in prison populations and hypothesized that XYY “supermales” had received an additional dose of “male” traits like aggression and physical strength. Later studies thoroughly discredited the “supermale” theory: XYY and XXY males were found to have similarly high rates of imprisonment (now attributed to slightly lower average intelligence caused by chromosomal imbalance). Even so, the XYY “supermale” theory captured the public imagination—highlighting, Richardson argues, how the X and Y chromosomes have been persistently conflated with social notions of gender.

Examples such as the XYY “supermale” theory illustrate how social ideas of gender can shape scientific inquiry, says Richardson. She is concerned not only with “black-and-white” cases of gender bias; in fact, she introduces the term “gender valence” to illustrate the varied and sometimes productive intersection of cultural and scientific understanding. Thus she highlights scientific debate over the theory of Y-chromosome degeneration, which posits that the Y chromosome is rapidly losing genes and may eventually disappear; the discussion, Richardson argues, consciously engages with societal anxieties over the status of men in a postfeminist world. “Gender beliefs are playing a role in the science here, but it doesn't have the pejorative connotation of bias,” she explains. “Bias, in my view, happens when we insert our assumptions into scientific research in a way that is not reflective, that’s invisible to us.”

She ends by examining modern research into sex differences. In the related area of race-based research, scientists have found that individual humans have similar amounts of genetic variation, whether they are from the same or different populations, and critical dialogue has revealed the potential pitfalls of ascribing biological significance to socially constructed racial categories. Sex-difference research, Richardson argues, requires this critical perspective as well. Per the New Yorker cartoon, she cautions that “older, once debunked, theories of sex difference [have been revived] decades later in the language of molecular genetics,” as mechanisms of gene expression or neurological wiring are used to reinforce existing ideas of gender. Building on several published statistical criticisms, Richardson finds that many sex-difference studies have fundamental logical flaws: for instance, scientists often fail to distinguish properly between biological and social influences, she observes, even though gendered norms in areas ranging from exercise to workplace interactions can complicate what appear to be essential biological differences.

The errors, Richardson writes, illustrate a broader conceptual problem. It has been too convenient to think of male and female as opposite, she says; the sexes must be seen not as “natural kinds”—distinct and separate categories—but rather as “permanently paired and dynamically interacting.” “Looking over 30 or 40 years of critical discussions of gender in science,” she says, “we can document how those conversations have begun to change and benefit the science” by pointing out gendered assumptions and suggesting alternative models. “The book makes the argument that we should continue to cultivate these discussions as we move into an age in which genomics will proliferate findings of human differences.”

~KATHERINE XUE

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Fusing Faculties of Mind

WHAT IF PEOPLE COULD COMMUNICATE WITH ANIMALS, AND EVEN WITH EACH OTHER, USING ONLY THEIR THOUGHTS? Such direct brain-to-brain communication became a reality, at least in a very basic sense, at Harvard last year, when a team of researchers led by associate professor of radiology Seung-Schik Yoo developed the first interspecies “brain-to-brain interface” (BBI). The mechanism retrieves a signal from a human's brain (generated by staring at a flashing light) and transmits it into the motor cortex of a sleeping rat, causing the rodent to move its tail. “We were interested in creating a way for information to be transmitted between two brains without using nerves or mus-
“We were interested in creating a way for information to be transmitted between two brains without using nerves or muscles,” says Yoo, who found—as reported in the journal PLOS ONE in mid 2013—that a human subject could successfully control tail movement 94 percent of the time.

To achieve this advance, Yoo and his colleagues incorporated discoveries made by others in the rapidly growing field of computer-brain interaction. In recent years, scientists have overcome immense technical challenges to build computers that read and interpret signals directly from the brain. These brain-computer interfaces (BCIs) have been adapted for use in clinical settings—for instance, doctors use them to allow quadriplegic and “locked in” patients to move computer cursors, mechanical arms, and even their own wheelchairs.

Using this research, Yoo and his team built a machine that not only receives signals from the brain using existing BCI technology, but also inserts those same signals into the brain of a separate organism. “The real challenge was figuring out how a computer can somehow control the brain activity in the rat—the computer-brain interface,” he explains. “The difficulty was to create a method that offered a fine level of control without having to perform surgery” to insert electrodes into the brain.

The most common method of noninvasive brain stimulation—transcranial magnetic stimulation—is not accurate enough to stimulate the tiny region of the rat’s brain associated with tail movement, Yoo says. Instead, he and his team relied on a technology that he has been studying since 2007, “focused ultrasound” (FUS), that enables stimulus of specific areas of the brain using focused beams of acoustic energy. One challenge of ultrasound imaging is that the sound waves cannot penetrate bone. But Yoo’s team “found that you can overcome those limitations if you are using low acoustic frequencies.”

In their experiment, the researchers attached an FUS machine, calibrated to activate the specific cortical region associated with tail movement, to a rat’s skull and placed a human volunteer in a BCI machine that reads neural signals using an electroencephalogram. Then they linked the two interfaces together via computer. In order to generate a command to send to the rat’s brain, the human subjects were asked to stare at a flickering light pattern on a computer screen whenever they intended to move the rat’s tail. This elicited a particular pattern of brain waves, which triggered a focused burst of ultrasound connected to the rat’s brain, causing its tail to move.

Despite the success of the experiment, Yoo sees three areas for improvement. First, he’d like to achieve the same results when the rat is awake. Second, the existing device is essentially just an on/off switch controlling the rat’s tail, but future brain-brain interfaces might be used...
Anecdotally, the cost of a healthy diet—rich in fruits, vegetables, fish, and nuts, for example—has been assumed to be higher than that of a diet consisting of unhealthy processed foods. Now research from the Harvard School of Public Health (HSPH) has quantified that cost difference, often cited as a barrier to eating well, as roughly $1.50 more per person per day. That’s “smaller than many people might have expected,” says senior study author Dariush Mozaffarian, an associate professor at HSPH and Harvard Medical School. It’s “the cost of a cup of coffee,” or about $550 a year ($2,200 for a family of four).

The findings, based on a meta-analysis of 27 studies undertaken in 10 high-income countries, are part of a larger effort to understand how government policy and existing food-supply systems affect health. The research shows that a healthy diet is affordable for most people, Mozaffarian says, given that “for 60 percent to 70 percent of people..."