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6. In our ongoing studies on human BAEP development, we have often observed what appear to be "reversals" in classification (normal or abnormal) on successive testing occasions. This is particularly true in the neonatal period and early infancy.
7. Of the 97 high-risk subjects, 55 were seen at Letterman Army Hospital and 42 were tested at the University of California School of Medicine (San Francisco) through the cooperation of the Follow-up Program.
8. Since most high-risk infants were connected to electrocardiogram and apnea monitors, the absence of electrical interference was assured before BAEP recording began. For both groups the ongoing electroencephalogram was continuously monitored for artifacts. In the presence of contamination, from any source, averaging ceased. An attempt was made to record from all subjects only during periods of quiescence.
9. In testing newborns (and particularly premature infants), we have observed that binaural stimulation substantially increases response resolution and waveform reproducibility. This greatly facilitates wave identification in the neonatal period. In contrast, monaural stimulation produces much more variable responses. Although monaural deficits could be obscured in binaural recordings, such effects were minimized through regular audiological evaluations.
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11. Wave V amplitude actually refers to the IV-V complex.
12. All computations were implemented with the university's computer (IBM 370/148) through the aid of the Scientific Computing Service and the SAS statistical package.
13. Six of the high-risk infants initially yielded no measurable BAEP. Two were later confirmed to be deaf. Data from one infant were not usable because of technical problems. Therefore, 90 high-risk infants were actually included in the analyses. Only two of these were found to have mild hearing loss at follow-up. Thus, approximately 8.25 percent of our high-risk population had or were suspected of having some auditory deficit. This figure is in keeping with the expected incidence of hearing loss among intensive-care nursery survivors [R. Galambos and K. E. Hecox, *Otolaryngol. Clin. N. Am.* **11**, 709 (1978)]. By eliminating these subjects, severe congenital hearing loss may be ruled out as a major contributor to the observed group differences.
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17. Despite the high between-subjects variability often observed for BAEP amplitude, the relatively low within-subject variability and known systematic age effects make response amplitude suitable for developmental or longitudinal analyses [(*16*); A. Salamy, C. Birtley-Fenn, M. Bronshvag, *Dev. Psychobiol.* **12**, 519 (1979)]. Further, our studies on discrete brainstem lesions indicate that abnormalities in the amplitude, latency, or both may occur for a given wave in a given patient. Thus, the measurement of both amplitude and latency provides a more complete assessment of brainstem function.
18. Multivariate analyses of variance confirmed significant ($P < .01$) differences in the BAEP between normal and high-risk infants at selected ages from birth to 1 year. [A. Salamy, T. Mendelson, W. H. Tooley, E. R. Chaplin, *Early Hum. Dev.* **4** (2), 179 (1980)].
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Goal Orientation by Blindfolded Humans After Long-Distance Displacement: Possible Involvement of a Magnetic Sense

Abstract. *A wide range of animals are able to orient toward home when subjected to displacement-release experiments. When comparable experiments are performed on blindfolded humans, a similar ability emerges. Such goal-orientation does not result from following the complete journey on a mental map, nor is it influenced by cloud cover. Bar magnets worn on the head do seem to exert an influence.*

A wide range of animals are able to orient toward home when experimentally displaced from that home and either released or tested in an orientation cage. Among animals that have been subjected to such displacement experiments and shown able to orient toward home are lobsters, snails, honey bees, fish, amphibians, turtles, rodents, bats, and, of course, birds (*1*). Human subjects are notably absent from this list. This report describes displacement experiments over tens of kilometers on blindfolded humans, in which they demonstrated an ability for homeward orientation.

The major experimental series was carried out in and around Manchester, England. "Home" was Manchester University. Groups of between 5 and 11 university students who had been living in Manchester for 2 years were placed in a Sherpa minibus, blindfolded, and then driven by a tortuous route to a release point between 6 and 52 km from the university (Fig. 1). Subjects were asked not to talk. The first 8 km of the outward journey were always the same and to the south southeast. This initial stage of the journey terminated at a major roundabout which was then driven round three times before a particular exit road was selected. On at least one other occasion during each journey, a similar maneuver was executed at another roundabout, as available. Also, on at least one occasion during each journey, an area of short, twisting roads with frequent junctions (for example, a housing development) was selected and driven through for 5 minutes. Most journeys also involved a section in which the road curved gradually through 50° or more. Backtracking, however, was used only for release site a (Fig. 1).

