allows measurement of the statistical properties of the device's vibrational motion. The authors applied the concept of intensity correlations to their experimental set-up. Such correlations were used by Robert Hanbury Brown and Richard Twiss nearly 60 years ago to detect correlations between photons emitted by distant stars[6]. Cohen *et al.* measured these correlations in the arrival of photons at the detectors, thereby probing phonon correlations in the optomechanical device. Using this technique, they could directly observe a transition in the statistical behaviour of phonons as the system underwent a change from a purely thermal, random state of vibrational motion to a coherent, more-ordered one, which was reached above a certain threshold of power of the incident laser light[7,8]. In other words, Cohen and colleagues observed the phononic analogue of the 'lasing' transition that enables lasers to emit coherent light — light that is made up of waves that have the same wavelength and are in step with each other.

Finally, and looking ahead, it should be noted that, in the realm of quantum physics, measuring is also acting. The very act of measuring a system may alter its state. Therefore, future optomechanical experiments operating in the single-phonon counting regime could be used to generate complex quantum states of phonons. Given the rapid pace at which the field of optomechanics is advancing, this point might be reached in the not-too-distant future. Such quantum optomechanical control of matter could allow researchers both to test the fundamental principles of quantum mechanics and to venture into new applications in acoustics, thermal management and electrical-conductivity engineering. ■

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EARTH SCIENCE

Landscape inversion by stream piracy

A model suggests that active deformation in mountains causes river networks to constantly reorganize, providing an explanation for the paradoxical formation of almost flat surfaces high in craggy mountain ranges. SEE LETTER P.526

JÉRÔME LAVÉ

For more than a century, Earth scientists' curiosity has been piqued by the existence of areas with low topographic relief, some nearly flat, perched high in rugged mountain ranges. One common explanation[1] posits that these surfaces are relicts of large peneplains — low-relief features formed as the ultimate result of fluvial erosion — that were once close to sea level before being uplifted by mantle convection or plate tectonics and then dissected by rivers or streams. On page 526 of this issue, Yang *et al.*[2] propose a very different mechanism, whereby low-relief surfaces in mountain landscapes form transiently as a result of the dynamic reorganization of river networks.

One of Earth science's greatest challenges is to document vertical movements of the crust at geological timescales. Step-like landforms called terraces are commonly used as passive markers of small-scale deformations that occurred during the past million years or less, but it is usually impossible to use such markers for large uplifted regions and events that occurred over longer time periods. Geologists are therefore forced to use other palaeoaltimetric methods[3] that generally have large uncertainties and are difficult to implement over large regions.

The lack of reliable tools is particularly problematic for studies of regional uplift caused by deep-seated geodynamic processes, or when investigating the upheaval of wide orogenic plateaus (which form as a result of colliding tectonic plates). In these cases, it is tempting to find other passive markers, such as the dissected and uplifted remnants of peneplains that are assumed to have once been nearly horizontal and close to sea level. By interpreting low-relief surfaces perched across

