assumption made about the temperature sensitivity of ecosystem respiration has a profound effect on the long-term future of the forest carbon sink in coniferous forest. If case 1 is correct, the sink diminishes, and the forest becomes less effective at removing CO₂ from the atmosphere; if case 2 is correct, the effect of an increasing rate of photosynthesis is not masked by an increasing respiration rate, and the forest becomes increasingly more effective as a sink for atmospheric CO₂.

In any case, the results from these two papers should send a powerful message to those working with models of global vegetation change. Setting the parameters for soil respiration models using only the results of short-term experiments may be quite misleading. When respiration models are eventually fully coupled to models of climate change, the resulting positive feedback between respiration and temperature that magnifies global warming may proceed only for a limited time — until the easily decomposed soil organic matter is depleted. Does this mean that the doomsday view of runaway global warming now seems unlikely? We hope so.

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Cognitive neuroscience
Seeing in the sound zone
Michael Merzenich

How is the development of the processing capabilities and organization of the brain's cerebral cortex controlled? Intrinsic mechanisms (such as genetically encoded developmental programmes) and extrinsic inputs (such as the things we see and hear, and the ways that this information is encoded by specific discharges within particular sensory systems) both have a say. But to what extent can the developmental pathways be overruled by inputs from the outside world? Two fascinating papers by Sur and colleagues, on pages 841 and 871 of this issue, provide some of the most compelling evidence yet for the exquisite sensitivity of cortical development to external cues.

How does one even start to determine the relative contributions of external and internal factors to cortical development? Ferrets have proved a useful model animal, in part because they are born before their development has progressed too far. Over the past decade, Sur and co-workers have been perfecting an experimental approach that consists of surgically manipulating the nerves that feed into different parts of the cortex of very young ferrets. Specifically, the nerves from the retina (which normally lead to a subcortical region, the visual thalamus, which in turn feeds into the primary visual cortex, or V1) are redirected to grow into the auditory thalamus (which feeds into the primary auditory cortex, or A1). The auditory thalamus itself is deprived of its normal auditory inputs in this model.

In early experiments, Sur and colleagues showed that this ‘rewiring’ procedure results in the emergence of a functional V1 in a cerebral cortex zone that was otherwise destined to develop into primary auditory cortex. The new visual cortex has a topographic organization that parallels that in normal V1. Moreover, different neurons in this rewired cortical zone — like those in normal V1 — are selective for differently oriented visual stimuli. The normal organization of A1, in contrast, goes awry: the A1 territory is taken over by visual inputs. Such experiments have provided important evidence that the organization and responsiveness of different cortical regions can be shaped by the particular patterns of neuronal discharge that result from neuronal stimulation by different inputs — in this case, retinal versus cochlear (auditory) inputs.

Sur and colleagues’ latest papers advance this theory by several crucial steps. First, Sharma, Angelucci and Sur show that particular higher-order features seen in normal V1 emerge in the rewired visual cortex (Fig. 1). These features are called ‘visual orientation columns’: each consists of a group of neurons that share a preference for visual stimuli with a particular orientation. The layout of these columns provides a basis for representation of important spatial characteristics of visual stimuli. The ‘pinwheel’ organization of these columns (Fig. 1) in the rewired animals resembles that in V1. The authors go on to show that horizontal connections — links between separate columns that represent corresponding stimulus orientations — emerge in the rewired auditory cortex, just as in normal V1. These horizontal connections and organizational structure have no equivalents in the normal A1. All of these studies convincingly show that much of what typifies the functional organization of V1 can be generated within A1 by delivering retinal inputs to A1 through the auditory thalamus.

But the story does not end there. Von Melchner, Pallas and Sur demonstrate that rewired animals show behavioural responses to visual stimuli that are presented only to the neurons feeding into the rewired cortex, a feature that is not found in normal animals.

Figure 1 Rewiring the brain. Sharma et al. and vom Melchner et al. have redirected neurons that normally lead to the visual thalamus (and then the primary visual cortex, or V1) into the auditory thalamus (and then the primary auditory cortex, or A1). a. The retina, showing its medial (M), dorsal (D), lateral (L) and ventral (V) dimensions. b. In the ‘rewired’ cortex, a ‘retinotopy’ (a map of neuronal inputs from different parts of the retina to different parts of the cortex) forms in the A1 area. (In some ferrets, in which V1 and the visual thalamus were left intact, a normal retinotopic map also forms in the V1 area). c. An enlarged view of the rewired A1. Features called ‘pinwheels’, seen in V1 in normal ferrets, also form in the rewired cortex. Each colour in a pinwheel represents a group of neurons that respond to a particular orientation of visual stimuli. Thus, a functional V1 is formed in the A1 area in the rewired cortex of these ferrets. (The key along the bottom relates to the pinwheel diagram in the centre of c. So, for example, the dark yellow colour in the pinwheel identifies a group of neurons that respond to a vertically oriented stimulus.)
In 1839, Faraday observed fast fluoride-conducting glasses. His discovery suggested that glasses might contain mobile oxide ions. Some, the oxide-ion electrolytes, are electronic insulators; others are mixed oxide-ion/electronic conductors.

**Oxide-ion conductors by design**

John B. Goodenough

Oxide-ion conductors are solid oxides that contain highly mobile oxide ions. Some, the oxide-ion electrolytes, are electronic insulators; others are mixed oxide-ion/electronic conductors. These materials form the basis of devices that have a huge market potential. The solid-oxide fuel cell, for example, uses an oxide-ion conductor. Such devices are a key element of the solid-oxide fuel cell.

**Ceramic technology**

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