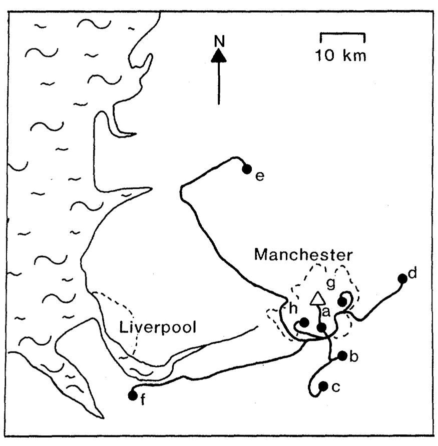

Fig. 1. Release sites and displacement routes during the Manchester experiments. Symbols: ●, release sites (*a* to *h*); △, home (Manchester University).

At the release point for each journey, individuals were removed from the minibus one at a time and, while still blindfolded, asked to state the compass direction (north, southwest, east southeast, and so forth) of the release point from the university. The use of these 16 compass directions to identify direction may generate noise in the data through subjects confusing north and south, or particularly east and west. However, this only makes homeward orientation more difficult to demonstrate.

In all, this first experimental series included ten separate journeys to eight dif-

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Table 1. Lack of effect of three factors on goal orientation by blindfolded humans.

Factor	N	Rayleigh's z test			Watson's $U^2_{n,m}$ test	
		θ	r	P	$U^2_{n,m}$	P
Distance of release (km)						
7	13	4°	.78	< .01	0.101	> .10
52	8	3°	.92	< .01		
Familiarity						
Familiar	9	31°	.58	< .05	0.060	> .10
Unfamiliar	60	15°	.55	< .01		
Sunshine during outward journey						
> 90 percent	60	15°	.55	< .01	0.134	> .10
0 percent	21	4°	.34	< .01		

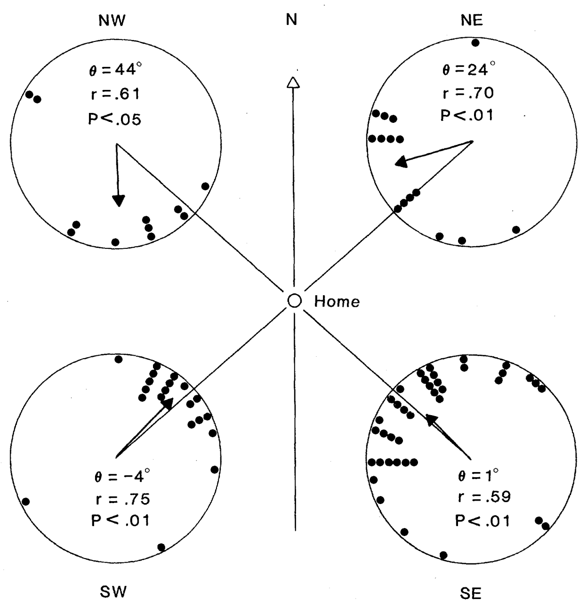
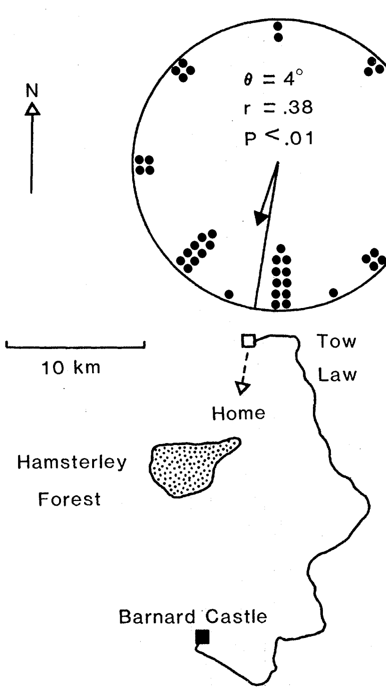


Fig. 2. Homeward orientation by blindfolded humans after displacement to release sites in four different compass quadrants relative to home. Home direction is shown by a radius leading to the central circle. Symbols: ●, estimate of home direction (relative to home direction at each release site) by a single individual; →, mean vector (2). Orientation was significantly nonuniform (Rayleigh's z test) and significantly clustered about the home direction ($P < .05$; V test) from all four quadrants: SW (sites f and h in Fig. 1); NW (site e); NE (sites d and g); and SE (sites a, b, and c). Sites a, b, and c were each visited twice, with different groups of students. Although group sizes were small (six or seven), these revisits give some indication of the reproducibility of mean angles. Results were: a (−10°, 0°); b (+58°, +12°); and c (−84°, −37°).

ferent release sites; 64 individual subjects, of which 36 were male, took part. A few subjects went on two journeys. Altogether, the series produced 86 individual estimates of home direction (Fig. 2).

