

Neuroethics of neuromarketing

Emily R. Murphy^{1,2†}, Judy Illes^{1‡} and Peter B. Reiner^{1*}

¹National Core for Neuroethics, University of British Columbia, Vancouver, BC, Canada

²Center for Law and the Biosciences, Stanford Law School, Stanford, CA, USA

- *Neuromarketing is upon us. Companies are springing up to offer their clients brain-based information about consumer preferences, purporting to bypass focus groups and other marketing research techniques on the premise that directly peering into a consumer's brain while viewing products or brands is a much better predictor of consumer behavior. These technologies raise a range of ethical issues, which fall into two major categories: (1) protection of various parties who may be harmed or exploited by the research, marketing, and deployment of neuromarketing and (2) protection of consumer autonomy if neuromarketing reaches a critical level of effectiveness. The former is straightforward. The latter may or may not be problematic depending upon whether the technology can be considered to so effectively manipulate consumer behavior such that consumers are not able to be aware of the subversion. We call this phenomenon stealth neuromarketing. Academics and companies using neuromarketing techniques should adopt a code of ethics, which we propose here, to ensure beneficent and non-harmful use of the technology in consideration of both categories of ethics concerns.*

Copyright © 2008 John Wiley & Sons, Ltd.

Introduction

In 1957, the marketing executive James Vicary announced that he had increased sales of food and drink at a movie theater by secretly flashing subliminal messages with the words “Drink Coca Cola” and “Eat Popcorn”. The study was never published and may have even been a hoax (Karremans *et al.*, 2006), but the episode illustrates the public's strong reaction to covert manipulation. An article in *The*

Nation called it “the most alarming invention since Mr. Gatling invented his gun” and *The New Yorker* stated that “minds had been entered and broken” (Moore, 1982). With growing public understanding that the brain is the mediator of behavior, the public's reaction to neuromarketing intrusions into their brains may prove to be equally vigorous.

The term “neuromarketing” identifies a new field of research championed by both academics and self-labeled companies using advances in neuroscience that permit powerful insights into the human brain's responses to marketing stimuli (Renois  and Morin, 2007; Senior *et al.*, 2007). The goals of neuromarketing studies are to obtain objective information about the inner workings of the brains of consumers without resorting to the subjective

*Correspondence to: Peter B. Reiner, Professor, National Core for Neuroethics, University of British Columbia, 2211 Wesbrook Mall, S121 Vancouver, BC V6T 2B5, Canada.

E-mail: peter.reiner@ubc.ca

†Fellow

‡Canada Research Chair in Neuroethics and Professor of Neurology

reports that have long been the mainstay of marketing studies. Thus, neuromarketing purports to provide qualitatively different information, ostensibly superior to that obtained by traditional means, about the economically valuable topic of consumer preferences.

There is, of course, nothing inherently problematic about the use of scientific technology to advance commercial interests (Eaton and Illes, 2007). But the use of technology that probes the inner workings of the human brain, especially beyond what one might divulge in traditional behavioral testing, raises substantial ethical issues. These concerns fall into two major categories: (1) protection of various parties who may be harmed or exploited by neuromarketing and (2) protection of consumer autonomy. The public outcry in response to Vicary's subliminal imagery reflects a clear ethical boundary – the autonomy violation produced intrinsic discomfort with consumers having their preferences manipulated when they did not and *could not* know as much. A similar boundary can be drawn for contemporary marketing, particularly when informed by information gleaned from novel neurotechnologies. Neuroethics, in proactively dealing with ethical issues unique to knowledge about and manipulation of the human brain, is well-positioned to offer guidance for beneficent and non-harmful deployment of neuromarketing techniques.

We will first briefly review the state of the art and state of the market in neuromarketing. The second section tackles current ethical issues in neuromarketing, which apply irrespective of the technological capabilities. We focus our discussion on potential harms to research subjects, exploitation of vulnerable niche populations, and the integrity of business relationships, public trust, and consumer confidence. The third section will thoroughly explore the most substantial neuroethical concern associated with neuromarketing: the incursion on autonomy made by neuromarketing if it achieves a level of effectiveness that amounts to consumer coercion. We conclude with pragmatic recommendations: an ethical code to be adopted by the

neuromarketing industry to prevent harms and preserve business integrity and consumer trust.

