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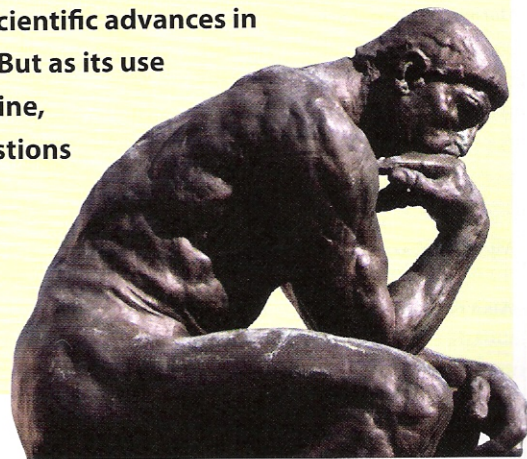
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By Christy Nicholson

Brain imaging has transformed many aspects of psychological research, and may be one of the greatest scientific advances in recent years. But as its use becomes routine, there are questions about claims for what fMRI data really show.

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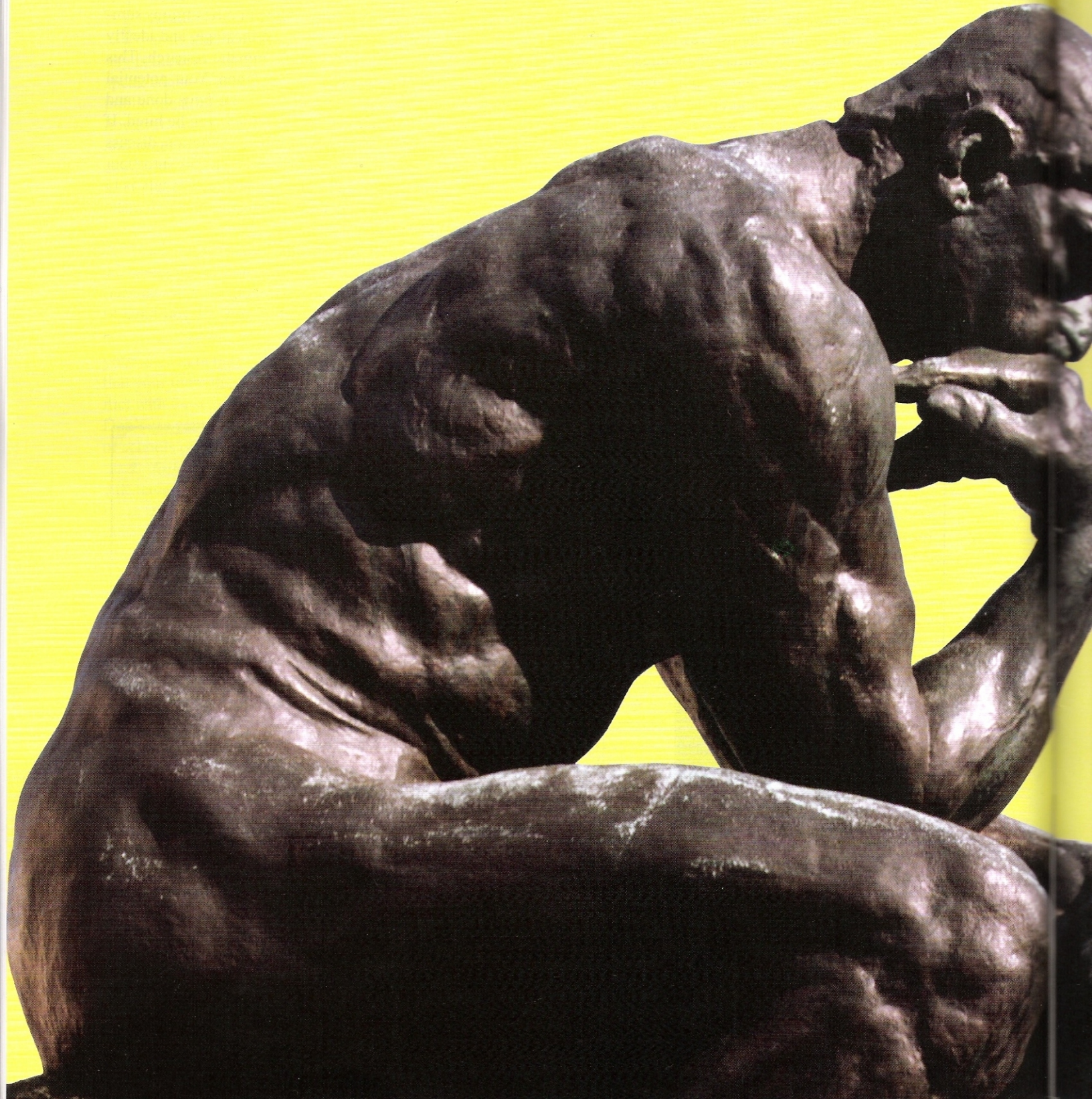
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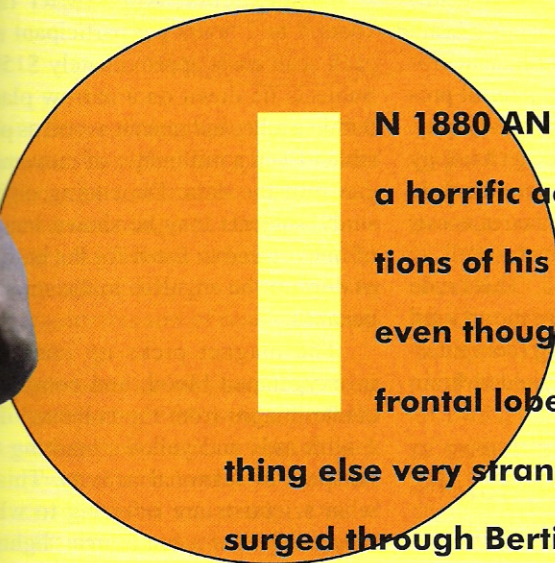
Thinking It Over

