membranes, and alter protein–protein interactions[12,14–17]. The *O*-palmitoyl structure described here may have specific significance for the action of this class of toxins. It is even conceivable that the lipid moiety allows toxin to penetrate membranes and act at an intracellular site[19]. The specific molecular mechanism of action of PLTX-II is not yet known, but components of *Plectreurys* venom are allosteric, noncompetitive inhibitors of ω-conotoxin binding in vertebrate brain[5].

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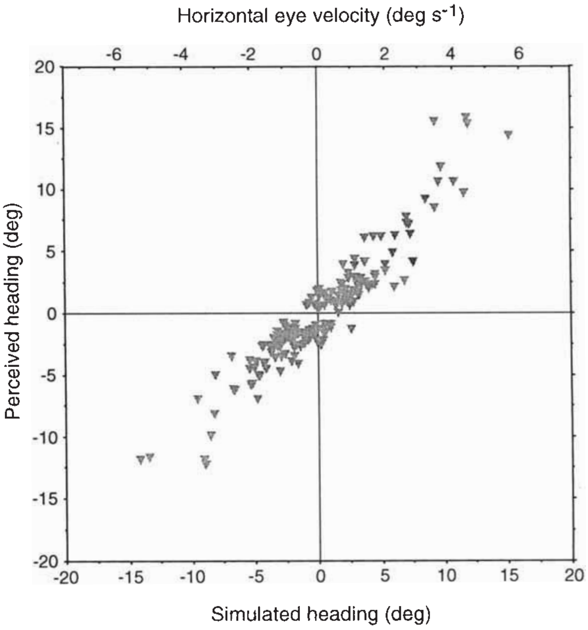
Scientific Correspondence

Scientific Correspondence is a relatively informal section of *Nature* in which matters of general scientific interest, not necessarily those arising from papers appearing in *Nature*, are published. Because there is space to print only a small proportion of the letters received, priority is usually given according to general interest and topicality, to contributions of fewer than 500 words, and to contributions using simple language.

Perception of heading

SIR — Royden *et al.*[1] demonstrate that people can accurately perceive their direction of heading across the ground plane while they pursue a moving object with their eyes. When the same retinal motion is presented to stationary eyes, large errors in perceived heading occur. The latter result is in conflict with earlier findings[2,3] that the heading percept is equally accurate in both conditions. Royden *et al.* conclude that the different outcome is caused by their use of 2–5 times faster simulated eye rotations as compared to those in ref. 2. If true, the visual stimulus alone is not sufficient for heading perception during natural locomotion; extra-retinal signals are required to perceive heading when making eye movements.

In the earlier studies[2,3], the fixation point was part of the rigid environment rather than an independently moving object. To exclude this difference as the cause for the conflict, Royden *et al.* demonstrated that subjects also could not perceive the direction of heading when they had presented to their stationary eye the retinal flow during forward motion through a rigid cloud of points, of which one was fixated. This demonstration is flawed because it confounds the effects of the layout of the points (planar in the main experiment and a cloud in the control experiment) and the motion of the fixation point. People do accurately perceive their direction of heading when fixating a point in the ground plane, even when the average simulated eye rotation is 5° s^{-1} (ref. 3) (see figure). This rotation rate is close to the maximum eye rotation used by Royden *et al.* In agreement with their results, heading perception during simulated eye rotation was grossly inaccurate when motion through a cloud of points was presented[3].



Perceived heading of one observer for motion across a plane of 256 randomly positioned white points. Forward motion of the observer (3 m s^{-1}) and the eye rotation required to fixate one red point in the plane were simulated in the display. This point was presented at the centre of the screen (dimensions: 60° horizontally; 50° vertically) and fixated by the subject. Each trial started with presentation for one second of the stationary scene followed by 0.83 s of motion. The simulated distance of the fixation point was initially 8 m. Initial eccentricity of the heading direction was varied between 0.25 and 10°. Subsequently, a probe appeared that the subject could move in the plane of dots along a circle through the fixation point that was concentric with the subject's feet. The subject pointed with the probe in the direction of heading. Indicated in the figure are the perceived and the simulated heading directions at the end of the motion sequence relative to the fixation direction. The direction of heading was perceived accurately up to about 15° eccentricity. As indicated in the upper scale the average horizontal eye rotation may exceed 5° s^{-1}. Although the scatter in the perceived heading increases for larger eccentricity, there is no indication that the perceived heading was biased towards the fixation point. The threshold for heading discrimination as estimated from the scatter would vary between 1 and 2.4°, depending on the average eye rotation.

Contrary to Royden *et al.*, I believe that the visual stimulus by itself is generally sufficient for perception of heading when making eye movements during locomotion, provided that the fixated target is part of the rigid environment. Current models for heading perception that visually decompose the retinal flow into a component due to the rotation and a component due to the translation of the observer would not predict such a requirement for the fixated object. In this respect, the new result[1] questions the validity of these models.

Although extra-retinal signals may not be required for heading perception in many cases, there is evidence that these signals can contribute to the heading percept. Information concerning heading is degraded for motion towards a fronto-parallel plane and when many noisily

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moving objects are in view[3]. Heading perception is much more robust for adverse conditions such as these[2,3], when the subject makes real rather than simulated eye movements.

