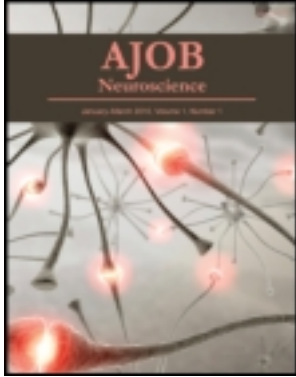


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Target Article

Brain Branding: When Neuroscience and Commerce Collide

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Products that align themselves with basic and clinical neurosciences do well in the market. There are reasons to be wary about such “brain branding” when commercial interests threaten to compromise scientific and clinical values. We describe three concerns. The first, exemplified in drug development and dissemination, is of the insidious effects of blurred boundaries between academia and industry. The second, exemplified by the sale of brain fitness products, is of commerce getting ahead of the motivating science. The third, exemplified by some functional imaging practices, is of the misuse of neuroscience in marketing technology. We propose three reasons for why brain branding appears to work. First is the seductive allure of neuroscience as providing seemingly deeper explanations of complex phenomena. The second is the persuasive power of pictures, which converges with the allure of neuroscience in brain imaging. The third is the context in which many physicians and patients find themselves. The relative lack of control over the course of chronic diseases may dispose physicians and patients to believe claims made by companies that align themselves with neuroscience. We outline circumstances when clinicians, patients, and consumers should question the usefulness of diagnostic tools and therapeutic interventions.

Keywords: brain games, marketing, neuroethics, neuroimaging, neurotechnology, SPECT scan

Brains make money. Increasingly, commercial products align themselves with basic and clinical neuroscience research (Lynch 2009). Recognizing this trend, the Neurotechnology Industry Organization (NIO), a recently created trade group, “is working on programs that could translate into millions of dollars to your company’s bottom-line and billions of dollars for commercial neuroscience” (NIO 2010). Certainly, we should celebrate the fact that neuroscience is coming of age and delivering on the promise of innovative technologies that will have an impact on the way that we diagnose and treat disease. However, we should also be wary of promises likely to fall short. In this article, we review some reasons these promises should be viewed with skepticism. These situations involve potential conflicts between values motivating bench and clinical science and those that drive the market.

Scientists ideally believe in the value of knowledge and advancing our understanding of the world. Social value is added when this knowledge is translated into precise diagnostic tools and effective therapies. Commercial value is added when these technologies are sold in an open market. Here, in the context of clinical neuroscience, we consider how commercial values can undermine scientific and social values. The concerns we raise are by no means confined to clinical neuroscience. In some form, they exist in all divisions of medicine. However, the tremendous growth of neuroscience knowledge in recent years, the hold that neuroscience has on the public imagination, and the vulnerability of the population in need of neuroscience technologies,

combined with potentially huge financial gains, give “brain brands” a special place in this evolving market.

We start with the principle that diagnostic tools and therapeutic interventions should conform to professional standards of care, and ideally they should be grounded in clinical and scientific evidence. Products sold in violation of this principle are suspect. Such violations arouse three kinds of concern. One concern is simply that blurring boundaries between academia and industry can insidiously compromise scientific and clinical standards. The second concern is that marketing can get ahead of the science; that is, neuroscience is used prematurely as a marketing tool to sell products. The third concern is that products can be sold by misusing neuroscience. We offer examples of each of these concerns. Our goal here is not to diminish the excitement over current and potential medical uses of neuroscience. Our goal is to highlight brain-branding practices of which we might be wary. Furthermore, we consider why people buy into brain branding claims even when caution is called for.

BLURRING BOUNDARIES BETWEEN ACADEMIA AND INDUSTRY

Neuropsychiatry drugs such as Zoloft and Ritalin represent some of the first and most successful of the “brain brands.” These and other incredibly successful pharmaceutical brands developed since 1980, when the Bayh–Dole Act allowed universities to retain ownership of patents generated from federally funded research, are products of a

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complex and evolving relationship between academia and industry. By 2000, industry's share of investment in biomedical research grew from 32% to 62%, while the federal government's share fell inversely (Bekelman, Li, and Gross 2003). Neuroscience funding followed these trends, with industry funding growing from 52% to 58% between 1995 and 2005 (Dorsey et al. 2006). More generally, by the mid 1990s, more than 90% of life sciences companies were involved in academic research, and 68% of universities held equity in companies that sponsored their faculty (Blumenthal 2003). As of 2003, one-quarter of academic biomedical investigators were sponsored by industry, and one-third had personal financial ties with industry (Bekelman, Li, and Gross 2003).