fMRI and Psychological Science





By Christy Nicholson



IN 1880 AN ITALIAN PEASANT NAMED BERTINO SURVIVED a horrific accident that cracked open his skull and left sections of his brain exposed. Surprisingly Bertino felt fine, even though one could see blood pulsating through his frontal lobes. His physician, Angelo Mosso, noticed something else very strange. Every time church bells rang in town, blood surged through Bertino's lobes. Mosso took a guess that the blood surged because the bells reminded Bertino of prayer. When Mosso asked Bertino directly, "Do the bells make you think of prayer?" Bertino answered, "Yes." At that moment blood again engorged the exposed veins. Then Mosso asked, "What is eight by 12?" Bertino answered, "96." More blood pulsed through. The link Mosso had stumbled upon was perhaps the first connection made between blood flow and brain activity — a serendipitous connection that, more than century later, would become the foundation for a revolutionary tool to study the brain: functional magnetic resonance imaging, or fMRI. ▶

Today, fMRI is routinely used to turn our dull grey matter into technicolor images of reds and yellows, which can tell us where in the brain we experience intangible emotions like romantic love, political passion, even petty glee over others' misfortune. This technological mind reader has captured the imagination of both scientists and the public. Indeed, scientific journals are devoting more and more pages to what many scientists call one of the greatest scientific advances of the last quarter century.

"This is the first time in history we have a non-invasive, high-resolution, totally safe way to look at a human brain," says Joy Hirsch, director of the fMRI Research

This is the first time in history we have a non-invasive, high-resolution, totally safe way to look at a human brain.

—Joy Hirsch

Center at Columbia University. "To look at how the brain drives and controls behavior — this is the single most important question in neuroscience."

But many caution that the flurry of excitement may be premature. Some worry that the dazzling brain images are usurping other important areas of psychology and convincing laypeople that science can do more than it can. Already the commercialization of fMRI is in the works. Private companies like No Lie fMRI, Inc. and Cephos Corporation are launching to capitalize on the potential for fMRI to replace the polygraph in lie detection. But the very scientists whose research has spawned these radical uses say it is too early to start depending on fMRI in ways that could have serious outcomes for an individual's life. fMRI research is evolving and yet to be perfected, they say.

"There is a lot more work that needs to be done before I would try to commercialize it," says APS Fellow and Charter Member (as well as APS President-Elect) John Cacioppo, Director of University of Chicago Center for

Cognitive and Social Neuroscience. "We might predict someone is lying, but when we can only get 85 percent accuracy, that's just not high enough."

