

Supplementary Figures of the tracks

1. **Figures showing the tracks**, with those of clock-shifted pigeons are given in *red*, those of control birds in *blue*. The release site is marked by a black triangle, the home loft by a black square. Incomplete tracks ending in flight are marked with an open triangle, tracks lost seconds after landing (probably because the contact to the satellites was interrupted) with an open circle, and tracks lost after a longer period of sitting with an open square.

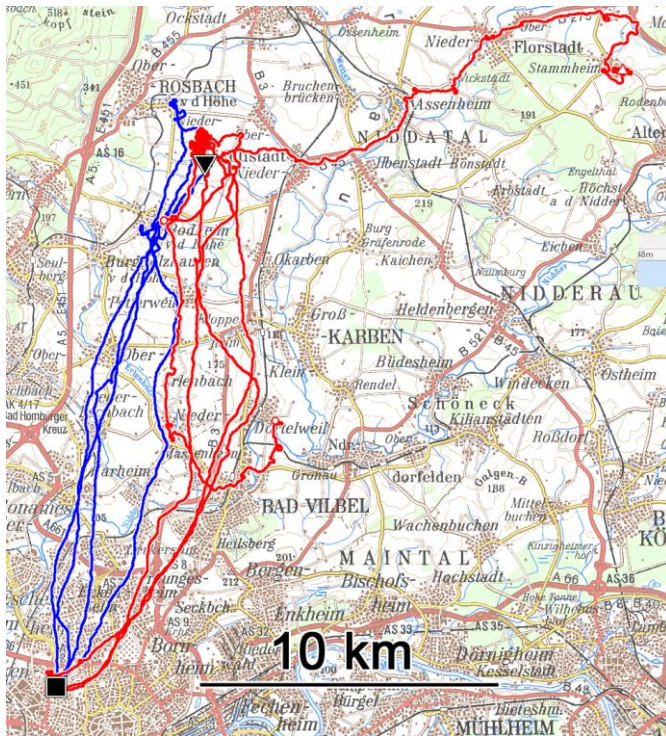


Fig. S1A Tracks of pigeons released at RB, 19.2 km south of the loft, home direction 194°

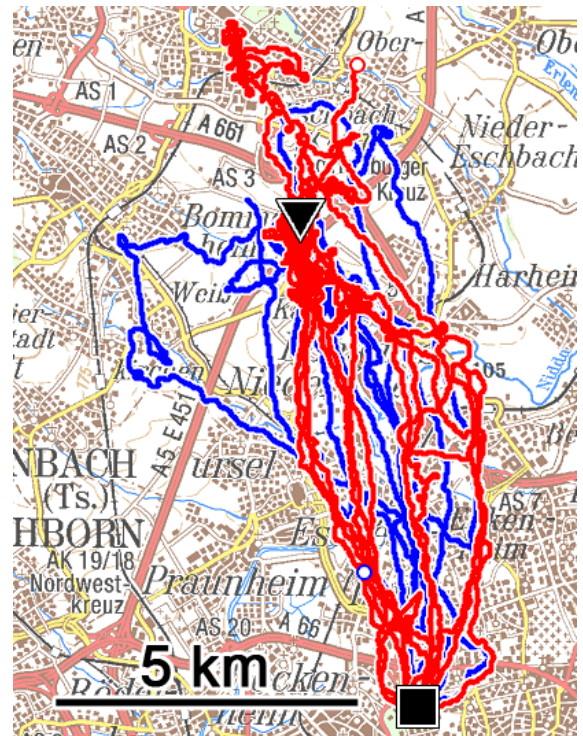


Fig. S1B Tracks of pigeons released at BH, 8.4 km north-north west of the loft, home direction 167°