Academic–industry collaborations can be extremely beneficial. Working synergistically, these collaborations have been instrumental in producing several effective drugs (Chin-Dusting et al. 2005; Maxwell 1990). Multimillion-dollar partnerships between academic neuroscience research and industry are currently under way. For example, the University of Maryland received \$24 million from the pharmaceutical company Novartis (Basel, Switzerland) to collaborate in investigating treatments for schizophrenia (University of Maryland Medical Center 1999). Under optimal circumstances commercial interests need not compromise scientific and clinical values. Unfortunately, optimal circumstances are not always the rule.

Academic–industry links can compromise scientific integrity in several ways. They can bias scientific research, have undue influence on clinical practice, and introduce other forms of conflict of interest. Studies sponsored by industry are almost four times as likely to restrict sharing their data and to report pro-industry conclusions (Bekelman, Li, and Gross 2003; Lexchin et al. 2003). Clinical trials often report incomplete or biased results (Rising, Bacchetti, and Bero 2008). For example, 51% of Food and Drug Administration (FDA) trials on 12 antidepressant medications had positive results, while 94% of published trials considered the drugs favorably (Turner et al. 2008). The reasons for these publication biases are not always clear. Perhaps in response to these concerns, Pharmaceutical Research and Manufacturers of America (PhRMA) is setting up a clinical studies results database that is designed to be widely accessible and with results presented in a standardized format (ClinicalStudyResults 2010). This database is not designed to replace the FDA, but is motivated by a desire for full scientific disclosure.

The integrity of academic literature can be compromised in other ways. For example, some physicians accept authorship of scientific papers drafted by ghostwriters working for drug companies (Götzsche et al. 2009). In the past, this practice occurred in about 10% of published articles (Flanagin et al. 1998; Mowatt et al. 2002). Healy, a psychiatrist quoted in (Collier 2009), says, "The biggest problem isn't the ghostwriting, per se, but the lack of access to raw data to check against the conclusions." For publicly funded research, access to the raw data is on the rise as agencies like the U.S. National Institutes of Health require that the raw

data from publicly funded clinical trials be placed in a registry that has met criteria established by the World Health Organization and the International Committee of Medical Journals Editors (Collier 2009). Beyond the issue of data access is the fact that the article may be biased by industry's financial interest in the outcome.

Today's medical journals are not only vehicles of academic exchange. They are filled with advertisements intended to influence clinical practice. A recent study of psychiatric drug advertisements in 69 medical journals examined the availability of sources cited and the accuracy of the claims. Just over half of the advertisements' claims provided no attainable source. When sources were found for claims of drug efficacy, they were only supported by the sources on 53.2% of occasions (Speilmans 2008).

Industry can influence clinical practice in ways that are of concern. A 2001 national survey found that 96% of off-label neuropsychiatric drug prescriptions written had little or no scientific support (Radley, Finkelstein, and Stafford 2006). Fines have been levied on drug companies for improperly promoting neuropsychiatric drugs (Mello, Studdert, and Brennan 2009). Pfizer's recent \$2.3 billion settlement for such alleged marketing practices was its fourth fine since 2002 (Harris 2009). Other channels of industry influence on clinical practice can be insidious. A 2003–2004 national survey found that 94% of responding physicians interacted with the pharmaceutical industry. They received free meals (83%), drug samples (78%), support for continuing medical education (35%) and payments for lectures or clinical trials (28%) (Campbell et al. 2007). While most physicians think that gifts do not influence their behavior, the data suggest otherwise (Harris 2009; Wazana 2000). Physicians who receive free drug samples are more likely to prescribe expensive and newer drugs without basing these decisions on accurate medical information (Wazana 2000). Physicians who engage in educational events sponsored by industry, or have their travel expenses subsidized by industry, are more likely to prescribe the sponsor's drugs over competitors (Wazana 2000). Physicians that receive research funding and honoraria and interact with pharmaceutical representatives are more likely to request that their sponsor's drug be added to their hospital's formulary (Chren and Landefeld 1994).