NUTS AND BOLTS

To be sure fMRI has starkly surpassed early attempts to see the brain in action. One of the first human neuroimaging techniques was a painful procedure called pneumoencephalography. Used in the early 1900s, the technology required that physicians drain the fluid surrounding the brain and then inject air in its place through holes in the skull, so the brain could be x-rayed. This crude technique remained state of the art until 1973, when CAT scanning (computerized axial tomography) yielded brain

images that were detailed enough for diagnosis of brain abnormalities.

CAT scans were followed by positron emission tomography or PET scans, which measured the decay of radioactive chemicals in brain tissue, and also MRI, which detected magnetic force. But all of these early images were static. The "movies" of brain function only became possible with confirmation of the link between blood flow and brain activity. This opened the possibility of using MRI to study more than just brain structure. With this connection the active *functioning* of the brain could be predicted. Hence the lower case "f" added to MRI.

The fMRI technology is possible solely because of two fortuitous quirks of nature. When a certain area of the brain is active, it pulls more oxygenated blood to that area than is actually needed. No one knows why it overcompensates, but the result is a surfeit of oxygenated blood associated with increases in neuronal activity. Here is the second quirk: deoxygenated blood has magnetic properties (because oxygen neutralizes the effect of iron in the blood). So the

ratio of oxygenated blood to deoxygenated blood can be picked up as a signal by the magnetic field of fMRI.

Experiments using fMRI take about 1 to 2 hours per participant and each scan costs approximately \$1500. Subjects lie down on a narrow plank, within a tube, and remain as still as possible. Even a millimeter of movement can ruin the data. Depending on the study, subjects may be shown images of lines, asked to listen for the barking of dogs, or be engulfed in the smell of bananas.

The magnet picks up increases in oxygenated blood, and computers create images from the collected data — with reds and yellows marking the hotspots of neuronal activity. This is what scientists are referring to when they talk about a brain area "lighting up" when someone is looking at a photo of say, Jennifer Aniston. So according to critics, what fMRI really measures is a correlation between blood flow and activity, and not the brain activity itself.

But much of scientific progress starts with seeing some kind of correlation that begs explanation, like Angelo Mosso noticing surges of blood in the unfortunate Bertino's brain. The data from fMRI provides another dependent variable that psychologists can use to help weigh competing psychological theories.

"It's got meaningful information," says Joshua Greene, assistant professor of psychology, Harvard University. "It's not just swooshing blood everywhere — it's far too specific and predictive of behavior."

The most well known shortcoming of fMRI is its slow timing. The blood flow response takes about two seconds, but a thought can happen in milliseconds. So it's difficult to say that a rush of blood is associated with a specific activity in the brain.

As a possible solution to this temporal lag, a few labs have started combining fMRI with other tools, like EEG

(electroencephalography) and MEG (magnetic encephalography). EEG and MEG can provide millisecond-by-millisecond recordings of electrical brain activity. Joy Hirsch believes that the next quantum leap in neuroimaging will require this sort of fusion of imaging tools.

Right now her lab is experimenting with performing EEG within the fMRI scanner itself. Some investigators think it's a waste of time, but Hirsch says there are strategies that can work. One of the difficulties is that the EEG signal is washed away by the giant magnetic field

of fMRI, so one strategy is to protect the EEG from the magnet. "We use a technology that allows for the interweaving of the EEG in the gradients of the scanner," she says.

This technique is proving beneficial in guiding surgeons who want to cut through exact areas of the brain that are prone to seizures.

"We can mark it in time and space," says Hirsch. "And this helps the surgeon take out smaller parts of the brain and be more detailed in their work."

Perhaps the most popular criticism of fMRI, and one fueled by the surge of media attention, is the tendency for fMRI studies to plant flags in different regions of the brain thereby claiming specific cortical zones that house concepts like love, self-will, and even the

so-called "God spot."

If we are not careful, says Marcus Raichle, considered to be one of the world's experts on brain imaging, the technique might be viewed as modern day phrenology, (the theory developed in 1800 that claimed personality traits could be localized by bumps on the head). Already, the psychologist William Uttal wrote a critique of fMRI in his recent book called, "The New Phrenology."

Certainly when we think about it there is more to religious belief than a specific neural center in the temporal lobe – it involves faith and practices. As Cacioppo explains, "The way to reach God is not through an electrode placed on the brain."