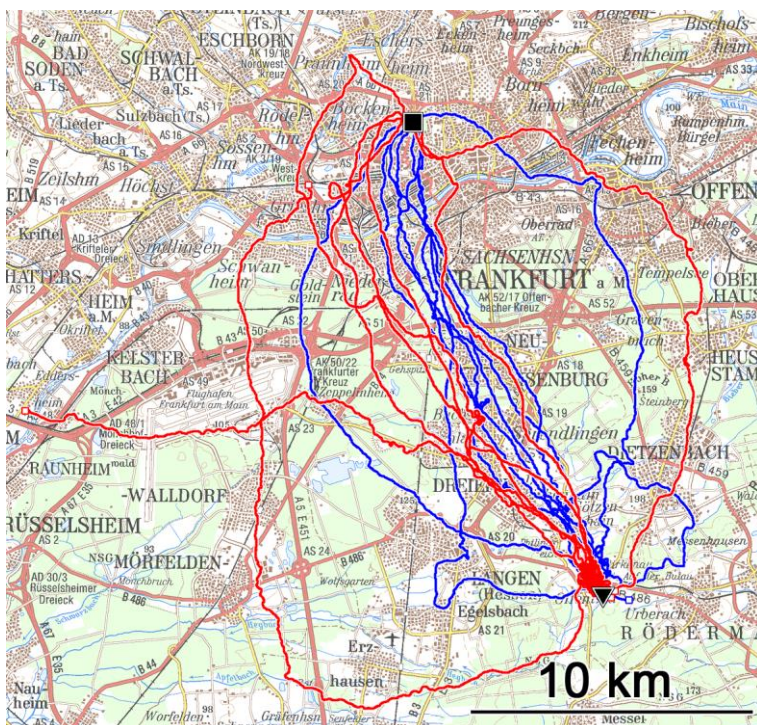


Fig. S1C Tracks of pigeons released of OT, 17.9 km southeast of the loft, home direction 338°

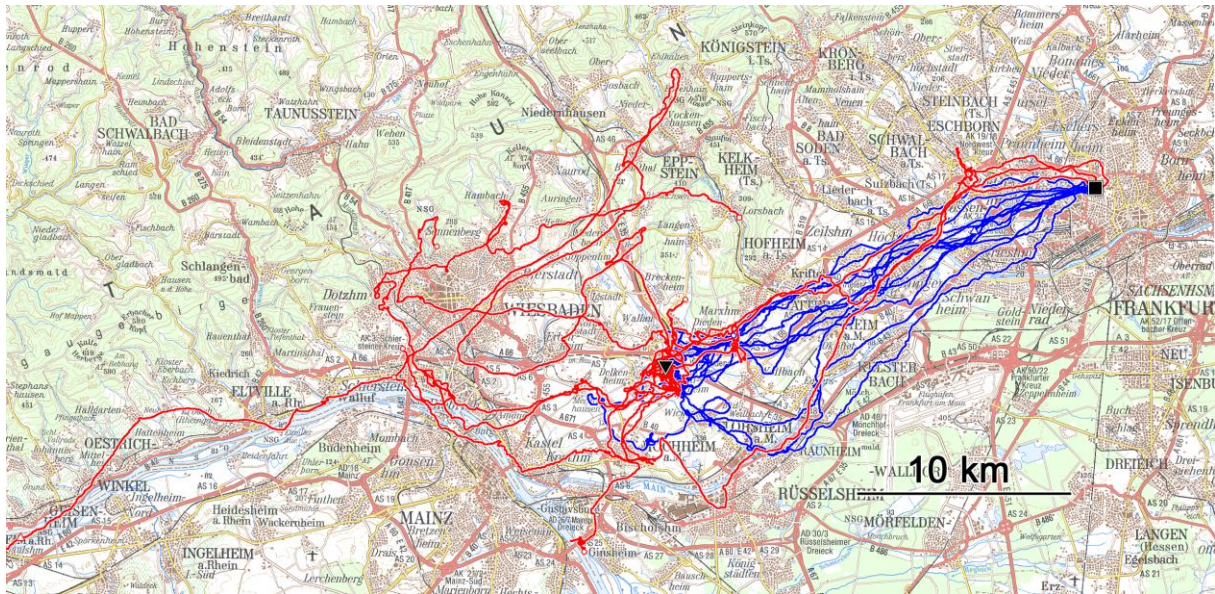


Fig. S1D Tracks of pigeons unfamiliar with the site, released for the first time at WAL, 21.5 km south-southwest of the loft, home direction 67°