Academic "thought leaders" with potential conflicts of interest can have a profound impact on treatment practices by influencing diagnostic norms. Diagnosing many neuropsychiatric disorders lacks precision, in part because these pathologic conditions do not often have clear and causally linked biomarkers. This lack of diagnostic precision can be of concern if the people who establish disease criteria and treatment guidelines have close ties to industry. Of the 170 panel members who contributed to *DSM-IV* (1994) and *DSM-IV-TR* (2000), 56% reported one or more financial associations with the pharmaceutical industry (Cosgrove et al. 2006). The entire panels on mood disorders ($n = 8$) and schizophrenia and other psychotic disorders ($n = 7$) reported financial ties to industry (Cosgrove et al. 2006). Of the 20 authors of clinical practice guidelines for schizophrenia,

bipolar disorder, and major depressive disorder, 90% had at least one *undisclosed* financial tie to companies selling drugs that were explicitly or implicitly identified in the guidelines (Cosgrove et al. 2009). Psychological research suggests that individuals are often unaware of how their affiliations can bias their decisions (Moore, Tanlu, and Bazerman 2010).

Neuropsychiatric drugs are developed and sold in a context where boundaries between academia and industry have become blurred. We are not suggesting that such close ties are problematic in principle. However, in some cases the result of these blurring boundaries is biased scientific literature and concerning clinical practices. Recently, PhRMA has published guidelines to mitigate the influence of commercial interests on the integrity of academic literature and clinical practices. However, because these guidelines remain voluntary, they should be taken with a “big grain of salt” (Goldstein 2009). While high-profile incidents receive considerable media attention, some question the pervasiveness of these compromises (Stossel 2005). Conflict of interest regulation in the extreme can itself be counterproductive to medical innovation and research (Stossel 2007). Ultimately, it is bias rather than conflict of interest that is the cause for concern, and bias is much harder to identify (Schwid and Gross 2005). For example, a neuropsychiatrist developing practice guidelines may have financial ties to a drug company, constituting a conflict of interest. But this conflict is not a problem unless it biases recommendations, and colleagues remain unaware of these ties. Neuroscientists and physicians should be vigilant about the ways in which the development and marketing of brain-branded drugs can compromise scientific values and clinical practices.

THE PREMATURE USE OF NEUROSCIENCE IN THE MARKETPLACE

We focused on pharmaceutical companies in discussing the insidious effects of blurring boundaries between academia and industry. The development and deployment of pharmaceuticals are highly regulated. A different kind of concern arises with unregulated health care products introduced into the marketplace before evidence of their efficacy has been established. Prime examples of such products are cognitive software programs. These “brain fitness” programs target clinical populations, but are not subject to regulations and standards associated with traditional medical interventions.

Currently, about 30 million people have dementia worldwide. Given that older people are deeply concerned about cognitive decline (Connell, Scott Roberts, and McLaughlin 2007) and treatments for dementia have limited efficacy, anything that could stave off this decline is desirable. Any such intervention would also be poised to make a substantial profit. This is where brain fitness programs come in.

The rationale for brain fitness programs rests on observations that active mental engagement is associated with decreased cognitive decline (Verghese et al. 2003) and that adult brains are more plastic than previously appreciated

(Lie et al. 2004). For example, the hippocampus has neurogenerative capabilities well into adulthood, suggesting that memory systems are subject to ongoing modulation (Kitabatake et al. 2007). Thus, it is plausible that behavioral interventions that promote such modulation would benefit people with cognitive decline.

