MEDIA WATCH

CAVEAT LEITOR:
THE PRESENTATION OF NEUROSCIENCE INFORMATION IN THE POPULAR MEDIA

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Brain-imaging technology has been enthusiastically embraced not only by the scientific and medical communities, but also by the public, through popular media reports of neuroscientific methods and findings. But recent research in cognitive psychology shows that people are often unduly swayed by neuroscience studies, because of their visually appealing pictures, because people lack the resources to critically process their claims, and because people have misleading intuitive beliefs about the nature of the mind's relationship to the brain. There is thus a danger that members of the public will uncritically accept neuroscience-based claims, or applications of neuroscience information to public questions and debates, without regard to their merits. Because of this danger, scientists can and should do more to monitor the ways in which these claims and applications are reported in the media.

The advent of brain-imaging technology, especially functional magnetic resonance imaging (fMRI), has been a boon for medicine and research. Scientists can use fMRI scanners to see the brain in action by taking advantage of the fact that the hemoglobin in our blood contains iron, which is magnetic. Inside a scanner, powerful magnets pulse a magnetic field on and off, repeatedly aligning the hemoglobin molecules and then allowing them to return to their original state. This process leads to changes in the brain's magnetic field. The scanner detects these changes and uses them to calculate the amount of blood flowing to different parts of the brain over time.

This technology has led to great strides in understanding the ways in which our brains process information and the ways in which different brain systems work together. Perhaps more importantly, a growing understanding of what normal, healthy brains look like has helped to further our understanding of what goes wrong in certain diseases. Because of this, brain-scanning technology has the potential to be a powerful diagnostic tool for mental illness, able to show us in detail the differences between healthy brains and patients' brains.

These neuroscientific methods and findings have been enthusiastically embraced not only by scientific and medical communities, but also by the public. Popular media publications are filled with claims about what happens in the brain, with pictures of fMRI or positron emission tomography (PET) scans, and with applications of these technologies to medicine, science, politics, law, and advertising. To judge from the ubiquity of such articles in a wide variety of news outlets, and from the prevalence of neuroscientific evidence brought to bear on current public issues, people find these reports interesting and informative.

There are many reasons to be optimistic about this trend. The mere fact that newspapers and other popular media outlets often report on such findings raises awareness of science in the public eye. People are genuinely interested in these studies and in the ways in which neuroscience findings can impact their lives. In our current science-skeptical culture, this is all for the best.

Unfortunately, this is not purely good news. The neuroscience findings that are reported to the public and the ways in which they are reported need to be taken with a large grain of salt. This is true for the usual reason that we should adopt a healthy skepticism towards
popular reports of scientific or medical findings: Articles are written to sell newspapers and magazines, and they often oversimplify or even distort the science involved in order to do so. Non-scientists reading these articles may draw incorrect conclusions or may come to believe that the results of a certain study are more definitive than they actually are. This warning applies to all popular reports of scientific findings as well as to neuroscience. But recent findings in cognitive psychology give us three reasons to be particularly concerned about the way that members of the public interpret neuroscience.

**HOW WE REACT TO NEUROSCIENCE**

*Pictures are persuasive*

The neuroscience studies that we see in the news are regularly accompanied by pictures of the brain, showing colorfully “glowing” bits of neural tissue. As humans, we are highly visual creatures, accustomed to relying on the fact that what we see is actually happening in the world. Looking at these brain pictures often gives us the feeling that we have a window into the brain and that we can actually see what the brain is doing. But this is simply not accurate. An fMRI scanner is not a window or even a microscope; the output that it provides is not really a picture of the brain, at least not in the way that the output of a camera is a picture of a face.

All brains are shaped and organized slightly differently, just like other parts of the body. My brain might be slightly smaller than yours, or my hippocampus located slightly more to the left. This means that a scan of my brain and a scan of your brain would not overlap exactly. But research studies require responses from multiple participants to ensure that the phenomenon under study is general, not subject-dependent. To solve the difficult problem of comparing the spatial structure of many brains when each of these structures is different, scientists have developed technical methods for standardizing each brain picture to fit a common template. This process ensures that all of the brains to be compared are of exactly the same shape and size, allowing the creation of a single measure of brain activation from brains with disparate shapes and sizes. What this means is that pictures of brain activation in the popular press are not pictures of single brains, as people unfamiliar with fMRI technology might assume. Instead, and in sharp contrast to photographs, these pictures provide summaries of the activation patterns from several brains.

