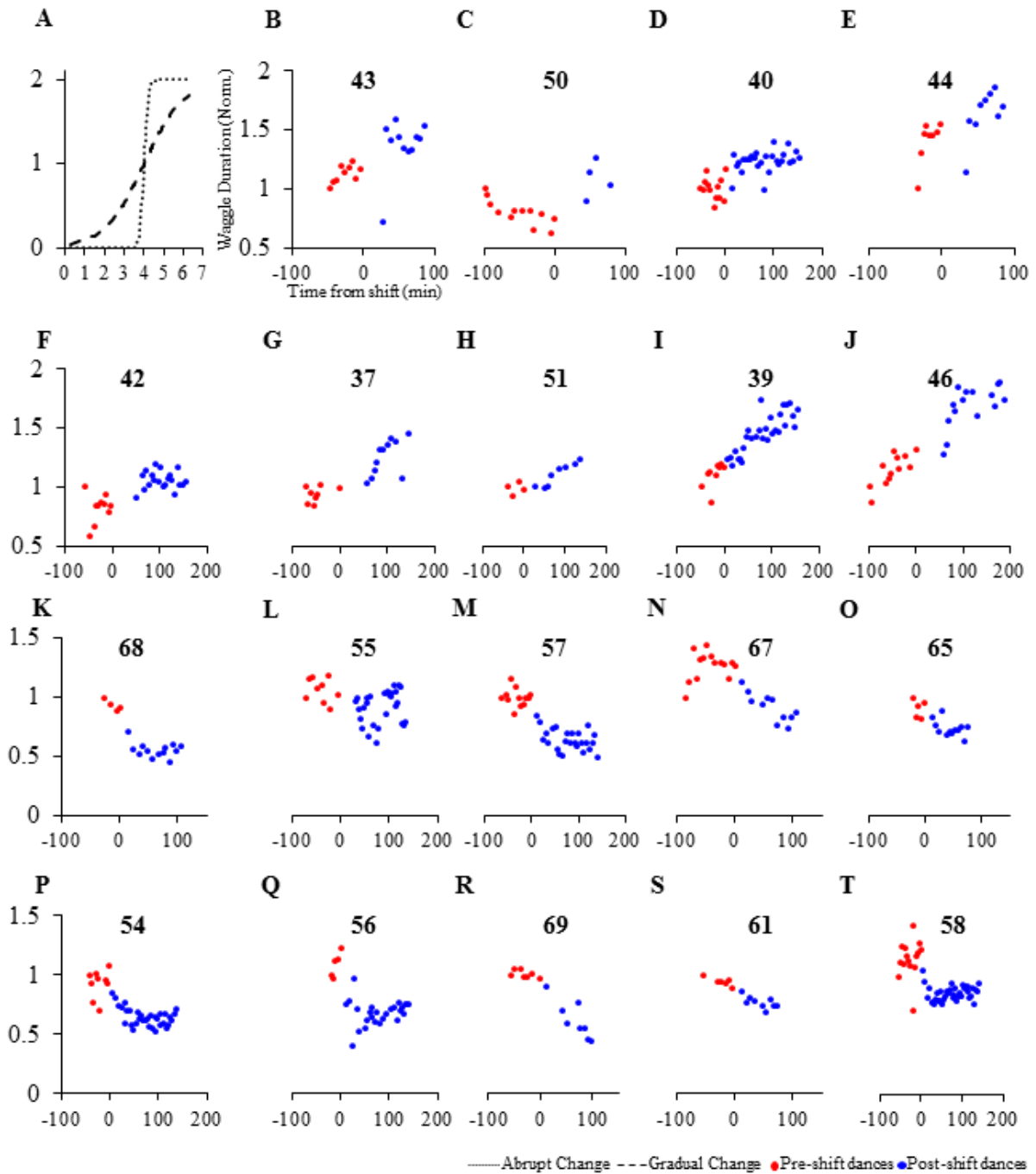


Fig. S3. Gradual and abrupt analysis in change of waggle dance duration. (A) Non-linear curve fitting in Method 1 to determine if the delayed update in waggle duration was gradual or abrupt. Two non-linear models were fitted to the dance series of an individual bee. The curve for the gradual change has a slope of 1 and the curve for abrupt change has a slope of 10. Inter-individual variation in waggle dance duration update process of foragers ( $n = 19$ ) in forward shift (B-J) and backward shift (K-T) experiments. Each subplot represents individuals showing a delayed update (CD + D and SD + D,  $n = 19$ ). For each individual bee, the dances are normalized to the first dance. The time axis is arranged in such a way that