The current evidence suggests that behavioral interventions can improve cognitive performance in adults including the elderly, and these gains can be maintained for several years (Schmiedek 2010). “Positive transfer” or the transfer of trained abilities to other domains is typically limited (Owen 2010). For training to significantly impact lives, it must not only improve skills relevant to the task, but also improve abilities that translate into something useful in people’s everyday lives. Two recent studies did demonstrate some positive transfer across domains. One study ($n = 49$) employing mindfulness meditation showed that brief, 20-minute sessions of meditative focus on breath improved visuo-spatial processing, working memory, executive functioning, and attention (Zeidan 2010). A second study showed that 100 days of intensive one-hour-long cognitive training using software and pen-and-paper working memory, processing speed, and episodic memory tasks showed improvements in tasks similar to those practiced (Schmiedek 2010). Whether these improvements would be maintained over time remains to be seen.

Despite these recent findings and the plausibility of the hypothesis that behavioral interventions might halt or reverse cognitive decline, direct, reliable evidence in support of the efficacy of brain software programs is sparse. A recent meta-analysis of the existing data on brain fitness programs points out several common shortcomings in this research (Papp, Walsh, and Snyder 2009). These shortcomings include the fact that definition of what constitutes adequate improvement is lacking, follow-up times are limited, active matched control conditions are often missing, and few outcome measures show changes in people’s daily activities.

A major limitation of most research on brain fitness programs is that much of the research on cognitive software is sponsored by the companies themselves and is conducted by authors with a financial stake in the outcome of the studies reported. For example, one of the first studies using Posit Science (San Francisco, CA) software reported modest improvements with trained auditory memory among older non-demented participants. The authors reported that the effect generalized to nontrained neuropsychological tests and was sustained for 3 months. All 10 authors held stock or options in the company and most of them worked for the company (Mahncke et al. 2006). The paper was published in *Proceedings of the National Academy of Sciences* (PNAS) as a “communication” by the senior author, Michael Merzenich, who is a founder of the company. Such papers are not subject to the rigors of the traditional peer-review process. As of January 1, 2009, PNAS no longer consider submissions using this route if the academy member or coauthors disclose a significant financial conflict of interest. A subsequent larger study ($n = 487$) also reported modest improvement in auditory memory (Smith et al. 2009). To its credit, this

study included an active control group. The two principle co-investigators were not employed by and did not hold equity in the company. However, Posit Science funded the study, and three authors received consulting fees and a fourth held stock options and was employed by Posit Science, again raising the specter of bias in the study. The program currently sells commercially for \$395 for a one-user version and \$495 for a two-user version. Of course, it does not necessarily follow that researchers with financial conflicts of interest will by definition produce biased results. However, it would be helpful in making efficacy assessments to have more studies conducted with specific brain fitness programs by investigators with no financial interest in the product's commercial success.

In addition to shortcomings of research methods, many studies in which subjects train using brain fitness software fail to show that training generalizes to abilities outside the tasks trained. One of the largest studies on brain fitness software, a trial on cognitive training with 2,832 participants, showed that memory training and speed of processing training provided some benefits within the domains trained but the benefits did not consistently generalize to other domains (Willis et al. 2006). However, reasoning training with a live instructor improved instrumental activities of daily living. Notably, some of the benefits in instrumental activities of daily living were sustained 5 years after the training. Identifying characteristics (such as higher education and age) that predict response to training is critical, and active research on this question is underway (Langbaum et al. 2009). In the largest and most recent study to date, more than 11,000 participants enrolled in a 6-week online brain fitness program. The game was designed to improve reasoning, memory, planning, visuospatial skills, and attention. The authors found that participants improved on each of these cognitive areas, but there was no generalization to untrained tasks, even those that were closely related to the cognitive domains being trained (Owen et al. 2010).

Brain fitness companies employ several tactics to divert attention away from the limited evidence of efficacy for their products. They align their programs with related, even if not directly applicable, neuroscience findings. MindSparke Brain Fitness, sold by "Mind Evolve" (Minneapolis, MN), founded by a philosopher, aligns its product with research showing that software-based training improves working memory and "fluid intelligence" (Jaeggi et al. 2008; Klingberg et al. 2005; Mind Evolve 2009). The company claims that this is the only brain fitness product proven to improve intelligence. The original study included a very demanding working memory task, which minimized the ability of participants to develop automatic and task specific strategies. Mind Evolve claims that training for 30 minutes per day with its program increases working memory by 50% to 80%, and increases "fluid intelligence" by more than 40% in less than 20 days (Mind Evolve 2009). Whether or not these claims are true remains uncertain, since the software being sold is an adaptation of what was used in the original study. It is not obvious that the software scales difficulty in a way that the original investigators thought was critical