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Time for tea

SIR — M. Spiro and D. Jaganyi (*Nature* **364**, 581; 1993) suggest that a chemical reaction takes place between tea and the suspension of calcium carbonate present in boiled hard water. I believe, however, that the main process taking place is physical adsorption of the coloured tannin from the tea on to the surface of the fine suspension of calcium carbonate that then settles on the surfaces of teapots and cups as a brown stain. Any chemical reaction is negligible. It is common practice for tea drinkers to add citric acid in the form of a slice of lemon to remove the calcium carbonate and prevent the formation of a stain.

I have extended the process by adding a small quantity of citric acid crystals to the hard water before boiling. The calcium bicarbonate hardness is converted into soluble citrate and no precipitate is produced after boiling.

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Velocities in the mantle

SIR — The Scientific Correspondence[1] from Wright quoted my News and Views article[2] out of context, and its complaints were unwarranted. My article, about the recent results of Vidale and Benz[3], explained that while regions of anomalously fast seismic compressional (P) and shear (S) velocities have been found in many places at the base of the mantle with many different data sources, the fast P-velocity core–mantle boundary feature found by Vidale and Benz was in a region (beneath Alaska) that had previously revealed slow P velocities[4–6]. Material exhibiting fast P-wave velocities certainly exists at the base of the mantle, but it was not expected in this region. The statement that led to confusion, "The results are all the more intriguing because they do not occur with previous studies", was therefore meant in a regional and not a global context.

Wright interprets this sentence as an implication that no other regions of fast seismic velocities had ever been found, says that my statement is incorrect, and cites some examples of his own work in which he found fast seismic zones at the base of the mantle in other parts of the world. His comments are unjustified, because the rest of the paragraph in my News and Views that contains the above quote lists nine other studies within the past 6 years in which fast seismic zones at the base of the mantle are reported. I am well aware, and made it clear, that the base of the mantle can display high-velocity zones. I certainly recognize the contributions that Wright has made to this subject, but point out that News and Views articles are intended to put pieces of current research into context. They are not designed to give a thorough historical background to the subject, nor could this be done with a dozen or fewer references.

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OH in Saturn's rings

SIR — The presence of the hydroxyl radical (OH) near the inner satellites of Saturn is not unexpected as the adjacent moons and rings are predominantly water ice. Nevertheless, the discovery[1,2] of OH is surprising because the amount observed implies a production rate of the H_2O parent molecule 20 times greater than theoretical calculations would suggest[1]. Typical sources for circumplanetary H_2O include collisions of interplanetary micrometeoroids into inner satellites and rings, and sputtering of these objects by ions and neutral particles. To account for their observations, Shemansky *et al.*[1] suggest that the interplanetary micrometeoroid flux to the saturnian system could be 20 times greater than currently believed. But such an increased flux would dramatically shorten lifetimes for the main saturnian rings to darken, for the rings to spread by angular momentum transfer and for ring particles to erode, which would make theories of the rings' primordial origin untenable. Instead, we suggest that H_2O is primarily produced by collisions of E-ring grains into the inner satellites of Saturn.

The faint E ring is composed of micrometre-sized icy debris, which is thought to be chips off the inner saturnian satellites[3,4]. The orbits of these tiny grains are strongly perturbed by the non-gravitational forces of electromagnetism and radiation pressure, which cause initially circular orbits periodically to become highly elliptical[3]. These elongate paths bring E-ring grains across the nearly circular orbits of the inner satellites so that an average E-ring grain will strike one of the moons with a typical velocity of about 2.5 km s^{-1} in about 20 years. These hypervelocity impacts eject relatively large amounts of vapour and sub-micrometre-sized debris into orbit around Saturn.

We now compare the relative importance of the E ring and interplanetary micrometeoroid contributions to the production of H_2O. Using values from refs 5 and 6, the total mass fluxes to the satellite Enceladus are estimated as follows:

$$\begin{gathered}\text{Interplanetary micrometeoroid flux:}\\ \text{(IP flux density) (area of Enceladus)} =\\ (4.5 \times 10^{-17}\,\text{g cm}^{-2}\,\text{s}^{-1})\,\pi(250\,\text{km})^2 =\\ 0.088\,\text{g s}^{-1}\end{gathered}$$

$$\begin{gathered}\text{E-ring particle flux:}\\ \text{(mass of E ring)/}\\ \text{(collisional timescale with Enceladus)} =\\ (7 \times 10^{11}\,\text{g})/(20\,\text{yr}) = 1{,}100\,\text{g s}^{-1}\end{gathered}$$

it is seen that the flux of E-ring grains to Enceladus exceeds the nominal flux of interplanetary micrometeoroids by a factor of about 10,000. Even after accounting for the larger collision speeds of the interplanetary particles (about 25 km s^{-1}), we predict that the E-ring grains will produce collisional products at least 100 times more efficiently than their interplanetary counterparts.

Mutual collisions among E-ring particles also occur relatively frequently and at high velocity. These grain–grain collisions further enhance the efficiency at which micrometre and sub-micrometre-sized collisional products are converted into H_2O vapour. Incorporating E-ring particles into gas production calculations, we find that the amount of material blasted from the satellites is sufficient to account for the missing factor of 20 in the water production rates.

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