that a lot of suffering, war, and conflict could be eliminated if we could agree to live by them more consciously."

This conclusion would follow if our universal moral sense had been implanted by an all-knowing and all-loving God. But biological evolution is a notoriously amoral force. Innate moral universals would have been shaped by the selective advantages that arise from caring for our kin and cooperating with our neighbours, but nothing in our genes tells us that slavery is wrong, or that men and women deserve equal rights. Such insights emerge through individual and group processes that engage all of our faculties, including our innate moral sense, but also the capacity to appreciate abstract arguments, formulate analogies, learn from experience, take other's perspectives and so on. Much of moral progress consists of using reason to override our gut feelings.

An excellent illustration of why ethics does not reduce to instinct comes from Gazzaniga's own treatment of issues such as stem cell research and euthanasia. This shows ethical reasoning at its best — rooted in common sense but also informed by a sharp, inquisitive mind and a deep appreciation of the facts. ■

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SCIENCE IN CULTURE

Eddies at The Gates

An art installation hints that, even in a forest, wind may disperse tree seeds farther than expected.

Henry S. Horn

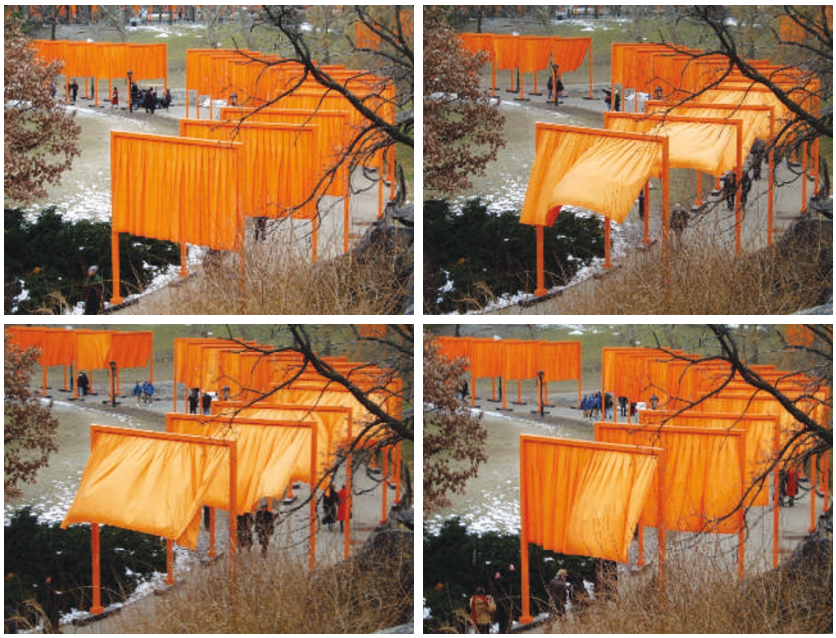
Tree seeds that are dispersed by the wind have parachutes, wings or sails to slow their descent. This keeps them in the airflow longer, allowing them to travel farther. But the assumption has been that a seed falling in a forest is doomed to travel only a short distance, because the wind is impeded as it passes among the trees.

To travel far, a seed must rise above the forest canopy on an updraft whose velocity exceeds the rate of fall of the seed in still air. If the updraft is part of a coherent rolling eddy, the seed might 'surf the wave' to a great distance. To guess how far a seed might get, it becomes important to know the sizes and lifespans of coherent wind eddies, but it seems that no one has made the appropriate measurements.

My colleagues and I have produced computer models that predict wind dispersal over long distances, but it has been difficult to convince others that our models are realistic (Nathan *et al. Nature* **418,** 409–413; 2002; *Div. Distrib.* **11,** 131–137; 2005). A visit to The Gates, Christo and Jeanne-Claude's temporary art installation in New York's Central Park this February allowed me not only to visualize coherent eddies, but also to measure their sizes and local lifespans. The measurements came from 57 photographs that I took with a digital camera on the afternoons of 24, 25 and 27 February 2005.

The Gates in Central Park, New York City, 1979–2005 comprised 7,500 gates, around 4 metres apart and 5 metres high, following the line of the paths through the park. Saffron-coloured fabric panels were hung from the top of each.

When there was no detectable wind or only a light breeze, the fabric of The Gates hung vertically with minimal flutter. The panels billowed out to within 20° of the horizontal for winds recorded near the ground at 2 to 5 metres per second (www.cdo.ncdc.noaa.gov/ulcd/ULCD). I measured the 'footprint' of a coherent eddy by counting a consistent number of contiguous billowing gates and calculating the distance they span. Footprints spanning at least 12–13 gates (about 45 metres) were common at wind speeds of 2 to 5 metres per second. From timed sequences of photographs of sets of gates, I recorded local lifespans of 32 to 57 seconds.



H. HORN

Seeing ghosts: a 58-second sequence showing the waxing and waning of a 25-metre eddy.

These records are biased toward shorter lifespans, as I chose to photograph sequences only when the gates were changing orientation rapidly. Some eddies lasted longer than 100 seconds, and the their footprints tended to move along a line of gates at scales of about 100 metres.

Seeds that are kept aloft by updrafts in a 45-metre coherent eddy, for 50 seconds, in a horizontal wind of 5 metres per second, could travel at least 0.25 kilometres. This is farther than we thought, even though the measurements behind the calculation are all substantial underestimates.

Thanks to Christo, Jeanne-Claude and The Gates, I now have direct quantitative observations, in moderate winds, of the coherent eddies that are crucial to long-distance dispersal of seeds and other biotic agents. Praise is also due to Christo for having anticipated realistic sizes for the wind eddies that drive The Gates in his conceptual drawings, which were made before construction of the work itself.

Of course, the aerodynamic presence of The Gates is part of the landscape that may interact with the generation and propagation of coherent eddies. Some details are likely to be peculiar to Central Park, and even to the installation itself. Nevertheless, the general pattern and its spatial and temporal scales are highly suggestive of features to be expected in a natural landscape. So the seed can indeed fall far from the tree.

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