Abstractions

LAST AUTHOR

DNA molecules can be folded to create arbitrary two-dimensional shapes, such as smiley faces and stars (P. W. K. Rothemund *Nature* **440,** 297–302; 2006). This pioneering discovery by Paul Rothemund has inspired many, among them Jørgen Kjems, a molecular biologist at Aarhus University in Denmark. He and his colleagues set out to see whether they could translate Rothemund's 'DNA origami' into three dimensions (see page 73). Kjems tells *Nature* about prompting DNA molecules to self-assemble into a hollow, nanometre-scale box.

How did you get DNA molecules to form a box shape?

All single-stranded DNA molecules can self-assemble, or direct themselves into a particular structural configuration. We first used a computer program to predict what sequences to synthesize that would direct the molecules to assemble into this structure. Then, we used one long, naturally occurring molecule from a virus, and about 220 short artificially synthesized molecules that bound to the long molecule to build a box 42 by 36 by 36 nanometres. This method can be used to assemble any shape — our DNA box is just the beginning.

Can you put anything into the box?

It may be possible to put an enzyme into the box that produces a signal only when the lid is open and the substrate becomes available. The box could effectively become a sensor to signal the presence of a gene from a virus or a bacterium, for example. We are also experimenting with hiding a drug in the box that can kill a cell when the box opens. And we think that the box could potentially be used to make simple arithmetic calculations. Thus, if you have many boxes, you can make very complicated calculations — or effectively create a DNA computer.

Were there surprises along the way?

What surprised me is that nature can direct self-assembly so nicely. I still don't understand how the process actually works. The biggest struggle we faced was working with the DNA itself. DNA isn't very stable because it is easily degraded by enzymes, which tear it into pieces. We're working on trying to use unnatural building blocks, by chemically altering the nucleotides that make up DNA, to make these structures more stable.

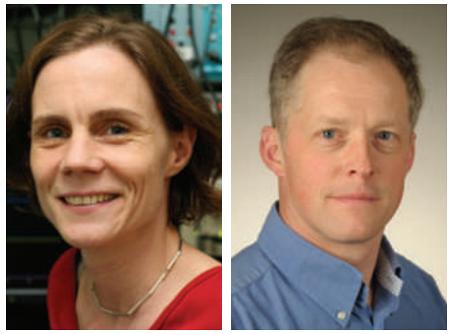
Is this a popular field?

Yes. We just managed to be the first group to publish a complex three-dimensional DNA structure — there is a wave of similar experiments going on worldwide. This is intriguing enough that you'd say, 'let's try it.' ■

MAKING THE PAPER

Hendrikje Nienborg & Bruce Cumming

The brain 'tampers' with incoming sensory data to fit expectations.



Hendrikje Nienborg (left) and Bruce Cumming.

Our brains decipher a wealth of sights, sounds and other sensory information to allow us to make sense of our environment. But interpreting sensory inputs isn't always straightforward, as anyone who has stared at the infamous 'young girl–old woman' illusion knows. Hendrikje Nienborg and Bruce Cumming, working at the National Institutes of Health in Bethesda, Maryland, have now discovered that the brain 'tampers' with the signals it receives to favour one interpretation over another.

Signals from sensory organs activate sensory neurons, which in turn relay those signals to the brain areas that decode them and act upon the information provided. Researchers have known for more than a decade that the activity of sensory neurons varies not only in response to a particular stimulus, but also according to how the brain ultimately interprets that stimulus. "Imagine you are walking in thick fog, looking for a friend wearing a green leather jacket," says Nienborg, who was a postdoc in Cumming's lab before moving to the Salk Institute for Biological Studies in La Jolla, California. "When a blob appears in front of you, you have to decide whether or not the blob is a green jacket." The activity of the sensory neurons will vary depending on whether the decision is 'yes' or 'no'.

The widely accepted explanation for such variation is that sensory neurons have a role in decision-making. To test this idea, Nienborg recorded the electrical activity of individual sensory neurons in two monkeys as the animals performed a simple task. Each monkey was shown a series of dot patterns on a computer screen, and had to decide whether the centre of a circular pattern was protruding or receding.

The work, which provided a detailed description of the sensory neurons' activities during the course of each trial, was painstaking. "One downside of the technique is that it requires a lot of data, so we had to do many, many trials for each neuron," says Nienborg. Although individual trials took only a couple of seconds, the monkeys performed between 800 and 900 trials for each neuron studied. And the data generated were not always of sufficient quality. "You could find out at the end of a week of recording all day, every day that you did not have any data," says Cumming. "On the other hand, the next week you could have recordings from five neurons."

In the end, they were able to analyse data from 76 neurons. But the results were not consistent with the conclusion that sensory neurons have a direct effect on decision-making (see page 89). Instead, Nienborg and Cumming concluded that brain areas involved in decision-making are sending signals to sensory neurons, altering their activity. "What we have shown is that the brain changes the sensory input," says Cumming. "In a way, the brain is tampering with the data." To explain the findings in terms of the fog analogy, Nienborg adds: "What this means is that if we expect to see a green jacket we are more likely to see a green jacket".

From an evolutionary perspective, this might indicate that, when faced with uncertain sensory information, it is better to commit to one interpretation or another than to hesitate. If you aren't sure where a predator is coming from, "it might be better to make the decision to run left and get it wrong 50% of the time than to just stand there and get killed every time", says Cumming. ■

FROM THE BLOGOSPHERE

When it comes to measuring the challenges of the 'human dimensions' of climate change, it seems social scientists will be taking centre stage. That was a key opening message from the International Human Dimensions Programme on Global Environmental Change Open Meeting in Bonn, Germany, 26–30 April, reports Anna Barnett on the blog Climate Feedback (http://tinyurl.com/ceekvx).

Barnett, assistant editor of *Nature Reports: Climate Change*, caught up with one of the keynote speakers, physicist Hans Joachim Schellnhuber, at a coffee break. He told her that physicists can describe climate threats increasingly vividly, but that it's up to social scientists to figure out how we bring about massive economic and social transformation.

For example, the technical problems with transferring solar power from the Sahara to Europe are already solved. It's the lack of legal frameworks, intergovernmental agreements and international will that stands in the way, Schellnhuber said. He urged social scientists to take the lead and to rethink their research scales from the local case study to globe-spanning projects. ■

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