The market for neuromarketing

Although the electroencephalography (EEG) has been in use for the study of marketing preferences for over 35 years (Krugman, 1971), there is little doubt that we have entered a new age of neuromarketing in which advanced technology is being used in unprecedented ways to probe consumer preferences. A raft of peer-reviewed papers and books have appeared in recent years in which positron emission tomography (PET), functional magnetic resonance imaging (fMRI) and quantitative EEG analyses have been used to assess consumer behavior (Smith *et al.*, 2002; Dickhaut *et al.*, 2003; McClure *et al.*, 2004; Mast and Zaltman, 2005; Ahlert *et al.*, 2006; Knutson *et al.*, 2007; Koenigs and Tranel, 2008; Plassmann *et al.*, 2007; Renvoisé and Morin, 2007; Schaefer and Rotte, 2007a, b). It has already been anticipated that other neuroimaging technologies such as magnetoencephalography and cortical manipulation with transcranial magnetic stimulation, as well as combinations of modalities will be adopted by “market researchers who wish to deploy a specialized neuromarketing profile” (Senior *et al.*, 2007). We refer the reader interested in details of each technology to the recent overview by Senior *et al.* (2007) as well as other papers in this Special Issue; different neuroimaging techniques have strengths and weaknesses in temporal and spatial resolution. The choice of modality by neuromarketers will no doubt be informed by *a priori* hypotheses and pilot research about relevant brain areas and activation patterns useful for predicting actual consumer behavior.

The convergence of increased power in the form of technology and advances in our understanding of cognitive function has emboldened some to make sweeping conclusions about the power of neuromarketing. Indeed, at least ten commercial enterprises have been established with the explicit

objective of using these advanced technologies to provide neuromarketing (Emsense, FKF Applied Research, Lucid Systems, Neurofocus, Neuroco, Neurosense Limited, OTOInsights, Sales Brain, Sands Research, and Thought Sciences) and at least one US patent has been issued on the topic (Zaltman and Kosslyn, 2000). Neuromarketing studies have garnered a great deal of attention from the public, with extensive coverage in both the mainstream press (Kelly, 2002; Roston, 2004; Greene, 2007; Haq, 2007; Park, 2007; Saletan, 2007; Baker, 2008; Brainard, 2008) and internet weblogs (Dooley, 2007). One study has even cautioned against a "neurorealism" created by press coverage of novel technologies and their real or potential applications in society (Racine *et al.*, 2005).

Protection of vulnerable parties in research, selling, and representation of neuromarketing

We first consider a set of issues that merit ethical analysis irrespective of whether the most speculative claims of neuromarketing hold up to rigorous scientific analysis. Ethical development of neuromarketing requires protection of the research subjects, responsible business-to-business advertising, and accurate representation of the state of the art of the technology to the public. Each of these duties can be enshrined in an industry-wide code of ethics that we propose be adopted by all researchers and vendors of neuromarketing and enforced by a discerning marketplace of neuromarketing consumers doing business with companies voluntarily adhering to the code of ethics. Not only would adoption of a code of ethics be justified on moral grounds, but it would also serve to insulate this young and dynamic industry from accusations of irresponsible behavior.

Human subjects' protection

It is well established that federally funded scientists working in academic, government,

