Pigeon homing and magnetic fields: a response to Luschi *et al.* (1996)

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This paper comments on an article 'Pigeon homing: evidence against reliance on magnetic information picked up en route at release sites' by P. Luschi, C. del Seppia, E. Crosio and F. Papi, which appeared in this journal. It is pointed out that the particular effects which these authors show to be stress-induced artefacts are restricted to their specific strain of homing pigeons. The same effects could not be observed in pigeons from two other lofts—a difference in response that was shown to have a genetic base. In view of this, conclusions drawn from the results of Luschi *et al.* must be restricted to their own findings; they cannot be generalized to the other findings which indicate the use of magnetic outward journey information in young homing pigeons.

Keywords: homing; stress; magnetic compass; oscillating magnetic field; *Columba livia*

Recently, P. Luschi, C. del Seppia, E. Crosio and F. Papi (1996) published a paper with the suggestive title 'Pigeon homing: evidence against reliance on magnetic information picked up en route at release sites'. The authors showed that pigeons that had been transported to the release site in irregularly oscillating magnetic fields or in total darkness were no longer homeward-oriented. Since treatment with the tranquillizer promazine cancelled these effects, the authors take them to be stress-induced—a logical conclusion. However, any further conclusion is impossible; in particular, it is not possible to expand the aforementioned conclusion to include the findings that indicated the use of magnetic information on the outward journey in young homing pigeons.

In 1978, we reported that very young pigeons were disoriented when displaced in an altered static magnetic field in the order of about the Earth's magnetic field intensity (R. Wiltshko & W. Wiltshko 1978). The fact that disorientation was observed only when the young birds were treated during displacement, but not when they were treated for the same period of time after arrival at the release site, showed that the treatment itself had no adverse effect; we concluded that it interfered with orientation by preventing the young pigeons from obtaining magnetic directional information during the outward journey (R. Wiltshko & W. Wiltshko 1978, 1985). This conclusion concurred with the observation that the effect was restricted to a very short phase in the development of the orientation system; it decreased rapidly when the birds grew older and began to develop a navigational 'map' (R. Wiltshko & W. Wiltshko 1985). The interpretation of the response to transportation in altered static fields based on the disruption of magnetic information is supported by recent findings involving transportation under various wavelengths of light (R. Wiltshko & W. Wiltshko 1998): young pigeons were disoriented only after being transported under the same light conditions that had

prevented migratory birds from using their magnetic compass (Wiltshko *et al.* 1993).

The effect of irregularly oscillating magnetic fields is fundamentally different from that described above on the static fields for the following reasons. (1) It is not limited to transportation. Birds treated with oscillating fields at the home loft, or at the release site, responded in the same way by showing large deviations from home and/or an increase in scatter (Papi *et al.* 1983). (2) The effect is not restricted to a transient phase in the young birds' development: it is also observed in older, more experienced pigeons (Benvenuti *et al.* 1982; Papi *et al.* 1983). These differences clearly indicate that the effect of irregularly oscillating fields is of a different nature.

An important point, however, is that the effect of the irregularly oscillating field is restricted to Italian pigeons. The same oscillating fields produced by the Italian coil system (which the Italian group had kindly provided) proved ineffective when pigeons of Wallraff's lofts in Germany (Wallraff 1980, 1986), and pigeons from our Frankfurt loft (Wiltshko, unpublished data) were treated. In order to learn the reasons for these differences in response, Benvenuti & Ioalè (1988) transferred nestlings of German stock to Italy and raised them together with young birds of Italian stock. Again, the birds of German stock proved unaffected by the oscillating fields, whereas their Italian foster-siblings showed marked deviations and/or an increase in scatter. The authors interpreted their data as indicating a genetic difference. In the light of the findings by Luschi *et al.* (1996), this means that the Italian strain of homing pigeon is genetically disposed to be more susceptible to stress.

A similar situation exists with regard to transportation in total darkness (see also Del Seppia *et al.* 1996). We (W. Wiltshko & R. Wiltshko 1981) had found that it caused disorientation in very young pigeons, which we attributed to a disruption of light-dependent processes of magneto-reception (Leask 1977), an interpretation that is supported

by the aforementioned findings on transportation of young pigeons under various wavelengths of light (R. Wiltschko & W. Wiltschko 1998). Being aware of the possibility of non-specific effects, we exposed pigeons at the release site to total darkness and found that their ability to orient was unaffected. Darkness itself therefore did not interfere with orientation. Transportation in darkness, like transportation in an altered static field, ceased to affect our pigeons as soon as they grew older and more experienced. Pigeons of the same age as the experimental birds of Luschi *et al.* (1996) were no longer affected (R. Wiltschko & W. Wiltschko 1985).

Thus, the two effects that Luschi *et al.* (1996) have shown to be caused by changes in the emotional state concern phenomena that are restricted to Italian pigeons of their particular strain. In contrast to the claim the authors make in their title, these findings have no bearing on our earlier results suggesting the use of outward journey information in very young pigeons. However, they have important consequences for all experiments concerning the pigeons treated with irregularly oscillating magnetic fields (e.g. Benvenuti *et al.* 1982; Papi *et al.* 1983; Ioalè & Guidarini 1985; Teyssèdre 1986; Wallraff *et al.* 1986), which must now be interpreted as reflecting a stress-related response. Aside from a number of unexplained points discussed by Luschi *et al.* (1996), three questions call for answers:

- (1) Treatment with regularly alternating fields produced responses that look different from what one might expect if they were merely stress-induced. At low frequencies, an effect was observed only with certain impulse shapes, but not with others (Ioalè & Guidarini 1985); at higher frequencies, the size of the induced deflection was closely correlated with frequency (Ioalè & Teyssèdre 1989). We used to regard these findings as reflecting specific interferences with magnetoreception (see R. Wiltschko & W. Wiltschko 1995)—must we attribute them now also to changes in the birds' emotional state?
- (2) Wallraff *et al.* (1986) reported that pigeons without access to atmospheric odours while treated with the irregularly oscillating fields were not affected. Does this mean that olfactory deprivation has the same effect as the tranquillizer?
- (3) The genetically based greater stress-susceptibility of Italian pigeons leads to the question to what extent can the Italian findings be generalized? In particular, it is striking that olfactory deprivation affects Italian pigeons to a much higher degree than pigeons from other countries (W. Wiltschko *et al.* 1987). Birds of Italian stock show marked deflections from controls and/or an increase in scatter, symptoms that are similar to the stress-related responses after treatment with oscillating magnetic fields. Since changes in the emotional state have been suggested as an alternative explanation for at least some of the phenomena observed after olfactory treatments (see R. Wiltschko 1996), it is important to learn how a tranquillizer would affect the behaviour of Italian pigeons that have been made anosmic.

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