

cartoon faces (see figure, panel D). In fact, many of the cells showed a weak but significant response to a few particular nonface objects; all of these objects turned out to be round (see figure, panel C). The weak but significant responses to round clocks and fruits in this area, as well as its relatively posterior position within the temporal lobe, indicate that it constitutes an early stage in the form-processing hierarchy. Recording from this area is a bit like peeking into a carpenter's shop and seeing the rough frame before fine chiseling—exactly what one wants for piecing together the basic mechanisms underlying face selectivity.

How do face cells encode specific faces? Early recordings in the middle face patch suggested that face cells distinguish faces on the basis of visual shape (e.g., the cells responded weakly to the round outline in a clock and an apple). To explore shape tuning of these cells quantitatively, I took advantage of their robust response to cartoon faces, which can be easily parameterized. I probed face cells with a cartoon face space consisting of 19 different fea-

ture dimensions, each sampled at 11 values; the space thus contained  $11^{19}$  possible different faces. The cartoon dimensions included ones describing the overall facial shape, the shape of individual features (e.g., iris size), and the relationship between features (e.g., intereye distance). Across the population, a vast majority of cells showed strong tuning to at least one cartoon dimension, and no cell was tuned to more than eight dimensions. The two most popular dimensions were face aspect ratio (i.e., Bert versus Ernie) and iris size. Most cells responded best to extreme features such as large irises, Ernie's or Bert's face, etc. These results show that we can understand face cells: Each cell acts as a set of face-specific rulers, measuring faces along multiple distinct dimensions. By combining the measurements of all these little rulers, it should be possible to reconstruct any face (including a bandit's, if not covered well).

My experiments show that the neural machinery for face processing in macaque monkeys consists of a set of discrete brain regions packed with highly dedicated components. This system offers a unique oppor-

tunity for exploring high-level form perception. By recording from several large, homogeneous populations of face cells identified through monkey fMRI, we can now understand the process by which the brain synthesizes the percept of a face in terms of underlying single-cell components.

#### References and Notes

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10. All the experiments here were performed together with Winrich Freiwald. I owe deepest thanks to my adviser Margaret Livingstone and to my father Thomas Tsao.

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## 2006 Grand Prize Winner

The author of the prize-winning essay, Doris Tsao, was born in Changzhou, China, and grew up in College Park, Maryland. Dr. Tsao studied biology and mathematics at Caltech, receiving her B.S. in 1996. She moved on to do graduate work in the laboratory of Dr. Margaret Livingstone at Harvard Medical School, where she studied binocular depth perception. While a graduate student, she became interested in monkey fMRI as a way to chart unexplored regions of the brain, and worked together with Roger Tootell to image macaque brain regions involved in depth and face perception. She received her Ph.D. in 2002 but remained as a postdoctoral fellow in Dr. Livingstone's laboratory in order to continue her experiments on face perception. In 2004, she received a Sofia Kovalenskaya Award from the Humboldt Foundation. This award allowed her to set up her own lab at the University of Bremen, Germany. Dr. Tsao's goal is to understand how a sheet of cells 2 mm thick can construct a three-dimensional world and effortlessly recognize the multitude of objects within it. Her laboratory uses a combination of electrophysiology, imaging, psychophysics, and anatomical techniques. Outside the laboratory, she likes to swim, cook, and play the violin.



### Finalists

Bernardo Sabatini for his essay, "Establishing synaptic independence: How neurons create diffusional barriers." Dr. Sabatini was born and raised in New York. He received his undergraduate degree in biomedical engineering from Harvard College in 1991. He received his M.D. and Ph.D. degrees in 1999 from Harvard Medical School, having completed his thesis work in the laboratory of Dr.

Wade Regehr. After graduation, he joined the lab of Dr. Karel Svoboda at Cold Spring Harbor Laboratory as a postdoctoral fellow. In 2001, Dr. Sabatini started his own laboratory in the Department of Neurobiology at Harvard Medical School, which is focused on understanding the processes that regulate the structure and function of synapses and how these processes are perturbed in neurological diseases. His life outside of science is mostly spent trying to keep up with his three sons.



Gábor Tamás for his essay, "Lighting the fire in cortical microcircuits: Exciting role for chandelier cells." Dr. Tamás was born in Dunaújváros, Hungary, and completed undergraduate studies in biology at the University of Szeged, Hungary. As a graduate student he was trained in neuroanatomy and physiology in the group of Peter Somogyi at the University of Oxford, where he investigated the function, number, and location of synapses between neocortical neurons. In 1998, Dr. Tamás returned to Szeged to establish his own laboratory and identified the first intercellular mechanism capable of synchronizing cortical neurons at gamma frequency. His group discovered that the so-called neurogliaform interneuron is capable of eliciting slow, GABA<sub>B</sub> receptor-mediated inhibition in the cerebral cortex. Dr. Tamás was a gymnast for 15 years but now gets his exercise from whitewater rafting, skiing, and hiking in the mountains.



For the full text of essays by the finalists and for information about applying for next year's awards, see *Science* Online at [www.sciencemag.org/feature/data/prizes/eppendorf/eppenprize.shtml](http://www.sciencemag.org/feature/data/prizes/eppendorf/eppenprize.shtml).