for the effects that they reported. The study sponsored by Posit Science assessing the impact of 40 hours of training with Brain Fitness in healthy elderly adults found improvements in auditory processing speed and attention (Smith et al. 2009). From these findings, the company claims that the program produces "an improvement in memory equivalent to approximately 10-years" (Posit Science 2009). R. Petersen notes that Posit Science has not thus far tested the longevity of the Brain Fitness improvements past 3 months and questions the real-world significance of their outcomes (quoted in Ellison 2007).

Other companies cite peer-reviewed research involving company software, but their claims do not always match the actual findings. CogniFit (New York, NY), producer of "personalized brain fitness," states that "99.9% of 972 users showed improvement in at least one cognitive ability after eight weeks training" and that subjects improved an average of eight abilities (CogniFit 2009). The study in which the software was featured tested the impact of insomnia on cognitive capacity and did not assess whether the software improved cognition (Haimov, Hanuka, and Horowitz 2008). Other studies cited on the company website are in abstract form and to date are not published in peer-reviewed journals. As such, they are not subject to the kind of scientific scrutiny that is helpful in determining the usefulness of such interventions.

Companies that sell brain fitness software programs enhance their credibility by relying on the authority of scientists that design the products or others that have company affiliation. Lumosity (San Francisco, CA) has a scientific advisory board of academicians from Stanford, CA, and the University of California-San Francisco. The company claims that its training improves memory and attention, but no scientific data using the actual software are offered (Lumos 2009). Nintendo (Kyoto, Japan) uses this approach to great effect. According to its website, more than 10 million people worldwide include playing Brain Age games in their daily lives (Nintendo 2009). According to Nintendo, Ryuta Kawashima, a neuroscientist who specializes in brain imaging, inspired Brain Age and is featured in the game. He claims that daily training with these games helps prevent cognitive decline because it enhances blood flow to the prefrontal cortex. These claims are derived from a study of 32 people with Alzheimer's disease. Half the participants were given reading and math tasks and the other half, no intervention. The training group, unlike the control group, showed improvements on assessments of frontal lobe functions and were observed to be more communicative than before the intervention (Kawashima et al. 2005). However, the authors acknowledge that they could not determine the role of social and emotional factors resulting from the special attention given to the treatment group over the 6 months of the study. The same treatment has since been introduced in more than 300 nursing homes in Japan (Fuyuno 2007). Kawashima says he uses the royalties from the game on his research and is not interested in conducting more detailed studies on the effects of the game (Fuyuno 2007).

In summary, brain fitness programs are examples of products that are designed with plausible scientific rationales. However, in these cases commerce has moved ahead of the science. Hypotheses that might be tested with the software are portrayed as foregone conclusions. The marketing of these products often exaggerates or misrepresents the science motivating their production. For credibility the companies rely on the authority of scientists, embellished by anecdotal testimonials. Some of these products may ultimately turn out to be effective. However, they are sold in the market before their efficacy has been established.

Many scientists might be uneasy about the fact that other entrepreneur scientists are willing to leave academia and enter the market place. Underlying this unease is the concern that they might forego basic tenets of the scientific methods in order to promote their wares. Despite this discomfort, one might reasonably ask the following question. Even if these products are not efficacious, what is the harm in them? Brain fitness programs keep older individuals occupied and can give them the sense that they are taking an active part in maintaining their health. The risks seem quite trivial compared to potential side effects of drugs. It seems reasonable that the sale of these programs would not be subject to the same regulatory scrutiny levied on pharmaceutical companies.

We would argue that it is precisely this lack of scrutiny that opens the way for companies to make claims that are not always justifiable. Furthermore, for older people with fixed incomes and limited resources, costs of several hundred dollars may not be trivial. In addition, the fact that these products might sequester the elderly away from more engaging activities might itself be of concern.

THE MISUSE OF NEUROSCIENCE IN THE MARKET-PLACE

Practices that violate basic norms of scientific and clinical practices arouse considerable concern. The use of functional brain imaging to diagnose neuropsychiatric conditions exemplifies this misuse of neuroscience.