and commercial settings have both ethical and legal responsibilities to obtain informed consent and protect the privacy of research subjects whose brain function is probed with imaging technologies, as per the Common Rule (DHHS, 1991). The legal framework for such privacy protection in the United States is covered under PRIVACY RULE of the Department of Health and Human Services (DHHS, 2005); while this applies in some instances, it is notable that such protections are apparently absent when the subject is participating in a study being carried out for marketing purposes (Tovino, 2005). Thus standards for protecting the privacy of individuals participating in neuromarketing studies in the United States are at the very least considerably compromised. In academic and medical research centers, subjects volunteering to participate in neuroimaging-based studies are protected by Institutional Review Board guidelines, which can include strict experimental guidelines because most imaging technologies are considered to be FDA-regulated medical devices (FDA, 1998). However, when moved into commercialized and private enterprise, such subject protections may not be present, and the particularly loose restrictions surrounding studies for marketing purposes are especially worrying. Moreover, if new technologies are developed that fall outside the purview of regulatory authorities, even these protections may be lost. A key initiative for neuroethics in neuromarketing is to develop published codes of subject protections equal to those required by academic and medical research centers. fMRI, the most prevalent of the neuromarketing imaging modalities, is arguably a low-risk technology; nonetheless, risks of various sorts are inherent in all brain-imaging research and all subjects regardless of the purpose of the study are deserving of adequate protection and appropriate informed consent procedures.

Even thornier than the issue of subject protection is the notion that advanced technology in the neurosciences, in particular fMRI, might allow invasion of the inner sanctum of private thought. It bears repeating

that such a breach is not possible today and may or may not be technically achieved in the future. Nonetheless, a vigorous discussion has emerged regarding this possibility (Kulynych, 2002; Illes and Racine, 2005; Tovino, 2005; Greely, 2006; Alpert, 2007; Appelbaum, 2007; Illes, 2007; Tovino, 2007) and it is certainly worth considering how society might manage such information if it became technically feasible.

Preventing exploitation of niche populations

Special ethics review should be a minimum standard for neuromarketing research that either involves or targets vulnerable populations. Among the individuals that would fall under this umbrella are persons (or family members of persons) with neurological disease or psychological disorders, children, and other members of legally protected groups (Civil Right Act (2008) 42 U.S.C.A. §§ 2000e et seq.; Coenen, 2007). While such "segmentation" and "target marketing" is standard business practice in the marketing industry, there is a fine line between target marketing and exploitation (Sims, 1997). Our neuroethical concern is about potential harms to vulnerable persons as: (1) subjects in unregulated neuromarketing research (introduced above), (2) targeted populations who may be especially sensitive to trumped-up claims of product effectiveness based on information derived from advanced neuroscience technologies, and (3) people particularly exposed to "stealth neuromarketing" techniques that such research and development may produce (see below). Fortunately, the prevention of such harms to vulnerable persons aligns with profit motive, for as Sims (1997) points out, when targeting a particular market "maligned those it tries to serve," it undercuts its own business interests.

Responsible business-to-business advertising and public representation

It is perhaps not surprising that neuromarketing oversells its wares - an occupational hazard of

sorts. Independent critics have openly and quite rightly condemned neuromarketing efforts that overstate the benefits of the approach. The editors of the high-impact journal *Nature Neuroscience* succinctly reviewed the dangers of over interpretation of neuromarketing results, noting that the traditional skeptical approach of scientific inquiry is being displaced by a wave of media hype which suggests that fMRI "is on the verge of creating advertising campaigns that we will be unable to resist" (Editorial, 2004). In this sense, neuromarketing represents just one example of a more general problem in neuroimaging research - the question of the degree to which results which are certainly fascinating and worthy of continued attention can be used to derive *bona fide* insights about the working of the human brain (Illes and Racine, 2005), and, with particular relevance to the claims of neuromarketing, the accurate prediction of human behavior. Business consumers of neuromarketing may find their advertising dollars misspent if the technology does not live up to its claims and pass the real-world test of accurate prediction of actual consumer behavior. However, we are not overly concerned here with business-to-business relationships; harms there are primarily the potential for financial loss, but are not inherently unethical (though they may not meet industry standards of "truth-in-advertising") (Frazier, 2007). However, potential for actual harm exists if such "neurohype" around the perceived capabilities of neuromarketing create fear, anxiety, or mistrust in the general public.