Moreover, another study used fMRI to show that Democrats and Republicans base their support on emotions rather than rational thinking. But there are hundreds of possible ways supporters make their decisions. As

Some Cautions About Jumping on the Brain-Scan Bandwagon

By Carole Wade

My interest in neuroscience and neuroimaging is primarily as a teacher and textbook author. Like any teacher, I want students to appreciate the astonishing progress being made by neuroscientists. But I also want students (and teachers) to think as critically about findings from brain-scan studies as about findings from any other domain of psychology.

The public has a tendency to equate technology with science, but PET scans and fMRIs are only tools; some people do great science with them, others do poor science with them. And many findings are less solid or meaningful than they first appear to be. Just as we teach students to be wary of poorly designed or interpreted surveys, experiments, and tests, we need to teach them to be wary of flawed methods and exaggerated conclusions in neuroimaging studies.

Critics like Joseph Dumit (2004) and William Uttal (2001) have pointed out some of the methodological and conceptual problems with neuroimaging studies. Because of the high costs involved, most brain-scan studies have used small samples; some studies reported with great fanfare by the media have had only four or five participants.

Many confounds can affect the results, such as time of day, anxiety levels of the participants, and presentation rates of stimuli. Further, decisions about color scales and the criteria for setting boundaries that define high, moderate,

and low neural activity can accentuate or minimize the contrasts among different brains or brain areas. Such decisions can affect whether the gorgeous images we see at conferences, in articles and textbooks, and in the popular press will be striking, ho-hum—or even misleading.

Many neuroimaging studies are done to identify areas of brain activation associated with particular psychological processes, but those processes are not always well defined. Most behaviors and mental processes denoted by a single term (memory, attention, pattern recognition, etc.) actually involve an intricate and complicated series of operations; the more complicated these operations are, the less likely it is that they are associated with a single region of the brain. It's far more likely that they involve the interaction of multiple circuits that communicate back and forth in highly complex and, as of yet, unknown ways.

There's also the vexing problem of individual differences in brain anatomy. In his 1981 Nobel Prize acceptance speech, Roger Sperry observed that the individuality inherent in brain networks made the uniqueness of fingerprints or facial features seem simple by comparison.



Richard Henson, University College London, who wrote the paper, "What can functional neuroimaging tell the experimental psychologist?" explains, "We need more focused questions where we compare two tasks, and control for everything we can and not be confounded by other variables."

The other problem is that cognitive functions do not exist in just one part of the brain – they can co-occur in many regions and it is the neural communication between regions that could be key. Just like harmony doesn't exist in one area of an orchestra – it is a

culmination of instruments working in intricate ways. There is no way to point a finger and say okay, the "happy" melody resides just there, next the oboe.

Certainly, the more abstract the concept the more likely it depends on this neural interconnection. Looking for the region of love in the brain might be akin to looking for the region of soul in a rhythm and blues band.

"Until recently most investigations are reporting clusters of activation in this region or that region," says Rich-

ard Davidson, professor of psychology, University of Wisconsin. "What really may be more important is the connections of these regions, how they constitute a circuit."

Unfortunately a timing issue comes up again when researchers attempt to study communication between regions. This high frequency connection can happen within a hundredth of a millisecond and blood flow is far too sluggish

Looking for the region of love in the brain might be akin to looking for the region of soul in a rhythm and blues band.

to mark it.

One trick to study the actual circuitry between networked regions is to design experiments where the communication between regions is slowed down, says Henson. Like when subjects are asked to focus attention solely on the color of a dot for a long period of time – then researchers change the hue slightly and note any change in the brain. Researchers can look at how the co-variation between two brain regions changes as a function of the color change.

Others say a progressive leap lies in squeezing out as much concrete information as possible from the fMRI signal. APS Member Frank Tong, Vanderbilt University, has been working with powerful algorithms to do just this. His team uses multivariate analysis which involves looking at patterns (or many variables) in several regions of the brain at one time, as opposed to the more common statistical method univariate analysis, which uses one variable.

Using a multivariate technique he can predict what orientation of a line a person is looking at, or even whether they are looking at a pigeon or a sparrow. But he is hesitant about calling this "true mind reading." He's more comfortable with the words, "brain decoding."

"Mind reading in the true deep sense, no, we can't do that yet," he says. "If we ask a subject to think of anything and then predict what they are thinking about – we're a long way off from being able to do that."