time = 0 represents the time of the shift. All pre-shift dances are on the -x axis side and all post-shift dances are on the +x axis side.

**Table S1. Summary of change point update and gradual-abrupt change analyses for individual bees.**

Bee ID.	Shift	Update	Shift-I	CPT-I	p-value	Method1	Method2	Shift-II	CPT-II	p-value
37	FS	SD+D	9	11	0.0004	G	G			
38	FS	SD+I	13	13	<0.0001		NA			
39	FS	CD+D	10	18	<0.0001	G	G			
40	FS	CD+D	14	15	<0.0001	NC	G		NA*	
41	FS	CD+I	10	10	0.0008		NA			
42	FS	CD+D	11	12	<0.0001	NC	G			
43	FB	CD+D	10	11	<0.0001	A	A	21	11	0.1068
44	FB	SD+D	9	10	0.0014	NC	A	18	12	0.0333
45	FB	SD+I	12	12	0.0058		NA			NA
46	FB	SD+D	13	15	<0.0001	G	G	28	16	0.0002
47	FB	SD+I	7	7	<0.0001		NA	17	12	0.1111
48	FB	SD+I	9	9	0.0044		NA	16	17	0.2578
49	FB	SD+I	4	4	0.0342		NA	7	10	0.144
50	FB	CD+D	13	14	<0.0001	A	G	22	14	0.94
51	FB	SD+D	5	8	0.0018	G	G	13	9	0.0011
52	FB	CD+I	10	10	0.0644		NA	13	13	0.5893
53	BS	SD+I	10	10	<0.0001		NA			
54	BS	CD+D	10	15	<0.0001	G	G			
55	BS	SD+D	10	12	0.0367	NC	G			
56	BS	CD+D	6	8	0.0042	G	A			
57	BS	CD+D	13	15	<0.0001	NC	G			NA*
58	BS	CD+D	16	18	<0.0001	G	G			
59	BS	SD+I	12	12	<0.0001		NA			
60	BS	SD+I	6	6	0.0012		NA			
61	BF	CD+D	7	8	<0.0001	G	G	16	17	0.0002
62	BF	CD+I	13	13	<0.0001		NA	27	30	0.0003
63	BF	SD+I	11	11	0.0206		NA	14	14	<0.0001
64	BF	SD+I	13	13	0.0148		NA	15	16	0.0038
65	BF	SD+D	6	7	0.0204	NC	G	18	19	0.0001
66	BF	SD+I	9	9	<0.0001		NA	21	21	0.0022
67	BF	CD+D	15	16	<0.0001		NA	26	27	0.0012
68	BF	SD+D	5	6	<0.0001	A	A	18	20	<0.0001
69	BF	CD+D	8	9	<0.0001	G	G	16	18	0.0166
70	BF	CD+I	11	11	<0.0001		NA	24	25	<0.0001
71	BF	SD+I	8	8	<0.0001		NA	16	17	0.0005

Shift - I and II: Serial number of the first post shift dance after first and second feeder shift respectively. CD: Continuous dancing. SD: Stopped and resumed dancing. I: Immediate update. D: Delayed update. CPT-I and -II: Serial number of the change point dances. Method 1: Non-linear curve fitting analysis. Method 2: Consecutive difference analysis. G. Gradual change in waggle dance duration. A: Abrupt change in waggle dance duration.

NC: Non-conclusive. NA: Not applicable for individuals showing immediate update (I). NA\*: Not applicable for individuals in single shift experiments.