The American Psychiatric Association (APA) does not support the use of functional brain imaging for the diagnosis of neuropsychiatric illnesses in children, adolescents, or adults (American Psychiatric Association 2006), with the exception of judicious use of positron emission tomography scans in patients suspected of having dementia. Functional imaging in its current form lacks the sensitivity and specificity needed to reliably diagnose individuals with neuropsychiatric diseases. Activity patterns in normal and diseased brains often overlap. Group findings comparing mean activation patterns are not easily applied to individuals. Because psychiatric diagnoses are often classified by symptoms, classical diseases often share clinical features with other disorders. Thus, activation patterns do not sort easily into distinct clinical disorders. Clinical inferences drawn from these images often assume that the presence or absence of activation in a brain region is specific to a particular cognitive process or symptom, an assumption not

usually justified (Poldrack 2006). The status of imaging in the diagnosis of psychiatric disorders remains elusive and, at this writing, may simply be a “pipe dream” (Poldrack 2009).

Neuropsychiatric diseases can be difficult to diagnose. They rely on subjective reports and often have overlapping clinical features. Objective diagnostic modalities with high sensitivity and specificity are desirable. The marketing of the diagnostic use of brain imaging can exploit this desire. For example, the Amen Clinics (Newport Beach, CA) use SPECT imaging to help diagnose and manage many neuropsychiatric illnesses. The Amen Clinics website claims that based on their imaging, they have identified seven different types of anxiety and depression, six different types of attention deficit disorder, and five different types of obesity. Their use of imaging extends medical diagnostic considerations to help with interpersonal issues. The Amen Clinics website cites an example of a couple having marital difficulties. The husband was found to have a “swiss cheese” appearance on his SPECT scan, which led to the discovery that he was being exposed to toxins in the factory where he worked (Amen Clinics 2009c). In another example, finding decreased activity in the left temporal lobe and prefrontal cortex on the SPECT scan of a child (Amen 2009a) led the clinician to conclude that a child had impulsive aggression for which anticonvulsant and stimulant medications were prescribed. These examples of the Amen Clinics practices violate the standard of care. An adequate history and clinical examination would have revealed the relevant information and would have been sufficient to establish a rational clinical intervention. There was no reason to obtain functional neuroimaging for diagnostic purposes in these cases.

Amen Clinics, Inc., has scanned more than 50,000 patients at a cost close to \$170 million (Amen 2009b). There is no systematic analysis of whether these thousands of studies are better than treatment as usual by psychiatrists (Leuchter 2009). The Brain Imaging Council of the Society of Nuclear Medicine offered to submit Dr. Amen’s analysis of a blinded set of SPECT scans to determine the effectiveness of his technique at correctly diagnosing subjects. Dr. Amen declined this offer to provide empirical support for his clinical approach (Adinoff and Devous 2010). He has been critiqued in the press by *Salon* (Burton 2008) for his practices, including making claims that Alzheimer’s disease can be prevented, and by *Quackwatch* (Hall 2007) for misleading patients during informed consent by not revealing that the American Psychiatric Association has warned of potential harm with SPECT scanning for children. He has also been critiqued in the scientific literature for the dangers in his approach (Adinoff and Devous 2010): the administration of radioactive isotopes without sound clinical rationale, the treatments contingent on SPECT interpretations that lack empirical support, and the potential detraction from clinically sound treatments.

Despite these critiques, Dr. Amen adds to his public credibility by appearing on more than a thousand “blockbuster fundraising shows” for public television, shows that are not vetted for their science (Burton 2008). Even a Public

Broadcasting Service (PBS) ombudsman has raised cautions about the misleading ways in which the program featuring Dr. Amen is broadcast (Getler 2008). The program is distributed to PBS by Executive Program Services and PBS does not evaluate the content of the program in any way. In response to criticisms, Joe Campbell, Vice-President of PBS Fundraising Programming, as cited in Getler (2008), stated:

One of the more confusing parts of public television is that individual stations get their programs from a variety of sources, not just from PBS. While we provide the bulk of the programs you see on your local station, many of those programs come from places like the BBC, alternative public television distributors, like American Public Television, and independent distributors. An easy way to tell if a program is from PBS is by looking for the "PBS Logo" that appears at the end of every program we distribute.