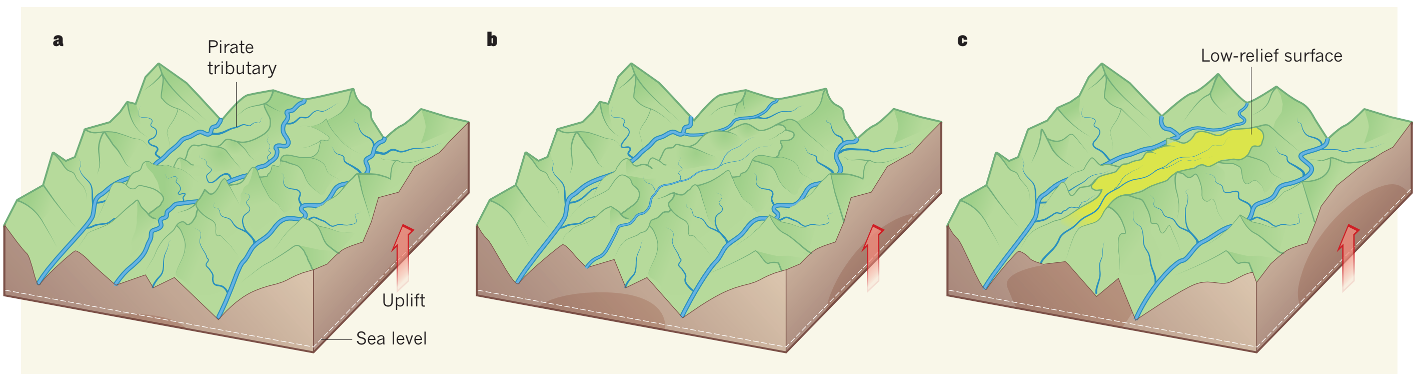

Figure 1 | Proposed origin of low-relief surfaces at high elevation. Yang *et al.*[2] suggest that when tectonic plates collide, the resulting large-scale deformation of the crust and upper mantle triggers permanent reorganization of river networks. **a**, In this illustration, a mountainous region is subjected to uplift, and a 'pirate' tributary of the left-hand river is indicated. **b**, Over time, the upstream part of the central river is captured by the pirate tributary, causing a sudden decrease in the central river's stream power and its ability to incise through bedrock. Sustained tectonic uplift is no longer equilibrated by fluvial erosion, leading to uplift of the disconnected valley, with continuous erosion of the hillslope around the valley lowering the relief. **c**, A low-relief surface at high elevation emerges and may survive for some time before being degraded or captured by streams eroding inwards from its outer perimeter.

the southeast Tibetan plateau in this way, a broad south-dipping slope of the plateau surface has been inferred[4], which was proposed as evidence of differential thickening of the underlying crust. Aspects of this interpretation have been questioned[5,6], but a two-stage mechanism has always been assumed, in which the formation of low-relief surfaces precedes river dissection.

Yang *et al.* challenge this idea. They first propose a new description of the fluvial network that drains southeastern Tibet, by using a modified metric[7] of the stream power equation, a widely used model in which fluvial incision into bedrock primarily depends on river slope and discharge. This model predicts that when regional uplift increases (as expected in the dissected-peneplain scenario), the profiles of all the major rivers and tributaries will display a change of slope (a 'knickpoint') at similar elevations[8] if the geometry of the fluvial network is fixed. By examining several regions in southeastern Tibet, the researchers show that the main tributaries do not display such a regular pattern. Instead, knickpoint elevations are widely scattered.

The authors then show that the long profiles of tributaries that drain low-relief surfaces are systematically shallower than expected, whereas those of tributaries that drain the slopes surrounding the low-relief surfaces are steeper. The authors interpret these peculiar features[9] as evidence of recent drainage captures — the diversion of headwater regions of main rivers to nearby tributaries — and dynamic reorganization of the river network (Fig. 1). The low-relief surfaces therefore cannot be relict landscapes, and must instead correspond to areas that formerly had normal relief, but where the main stream has lost its power to incise bedrock because its headwater has been captured. If subjected to sustained uplift, such areas would gain elevation, and their local relief would be smoothed down because of erosion of the surrounding hill slope. The process is a kind of topographic inversion, because formerly incised valley bottoms and rugged topographies end up as flatter surfaces at high elevations.

To simulate this mechanism, the authors built a computational model in which a section of crust is squeezed between two rigid plates while undergoing constant thickening — a situation that may have occurred in southeastern Tibet[10]. This model and the associated video (see the paper's Supplementary Information[2]) wonderfully illustrate how crustal shrinkage reduces the overall drainage area that feeds the rivers, causing continuous reorganization in which 'victim' rivers lose their upstream area to 'pirate' river networks. Crucially, they demonstrate how stream piracy in this deforming setting is a self-sustained or cascading mechanism. Once a network has lost part of its drainage area, its ability to incise the crust decreases, its elevation above surrounding major rivers increases, and it becomes easier for pirate networks to capture even more of its drainage area.

Yang and colleagues' decision to reject the classical explanation of the low-relief surfaces in southeastern Tibet merits some discussion. First, part of the observed scattering of knickpoint elevations might result from river-incision behaviour that is not encapsulated in the simplified stream power model used by the authors, from local variations of tectonics, or from the initial topography of the raised low-relief surface. Second, the authors' model does not easily apply to the northern part of the studied region (north of 30° N), where there have been low rates of erosion during the past 50 million years[11] and where reduced river incision has probably limited the reorganization of fluvial networks; low-relief surfaces in this region represent more than half of the landscape, whereas the model predicts a much smaller fraction.