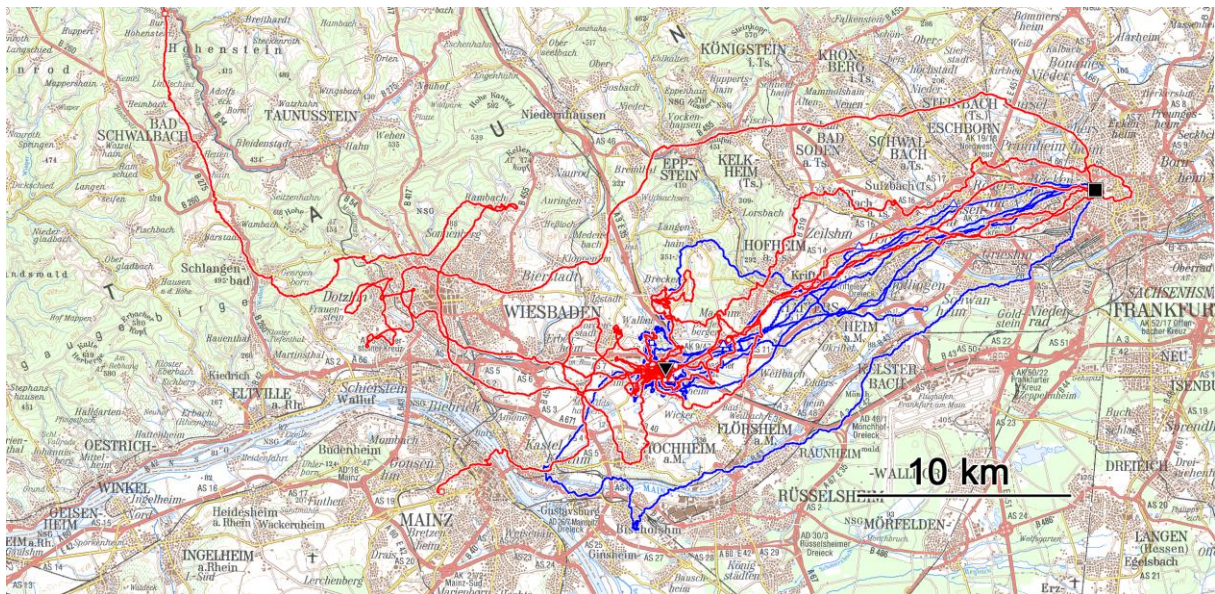


Fig. S1E. Tracks of pigeons familiar with the site, released for the second time at WAL, 21.5 km south-southwest of the loft, home direction 67°

Figures of the tracks with the short-term correlation dimension indicated

The following figures S2A–E give tracks of control and experimental pigeons separately. The release site is marked *blue* for the controls and *red* for the clock-shifted pigeons; the location of the loft is marked in *white*. The value of the short-term correlation dimension is indicated by the color of the tracks, see map legend.

