size or larger than the wild type [1]. Together, these results indicate that KLU positively regulates a mobile signal which affects proliferation at a distance from its site of synthesis. What could this signal be? It is not the KLU protein, which localizes only where the KLU gene is expressed [4], so it is a signal downstream from KLU. Previous work on plant cytochrome P450 genes, of which KLU is a member, indicates they may be involved in the regulation of plant hormones [7]. KLU seems to act independently of the classical plant hormones [4], and may therefore be involved in the regulation of a novel signal.

If KLU positively regulates a mobile signal that affects growth, how mobile is this signal? If KLU expression in one part of the plant affects growth in another part, this may provide a means to coordinate growth across different organs. To investigate the range of action of the KLU-dependent signal, the Lenhard group used an elegant technique to generate fluorescent chimeras [1,5]: these plants have a combination of klu mutant tissues and KLU wild-type tissues (Figure 2). The genotype of the tissue can easily be visualized because tissues with the KLU genotype fluoresce in yellow whereas tissues with the klu mutant genotype fluoresce in blue [1,5]. A range of chimeras were generated, which were then examined to test the effect of the presence of the KLU genotype on neighboring klu tissues.

Results indicate that the KLU-regulated signal can move within an inflorescence, and that the overall size of a petal depends on the total amount of KLU protein in the flower and in the inflorescence [1] (Figure 2). The signal does not move between inflorescences because in chimeras with mutant and wild-type inflorescences, petal size in each inflorescence is the size expected from the inflorescence’s genotype.

Any alteration in the expression pattern of locally produced regulators with low mobility may affect spatial growth patterns, and therefore organ shape. Conversely, the fact that the overall organ size in an inflorescence depends on the total amount of KLU, no matter where KLU is produced, provides a way to coordinate organ size between floral organs and between flowers, so that any spatial or temporal alteration in the production of the signal in individual petals would affect flower size without affecting flower shape. The different mobility properties of diverse, locally produced growth regulators may therefore be a key factor to uncouple the evolution of organ size and shape.

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Brain Imaging: Decoding Your Memories

Recent advances in neuroimaging allow mental states to be inferred from non-invasive data. In a new study, memories of complex events were successfully decoded solely from imaged activation in a memory-related brain structure.

Johannes Schultz

Imagine you have just come back from a fantastic holiday, in which you explored a far-off part of the world and saw incredible landscapes and rare animals. The many pictures you took cannot fully convey the way you remember these events. Wouldn’t it be nice if your friends could directly ‘read’ the content of your memories of that trip? Well, maybe this idea is not as crazy as it seems. Progress in neuroscience has made it possible to...
associate perceptual or cognitive processes with particular brain structures. However, because a given brain region is often associated with several processes, a person’s mental state or perceptual experience can only rarely be determined from the average activity of a single brain area [1,2].

Recently, however, approaches that analyse the signal from many volume elements (voxels) of the brain simultaneously have started to change the game. Although such multivariate methods have been considered a while ago [3], they became really popular when a now classic study [4] showed that patterns of brain activation could be systematically associated with perceiving pictures of different object categories. These analyses demonstrated that there is meaningful information in the local variation in activation across voxels. In fact, the information gain when considering activation patterns is so great that reliable information can even be obtained from single trials or single brain scan images. This greater ‘functional resolution’ power offered by multivariate analyses of neuroimaging data is very well suited for discriminating relatively similar cognitive tasks, and even makes it possible to distinguish between different mental state contents.

Examples of successful decoding include the orientation of visual grating stimuli, alternative percepts engendered by multi-stable stimuli, object categories, intentions, arithmetic operations or emotions in voices (for reviews see [5,6]).

In a study reported recently in Current Biology, Hassabis et al. [7] used such a multivariate analysis method to ‘read out’ the location of a participant in a virtual reality environment from patterns of activation in the hippocampus, an elongated brain structure in the medial temporal lobe (shown in light gray in Figure 1). This result fits well with the existence of so-called ‘place cells’ in the hippocampus: these neurons represent particular locations in space [8]. The hippocampus is also involved in storing spatial locations in memory: it has been shown that patterns of neural activity observed when an animal is located in a particular position in space get reactivated during sleep [9].