Future modelling should investigate the roles of horizontal strain and vertical uplift in the dynamics of river capture. Would the model have led to such a dynamic stream reorganization and production of low-relief areas if the authors had considered much lower finite erosion[11] and the present north–south flow deformation[12] in southeastern Tibet, which is in sharp contrast to the east–west shortening simulated in the model?

In any case, the process proposed by Yang *et al.* changes our thinking about the genesis of low-relief surfaces in mountainous areas, and will reignite debate about their origin and use as uplift markers in other orogenic settings, such as the Pyrenees[13] or the Eastern Andes cordillera[14]. The multicapture scenario will also alter the way we look at the evolution of river networks in many landscapes, and, as a corollary, affect interpretations of sedimentary archives that have recorded past erosion of regions undergoing deformation. Finally, if stream reorganization is highly sensitive to horizontal and vertical tectonics, it highlights both the richness and the complexities provided by river-network geometry for unravelling the tectonic history of orogenic features[10]. ■

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50 Years Ago

With sympathy and understanding, the Editor of *Nature* publishes the following communication from Prof. H. Newton Barber, professor of botany in the University of New South Wales, Sydney, Australia … "I recently had to read an account of the VII SCOR Meeting held in Hamburg … One paragraph of the report read as follows: 'If the IAMAP-IAPO WG on Air–Sea Interaction cannot be brought to life, SCOR will try to form a joint IAMAP-IAPO-SCOR-UNESCO WG'… I have still to decode this message. I doubt whether the effort is worth it … Is it not time for us to consider turning some of these into a more standard English form? I have in mind DNA and RNA … Instead of stark, upper-case initials, can we not manufacture more good old English four-letter words … Let us in future refer to DNA as Dona and RNA as Rina."
From *Nature* 24 April 1965

100 Years Ago

My Life. By Sir Hiram S. Maxim — To write in the first person singular is not according to the English temperament; even the best autobiographies annoy us, and the more we admire a man the sorrier do we feel when reading his life. Therefore it is thought to be better "form" to let a friend write one's life. But if we are to know Sir Hiram Maxim, we must listen to him telling his own story in his own way … He reveals himself as no Englishman dare do, but if the reader will only call to mind the fact that there are other formulæ of behaviour than his own, he will find the book well worth reading … He made discoveries about gunpowder and other explosives … but does not seem to think them of much more importance than his experiments on the roasting of coffee.
From *Nature* 22 April 1915

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SENSORY SYSTEMS

The yin and yang of cortical oxytocin

Female mice can learn to respond to distress calls from young mice — an ability that has now been found to be improved through signalling by the hormone oxytocin in the left auditory cortex of the brain. **SEE ARTICLE P.499**

ROBERT C. LIU

When newborns cry in the night, they capture the attention of sleepy parents, who become suddenly alert, ready to comfort their babies. This response might seem like instinct, but our ability to recognize social cues from infants is heavily shaped by experience[1,2]. Mothers and fathers of many species, including humans, learn over time to recognize the cries of their own babies[3]. In this issue, Marlin *et al.*[4] (page 499) investigate how the brain learns this information. They report that oxytocin, a well-studied hormone released in the brain in social situations, acts in an unexpected manner to help to create memories of infant cues.

Oxytocin is a neuropeptide molecule produced in the brain's hypothalamus. It acts in both the peripheral and central nervous systems, exerting prosocial effects on behaviour by promoting pair bonding, parental care, social reward, and attention to and memory of social cues[5–7]. But how oxytocin actually acts on neurons to affect social behaviours is only just beginning to be explored[8,9], with much still unknown about the mechanisms by which it influences sensory-information processing and memory in social contexts.

To address this gap in knowledge, Marlin and colleagues studied how female mice react to the ultrasonic cries made by pups. Mothers and virgin 'nanny' mice (which have experience of caring for pups) recognize the cries as distress calls and respond by approaching calling pups, picking them up and carrying them to the nest. By contrast, inexperienced (naive) mice fail to recognize the cue and do not retrieve pups. There is evidence[10] that memories of the pups' cries in maternal mice are linked to the activity of neurons in the auditory cortex of the brain — part of the neocortex, which controls higher brain functions, including sensory perception (Fig. 1). Marlin *et al.* used pharmacological inactivation to demonstrate that, without left-auditory-cortical activity, pup retrieval is severely impaired in most experienced female mice. Inactivating the right auditory cortex had little effect, adding neuronal evidence to other work[11] suggesting that control of communication processing in mice is dominated by one side of the brain (lateralized), much as it is in other species.