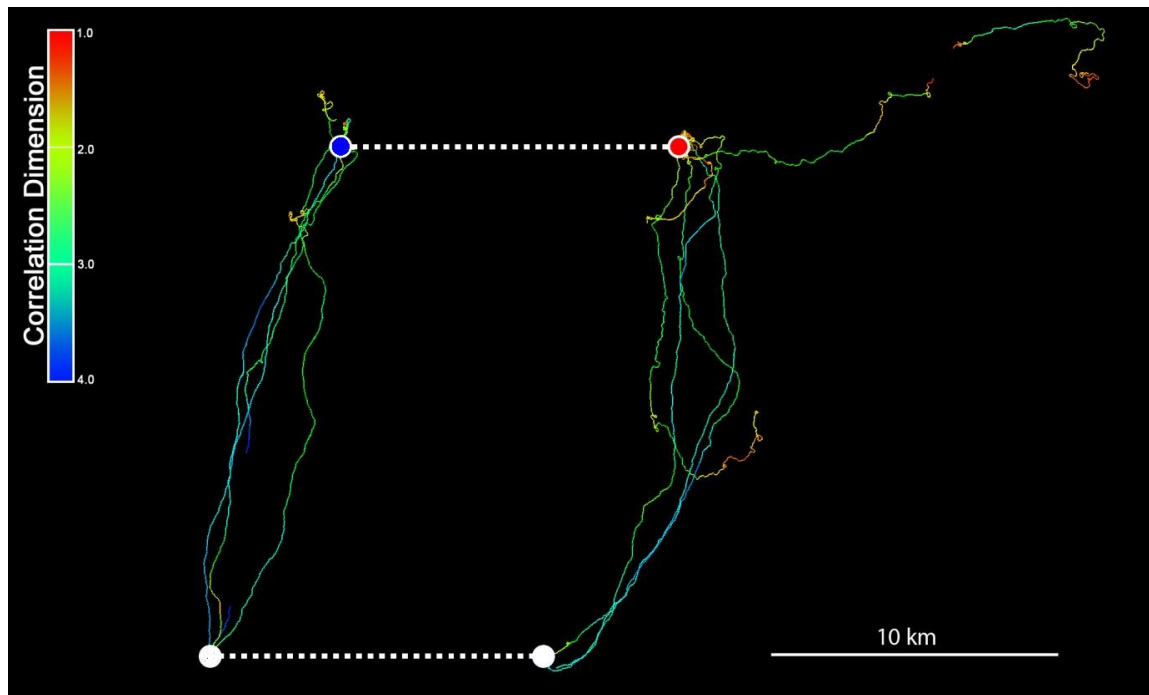


Fig. S2A. Tracks of pigeons released at RB, 19.2 km north of the loft, home direction 194°

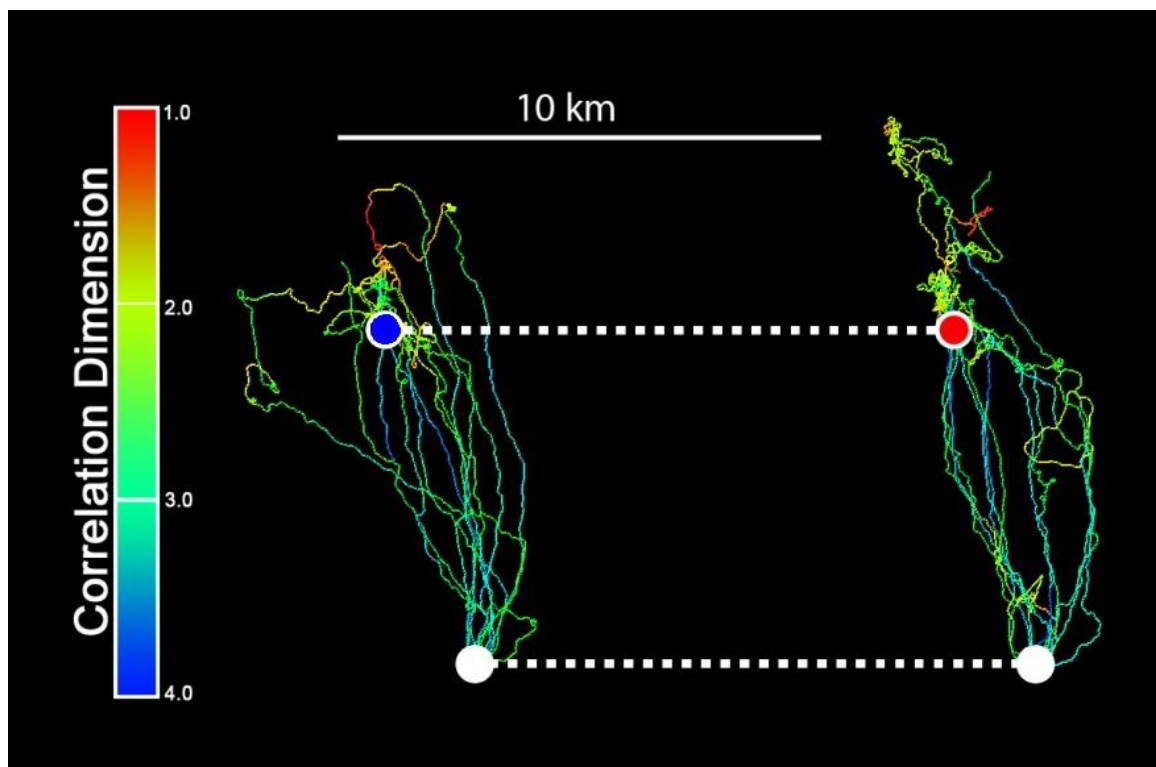


Fig. S2B Tracks of pigeons released in BH, 8.4 km north-northwest of the loft, home direction 167°