At the suggestion and under the supervision of Yorkshire TV, a second set of two experiments was also carried out. Location, experimental subjects, and equipment were all chosen by the television company and were unknown to the author until the day of the experiment. In the first of the two experiments, carried out on a single day, 42 sixth-form students (16 and 17 years old) from two adjacent schools in Barnard Castle, Durham County, England, were blindfolded and transported by coach to a release point 22 km and 15° east of due north from the school. The outward journey was about 40 km long and was in the form of a dogleg (Fig. 3) beginning with displacement to the south and southeast. The roundabout maneuver was again included, this time 30 km into the journey. Upon arrival at the destination the subjects were asked, while still blindfolded and without leaving the coach, to write on a card their name and an estimation of the compass direction of the release point from Barnard Castle. The cards were collected before the blindfolds were removed.

For each set of estimates of home direction, I calculated the mean vector defined by (r, θ), where r is the vector length and θ the mean angle from the true direction (2). Nonuniformity was tested



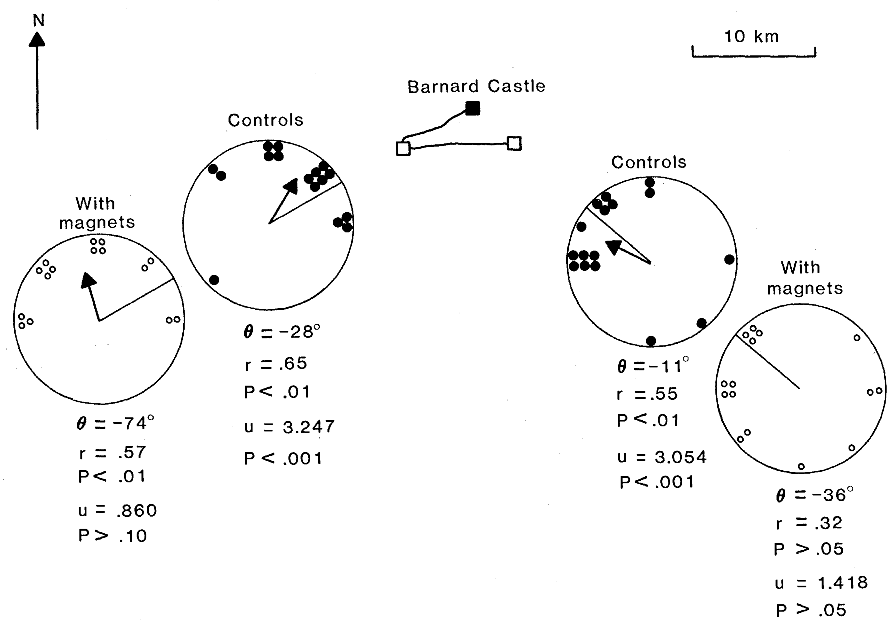


Fig. 3 (left). Release site, route and results for the first Barnard Castle experiment. Line indicates displacement route; □ indicates release site. Other conventions are as in Fig. 2. Fig. 4 (right). Possible influence of bar magnets on homeward orientation in second Barnard Castle experiment. Wavy line indicates displacement route; □ indicates test site. Other conventions are as in Fig. 2. Mean vector is shown only when the distribution is significantly nonuniform at the 5 percent level (Rayleigh's z test[2]).

with Rayleigh's z test and clustering about the home direction was tested with the V test [test statistic = u]. In Table 1, Watson's $U^2_{n,m}$ nonparametric two-sample test has been used to compare estimates made under different conditions of cloud cover, distance, and familiarity.

In Fig. 2, the Manchester data are grouped to show results for releases in four compass quadrants relative to the home site. The results of the Barnard Castle experiment are shown in Fig. 3; humans have an ability to recognize homeward direction even in the absence of visual cues.

The subjects themselves could give no convincing description of the mechanism they used during the experiment. A few claimed to have followed the outward route for a short distance (approximately 2 to 5 km) on a mental map of the area, but then to have become lost. On sunny days, some claimed also to have used the sun as a reference point by detecting the heat of the sun on the face. Most, however, were surprised when their guess was so near the correct direction.

