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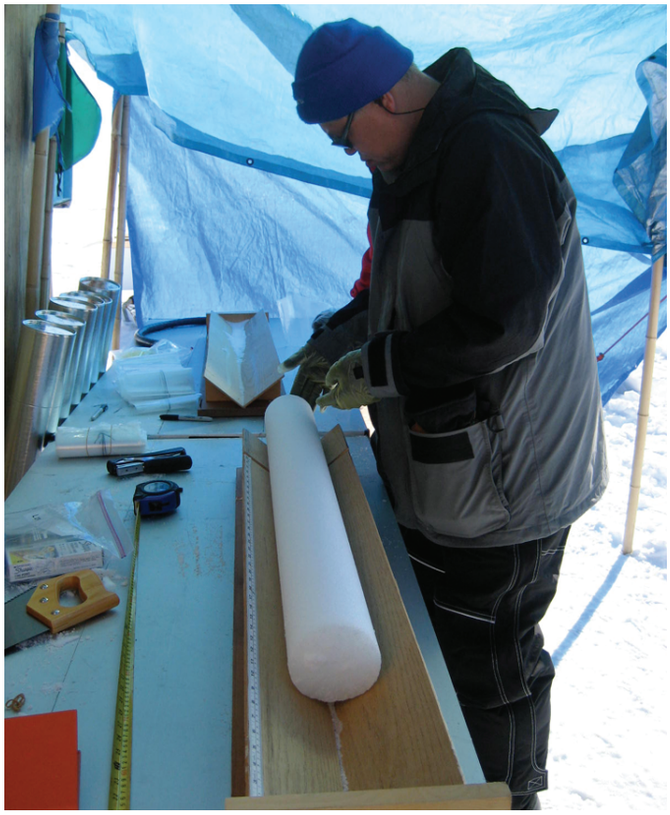
In This Issue

Atmospheric processes affecting nitrogen isotopes

Records of past atmospheric composition that are preserved in remote lake sediments and ice cores show a decline in the ratio of stable nitrogen isotopes since 1850. Researchers previously considered the isotope ratio as an indicator of atmospheric nitrate sources and attributed the decrease to an influx of anthropogenic nitrate into the atmosphere, yet increases in atmospheric nitrate over time do not always accompany decreases in the nitrogen isotope ratio. Lei Geng et al. (pp. 5808–5812) compared nitrogen isotope trends with long-term trends in atmospheric acidity along with concentrations of nitrate and sulfate. The authors report that isotope ratios corresponded most closely with atmospheric acidity levels associated with the abundance of sulfuric and nitric acids, suggesting that correlations between nitrogen isotopes and nitrate may be due to independent processes. Increased atmospheric acidity likely resulted in elevated atmospheric nitrate in its gaseous form, which is depleted in the nitrogen-15 isotope. Isotope ratio trends leveled off around 1970, the authors report, likely due to air pollution mitigation measures that also affected atmospheric concentrations of nitrate and sulfate. The results suggest that studies using nitrogen isotopes as an indicator of changes in the nitrogen budget should take into account atmospheric processes that may alter the ratio, according to the authors. — P.G.



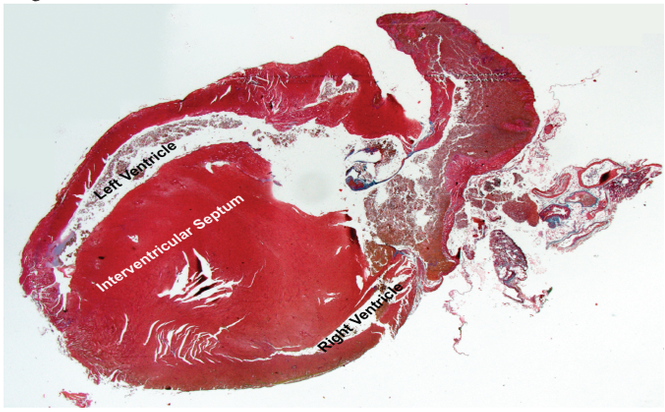
Ice core logging at Summit, Greenland.