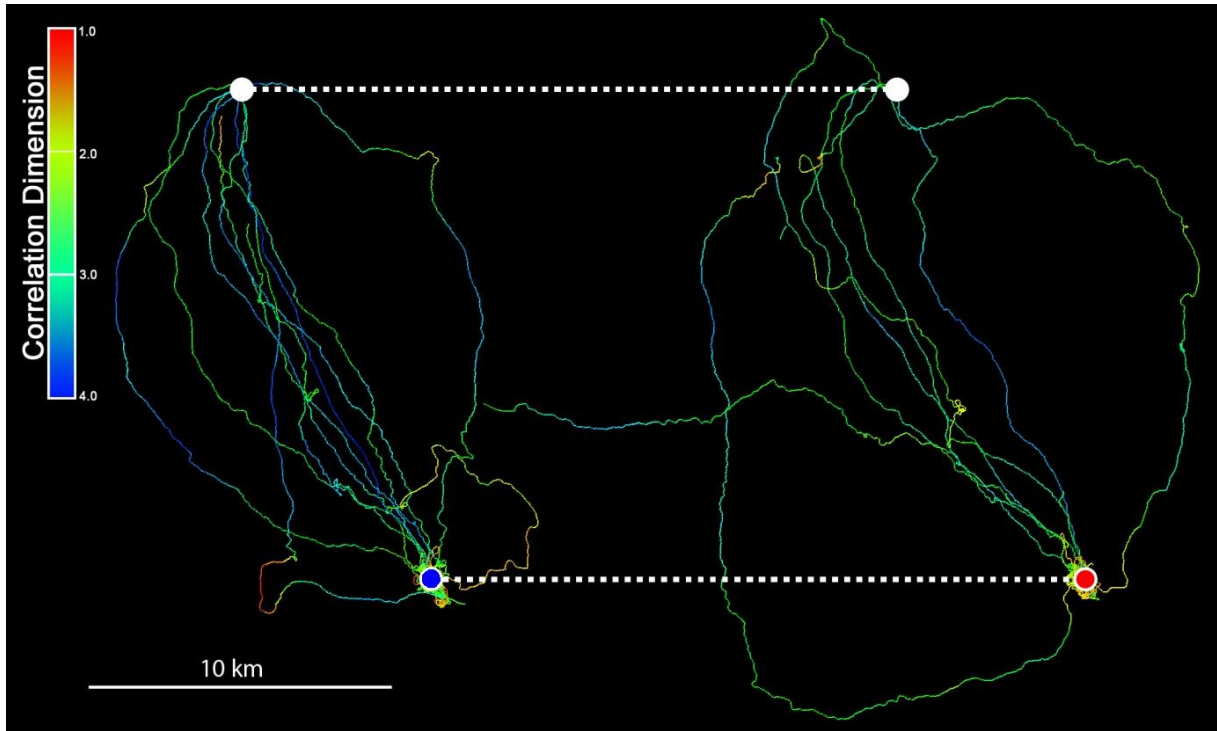


Fig. S2C Tracks of pigeons released at OT, 17.9 km southeast of the loft, home direction 338°