Scientists working in the field of neurobiology recognize the considerable challenge involved in the translation of the brain's extraordinary connectivity - the human brain is arguably the most complex biological organ in the known universe, with tens of billions of cells, each of which make thousands of connections with other cells (Purves *et al.*, 2008) - into the complex repertoire of behavior exhibited by humans. At the same time, the general public finds color-coded images of brains in action accompanied by neuroscientific explanations to be particularly persuasive (Dumit, 2003; McCabe and Castel,

2007; Weisberg *et al.*, 2008). This tension leads to a situation where highly sophisticated scientists, subject to both public adulation and profit motive, are tempted to provide simplistic answers to what in reality are highly nuanced questions.

The neuromarketing field has already seen egregious abuse of such information. In an op-ed piece in the *New York Times*, a group of academics and neuromarketers presented a small body of unpublished data on the results of an fMRI study of political preferences of so-called 'swing voters' (Iacoboni *et al.*, 2007). The results were presented essentially as *de facto* probes into the minds of their subjects in one of the most widely read newspapers in the world; for several days after its publication, the article topped the rankings of those most frequently emailed by readers of the online version of the *New York Times*. Given widespread concerns about over-interpretation of fMRI data (Illes *et al.*, 2006b), it was notable that the op-ed piece contained none of the qualifications that would normally accompany a scholarly article in a peer-reviewed journal. Academic colleagues responded with considerable outrage in letters to the editor (Aron *et al.*, 2007) and most visibly in a scathing editorial in *Nature* (Editorial, 2007). Incidents such as this draw attention to the absence of a code of ethics for responsible media - if not academic - representation in the field of neuromarketing. Such misrepresentation can do considerable damage to the public trust of science and may even generalize in public perception to create anxieties about the perceived motivations of neuroscientists conducting human neuroimaging research. In the current climate of tightening public funds for basic research, any such anxiety threatens the future of the field, with potential harms to public health. Academic and private sectors of neuroscience research need to maintain close partnerships and work together to promote public trust and investment in neuroscience research. That trust can be earned with forthright communication and full disclosure of risks, benefits, and limitations of research findings.

Stealth neuromarketing

In our view, the most vexing of the issues raised by neuromarketing is in the realm of autonomy. One could argue that the essential objective of marketing as a discipline is to manipulate consumer behavior - effectively, a "soft" attack on autonomy. Moreover, many of the traditional tools of marketing such as focus groups and polls rely upon nuanced interpretations of human psychology to draw conclusions about consumer behavior and then use that information to inform marketing decisions. The implicit question in the present discussion is whether the new tools of neuromarketing will provide sufficient insight into human neural function to allow manipulation of the brain such that the consumer *cannot* detect the subterfuge and that such manipulations result in the desired behavior in at least some exposed persons. Such *stealth neuromarketing* is not possible with current technology, but if developed would represent a major incursion on individual autonomy. In this analysis, we deliberately consider a set of issues that will only arise with developments in technology that are yet to be realized and may never come to fruition. Nonetheless, it is in the best interest of all parties involved in the discussion that these issues are considered today rather than at some unspecified time-point in the future, possibly in response to an adverse event. To appreciate how stealth neuromarketing may come to pass, we present a short discourse on phenomena in which decision-making and motivation occur without explicit conscious awareness.

It is well established that cognition is not a monolithic process but rather one with various submodalities carrying out a variety of functions, some of which have been reasonably well delineated. Of relevance to the present discussion are two well-studied phenomena in cognitive neuroscience. The first is blindsight (Weiskrantz, 1990), in which individuals with damage to portions of their visual cortex declare themselves unable to see objects placed in the damaged portion of their visual field, but when asked to guess are easily able to

identify the object. These experiments unequivocally demonstrate that there is a distinction between perception and conscious awareness. The second phenomenon is implicit learning (Reber, 1993), in which normal subjects are presented with seemingly random strings of letters and asked to memorize them. Unknown to the individuals is the fact that there is a set of rules being employed, but their attention is directed towards memorization in the first part of the experiment. Later they are asked to describe the rules, and after protesting that they did not know there were any rules, they are asked to guess. Remarkably, subjects correctly identify the rules over 70% of the time. A recent brief report in *Science* (Aarts *et al.*, 2008) takes these phenomena one step further and demonstrates how subliminal priming effects can actually motivate and mobilize people to respond more quickly and spend extra effort on a simple motor task. The simple but elegant study provides evidence for the "human capacity to rely on mental processes in preparing and motivating behavior outside of awareness" (Aarts *et al.*, 2008). As the authors note, such responses are of considerable utility insofar as they prepare individuals to react quickly as circumstances necessitate; at the same time, subliminal priming represents an additional step towards realization of stealth neuromarketing.