**Table S2. Summary of difference in waggle run durations in the single feeder shift experiments for individual bees obtained from the linear mixed effect model.**

Bee Id	Experiment	Distances	Difference	CI (lower, upper)	p-value
1		175m-200m	-78.706	-124.971, -32.442	<0.0001
2		175m-200m	-54.683	-98.725, -10.641	0.0017
3		175m-200m	-66.368	-97.252, -35.484	<0.0001
4		175m-200m	-3.644	-115.938, 108.648	1
5	25F	175m-200m	-13.880	-84.850, 57.089	1
6		175m-200m	-7.132	-83.909, 69.644	1
7		175m-200m	-5.027	-85.633, 75.578	1
8		175m-200m	-42.886	-141.719, 55.947	0.999
9		175m-200m	-0.804	-71.198, 69.588	1
10		175m-150m	19.253	-87.42, 125.927	1
11		175m-150m	74.490	-3.113, 152.094	0.0808
12		175m-150m	90.739	-23.310, 204.788	0.4164
13	25B	175m-150m	84.500	-12.979, 181.981	0.2209
14		175m-150m	59.023	-11.896, 129.942	0.3059
15		175m-150m	25.242	-24.354, 74.838	0.9991
16		175m-150m	67.362	-18.595, 153.320	0.4564
17		175m-150m	107.698	-26.126, 241.523	0.387
18		225m-275m	-78.805	-117.033, -40.578	<0.0001
19		225m-275m	-42.259	-73.181, -11.337	0.0002
20		225m-275m	-83.759	-115.636, -51.883	<0.0001
21		225m-275m	-122.500	-151.426, -93.574	<0.0001
22	50F	225m-275m	-14.918	-48.357, 18.5206	0.9999
23		225m-275m	-91.952	-128.119, -55.785	<0.0001
24		225m-275m	-92.175	-130.71, -53.640	<0.0001
25		225m-275m	-2.904	-33.087, 27.279	1
26		225m-275m	-56.127	-96.358, -15.896	0.0001
27		275m-200m	33.0941	-40.066, 106.254	0.9999
28	75B	275m-200m	81.315	-81.657, 244.289	0.9995
29		275m-200m	65.703	-24.4496, 155.8566	0.651



30		275m-200m	139.375	80.2561, 198.4957	<0.0001
31		275m-200m	176.411	119.859, 232.962	<0.0001
32		275m-200m	29.449	-76.546, 135.446	1
33		275m-200m	121.258	65.007 177.509	<0.0001
34		275m-200m	136.211	34.336, 238.086	0.0003
35		275m-200m	160.987	5.7471, 316.227	0.0313
36		275m-200m	274.576	112.427, 436.725	<0.0001
37		300m-400m	-203.226	-274.378, -132.075	<0.0001
38		300m-400m	-265.658	-340.618, -190.699	<0.0001
39	FS	300m-400m	-193.901	-257.946, -129.857	<0.0001
40		300m-400m	-165.906	-217.027, -114.786	<0.0001
41		300m-400m	-124.010	-182.051, -65.969	<0.0001
42		300m-400m	-186.309	-248.777, -123.842	<0.0001
43		300m-400m	-192.034	-259.566, -124.503	<0.0001
44		300m-400m	-148.481	-217.967, -78.995	<0.0001
45		300m-400m	-185.693	-263.669, -107.719	<0.0001
46		300m-400m	-252.871	-304.219, -201.524	<0.0001
47	FF	300m-400m	-197.657	-250.763, -144.552	<0.0001
48		300m-400m	-178.748	-236.082, -121.415	<0.0001
49		300m-400m	-136.663	-222.921, -50.405	<0.0001
50		300m-400m	-174.772	-238.876, -110.669	<0.0001
51		300m-400m	-99.950	-209.037, 9.136	0.1323
52		300m-400m	-77.925	-160.343, 4.491	0.09542
53		300m-200m	186.579	151.6828 221.475	<0.0001
54		300m-200m	207.373	149.952, 264.794	<0.0001
55		300m-200m	108.029	42.452, 173.607	<0.0001
56	BS	300m-200m	230.447	117.695, 343.200	<0.0001
57		300m-200m	205.839	168.210, 243.469	<0.0001
58		300m-200m	180.642	135.422, 225.862	<0.0001
59		300m-200m	198.935	151.559, 246.311	<0.0001
60		300m-200m	182.650	120.453, 244.848	<0.0001
61	BB	300m-200m	117.322	69.213, 165.432	<0.0001