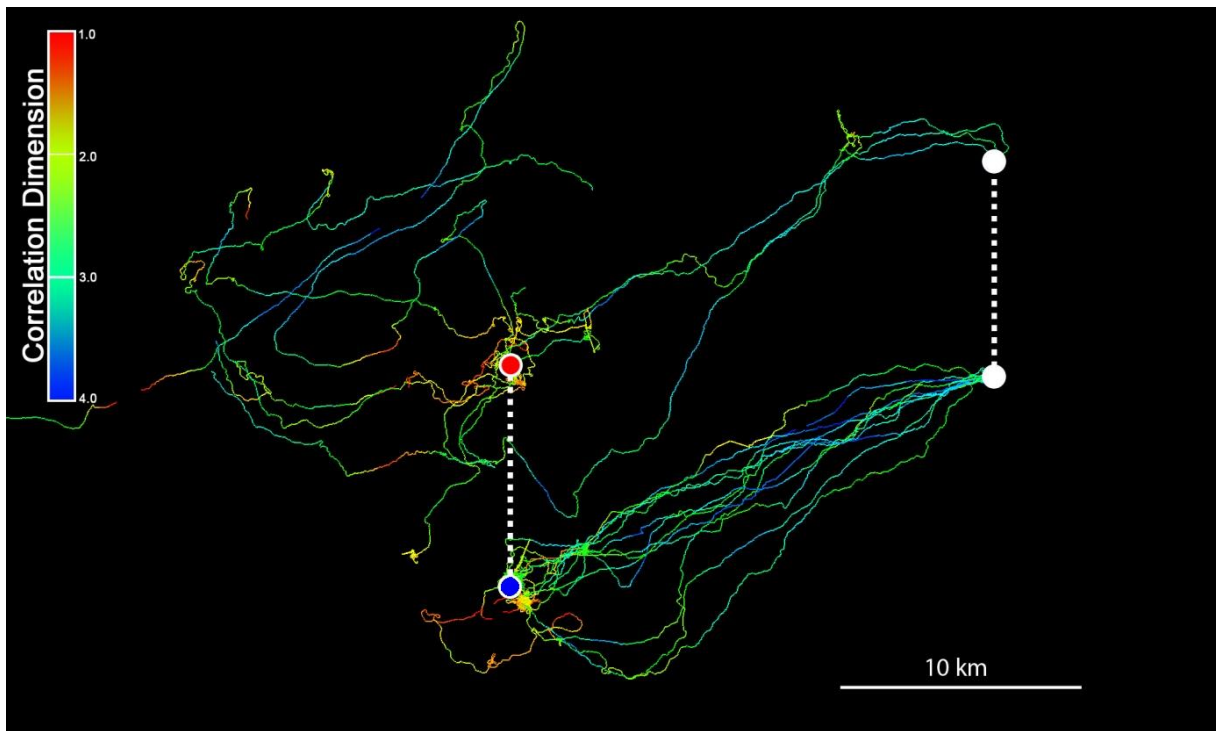


Fig. S2D Tracks of pigeons *unfamiliar* with the site, released for the first time at WAL, 21.5 km south-southwest of the loft, home direction 67°.

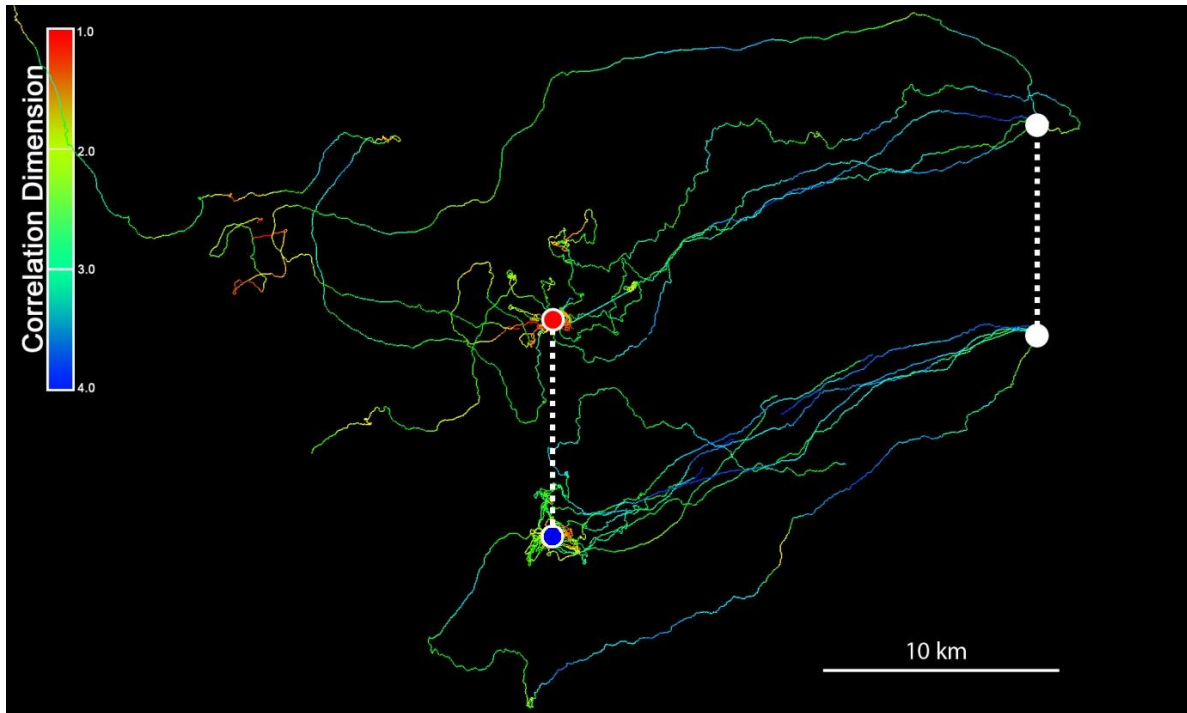


Fig. S2E Tracks of pigeons *familiar* with the site, released for the second time at WAL, 21.5 km south-southwest of the loft, home direction 67° .