If it is possible to carry out highly sophisticated cognitive tasks such as visual perception or understanding grammatical rules, as well as to enhance motivation and mobilization of voluntary action without the relevant neural computation arising to the level of perceptual awareness, then it follows that at some point in the future insights from advanced technology in the neurosciences might allow corporations, governments and others to influence decisions and actions regarding brand preference without the individual being aware of the subterfuge. We would propose such an eventuality as the sensible point at which the erosion of personal autonomy becomes so substantial that one might consider regulatory control, voluntary or otherwise, to protect the citizenry from unwanted intrusions on individual agency.

Recommendations

We conclude with a preliminary version of a code of ethics that we recommend be adopted by the neuromarketing industry. The overarching goal of this code of ethics is to promote research and development, entrepreneurship, and profitable enterprise alongside beneficent and non-harmful use of neuroimaging technology at all stages of development, deployment, and dissemination. These codes should be discussed within the neuromarketing community with the advice of independent academic researchers working in the area of neural correlates of decision-making, social behavior, and consumer preferences, as well as neuroethicists and professionals in marketing industry ethics. Proactive development of such guidelines within the professional community will provide credibility and garner greater acceptance than those that may be imposed upon the field by regulatory bodies, especially if they arise in response to adverse events (Illes *et al.*, 2003). Timeliness in this effort is critical given the rapid pace of advancements in the field.

- *Protection of research subjects.* Policies for responsibly managing clinical findings, including provision of sufficient subject protections, procedures for informed consent, and explicit protocols for dealing with incidental findings (Illes *et al.*, 2006a) are a requirement for any entity involved in brain research. Furthermore, private companies offering financial incentives for participation in research studies significantly greater than those offered in academic settings should be cautious of undue influence of such incentives, which may cross over into indirect coercion. While most technologies used by neuromarketing may be considered minimal risk, subjects should be advised and reminded of their right to withdraw from any study for any reason, including minor discomfort.
- *Protection of vulnerable niche populations from marketing exploitation.* Policies for research subjects' protection should include

additional ethics review for research done on protected or potentially vulnerable subject populations. In addition, neuromarketing-influenced advertising targeted at specific protected consumer groups should aim to beneficently serve the special needs of the population without marginalizing, maligning, or otherwise causing harm, whether psychosocial or financial in nature.

- *Full disclosure of goals, risks, and benefits.* Disclosure can be achieved through the publication of ethics principles that have been adopted to protect the privacy and autonomy of human subjects and consumers. Publication infers all aspects of the process from consent documents to reporting and advertising and applies to both written and verbal communication.
- *Accurate media and marketing representation.* Neuromarketing companies bear the burden of accurately representing their wares in media and business-to-business marketing materials. At a minimum, this standard encompasses full disclosure of scientific methods and measures of validity in mass media formats such as invited opinions, editorials, and news reports. Adherence to a code of responsible communication and truth-in-advertising will help maintain a positive and trusting public perception of brain science research as well as promote development of effective technologies.
- *Internal and external validity.* Eaton and Illes (2007) have outlined the challenges in initial and sustained product validity in the commercialization of any neurotechnology. We extend their recommendations here to any marketing product influenced by neuromarketing research with particular attention to the point that the validity questions “arise most acutely for neurotechnology that can be deployed without a regulatory gatekeeper, such as the FDA” (Eaton and Illes, 2007). At a minimum, internal validity checks should ensure a sufficiently comprehensive research database to provide meaningful and effective results to neuromarketing consumers. External and

sustained validity will require neuromarketers to align their product with changing technologies and expanding neuroscience knowledge. Maintenance of safety and efficacy verification in any research, development, and deployment of neuromarketing is absolutely required.