Another difference between brain images and photographs is that fMRI technology does not measure brain activation directly. Those glowing brain pictures are not actually pictures of a glowing brain. The way that those pictures are created involves several steps of analysis and hence are several steps removed from the brain itself. What fMRI scanners actually measure—and only indirectly at that—is the amount of blood flow to a given brain area, a reliable correlate of neural activity. To create a picture of brain activation from measures of blood flow, scientists first calculate the difference between the amount of blood flow in an area during one task and the amount of blood flow in the same area during a related task or a rest state. Using a grid superimposed over the brain picture, they then perform statistical tests to see whether the difference in the two amounts of blood flow in each grid square is unlikely to be due to chance. Colors are assigned to the grid squares based on degree of statistical significance. What we see when we look at the colored splotches in brain pictures are thus patches of statistical significance, not of activation itself. While neuroscientists and others who know about this process can interpret these pictures correctly, the majority of newspaper readers cannot, since they do not know how these pictures were created. Thus, there is a danger that most consumers of fMRI pictures believe them to be something that they are not: a direct picture of activity in a single brain.

Nevertheless, the brain pictures that we see in the news are powerful images, so much so that they make us believe that we can actually see what is happening in the brain. A recent study by David McCabe and Alan Castel (2008) supports this claim. In this study, four groups of subjects read the same written description of a scientific finding. The first group saw only the text of the description. The other three groups saw the text as well as a visual representation of the described data: a bar graph; a brain image like those seen in the media; or a topographical map of brain activation that was derived from brain-activation data but did not display those data as a brain picture. Subjects were asked to rate whether they agreed with the scientific claims made in the text. McCabe and Castel found that subjects were much more likely to agree with the claims and to think that the scientific reasoning in the description was sound when they saw the brain image than when they saw any other type of image. Furthermore, these researchers found no difference between subjects’ ratings of the scientific reasoning when they saw a topographical map, a bar graph, or no image at all. These results strongly suggest that the brain images we see in the media can have a dispropor-
tionate effect on whether we believe the claims in a given article.

The role of jargon

A second reason that fMRI information can be unduly seductive lies in the role that such information plays in a scientific argument. The studies described in the popular media usually claim to be explaining some cognitive or medical phenomenon, like why men are different from women or why drinking alcohol impairs motor functions. Some of my own research (Weisberg, Keil, Goodstein, Rawson, and Gray, 2008) shows that people find such explanations more satisfying when they contain some reference to neuroscience than when they do not. In this study, my colleagues and I gave people two types of explanation for a set of psychological phenomena. These two explanations were identical, except that one contained some irrelevant neuroscience jargon and the other did not. For example, one of the neuroscience explanations read: “The researchers claim that binocular rivalry happens because we can only process one complete image at a time,” whereas the matched with-neuroscience explanation read: “Patterns of activation in subjects’ brains indicate that binocular rivalry happens because we can only process one complete image at a time in VI, the visual area of the brain.”

The irrelevant neuroscience information is italicized here to illustrate that it has no impact on the logic of the explanation itself, although subjects in the study did not see any such highlighting. We found that subjects who saw the explanations with the neuroscience jargon judged them as more satisfying than subjects who saw the explanations without any jargon.

Surprisingly, this was especially true when subjects judged the original, no-jargon explanations to be poor. Some of the explanations in the study were merely circular restatements of the phenomenon that they were meant to explain, for example: “The researchers conclude that women’s poor performance relative to men’s explains the gender difference in spatial reasoning abilities.” These subjects saw much less difference between these bad explanations and their informative counterparts. That is, adding irrelevant neuroscience information resulted in a more dramatic increase in ratings of bad explanations than of good explanations.

It is not yet clear why the presence of neuroscientific information has such an effect. But these results do urge caution when reading popular reports of fMRI findings. Just as showing a brain picture can affect people’s judgments of a scientific claim, merely mentioning a brain area or scan in a scientific explanation can be persuasive—above and beyond what is actually warranted by the data.

Dualist intuitions

A final reason to be particularly cautious about neuroscience claims reported in the popular press is that we tend to misunderstand the scope of such claims. The usual form of a newspaper report on fMRI research is to identify a phenomenon (checking email, having a psychotic episode, voting Republican, etc.) and then to report that, when people do some task related to the phenomenon in the scanner, something happens in their brains. Of course, that really should not be news. All cognitive processing happens in the brain, somewhere. Neuroscientific imaging studies can and do tell us where this processing happens, whether that’s in the frontal lobes, the amygdala, or the right temporal gyrus. This information does expand our scientific knowledge. But the crucial point is that “where” is not equivalent to “why” or “how.” Knowing that the hippocampus is involved in memory, for example, does not necessarily tell us how memory works, why we have trouble remembering certain things, how we retrieve old memories, or how we create news ones. In addition, fMRI data tell us only about correlations, not about causation. A brain area that is active during a certain task might be actually performing the task, but it might also be monitoring activity elsewhere in the brain, or even inhibiting other activities that would interfere with the task.

