unilateral neglect, so this delay in time over which visual selection operates may be an inherent part of the neglect syndrome. In patients with visual neglect there is an abnormally long period during which the mind is temporarily 'blind' to new stimuli.

The new results indicate that the clinical pattern of neglect can derive from two sources — a spatial bias in selecting visual information (favouring the ipsilesional side) and a prolonged period over which selection occurs. In other words, it takes an abnormally long time for stimuli at the neglected location to be selected by attention, so whilst one process is still being selected, attention cannot be focused on the next stimulus that occurs. It may well be this prolongation of the time for selection that leads to the problems such patients encounter in everyday life, when they fail to respond to objects on the contralesional side. For example, if selection is prolonged for all stimuli and there is also a bias to select an ipsilesional stimulus, then contralesional objects may be missed (particularly if they appear for brief durations). To account for everyday behaviour and associated clinical impairments in that behaviour, it is vital to understand how vision operates over time as well as space, and to acknowledge that temporary mind blindness can be as debilitating as more sensory deficits.

Several questions remain. For example, at present we do not fully understand why visual selection takes time and why this time period may be extended in neurological patients. It could be that time is required to 'bind' visual features together[7], or it may be that selection is based on synchronized firing of neurons, which requires time to take effect[9]. Brain damage may disrupt feature binding or temporal synchrony in neural firing. The answers should provide us with fundamental knowledge concerning the processes that underlie our seemingly instantaneous experience of the visual world. ☐

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CARBON CYCLE

Microbial breathing lessons

David L. Kirchman

In a recent article in *The New York Times*, Stephen J. Gould barely stifled a yawn over descriptions of evidence of past life on Mars, arguing that we should not be surprised that bacteria could have once flourished on the Red Planet given that they have been so successful on Earth. According to Gould, it has been the Age of Bacteria since life's beginnings about 3,500 million years ago.

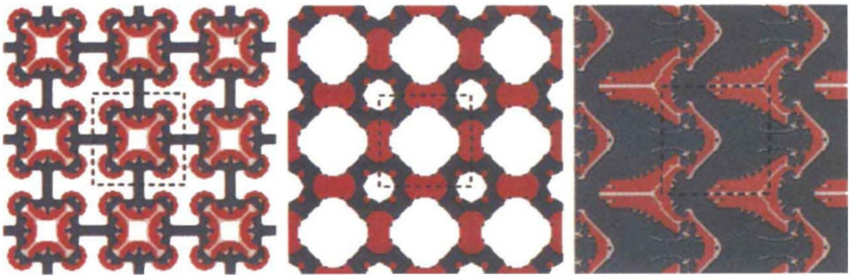
Perhaps the report by del Giorgio *et al.*[1], which appears on page 148 of this issue, will surprise even those who are well aware of the preponderance of bacteria on Earth. The authors come to a disarmingly simple conclusion. Respiration by bacteria exceeds plant production in aquatic systems when production is low — that is, carbon going out can sometimes exceed carbon coming into aquatic biota.

It is hard to imagine an observation with more ramifications for understanding the biogeochemistry of lakes and oceans. For starters, an imbalance between bacterial respiration and plant production would lead to net production of CO_2 and consumption of oxygen, which in turn affects just about everything in nature. Taken at face value, it also implies that there is not enough plant production in some waters to feed even all bacteria, much less other organisms. If so, it may be easier to understand life on Mars than the existence of life forms higher than bacteria in some of Earth's lakes and oceans.

Explaining how higher life forms can survive is easy for ecologists, once they know what happens to the carbon fixed by terrestrial plants and phytoplankton (primary production). In aquatic environments, much of phytoplankton carbon is fated to be eaten or to sink and to be buried eventually in sediments, but some primary production is also converted to dissolved organic matter (DOM) which is used mostly by heterotrophic bacteria. Uptake of DOM fuels production of bacterial biomass, which in turn supports a microbial food web and eventually larger organisms. Reports of high rates of bacterial respiration[2] appeared when this world of aquatic heterotrophic bacteria was being discovered some 20 years ago. But microbial ecologists have paid more attention to bacterial production than to respiration, one reason being that it is easier to measure production.

The paper by del Giorgio *et al.* brings our attention back to bacterial respiration by examining published studies of bacteria

Fit-to-shrink materials



Can a structure made from ordinary materials shrink when heated? Yes, if you add some empty space.

The pattern on the left, made from hypothetical materials of high (red) and low (blue) positive expansivity, has an overall negative thermal expansivity. Each cell scrunches up, with the solids occupying some of the void, and the whole thing gets denser. The volume fractions of each material are fixed.

It was designed using an iterative finite-element method (O. Sigmund & S. Torquato *Appl. Phys. Lett.* 69, 3203–3205; 1996), which can similarly optimize other thermal and mechanical properties. In the centre is a structure designed to expand with as much force as possible. On the right, a stranger shape results from relaxing the geometrical constraints. Here the materials correspond to nickel and Invar. On heating, this pattern contracts with the greatest possible force.

According to the authors' unpublished calculations, arbitrarily high contraction or expansion can be achieved, albeit at the cost of vanishing stiffness. (Such flimsy structures are unlikely to be practical on Earth, but might they find uses in the zero-gravity environment in orbit?)

The designs shown here could be made on the micrometre scale by ordinary lithography and micromachining techniques. And although three-dimensional structures might be trickier to manufacture, the authors plan to design 3D sensors and actuators too.

Stephen Battersby