These recommendations form the basis for immediate and short-term action in the neuromarketing community and longer-term empirical research. Multidisciplinary collaboration will enable efficient and positive progress along this continuum.

In the 50 years since Vicary’s subliminal imagery marketing stunt, interest in the possibility that neuroscience might be used in the service of a marketing agenda has remained robust, with the current resurgence of interest and proliferation of companies in the new neuromarketing being noteworthy. It should be emphasized that there is no evidence that at the present time that any advanced neurotechnology permits the types of insights and subsequent manipulation that Vicary envisaged (Illes and Racine, 2005; Illes, 2007). However, the fact that one must insert qualifiers such as “at the present time” provides ample reason to carefully consider the implications that such a development might have and the means by which it might be sensibly managed. In the meantime, there are a host of ethical issues in the research, marketing, and deployment of neuromarketing on the table right now. Such proactive conduct is at the heart of the neuroethical agenda.

Acknowledgements

This study was supported by grants from the Canadian Institutes of Health Research (Institute for Neuroscience, Mental Health and Addiction and the Ethics Office of CIHR), the Canadian Foundation for Innovation, the British Columbia Knowledge Development Fund, the Dana Foundation, the Greenwall Foundation, and the MacArthur Foundation-funded Law and Neuroscience Project.

Biographical notes

Emily R. Murphy is a research fellow at the Stanford Law School Center for Law and the Biosciences, a research fellow on the MacArthur Foundation-funded Law and Neuroscience Project, and a visiting fellow at the National Core for Neuroethics, UBC. Dr Murphy received her Ph.D. in behavioral neuroscience from the University of Cambridge, where her work focused on neural and neurochemical correlates of behavioral inhibition and behavioral flexibility. Her current research interests are at the intersection of law and neuroscience, particularly in the areas of neuroimaging as evidence, and the neuroscience of decision-making and drug addiction.

Judy Illes is the Director of the National Core for Neuroethics at UBC and a pioneer in the field with deep interests in ethical, social, and policy challenges at the intersection of the neurosciences and biomedical ethics. Dr Illes has written numerous books, edited volumes and articles. Her latest book, *Neuroethics: Defining the Issues in Theory, Practice and Policy*, was published by Oxford University Press in 2006. Dr Illes is a member of the Internal Advisory Board for the Institute of Neurosciences, Mental Health and Addiction (INMHA) of the Canadian Institutes of Health Research (CIHR), the Institute of Medicine, Forum on Neuroscience on Neurological Disorders, the Dana Alliance for Brain Initiatives, and co-Chair of the Committee on Women in Neuroscience for the Society for Neuroscience.

Peter B. Reiner is a Professor in the National Core for Neuroethics at the University of British Columbia. Following a distinguished career as a research scientist studying the neurobiology of behavioral states and the molecular underpinnings of neurodegenerative disease, Dr Reiner became President & CEO of Active Pass Pharmaceuticals, a drug discovery company that he founded to tackle the scourge of Alzheimer's disease. Upon returning to academic life, Dr Reiner refocused his scholarly work in the area of neuroethics, focusing upon the ethical issues associated with commercial-

ization of neuroscience, with a particular interest in the emerging debate over cognitive enhancers.