Innate responses to syllable structure

Regardless of language, people perceive syllables such as *blif* more easily than syllables such as *lbif*. This preference is reflected in adult speakers' more frequent misperceptions of *lbif* than *blif* in psychological experiments and in the prevalence of the latter syllable type across languages. To determine whether preferred syllable structures are shaped by cultural processes or by innate linguistic constraints, David Gómez et al. (pp. 5837–5841) played recordings of a native Russian speaker pronouncing various syllable types to 72 newborns between 2 and 5 days of age. The authors monitored the newborns' brain activity during the experiment using near-infrared spectroscopy, measuring the oxygen flow to the temporal lobe and perisylvian areas in both hemispheres. The authors report that the newborns' left hemispheres were critically involved during the experiment, consistent with previous research suggesting that newborns process speech in the brain's left hemisphere. Further, oxyhemoglobin concentrations in the newborns' left temporal lobe and perisylvian areas were lower during playback of preferred syllables such as *blif* than during playback of dispreferred syllables such as *lbif* or *bdif*, suggesting that the babies' brains distinguished between the two syllable types. The parallels between newborns' range of responses to syllable structure and adults' linguistic preferences suggest that lifelong phonological preferences are present at birth, according to the authors. — P.G.

Erbin and cardiac hypertrophy

During normal development, the heart expands by increasing the size of cells called cardiomyocytes. Excessive growth, termed cardiac hypertrophy, accompanies many forms of cardiac disease and can lead to heart failure; the tyrosine kinase receptor ErbB2/Her2 protects against pathological hypertrophy. Inbal Rachmin et al. (pp. 5902–5907) investigated the role of the ErbB2 interacting protein, Erbin, in both normal and hypertrophic heart function. When the authors induced cardiac hypertrophy using different methods, Erbin expression in the mouse heart was decreased. Patients with end-stage heart failure also had reduced levels of Erbin in their hearts. In



Hearts derived from Erbin KO mice 3 days after severe abdominal aortic constriction.

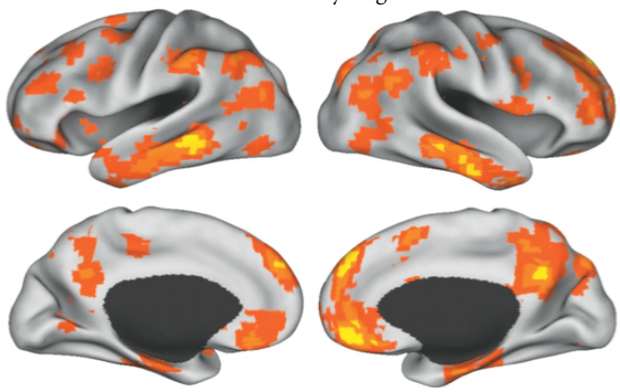
mice lacking Erbin, heart function largely appeared normal under basal conditions. However, Erbin knockout mice demonstrated an exaggerated response to induced hypertrophy, compared with control mice, as assessed by echocardiography, along with increases in cardiomyocyte diameter, heart size, and fibrosis. Aortic constriction, a technique used to induce hypertrophy, caused mortality in 37% of wild-type mice but 100% of Erbin knockout mice. Following β-adrenergic stimulation, an alternative technique for hypertrophy, Erbin knockout mice demonstrated increased phosphorylation of a mediator of cardiac hypertrophy, relative to wild-type mice. The results suggest that the absence of Erbin disrupts temporal control of hypertrophy, according to the authors. — C.B.