The limiter is not in the computa-

But when scans from a number of individuals are averaged or pooled to produce a single image, as they usually are, such individuality tends to get overlooked. Of course, scientists pool or summarize all kinds of data. But because brain scans are so beguiling, students and nonspecialists may not realize that an image of a composite brain with apparently well-demarcated active brain areas may not represent the precise pattern of activity in any of the individual brains studied.

The most important problems discussed by critics like Dumit and Uttal have to do with interpreting the results. If an area "lights up" while a person is doing a task or solving a problem or memorizing a list of words, it could mean any number of things. That area may be the sole locus of the operation; or it may have been disinhibited by some other area that is of equal or greater importance even though less active; or it may be necessary for a particular mental operation but not sufficient unless other areas are also involved; or it may contain neurons that operate less efficiently than do those in other areas and therefore require more glucose. Sometimes it is hard to know whether the image in a brain scan even tells us anything about the operation in question. If a scan shows that a brain

area "lights up" when someone is doodling, that doesn't mean the area is a doodling center!

Most researchers are well aware of these and other problems, and the best research avoids such pitfalls. But as we teach about the wondrous new work in neuroscience, we need to impress on students – and remind ourselves – that even the best brain research can take us only so far. Even if we could monitor every cell and circuit of the brain, we would still need to understand the circumstances, thoughts, and cultural rules that affect whether we are gripped by hatred, consumed with envy, or transported by joy. ♦

REFERENCES

- Dumit, J. (2004). *Picturing personhood: Brain scans and biomedical identity*. Princeton, NJ: Princeton University Press.
- Uttal, W. (2001). *The new phrenology: The limits of localizing cognitive processes in the brain*. Cambridge, MA: MIT Press/Bradford Books.

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Do We Need To Study The Brain To Understand The Mind?

By Tor D. Wager

The brain is the most complex object in the known universe. Some 100 billion neurons release hundreds of neurotransmitters and peptides in a dynamic spanning timescales from the microsecond to the lifetime. Given this complexity, neurobiologists can spend productive careers studying a single receptor. Might psychologists more productively understand the mind by ignoring the

hardware). The separation implies that the same computational goals and algorithms may be accomplished by a human brain or a computer, and the physical medium—neuron or silicon—is irrelevant. This concept was fundamental to the cognitive science movement and has given its practitioners permission to comfortably ignore the brain. But →

brain altogether?

Marr (1977) suggested that mental processes may be studied at three levels of analysis: computational (the goals of the process), algorithmic (the method), and implementation (the

tional methods but in the signal from the neurons, Tong says. Right now the signals are too sloppy.

“If we could measure every single neuron day in and day out, it would be shocking what we could find out,” he says. “Things like knowing when another’s mind wanders to what they ate for breakfast.”

What about knowing the integrity of another person? Some recent fMRI studies claim to show how honorable we are.

Joshua Greene gave undergraduates a moral dilemma: 1) flick a switch that will kill one person to save five people, or 2) use your hands to kill one person to save five others. The area of the brain responsible for abstract reasoning “lit up” when students face the first, less personal problem of flicking a switch. But areas associated with emotion lit up when they faced the second choice killing with their bare hands.

“This is very intuitive,” said Sabine Kastner, Princeton University, “but we can’t use this to predict that one individual will flick the switch versus knocking the person off with their bare hands.”

There are stereotypical brain patterns that can be activated by different causes, Kastner explained. The same system could light up when running into a snake on a path while hiking as when you suddenly see that the last piece of chocolate cake is gone. Snake or cake, it’s not a specific system for each emotional situation.

Greene acknowledges the industry is still in a learning curve and some of the hype has been overblown. “I think it’s really the beginning and we’re just getting our bearings,” Greene said. “What we are going to learn from imaging has yet to come – right now we are just learning our way around the brain.”

In 30 years however, he says it might be possible for a summer camp to screen their employees for say, pedophilia. The camp could put employees into a scanner, show them photos of children in bathing suits and see how their brains

If this much has erupted in the last decade, where might the next decades take us?

light up. “There are pockets in the not too distant future where we will see something that is deep, personal and socially relevant,” he said. Right now Greene is working on research about when and how people keep promises.

If this much has erupted in the last decade, where might the next decades take us?

Many scientists dream of a time when they can free their subjects from the artificial environment of the scanner. To create a sort of “hat scanner” so they can study brains at work in the real world. They also dream of seeing the finer details.

“I’m greedy,” says Randy Buckner, Harvard University. “I want to see things at the cellular level in real time

– lots of them, or all of them. I want to see different aspects of cellular function and molecular function.”