62		300m-200m	197.713	140.586, 254.841	<0.0001
63		300m-200m	148.422	33.6026, 263.242	0.0007
64		300m-200m	410.192	229.920, 590.465	<0.0001
65		300m-200m	133.736	53.225, 214.247	<0.0001
66		300m-200m	209.241	159.009, 259.473	<0.0001
67		300m-200m	259.572	205.379, 313.764	<0.0001
68		300m-200m	248.851	186.108, 311.5955	<0.0001
69		300m-200m	278.441	210.669, 346.213	<0.0001
70		300m-200m	140.205	103.272, 177.137	<0.0001
71		300m-200m	206.727	136.012, 277.441	<0.0001
72	FB2	300m-200m	-381.364	-578.816, -183.912	<0.0001
73		300m-200m	-114.355	-173.52, -55.191	<0.0001
74		300m-200m	-212.708	-414.654, -10.763	0.02541
75	FF	300m-200m	-114.163	-177.711, -50.616	<0.0001
76		300m-200m	-166.390	-239.057, -93.724	<0.0001
77		400m-300m	236.527	173.158, 299.896	<0.0001
78		400m-300m	145.012	72.004, 218.020	<0.0001
79		400m-300m	319.474	206.650, 432.299	<0.0001
80	BB + BS2	400m-300m	196.047	123.612, 268.481	<0.0001
81		400m-300m	238.232	119.479, 356.986	<0.0001
82		400m-300m	298.843	184.156, 413.529	<0.0001
83		400m-300m	231.451	167.542, 295.361	<0.0001
84		400m-300m	275.815	191.227, 360.404	<0.0001

Experiment codes: 25F: 25 m forward shift. 25B: 25 m backward shift. 50F: 50 m forward shift. 75B: 75 m backward shift. FS: 100m forward shift. FB2: additional 100m forward backward shift. FF: 100m forward forward shift. BS: 100m backward shift. BB: 100m backward backward shift. BS2: additional 100m backward shift.

**Table S3. Summary of difference in waggle run durations in the double feeder shift experiments (FB, BF, FB2, FF and BB) for individual bees obtained by generalized linear hypothesis.**

Bee.ID.	Experiment	Distances (m)	Difference	CI (lower, upper)	p-values
46		300-400	255.650	202.791, 308.509	<0.0001
		Δ300	207.304	155.259, 259.349	<0.0001
		400-300	-48.345	-86.573, -10.119	0.0014
47		300-400	201.828	147.23, 256.428	<0.0001
		Δ300	247.753	156.626, 338.880	<0.0001
		400-300	45.924	-38.503, 130.352	0.9778
48		300-400	188.209	129.013, 247.405	<0.0001
		Δ300	105.909	52.223, 159.595	<0.0001
		400-300	-82.300	-148.527, -16.073	0.002
49		300-400	136.583	48.347, 224.819	<0.0001
		Δ300	182.302	98.826, 265.778	<0.0001
		400-300	45.718	-29.724, 121.162	0.9083
50	FB	300-400	178.685	113.539, 243.831	<0.0001
		Δ300	174.446	109.53, 239.361	<0.0001
		400-300	-4.239	-83.423, 74.945	1
51		300-400	103.485	-6.347, 213.318	0.0951
		Δ300	110.880	14.194, 207.567	0.0079
		400-300	7.395	-89.057, 103.8475	1
52		300-400	89.685	6.123, 173.247	0.0206
		Δ300	131.574	26.778, 236.370	0.0017
		400-300	41.888	-84.432, 168.209	0.999
43		300-400	202.290	133.764, 270.816	<0.0001
		Δ300	168.411	106.095, 230.727	<0.0001
		400-300	-33.878	-99.968, 32.210	0.9914
44		300-400	159.540	88.919, 230.160	<0.0001
		Δ300	84.211	25.621, 142.800	0.0001
		400-300	-75.328	-139.071, -11.585	0.0049
66	BF	300-200	-200.474	-252.49, -148.456	<0.0001
		Δ300	-76.989	-142.898, -11.081	0.0059
		200-300	123.485	61.776, 185.194	<0.0001

