Initial orientation of homing pigeons: different sensitivity to altered magnetic fields in birds of different countries [1]

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Summary. In experiments performed in Italy, altered magnetic fields were effective in biasing the initial orientation of Italian pigeons but not that of German pigeons raised in Italy, suggesting a genetic difference between the two bird stocks.
Key words. Orientation; navigation; homing; pigeons; magnetoreception.

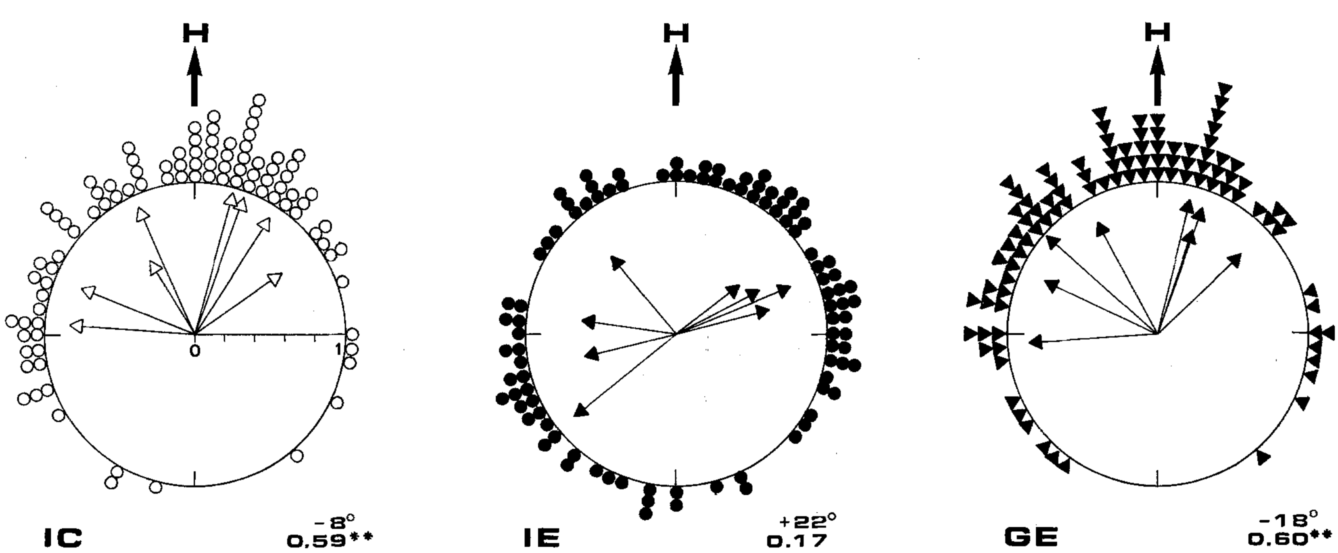
It has often been reported that the initial orientation of Italian pigeons can be influenced by exposing the birds to oscillating or to near-zero magnetic fields prior to the toss at unfamiliar sites. This result was obtained when the magnetic treatment was applied during the journey to the test site, when it was applied for 2–3 h at the release site prior to the actual toss or when applied at the home loft before the journey [2,3].

We have no satisfactory explanation for this effect. It seems unlikely that the observed bias in initial flight behavior was caused by interference with the pigeons' magnetic compass because the experiments were mainly performed on sunny days, when the sun compass was available. Interference with a hypothetical magnetic navigational system also seems to be excluded by the fact that the homing performance was not consistently affected, even when the birds carried a device altering the magnetic field across their heads [4–6]. We have to admit that the bias in the vanishing bearings induced by the magnetic disturbance was easily corrected by the pigeons soon after vanishing from the sight of the observer [7].

On the other hand, a long series of experiments performed in Italy and in Germany has been interpreted by the authors as evidence that olfactory information is an essential component of pigeon homing mechanism [8,9]. Altered magnetic fields, however, may prevent the birds from perceiving and/or processing the olfactory cues in the normal way, as indicated by the fact that magnetic treatments are effective only when the birds are simultaneously able to smell ambient odors [10]. This may be an indication of magnetic and olfactory cues being components of an integrated system.