Systemically delivered oxytocin facilitates maternal behaviours such as pup retrieval[2,7], but it has been presumed to act on evolutionarily conserved circuits for maternal responsiveness that are located in subcortical brain regions beneath the neocortex. Oxytocin-receptor proteins have previously been discovered in the prefrontal region of the neocortex[9], but Marlin *et al.* found that both oxytocin receptors and projections from hypothalamic oxytocin-producing neurons are present in the auditory cortex of mice, with the former (but not the latter) being more numerous on the left side than on the right.

Amazingly, naive virgins that had been injected with oxytocin in the left auditory cortex began retrieving pups earlier than counterparts that received saline. It remains to be seen whether oxytocin's cortical effect on pup retrieval is lateralized, because the authors did not repeat the experiment in the right auditory cortex. Blocking oxytocin-receptor activation in the left auditory cortex of experienced retrievers did not impair performance, which perhaps indicates that oxytocin in the auditory cortex facilitates learning about calls rather than maintaining memories of them. If so, blocking auditory-cortical oxytocin receptors during endogenous systemic oxytocin release in naive mice should prevent them from learning pup-retrieval behaviours.

What is the role of oxytocin in the auditory cortex? In technically challenging experiments, Marlin and colleagues analysed the neuronal inputs to auditory-cortical neurons, and showed that oxytocin can alter the balance between inhibitory and excitatory inputs, which are both activated by pup calls — they are the yin and yang of neuronal signalling. The team found that inhibitory and

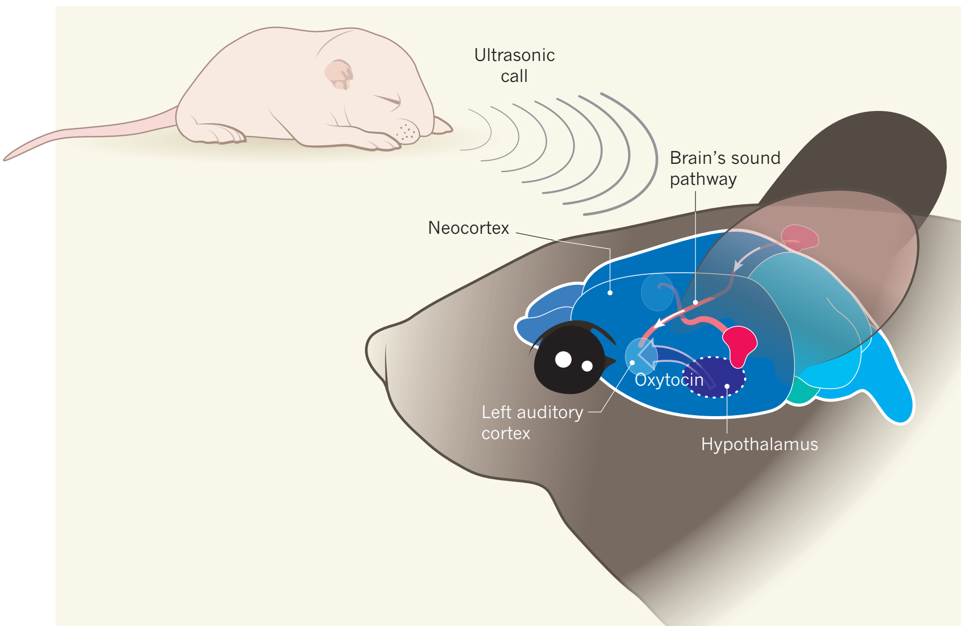

Figure 1 | From cry to cortex. Ultrasonic distress calls made by young mice act as social cues that elicit a maternal response in females that have experience of caring for pups. Memories associated with this cue seem to be linked to neurons in the auditory cortex, part of the neocortex region of the brain. The hormone oxytocin, which is produced in the hypothalamus, can be released in the neocortex. Marlin *et al.*[4] report that oxytocin can act directly in the left auditory cortex to facilitate the behavioural response to the cries of pups, which are relayed to this brain region through a sound pathway.