Getting past the blood to see directly into a neuron is considered the greatest fantasy. But there are realistic changes underway. Standardization across the industry and strict designs for experiments might help make results more precise and free of bias. Making neuroanatomy and neuroscience requisites for a psychology degree will better train future researchers. And with the growth of computer power and the use of fusion techniques it’s quite possible that seemingly outrageous findings are within a shorter grasp than we think.

“It’s not just another fad like phrenology. It’s more than just correlational,” said Richard Henson. “With fMRI we can dynamically set up experiments and perturb them, and watch how the brain changes as function of what you are controlling experimentally.”

fMRI has been like placing the long word on a tight Scrabble board. It’s opened up the game. At once the players heave a sigh of relief and buckle down excitedly, to study all the new possibilities. And like the long word, fMRI hasn’t necessarily won the game but it might have laid the path to win.

“It’s opening the door to a whole new field,” said Kastner. “I think that if we really want to understand behavior in relation to brain function this is how we are going to do it.” ♦

it has been seriously challenged: A high-level computation (e.g., deciding the next move in a chess game) can be accomplished in a virtually infinite number of ways. Building a computer model that accomplishes the computational goal says little about whether it does so in the same way that a human would. The hardware provides critical constraints on the space of possible models.

The debate about whether we need to study the brain to understand the mind is now being conducted among a network of thousands of scientists and scholars worldwide. The emerging consensus appears to be that implementation is important. Interestingly, the inverse question is also being asked by neurobiologists—do we need consider the mind to understand the brain?—and answered largely and increasingly in the affirmative.

We can learn much about the mind without knowing a neuron from an astrocyte. As I often repeat to myself and occasionally to others, "If you want to understand human performance, study human performance." But brain data provide information about the mind that cannot be gleaned from even the most careful studies of behavior. In short, brain data provide a physical grounding that constrains the myriad otherwise-plausible models of cognition. They give us a direct window into which mental processes involve similar and different neurobiological processes, allowing us to use biology to 'carve nature at its joints' and understand the structure of mental processes (Kosslyn, 1994). Brain function also provides a common language for directly comparing and contrasting processes that are otherwise 'apples and oranges,' such as attention and emotion. This common language is a basis for the integration of

knowledge across different types of research—basic and clinical, human and nonhuman.

As the general uses of neuroimaging have been eloquently discussed elsewhere, I focus here on a few examples of how functional magnetic resonance imaging (fMRI) has been useful in my work (see Jonides, Nee, & Berman, 2006). Also, as every method has its limitations, I discuss some of the pitfalls of making psychological inferences from neuroimaging data.

One use for me has been in understanding the structure of emotion and executive control processes, and the ways in which cognitive control operates in emotional and nonemotional situations. My colleagues and I have asked: Is pain different from negative emotions such as sadness and anger, or are they variants on a common theme? In meta-analyses we have found that pain and negative emotions activate distinct brain networks, but share features such as anterior cingulate and frontal cortex activity with a broader class of processes, including attention (Wager & Barrett, 2004; Wager, Reading & Jonides, 2004). In contrast, different varieties of negative emotion engage largely overlapping networks. Thus, pain appears to be distinct from negative emotion, but commonalities suggest ways in which they may share underlying processes such as heightened attention.

Questions about the similarity and distinctiveness of mental processes have been at the heart of psychology since its inception, but definitive answers have been elusive. Inferences have been based largely on correlations in performance across tasks (or in physiological responses, for emotion). But performance data are relatively information-poor: the fact that two tasks take about as long to complete says little about whether processes involved in selecting the response were the same. Physiological responses suffer from similar problems of specificity. Neuroimaging provides a much richer source of information: if two tasks activate the same brain regions to the same degree, they are likely to involve similar processes. This logic provides a way to assess the structure of mental processes based on the similarity of their brain activation patterns. In a study based on these principles, we asked whether diverse 'executive control' tasks involve a common brain substrate (Wager, et al., 2005). Substantial overlapping activation suggested a common network for controlled response selection.

Though questions about mechanism are more difficult to address, neuroimaging can be informative here as well. In an fMRI study of pain, my colleagues and I found that expectation of pain relief induced by a placebo engages the frontal cortex and midbrain pain-relieving mechanisms (Wager et al., 2004). Frontal activation suggests a common substrate for maintaining cognitive context that shapes

both perceptual/motor and affective processes, and mid-brain activation suggests engagement of opioid analgesic systems. Such direct evidence on the mechanisms by which expectations affect pain would be hard to come by without studying the brain.