Evidence can be presented that neither the use of solar cues nor map following was the primary method of orientation in these experiments. The dogleg technique prevents subjects from extrapolating from the direction of the first part of the route with which they may be familiar. Moreover, there was no indication of decreased accuracy of orientation with distance over the range tested (Table 1). Finally, individuals that were familiar with the release site (that is, upon removal of the blindfold claimed to have visited the area before and could name the location to within 2 km) were not more accurate when blindfolded than individuals unfamiliar with the release site (Table 1). As far as the use of the heat of the sun on the face during the outward journey is concerned, homeward orientation occurred both when displacement was under total overcast throughout and when it occurred under more or less continuous sunshine (Table 1).

The second Barnard Castle experiment examined in a preliminary way the possibility that goal orientation in humans may be influenced by perturbations in the magnetic field through the head. Under totally overcast conditions, 31 subjects were taken through a second dogleg displacement of 16 km to release points 5 km southwest (238°) and 5 km southeast (125°) of the home site. Subjects were not allowed to remove their blindfolds after making their estimates at the first site and were given no indication of the correct position. The roundabout maneuver was excluded from this journey, but the first 2 km were extremely tortuous, involving many twists and turns through the town center.

Before the experiment began, 15 experimental subjects placed at the backs of their heads bar magnets held in position by the elastic of their blindfolds. Each of the remaining 16 controls placed brass bars of dimensions 7.5 by 1.5 by 0.5 cm (similar to the real magnets) in the same position. All subjects thought they were wearing real magnets.

The results of this experiment are presented in Fig. 4. At both sites, the estimates made by the control subjects wearing brass bars were significantly clustered about the home direction (as evaluated by V tests). At neither site, however, was this true for the experimental subjects wearing magnets. This result suggests some influence of the bar magnets on orientation. Full evaluation is impossible, however, as (i) the bar magnets were not of uniform strength, having pole strengths that varied from about 140 to 300 G; (ii) the position and orientation of the magnets on the head could not be standardized, for, although positioned initially with the north pole up, they tended to twist around and slip from the elastic as the journey progressed; and (iii) seating could not be arranged to prevent control subjects from being influenced by the magnets worn by experimental subjects and at the same time to prevent interaction between the fields generated by adjacent experimental subjects. Despite these shortcomings in experimental design, the results were sufficient to encourage the design of an experimental series using Helmholtz coils to test the possible influence of the magnetic field on the goal orientation of blindfold humans (*3*).

R. ROBIN BAKER
Department of Zoology, University of Manchester, Manchester, M13 9PL

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4. I thank all those students who cooperated as subjects in these experiments and Yorkshire Television and D. Bellamy for organizing and financing the Barnard Castle experiments. Comments by the late Professor William T. Keeton and by C. Walcott on an early draft of this work, as well as by anonymous reviewers, improved this report considerably.

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Medial Nucleus of the Amygdala Mediates Chemosensory Control of Male Hamster Sexual Behavior

Abstract. *Bilateral lesions restricted to the medial nucleus of the amygdala eliminate mating behavior in the male hamster and severely diminish the male's sniffing and licking investigation of the female hamster's anogenital region. The results suggest that olfactory and vomeronasal sensory information critical to male mating behavior is processed in the medial nucleus, which is an androgen-binding brain area. Thus the medial nucleus may act as a relay through which chemosensory information influences activity in the medial preoptic–anterior hypothalamic junction and the bed nucleus of the stria terminalis, areas important in the mediation of male sexual behavior.*

The amygdala has long been viewed as a modulator of affective behavior and neuroendocrine function (*1*). It has been suggested, for example, that the amygdala provides an appropriate "affective bias" in response to those conspecific and environmental stimuli, and endogenous hormonal cues, which govern normal social interactions (*2*). This hypothesis is based in part on well-established observations that extensive amygdaloid lesions dramatically alter male sexual behavior in human and other vertebrates (*3*). Neuroanatomical studies, however, have emphasized major differences in the afferent and efferent connections of individual nuclei in the amygdala (*4, 5, 5a*), and consequently suggest the need for a more detailed analysis of amygdaloid function. We now present evidence, from the male Syrian hamster, that the integrity of one particular nucleus of the amygdala, the medial nucleus, is necessary for normal male mating behavior to occur. On the basis of our results and evidence from neuroanatomical and hormone uptake studies, we suggest that the medial nucleus in this species may act as an androgen-sensitive site of integration of chemosensory information, which influences preoptic area activity and the display of male mating behavior.