tension-generating properties[11]. Filopodia are thought to combine motor and sensory functions in the guidance of nerve growth[9,12]. The active extension of the filopodium allows it to explore embryonic space, while its adhesion and retraction may allow it physically to steer the growth cone. Because filopodia are usually long in comparison to the dimensions of the growth cone 'body', they may provide for increased sensitivity in the detection of a spatial concentration gradient.

Zheng *et al.* used a micropipette to create well-defined ACh gradients near growth cones of fibres growing from cultured *Xenopus* spinal cord neurons (see figure). They observed the cones using a high-resolution, transmitted-light microscopy method that allowed for clear observation of the growth cone and its filopodia; they also used a fluorescence calcium-imaging method. Within two hours, most growing fibres exhibited a pronounced turning towards the ACh source.

Two much earlier effects of ACh (within minutes of gradient onset) were also evident. First, increases in the number of filopodia on the side of the growth cone facing the pipette; and, second, an increase in cytoplasmic Ca^{2+} concentration within the growth cone. In a few large growth cones, the increase in Ca^{2+} concentration sometimes appeared to be largest on the side of the cone facing the pipette. These early responses precede turning, so they may be causal. For instance, ACh receptors might promote a gradient of Ca^{2+} influx parallel to the ACh gradient, promoting increased filopodial sprouting towards the pipette, and eventually leading to a net turning force. Many alternatives are possible, and experimental analysis of them should now be within reach.

Although their imaging evidence for an oriented intracellular Ca^{2+} gradient is preliminary, Zheng *et al.* buttress the idea that Ca^{2+} ions are involved in turning with complementary pharmacological experiments. These experiments implicate nicotinic ACh receptors, influx of Ca^{2+} ions across the surface membrane, and the calmodulin-dependent protein kinase II in the ACh-induced turning response. These findings are consistent with earlier indications that an experimentally created Ca^{2+} gradient within a growth cone can produce directed protrusion[13]. The molecular mechanisms by which Ca^{2+} ions might influence cytoskeletal force generation in the growth cone are just beginning to be explored[14].

It is hard to speculate very seriously about the possible cytoarchitectural consequences of ACh-induced turning without knowing more about the responsive cells and fibres. Are the cells motor, sensory or interneurons? Are the fibres axons, dendrites or both? The next job will be to resolve these issues, so that the real speculation can begin.

Although the developmental significance, if any, of neurotransmitter chemoattraction remains to be established, a whole set of related questions is now thrust to the fore. Do significant gradients of ACh actually exist within the embryonic spinal cord or periphery? Can they be created by activity-dependent release of the neurotransmitter? Do they actually shape neuronal cytoarchitecture? If the answers turn out to be 'yes', the ability of a neurotransmitter to turn a growth cone could become central to a molecular understanding of the ways in which neural activity shapes brain structure and function. □

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Fire, brimstone and seismicity

CAN volcanic eruptions be predicted? That age-old preoccupation is behind the work of T. P. Fischer and colleagues reported on page 135 of this issue. Their subject is the intensively monitored Galeras volcano in Colombia, the top of which is pictured above in a scene from December 1989 when the vent was virtually open and the volcano was emitting massive amounts of sulphur dioxide (some 5,000 metric tonnes a day). The authors have compared records of SO_2 flux from Galeras with those of a distinctive type of seismicity, which is thought to reflect pressure fluctuations in the plumbing system connecting the volcano's deep magma body with the surface. Galeras is notorious for its eruption in January last year, in which several members of the monitoring teams and others died, but Fischer *et al.* concentrate on the subsequent, larger event in March. Broadly put, the observations indicate that some time before an eruption occurs an inverse correlation develops between SO_2 emission and seismicity, which can be interpreted as a gradual closing of pathways by which gases escape, and concomitant build-up of pressure inside the volcano. Such a correlation is consistent with previous evidence from other volcanoes. But the most predictable thing about volcanoes will no doubt continue to be their unpredictability. T.L.