67		300-200	-257.725	-313.13, -202.319	<0.0001
		Δ300	-119.393	-173.673, -65.113	<0.0001
		200-300	138.332	79.754, 196.911	<0.0001
68		300-200	-242.347	-306.423, -178.27	<0.0001
		Δ300	-72.426	-137.207, -7.647	0.0116
		200-300	169.920	117.889, 221.952	<0.0001
69		300-200	-272.774	-341.769, -203.78	<0.0001
		Δ300	-148.325	-209.75, -86.902	<0.0001
		200-300	124.448	61.629, 187.268	<0.0001
70		300-200	-132.322	-171.220, -93.425	<0.0001
		Δ300	8.291	-29.068, 45.651	1
		200-300	140.613	104.669, 176.558	<0.0001
71		300-200	-203.902	-276.04, -131.763	<0.0001
		Δ300	-98.281	-162.051, -34.512	<0.0001
		200-300	105.620	48.316, 162.926	<0.0001
65		300-200	-112.070	-161.831, -62.310	<0.0001
		Δ300	49.749	-1.631, 101.130	0.0715
		200-300	161.820	116.835, 206.806	<0.0001
64		300-200	-192.298	-250.506, -134.09	<0.0001
		Δ300	-118.320	-178.574, -58.068	<0.0001
		200-300	73.977	19.593, 128.361	0.0003
63		300-200	-144.871	-260.872, -28.872	0.0019
		Δ300	18.769	-48.409, 85.949	0.9999
		200-300	163.641	47.247, 280.037	0.0001
62		300-200	-393.013	-573.719, -212.31	<0.0001
		Δ300	-89.2161	-156.069, -22.363	0.0005
		200-300	303.796	121.424, 486.170	<0.0001
61		300-200	-130.180	-211.718, -48.644	<0.0001
		Δ300	-18.359	-98.450, 61.731	1
		200-300	111.821	61.672, 161.971	<0.0001
72	FB2	200-300	116.447	55.553, 177.342	<0.0001
		Δ200	124.268	72.136, 176.402	<0.0001

		300-200	7.821	-50.768, 66.410	1
		200-300	378.107	180.306, 575.910	<0.0001
73		$\Delta$ 200	318.164	112.177, 524.152	<0.0001
		300-200	-59.943	-201.583, 81.697	0.9998
74		200-300	200.394	0.181, 400.606	0.0495
		300-400	252.900	167.028, 338.771	<0.0001
76	FF	200-300	158.188	84.366, 232.009	<0.0001
		300-400	127.356	58.577, 196.135	<0.0001
75		200-300	114.694	48.763, 180.626	<0.0001
		300-400	140.137	76.349, 203.925	<0.0001
77		400-300	-240.366	-305.14, -175.592	<0.0001
		300-200	-67.468	-126.011, -8.925	0.0098
79	BB	400-300	-316.968	-429.526, -204.41	<0.0001
		300-200	-135.652	-230.557, -40.747	0.0002
78		400-300	-153.985	-229.874, -78.095	<0.0001
		300-200	-91.813	-129.183, -54.443	<0.0001

$\Delta$ 300: difference in waggle dance duration for first and second visit at 300 m in FB and BF.  $\Delta$ 200: difference in waggle dance duration for first and second visit at 300 m in FB2.