For these reasons, neuroscience has occasionally been accused of being no more than “the new phrenology” (Uttal, 2001), mapping out which cognitive processes involve which parts of the brain without adding anything to our knowledge of the processes themselves. This is a somewhat unfair characterization of neuroscientific research, which aims to use brain-imaging techniques to gain a better understanding of mental processes themselves and not merely to localize these processes.
But it does seem to be an accurate description of reports of neuroscientific studies found in the popular press. More often than not, these articles promote the completely uninformative claim that a certain mental process takes place in the brain—even though this is the only possibility for all of our mental processes.

Why, then, are reports of such neuroscientific findings so interesting and so ubiquitous? One reason, championed most notably by the psychologist Paul Bloom, is that we are intuitive dualists (Bloom, 2004). We believe that people are made up of two fundamentally different parts: physical bodies and immaterial minds or souls. Although these parts are connected to each other and can influence each other, we generally assume that they are separate. Mental processes, like reading, feel different from physical processes, like running. Many religious and literary creations take advantage of this belief: ghosts are souls without bodies; zombies are bodies without souls. The fact that such creatures are so easily comprehended is a testament to our natural intuition that minds and bodies are separate. But neuroscience turns this intuition on its head. Neuroscience gives us compelling evidence that our minds are located inside our bodies, in our brains. Mental changes, such as learning a new word, can be understood in terms of physical changes, such as forming new neural pathways. Our minds are just our brains in action. But this claim is so different from what we intuitively expect to be true that neuroscience becomes fascinating. As Bloom succinctly puts it: “When a New York Times article rhapsodized about neural correlates of passion (‘Watching New Love As It Seams the Brain’), the interest of the article for the average reader did not lie in the details about the role of the caudate nucleus. Rather, it lay in the fact that the brain is involved at all in anything as interesting and personal as falling in love.” (Bloom, 2006)

**NEUROSCIENCE IN THE PUBLIC SPHERE**

These three arguments tell us that we read neuroscience studies with a biased eye. Whether because of their visually appealing pictures, because we lack the resources to critically process their claims, or because of our intuitive beliefs about the nature of the mind, we tend to find scientific claims more interesting and more convincing when they reference some neuroscientific method or result. Unfortunately, this is not a harmless bias. It means that people are more likely to accept scientific information when it is presented as coming from a brain scan than when it was obtained through other methods, even when the other methods are more effective tools for studying the topic at hand. Did we really need a brain scan to tell us that smoking is addictive (“Smoking changes brain…”, 2007), that repeated experiences of jet lag can affect one’s memory (Okie, 2001), or that people with anorexia nervosa react differently to pleasure than people who do not have this condition (“Anorexia visible with brain scans”, 2007)? No. Behavioral measures, interviews, and laboratory studies can provide us with this information. The trouble is, only now that there is neural evidence to support these claims do these findings seem convincing to a wide audience. This creates a dangerous situation in which it may not be the best research that wins debates in the public sphere. At worst, it is the research that produces the prettiest pictures or is performed with the most expensive equipment that galvanizes public opinion, earns grants, and changes the shape of the debate.

For example, there has been a recent vogue for studies of political convictions in the brain. Subjects in a scanner respond to questions or look at pictures of politicians while their brain activity is recorded. Researchers then look at their activation patterns and make inferences about how these subjects feel about certain candidates: the insula, a structure often involved in disgust responses, was active when subjects viewed pictures of a certain candidate, so it is likely that people will not vote for this candidate (Iacoboni, et al., 2007). But, as several recent opinion and editorial pieces have pointed out (Aron et al., 2007; “Mind games,” 2007; Rubin, 2007), any such conclusions are suspect, because they rely on many leaps of logic. The insula is indeed involved in disgust reactions, but brain structures rarely perform only one task. This means that the insula might have been involved in subjects’ reactions to this candidate for a different reason, not because they felt disgusted. Even if the subjects did feel disgust for this candidate, they might have felt this way because they were upset that he or she was doing poorly, not because they disliked him or her. Regardless, if one wanted to find out how subjects feel about a certain candidate, wouldn’t it have been easier to just ask?

Actually, there is no real way for us to tell in advance whether brain-imaging studies will give us insight into a psychological process beyond what we could obtain from asking people about their preferences. But the message from the cognitive psychological research is that “just asking” is not nearly as convincing, even in cases where neuroimaging data does not add any insight to our explanations.