"Change Your Brain, Change Your Life" was distributed by one of those independent distributors, not by PBS. They offered the program to public television stations across the country, and the individual stations decided whether or not to use it according to their own local standards. I hope you will forward your concerns to the station(s) in your viewing area. They may not be aware of the issues you raise about the program. Thank you again for letting us know about your concerns.

To date, there has been no serious attempt by PBS to evaluate the science of shows provided by third parties and shown on its television stations.

The commercial success of the Amen Clinics appears to serve as a model approach for other companies. The Clements Clinic (Plano, TX) uses a similar strategy. In fact Dr. Clements worked in the Amen Clinics from 2006 before becoming the medical director of the clinic that bears his name in late 2008. For example, the Clements Clinic website (*The Clements Clinic*) states, "Our brain affects everything you do: how you think, how you feel and how you act. When your brain doesn't work right, you don't work right. But how can we know how your brain is functioning unless we look? Unlike other physicians, psychiatrists have not had the means to routinely look at the organ they treat—the brain. Finally, with new advanced medical technology, that is changing." The site claims that the clinic's SPECT scans enables it to evaluate areas of brain that work well, areas of the brain that work too hard and areas of the brain that do not work hard enough. It goes on to say, "Armed with these images, we can more precisely diagnose problems, target treatments and tailor therapies." Michael Uszler at DrSpectscan.com uses a similar strategy. The website claims, "After all, who would have a fracture treated without first getting an x-ray or a scan to see exactly what it look [sic] like? Makes sense, doesn't it. I'm Dr. Michael Uszler and I do brain SPECT scans on children and adults to help them literally see for themselves how their brain is working." BraininSpect.com (Silicon Valley Brain Spect Imaging, Inc.) employs a similar approach in Silicon Valley. Again, patients are paying thousands of dollars for these diagnostic procedures that insurance companies do not cover (Farah 2009). In each of these cases, with a proper clinical

history and exam, it is not clear that SPECT scans add to the diagnostic utility or rationally guide treatment. At the same time, these scans subject people to unwarranted risks of radiation.

WHY ARE PEOPLE VULNERABLE TO BRAIN BRANDING?

Given the concerns about brain branding, why do people buy into these claims? We suggest that three factors contribute to people's susceptibility to this kind of marketing: the allure of neuroscience, the power of images, and the potential vulnerability of patients.

The Allure of Neuroscience

People believe explanations couched in neuroscience verbiage. The persuasive power of neuroscience is evident in political commentary, marketing, and even court deliberations (Aguirre 2008; Dresser 2010; Mast and Zaltman 2005; Morse 2006). Weisberg and colleagues refers to this phenomenon as "the seductive allure of neuroscience." They reported that people find behavioral explanations with neuroscience verbiage more satisfying than those without such language, even when the neuroscience information adds nothing to the explanation (Weisberg et al. 2008). In fact, the neuroscience verbiage disproportionately impairs people's ability to detect logical flaws in bad explanations.

People find neuroscience explanations alluring for many reasons. Neuroscience language is reductionist (Trout 2008) and is appealing because it is concrete and appears technical and objective. Neuroscience descriptions are easily misconstrued as providing causal explanations, which people prefer over descriptions of covariation of complex phenomena (Brem and Rips 2000). People are also not good at judging the validity of complicated explanations (Evans 1993; Keil 2005). They accept inappropriate teleological explanations, are distracted by seductive details, and fail to recognize logical circularities (Harp and Mayer 1998; Lombrozo and Carey 2006; Rips 2002). Despite not being good at judging the quality of explanations, people overestimate their own abilities to explain complex phenomena (Keil 2003).

Thus, it appears that the appeal of seemingly causal explanations combined with an overconfidence in the validity of complex explanations probably contributes to the allure of neuroscience. This allure confers on brain branded products a sense of credibility.