This view, however, conflicts with the recent finding that German (Bavarian) pigeons, which depend on olfactory information for homing [9], are not influenced by altered magnetic fields. In the attempt to clarify the cause of this discrepancy, Bavarian pigeons were transported to Italy at the fledging time and raised there together with a group of Italian pigeons of a similar age. The two groups shared the same loft and were subjected to the same treatment (daily spontaneous flights but no training tosses). In September-October 1986, when the birds were roughly five months old, they were assigned to 3 treatment groups (IC, Italian untreated controls; IE, Italian experimentals; GE, German experimentals) and subjected to test releases at unfamiliar sites symmetrically arranged NNW and SSE of the loft (25–105 km). IE and GE were exposed to a randomly oscillating magnetic field for 3 h including the transportation to the release site (details of the experimental set up and treatment, and on technical procedures in collecting and analyzing vanishing bearings in refs 2, 3 and 11).

The results (in the figure and in table) show that the initial orientation of the IE group was strongly influenced by the treatment, in contrast with well homeward-oriented IC (pooled data, Watson U2 test: IE vs IC, $p < 0.001$). On the other hand, GE were not significantly different from IC but differed dramatically from IE (GE vs IC, $p > 0.1$; GE vs IE, $p < 0.001$).



Initial orientation in the experimental series; 8 experiments have been pooled with the home direction (H) set to 0°. In the three diagrams each inner arrow represents the mean vector of the bearing distribution obtained in a single experiment (the length of the vectors can be read using the scale in the 1st diagram). IC, IE and GE = untreated Italian controls, Italian and German experimentals, respectively. Numerical values (direction and length) of the second-order mean vectors are also given (asterisks indicate levels of significance using Hotelling's T2 test, according to the key given in the table). The symbols on the periphery of the circles represent the pooled vanishing bearings.

Results of the experiments

Date	Dis.	Dir.	Tr	n(N)	r	a	Hc	U2 Test IC vs IE IC vs GE IE vs GE
1) 11-9-86	25.0	176°	IC	12(12)	0.92***	209°	0.768***	–
			IE	12(12)	0.78***	229°	0.473**	–
			GE	12(13)	0.89***	196°	0.838***	–
2) 12-9-86	31.0	327°	IC	12(12)	0.81***	259°	0.303	–
			IE	12(12)	0.63**	223°	– 0.150	–
			GE	12(12)	0.86***	233°	– 0.064	–
3) 18-9-86	40.4	161°	IC	12(13)	0.96***	181°	0.906***	*
			IE	12(12)	0.83***	229°	0.316	–
			GE	12(13)	0.72***	180°	0.684**	*
4) 19-9-86	54.6	336°	IC	12(13)	0.91***	312°	0.831***	***
			IE	12(12)	0.87***	207°	– 0.544	*
			GE	12(12)	0.98***	287°	0.640**	***
5) 30-9-86	40.4	161°	IC	12(12)	0.97***	176°	0.939***	***
			IE	12(13)	0.92***	224°	0.411*	–
			GE	12(13)	0.91***	175°	0.887***	***
6) 3-10-86	54.6	336°	IC	12(13)	0.83***	250°	0.064	–
			IE	12(15)	0.63**	254°	0.089	–
			GE	12(12)	0.83***	271°	0.354*	*
7) 7-10-86	105.3	326°	IC	11(14)	0.57*	284°	0.419*	–
			IE	12(12)	0.66**	286°	0.505**	–
			GE	12(13)	0.84***	297°	0.732***	–
8) 10-10-86	51.0	152°	IC	12(14)	0.71**	207°	0.412*	–
			IE	12(14)	0.65**	228°	0.162	–
			GE	12(12)	0.77***	199°	0.522**	–

Dis. = Home distance (km), Dir. = Home direction, Tr = Treatment (IC = Italian controls, IE and GE = Italian and German experimentals, respectively); n and (N) indicate the number of bearings and of birds actually released, respectively; r and a indicate the length and the direction of the mean vector, respectively, Hc = Homeward component. Significance by the Raleigh test (r), by the V test (Hc) and by the Watson U2 test is indicated by asterisks: *, ** and ***, $p < 0.05$, $p < 0.01$ and $p < 0.001$, respectively.

Unfortunately, German untreated controls (GC) were not available. One might speculate that the initial orientation of GE could have been poorer than that of (unavailable) GC. This hypothesis, however, is improbable considering that this hypothetical result would require a group of GC significantly better than IC, whereas it has been shown that German birds raised in Italy behave like local pigeons[12]. The present results indicate that German pigeons, in contrast to Italian ones, are not significantly affected by the magnetic treatment.

This suggests the existence of a genetic difference between the two bird stocks, which had not been revealed in previous experiments in which only untreated German and Italian pigeons, raised in Italy and in Germany, respectively, were compared to local pigeons[12].

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