The hippocampus is, however, also important for non-spatial memories: bilateral resection of the medial temporal lobes including the hippocampus prevents acquisition of new memories of everyday events — episodic memories. This is very well documented through the life of Henry Gustav Molaison, better known as H.M., who suffered complete anterograde amnesia following this surgery [10,11]. Studying how episodic memories are represented is arguably only possible in humans. As a consequence, how neurons code different episodic memories is still poorly known: For example, only very recently was it shown by electrophysiological recording that cells in the human hippocampus can be associated with distinct episodic memories [12].

Decoding freely recalled memories had until now only been demonstrated for the discrimination between faces, objects and locations using activation patterns from the whole brain [13]. In that study, the most informative parts of the activation pattern were located not in memory-associated areas but in stimulus-specific visual areas — for example, the lateral fusiform gyrus coded for the presence of faces. As reported in this issue of Current Biology, Chadwick et al. [14] have now demonstrated successful discrimination of very similar episodic memories solely on the basis of hippocampus activation patterns (Figure 1). This suggests a functional differentiation in the representation of episodic memories within the hippocampus, similar to what is known about spatial locations, with different cell populations coding for different memory contents.

Figure 1. Activation patterns in the hippocampus code for different episodic memories. The hippocampus is shown in lighter gray color on the reconstructed medial surface of the right hemisphere of a template brain. Dashed circles represent spherical search volumes of spatially contiguous voxels which show different activation patterns depending on memory content (three short movies controlled for duration, complexity and content were used in the study [14]). Significant but worse decoding was found in neighboring entorhinal cortex and parahippocampal gyrus.
This new study [14] allows us to think about a host of further questions. For example, are memories of the same events stored in a similar way by different people, at least to the degree to which the content of their memories are shared? For this, the patterns of brain activation do not need to be equal, but the amount of information stored in different structures and their relative contribution to memory-associated patterns might be similar, as was indeed found by Chadwick et al. [14]. Similarity in activation patterns can even carry quite specific information: response patterns in the data of a group of subjects can be used to differentiate cognitive tasks in a separate individual [15,16].

Combining within-subject and between-subject classifiers might thus make it possible to differentiate the response patterns representing aspects of memories that are shared across people from those that differ, getting at the neural correlates of inter-individual differences in memory content.

Progress in neuroimaging techniques is followed with interest by the public, as neuroscience methods have started to be used to address legal questions. The judge of a court in India directly referred to a forensic analysis of electroencephalography data in his written opinion of a murder trial, and similar brain data analysis methods have been admitted in legal proceedings in the USA (see [17] for a recent review). Commercial applications have started to spring up, such as assessing the attractiveness of products (Neuromarketing) or quantifying the effect that movies might have on people’s perception (Neurocinema). Further extensions of the method are to be expected: if what has been achieved for vision (reading observed letters from early visual cortex activity [18]) becomes possible for memory, then maybe one day we could be able to read the contents of a person’s memory.

It might be possible to change stored memories too: conditioned fear responses can be erased with purely behavioral methods [19]. Combining reading and modification of memories brings closer a host of science-fiction scenarios, as for example in novels such as “We can remember it for you wholesale” by Philip K. Dick (adapted into the movie "Total Recall") and countless other Hollywood movies, for example, *Eternal Sunshine of the Spotless Mind, The Manchurian Candidate* and *Vanilla Sky*.

All these applications and fictional scenarios are of course seen with very cautious reserve by scientists, and rightly so: To convince researchers, a scientific method needs only to yield results reaching statistical significance (that is, beat chance). When considering the application of a method in everyday life, however, one must consider the consequence of any deviation from perfect performance. Discussion of ethical, sociological and legal aspects of the application of multivariate analyses promise a number of interesting debates.

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Meiosis: A PRDM9 Guide to the Hotspots of Recombination

During meiosis, homologous recombination occurs preferentially at defined hotspots. In mammals, the fast-evolving DNA-binding domain of PRDM9 has now been identified as a major hotspot determinant that may explain the rapid rates of hotspot redistribution during evolution.

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In most sexually reproducing organisms, the homologous chromosome pairs of germ cells recombine during meiosis. That is, DNA sequences from one homologous chromosome are joined to the corresponding sequences on the other homolog, and vice versa, to produce what is known as a crossover. Depending on the organism, between one and half