The Power of Pictures

What we see is influenced by our biases, and, in turn, what we see influences our beliefs and behaviors. Pictures, more than text, affect how consumers remember or anticipate experiences with products (Braun-LaTour et al. 2004). The power of pictures converges with the allure of neuroscience in neuroimaging. Brain imaging studies have disproportionate credibility in the scientific community (Chatterjee 2005; Fellows et al. 2005) as well as with the

public. Articles summarizing cognitive neuroscience research using brain images are rated more highly for scientific reasoning than articles with bar graphs, topographical maps, or no images (McCabe and Castel 2008). Functional images resemble other structural medical images such as x-rays or magnetic resonance imaging (MRI) scans and may be viewed as pictures of an active brain, rather than as statistical maps (Henson 2005).

The press often helps dramatize the importance of brain imaging. An NPR headline proclaims, "Neuroscientist Uses Brain Scan to See Lies Form" (Temple-Raston 2007). Other press reports construe brain images as establishing causation, claiming that "brain imaging provides visual proof that acupuncture alleviates pain" (Racine, Bar-Ilan, and Illes 2005) or "School bullies—Is the Amygdala to Blame?" (Malka 2008). A study of 132 press articles on functional MRI (fMRI) published between 1994 and 2004 found that two-thirds of articles made no mention of limitations of fMRI methods (Racine, Bar-Ilan, and Illes 2006). The dramatic pronouncements made in press articles combined with vivid brain pictures contribute to people's belief that functional brain images reveal more than they do.

Vulnerability of Patients

While the allure of neuroscience and the power of pictures can bias most people's ability to judge complex explanations, these factors take on added force in patients and caregivers who are confronted with difficult health care decisions. In this context, lack of control and desire for a particular outcome can further push patients into believing claims made by brain brands.

People tend to evaluate evidence in a way that confirms their prior beliefs (Nickerson 1998). Lord found that people evaluating evidence for and against the deterrent effects of capital punishment were apt to accept evidence that validated their existing views at face value and to be critical of disconfirming evidence (Lord 1979). Furthermore, participants' attitudes become more extreme in the direction of their initial point of view when presented with mixed evidence (Miller 1993). These observations raise the possibility that physicians and patients who wish to believe in the accuracy of diagnostic technologies or the efficacy of therapeutic interventions might be inclined to believe in the claims being made even when these claims are inadequately supported or the evidence is mixed.

People with chronic diseases have limited control over their illnesses (Ackerman 1982). Their symptoms may be unpredictable and treatments limited. Regardless of the condition of their health, people who lack a sense of control are disposed to infer causes where there are none. Whitson and colleagues (Whitson and Galinsky 2008) showed that healthy participants who lacked control were more likely to form false correlations from stock market data, develop conspiracy beliefs, and make superstitious causal connections. Patients with limited control over the course of their diseases might be similarly disposed to believe unwarranted causal claims when facing the promises of brain brands.

CONCLUSION

As neuroscience advances, the gap between scientific and clinical knowledge and public understanding widens. Scientists have a responsibility to communicate science to the public and offer antidotes to the press' tendencies to simplify, exaggerate, and dramatize findings. Clinicians have a responsibility to guide patients making important health care decisions that involve a biological understanding of mind. These responsibilities are particularly important because the allure of neuroscience, the power of brain images, and patients' conditions and desires make them especially vulnerable to the claims of the brain brands.

Clinicians should be vigilant when scientific and commercial enterprises combine. They should be concerned when neuroscience is used prematurely and when it is misused to sell diagnostic or therapeutic products. Independently conducted peer-reviewed research in support of diagnostic utility or therapeutic efficacy remains the gold standard. Considering that many brain brand products fall short of this standard, what might clinicians suggest that buyers bear in mind? Buyers should be wary of brain brands that rely on the scientific authority of individuals with financial interests in the company. They should be wary when products emphasize anecdotes, testimonials, and press releases, and are adorned with pretty pictures. When such marketing practices are evident, products deserve further scrutiny. Does the seller frame unproven hypotheses as foregone conclusions? Does the seller misrepresent the science behind the product? Does the use of the product violate the basic norms of clinical practice? Sensitivity to such questions will help physicians better advocate for the responsible care of their patients, and will help patients be better and more critical consumers of health care technologies. ■

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