Supplementary Table S1

Data from the various phases of the individual releases

site	tr.	Entire Track			n _b	Initial Phase					Departure Phase			Final Homing Phase			
		n _c	PoDs	eff.		dur.(s)	dist.(m)	Δh	r	stead.	Δh	r	stead.	n _h	Δh	r	stead.
BD	C	9	1.8	0.88	9	150	1342	- 12°	0.98	0.55	- 14°	0.93	0.91	10	+8°	0.99	0.88
BD	CS	5	2.4	0.81	6	128	597	- 132°*	0.45	0.36	-117°*	0.79	0.83	8	- 25°*	0.82*	0.78
RB	C	4	1.3	0.93	4	150	659	- 10°	0.74	0.31	+9°	1.00	0.87	4	+2	0.99	0.93
RB	CS	3	1.7	0.95	6	135	565	- 36°	0.84	0.31	- 30°	0.83	0.71	3	- 19	0.99	0.95
BH	C	9	1.2	0.86	10	135	1070	- 8°	0.33	0.40	- 9°	0.73	0.85	11	- 14°	0.99	0.84
BH	CS	6	1.3	0.87	7	195	1727	- 66°	0.54	0.23	- 35°	0.43	0.76	11	- 7°	0.98	0.87
OT	C	8	1.6	0.91	9	150	1292	- 39°	0.77	0.24	- 22°	0.91	0.82	9	-18	0.95	0.9
OT	CS	5	2.2	0.89	8	158	661	- 23°	0.91	0.30	- 30°	0.89	0.74	5	-29	0.98	0.89
WAL1	C	8	2.3	0.86	10	120	534	+23°	0.35	0.21	+22°	0.30	0.60	11	-10	0.99	0.85
WAL1	CS	3	3.7	0.84	10	165*	986	+143°	0.24	0.38	+172°	0.21	0.73	3	- 20	0.97	0.83
WAL2	C	4	1.5	0.77	9	165	1123	- 120°	0.62	0.27	+102°	0.32	0.58	5	-3	0.99	0.8
WAL2	CS	4	1.8	0.71	8	188	897	- 130°	0.85	0.24	- 58°	0.33	0.68	5	-13	0.98	0.78

Abbreviations: tr, treatment: C, untreated control pigeons; CS, pigeons clock-shifted 6 h fast. n_c, number of complete tracks; PoDs, mean number of Points of Decision; eff., median overall efficiency of complete tracks. n_b, number of tracks for which the initial phase and the departure phase could be analysed, n_h, number of tracks of which the final homing phase could be analysed. dur.(s), duration of the initial phase to the first Points of Decision in seconds; dist. (m), distance of the first Point of Decision from the release point in meters. Δh, headings with respect to the local home direction; r, vector length of the headings; stead., median steadiness of flight. Significant differences (P < 0,05) between clock-shifted and control pigeons are marked by an asterisk and indicated in bold.

Supplementary Table S2

ANOVA statistics of the short-term correlation dimension

The short-term correlation dimensions were compared for each site separately by a two way ANOVA with repeated measurements using a factorial design, with the independent factors being (a) experimental treatment, that is, control of clock-shift, and (b) distance from the release sites at which the short-term correlation dimension estimates were taken. When the ANOVA indicated significant differences, we used the Tuckey HSD test to look for differences between controls and clock-shifted pigeons. The test statistics are given in table S1 below

Results of Two way ANOVA for the short-term correlation dimension

Site	Df _w	Control v.s. Clock-shift			Distance From Release Site			Interactions		
		Df _b	F	Sig.?	Df _b	F	Sign?	Df _b	F	Sig.?
BD	355	1	5.94	*	45	2.945	***	34	1.397	n.s.
RB	582	1	22.26	***	38	2.751	***	38	0.447	n.s.
BH	583	1	0.05	n.s.	16	5.562	***	16	1.153	n.s.
OT	255	1	39.32	***	42	3.597	***	36	0.592	n.s.
WAL1	731	1	52.72	***	75	5.407	***	43	0.549	n.s.
WAL2	532	1	74.27	***	95	3.138	***	43	0.743	n.s.

Df_b, degrees of freedom between groups and Df_w, degrees of freedom within groups; F, F-Value of the Anova, with F(Df_b,Df_w), which in the case of F(1,x) is the same for the ANOVA and the Tuckey HSD test; significance levels: n.s, not significant; *, p<0.05; ***, p<0.001.