Twin study examines how genetics influences adaptive immune system

The adaptive immune system protects humans from infection partly through the action of hypervariable receptor molecules on the surface of B and T cells that can recognize and target invading pathogens. In every individual, the receptor molecules reflect individual genetic traits augmented by environmental factors, including all possible self and foreign antigens. To assess how genetics influences the formation of adaptive immunity, Ivan Zvyagin et al. (pp. 5980–5985) used next generation sequencing to analyze the T-cell receptor (TCR) repertoires of three pairs of monozygous (MZ) twins. The authors found that the overlap between general TCR repertoires in MZ twins is very similar to the overlap between nonrelated individuals, an unexpected finding given that all genes, including those that form the TCR repertoire, are identical in MZ twins. However, twin TCR repertoires share certain features, the authors report, particularly in the third complementarity determining region, which is crucial to antigen specificity. The authors also show that individual genetic makeup determines the recruitment of certain TCR genes for recombination and subsequent selection in the thymus, the immune system organ in which T cells mature. — T.J.

Head movements during brain scans indicate differences in brain connectivity

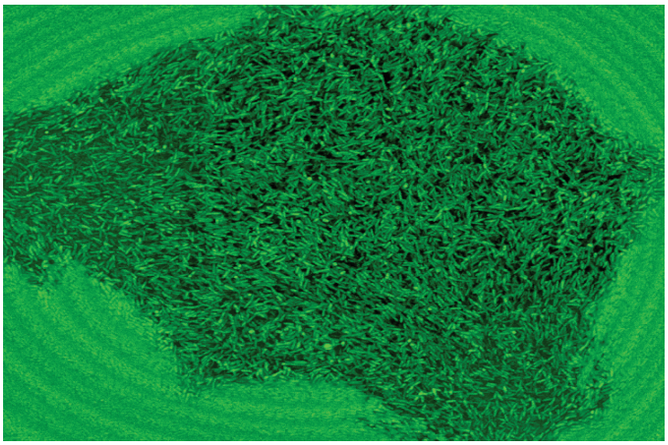
People differ in the steadiness with which they hold their heads during brain imaging. Researchers have long known that head motion causes distortions in connectivity measurements that must be corrected. Ling-Li Zeng et al. (pp. 6058–6062) examined the possibility that differences in brain connectivity might also cause head motion variability. By comparing scans of the same people over time, the authors first confirmed that the tendency to move the head is a generally stable trait. Next, the authors studied two groups of healthy young individuals, matched for demographics and scan parameters, from a database of more than 3,000 participants: 26 people in two groups with either high or low levels of head movement The authors found that distant functional connectivity, primarily in the default network, was significantly greater in the participants with low head motion, compared with those with high head motion levels. The authors selected another group of 26 individuals who showed high levels of head movement on one day but low levels of head movement on a different day, and found distant connectivity remained stable within the same individuals across time. Differences in brain connectivity reflect a biological trait rather than a technical artifact, and may lead to revisions of the interpretations of imaging data in many neurodevelopmental studies, according to the authors. — B.A.



People who were able to hold their heads steady showed increased functional connectivity in certain brain regions.

Evolutionary pressure to jockey for position in a microbial community

Microbes form structured communities that influence their role as gut symbionts, infectious agents, and bioremediation or biofouling agents. Wook Kim et al. (pp. E1639–E1647) tracked the evolution of the soil bacterium *Pseudomonas fluorescens* in laboratory colonies to understand how microbes compete in structured communities. The authors observed that *P. fluorescens* mucoid variants, mutant cells that produce multiple secretions, repeatedly arose in the colonies and ultimately grew to cover the colony surface. The mucoid variants did not grow faster than wild-type cells when the two strains were grown separately, suggesting that the secretions did not affect growth rate. Instead, microscopy and modeling techniques suggested that the secretions enable cells to push their way through and out of the colony to gain greater access to oxygen and outcompete neighboring nonmucoid cells. Genome sequencing revealed that all mucoid variants had undergone a mutation in a single gene, *rsmE*, resulting in increased secretion levels and a competitive growth advantage. Examination of more than 500 different mutations in *rsmE* revealed differences in the competitive phenotype that could be tied to the molecular effects of each mutation. According to the authors, microbes compete to reach community edges where nutrients are plentiful, similar to plants that grow tall to compete for light. — J.P.J.



Mucoid bacterial cells (dark patch at center) emerge from and take over the surface of a dense community of wild-type cells.