Other proposals to bring neuroscience out of the lab and into the public sphere are equally suspect. Some
people advocate using brain scanners as lie detectors (Talbot, 2007) or as diagnostic tools to analyze flaws in our leaders or each other (Amen, 2007). Again, we have tools that are at least as valid as brain scans, if not more so, to address both of these issues. In the case of lie detection, for example, polygraphs are not very accurate at distinguishing someone who is telling the truth from someone who is lying—but neither are fMRI machines. The momentum behind such proposals comes not necessarily from the science, but from its seductive veneer.

**HOW CAN WE RESPOND?**

Cognitive psychological research suggests that we may have some deeply rooted biases that make neuroscientific information particularly interesting and convincing. This means that wholesale efforts to combat these biases are likely to fail. But there are still several possible avenues for action—some more viable than others—open to those of us who are concerned about the ways in which neuroscientific data are presented to the public.

One obvious route is to improve science education. Scientists, researchers, and medical practitioners can let people know about both the promise and the potential pitfalls of neuroscience studies, as well as explain the ways in which neuroscientific information can bias our judgments. While this is the solution I would prefer as a scientist, it is the most costly and the most time-intensive, which unfortunately makes it extremely unlikely to happen. Furthermore, it is unlikely to be effective, as results from my own study show (Weisberg et al., 2008). My colleagues and I gave the same judgment task as I described earlier to two additional groups of subjects: students in an intermediate-level neuroscience course, who were learning about the limitations of neuroscience data; and neuroscience experts, who were graduate and postdoctoral researchers actively conducting neuroscience studies. As with the novices, these subjects had to judge whether a given with-neuroscience or without-neuroscience explanation was satisfying. We found that only the experts were immune to the effects of neuroscience information. The students in the psychology class responded to the questions in the same way that novices did, showing that a short period of education is not enough to dampen the impact of neuroscientific information on judgment. A different solution is needed.

A somewhat more practical suggestion relies on the fact that brain studies are not always conducted with fMRI scanners, although it sometimes seems that way from reading newspapers and magazines. There are other methods that scientists use to watch the brain's responses to stimuli in real time, such as electroencephalography (EEG), which measures the electronic fluctuations of the brain, often by using a cap fitted with electrodes. As McCabe and Castel (2008) showed, it is the brain pictures, not necessarily the brain-derived data, that people find seductive. Turning our attention and our research funding towards a variety of means of examining brain activity can move us away from the glowing pictures and help to salvage the good science while tamping the hype. But Bloom's dualism argument suggests that this will not solve the problem entirely. Part of what is seductive about neuroscience is the pictures, to be sure, but another part is the fact that we can measure anything that is happening in the brain at all.

One cynical way to get around this issue is simply to wait it out. The current fad of scanning people to ask any sort of question and then reporting that the brain is involved in said question may be just that—a fad. Although we see myriad "X in the brain" studies in the news these days, public interest in reading such reports may not last. If we wait long enough, a different technology or a new set of findings will almost certainly come along to supplant fMRI in the minds and hearts of newspaper readers.

There are two main things that we can do until that day comes. The first is to take a more active stance as scientists, medical practitioners, and researchers. We should hold journalists to higher standards in their reports of scientific claims, particularly to guard against over-interpretation of the data. One way to do this is to be more vocal critics of such articles, whether by writing letters to the editor, as Aron et al. (2007) did, or by otherwise taking media publications to task. As an example, the James S. McDonnell Foundation, a private granting foundation, maintains a webpage where a group of self-titled "neuro-curmudgeons" critique particularly egregious examples of overblown neuroscience-based claims in the media (see http://www.jsmf.org/badneuro/). But it would be even better to counter the possibility of over-interpretation in advance. We can do this too, by putting pressure or newspaper and magazine writers to cover scientific issues with more depth and nuance, and by making our expertise more available to members of the media to help them do so.

The second thing we can do is to remember to read all science reporting with a skeptical eye. We need to ask of any study, in any field, whether it tells us something new or merely leaves us with the illusion that we have learned something new. If we know that we are vulnerable to such illusions, then we will be better equipped to
evaluate the evidence that is presented to us. We need to remember that we tend to be convinced by neuroscience data and tone down our responses accordingly. We also need to remember that neuroscience, as a method for studying the mind, is still in its infancy. It shows much promise to be someday what many people want to make it into now: a powerful tool for diagnosis and research. We should remember that it has this promise, and give it the time it needs to achieve its potential—without making too much of it in the meantime.

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REFERENCES


