GPS tracking of homing pigeons with monocular viewing: symmetrical deviations in initial orientation but asymmetries in homing performance

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The left and the right hemispheres in birds are supposed to contribute differently to visuospatial cognition. Because of a complete crossing of the optic tract and lack of a corpus callosum, monocular occlusion permits to block visual input to the contralateral hemisphere. Three previous studies using this technique have found results that were not always congruent (Ulrich *et al.*, Behav. Brain Res 104: 169-178 (1999); Diekamp *et al.* Behav. Brain Res. 136: 103-111 (2002) and Prior *et al.*, Behav. Brain Res. 154: 301-310 (2004). In Germany (1999, 2004), blocking either eye significantly prolonged flight times; but pigeons receiving optic input into the left hemisphere were less impaired, while such differences were not apparent in Italy (2002). Vanishing bearings were mostly biased towards the side of the open eye, but only one study reported a distinct lateralization of vanishing bearings, pigeons seeing with the right eye correcting the flight direction more rapidly than birds using the left eye.

In order to study the reasons for the prolonged homing times and their possible cerebral lateralization, we released a total of 30 pigeons from 3 different familiar release sites around Rome Italy, one of them in the Mediterannean sea. From each release site (distance to loft between 25 and 50 km) pigeons returned once with the left or right eye covered, and once with binocular vision, the order of conditions balanced. The flight paths of the pigeons were recorded by miniature GPS data loggers storing position of the bird at intervals of 1 sec.

Out of 30 pigeons, 17 were lost (1 binocular; 4 right-eye covered and 12 birds with occluded left eye) indicating more severe orientation problems of pigeons lacking visual input to the right hemisphere. Among the remaining pigeons with a complete data set, the initial orientation of monocular birds deviated towards the side of the open eye, approximately equally towards each side. Monocular birds also completed more loops (towards the side with eye-sight) than under binocular conditions. Once a direction was chosen, the monocular birds maintained a deviant course over many kilometers. Homing times were significantly prolonged because monocular pigeons took more and longer rests than under binocular conditions. When approaching the larger home area (radius of about 8 km), pigeons with binocular view practically never overshot that region but corrected the flight, often according to well-established landmarks. On the other hand, pigeons seeing with one eye only frequently overshot the home area, even when approaching it along a familiar route. Possibly, there was a trend of pigeons with the left eye covered to have more problems in the final approach.

Taken together, our study revealed an unexpectedly strong role of visual input to the right hemisphere in homing from familiar sites, evidenced primarily by losses of pigeons when released with the left eye covered, and then in more subtle impairments during the homing flight of those birds which had managed to return from all sites with the left eye occluded. At present, we can only speculate why this study revealed a critical role of visual input to the right hemisphere as contrasted to earlier studies (including ours) emphasizing left-hemispheric dominance.

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