The study also points to an additional benefit of neuroimaging: In cases where self-report may be inaccurate, imaging can provide converging direct measures of central processing of a stimulus. Whereas expectations might affect pain reports for uninteresting reasons related to cognitive reporting bias, the evidence that expectations affect ongoing pain processing provides converging evidence that they shape pain experience.

Yes, there are many ways in which neuroimaging data can be misused or misinterpreted. Gross levels of regional brain activity might in some cases be uninformative about the similarity of psychological tasks: Two dissimilar tasks may involve the same regions but use different populations

Brain data provide a physical grounding that constrains the myriad otherwise-plausible models of cognition. They give us a direct window into which mental processes involve similar and different neurobiological processes, allowing us to use biology to 'carve nature at its joints' and understand the structure of mental processes.

of neurons or involve different patterns of connectivity between regions. Two similar tasks might involve different regions but involve the same type of computation. Neural activity may be missed, as observed imaging signal only indirectly reflects neural activity, and observed imaging activation may not be essential for the task.

One of the biggest pitfalls is the temptation to observe brain activity and make inferences about the psychological state—for example, to infer episodic memory retrieval from hippocampal activity, fear from amygdala activity, or visual processing from activity in the 'visual cortex' (Barrett & Wager, 2006; Poldrack, 2006; Wager et al., in press). These inferences ignore the scope of processes which may activate each of these areas and involve a fallacy in reasoning: "if memory then hippocampus" is not the same thing as "if hippocampus then memory." The fact that few brain areas, including the 'visual cortex,' are dedicated to one process means that self-report is still the gold standard for assessing emotional experience and the contents of thought (Shuler

& Bear, 2006). This is a serious challenge for those who would like, for example, to assess your brand preferences or your political affiliation from a brain scan. (And isn't it easier just to ask?)

These problems are significant, but there is no perfect method—an understanding of the mind must emerge from a coordinated effort using converging evidence from all the tools at our disposal. Many of the issues above are being addressed by advances in data acquisition and analysis methods, the accumulation of more data on the mapping between brain structure and psychological function, and more nuanced views of what kinds of inferences are plausible. I believe that as the field matures, the exuberance of youth will give way to a more level-headed view of when and how neuroimaging can inform us about the mind. What we have learned already is considerable, and the accelerated integration across fields is leading to ever more and sophisticated and veridical models of the mind. ♦

References

- Barrett, L.F. and Wager, T.D. (2006). The structure of emotion: Evidence from neuroimaging studies. *Current Directions in Psychological Science*, 15, 79-83.
- Jonides, J., Nee, D.E., Berman, M.G. (2006). What has functional neuroimaging told us about the mind? So many examples, so little space. *Cortex*, 42, 414-427.
- Kosslyn, S. M. (1994). Carving a system at its joints. In *image and brain: The resolution of the mental imagery debate*. Cambridge, MA: MIT Press.
- Marr, D. and Poggio, T. (1977). From understanding computation to understanding neural circuitry. *Neurosciences Res Prog Bull*, 15, 470-488.
- Poldrack, R.A. (2006). Can cognitive processes be inferred from neuroimaging data? *Trends in Cognitive Sciences*, 10, 59-63.
- Shuler, M.G., Bear, M.F. (2006). Reward timing in the primary visual cortex. *Science*, 311, 1606-1609.
- Wager, T.D. and Barrett, L.F. (2004). *From affect to control: Functional specialization of the insula in motivation and regulation*.
- Wager, T.D., Reading S., Jonides, J. (2004). Neuroimaging studies of shifting attention: A meta-analysis. *Neuroimage*, 22, 1679-1693.
- Wager, T.D., et al. (2005). Common and unique components of response inhibition revealed by fMRI. *Neuroimage*, 27, 323-340.
- Wager, T.D. et al. (in press). Elements of functional neuroimaging. In J. Cacioppo and R.J. Davidson (Ed.), *Handbook of Psychophysiology*. Cambridge, MA: Cambridge University Press.
- Wager, T.D., et al. (2004). Placebo-induced changes in fMRI in the anticipation and experience of pain. *Science*, 303, 1162-1167.

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