References

- Aarts H, Custers R, Marien H. 2008. Preparing and motivating behavior outside of awareness. *Science* **319**: 1639.
- Ahlert D, Kenning P, Plassmann H. 2006. A window to the consumer's mind: application of functional brain imaging techniques to advertising research. In *International Advertising and Communication*. 163-178.
- Alpert S. 2007. Brain privacy: how can we protect it? *The American Journal of Bioethics* **7**: 70-73.
- Appelbaum PS. 2007. Law & psychiatry: the new lie detectors: neuroscience, deception, and the courts. *Psychiatric Services* **58**: 460-462.
- Aron A, Badre D, Brett M, Cacioppo J, Chambers C, Cools R, Engel S, D'Esposito M, Frith C, Harmon-Jones E, Jonides J, Knutson B, Phelps L, Poldrack R, Wager T, Wagner A, Winkielman P. November 14 2007. Politics and the brain (Letter to the Editor). *New York Times*.
- Baker S. 2008. What you really want to buy. *Business Week*. http://www.businessweek.com/technology/content/jan2008/tc20080127697425.htm?chan=technology_technology+index+page_top+stories [10 March 2008].
- Brainard C. 2008. Beware of "neuropunditry". *Columbia Journalism Review*. http://www.cjr.org/campaign_desk/beware_of_neuropunditry.php [11 March 2008].
- Coenen D. 2007. The future of footnote four. *Georgia Law Review* **41**: 797.
- DHHS, Department of Health and Human Services, NIH, and OPRR. 1991. 45 CFR 46.
- DHHS, Department of Health and Human Services, 45 C.F.R. Parts 160 and 164, 2005.
- Dickhaut J, McCabe K, Nagode JC, Rustichini A, Smith K, Pardo JV. 2003. The impact of the certainty context on the process of choice. *Proceedings of the National Academy of Sciences* **100**: 3536-3541.
- Dooley R. 2007. Neuromarketing blog [Internet], <http://www.neurosciencemarketing.com/blog/>, accessed on November 26, 2007.

- Dumit J. 2003. *Picturing Personhood: Brain Scans and Biomedical Identity*. Princeton University Press: Princeton, NJ.
- Eaton ML, Illes J. 2007. Commercializing cognitive neurotechnology – the ethical terrain. *Nature Biotechnology* **25**: 393–397.
- Editorial. 2004. Brain scam? *Nature Neuroscience* **7**: 683.
- Editorial. 2007. Mind games. *Nature* **450**: 457.
- FDA. 1998. Guidance for institutional review board and clinical investigators. Medical devices.
- Frazier M. 2007. Hidden persuasion or junk science? *Advertising Age* **78**: 1–2.
- Greely HT. 2006. The social effects of advances in neuroscience: legal problems, legal perspectives. In *Neuroethics: Defining the Issues in Theory, Practice, and Policy*, J Illes (ed). Oxford University Press: Oxford; 245–264.
- Greene K. 2007. Brain sensor for market research. *Technology Review*. <http://www.technologyreview.com/Biztech/19833/> [10 March 2008].
- Haq A. 2007. This is your brain on advertising. *Business Week*. http://www.businessweek.com/globalbiz/content/oct2007/gb2007108_286282.htm?chan=top+news_top+news+index+global+business [11 March 2008].
- Iacoboni M, Freedman J, Kaplan J, Jamieson KH, Freedman T, Knapp B, Fitzgerald K. 2007. This is your brain on politics. *The New York Times*. http://www.nytimes.com/2007/11/11/opinion/11freedman.html?_r=1&sq=marco%20iacoboni%202007&st=cse&oref=slogin&scp=1&pagewanted=all [18 November 2007].
- Illes J. 2007. Empirical neuroethics. Can brain imaging visualize human thought? Why is neuroethics interested in such a possibility? *EMBO Reports* **8**(Spec No): S57–S60.
- Illes J, Racine E. 2005. Imaging or imagining? A neuroethics challenge informed by genetics. *The American Journal of Bioethics* **5**: 5–18.
- Illes J, Fan E, Koenig BA, Raffin TA, Kann D, Atlas SW. 2003. Self-referred whole-body CT imaging: current implications for health care consumers. *Radiology* **228**: 346–351.
- Illes J, Kirschen MP, Edwards E, Stanford LR, Bandettini P, Cho MK, Ford PJ, Glover GH, Kulynych J, Macklin R, *et al.* 2006a. Ethics. Incidental findings in brain imaging research. *Science* **311**: 783–784.
- Illes J, Racine E, Kirschen MP. 2006b. A picture is worth 100 words, but which 1000?. In *Neuroethics: Defining the Issues in Theory, Practice, and Policy*, J Illes (ed). Oxford University Press: Oxford; 148–168.
- Karremans JC, Stroebe W, Claus J. 2006. Beyond Vicary's fantasies: the impact of subliminal priming and brand choice. *Journal of Experimental Social Psychology* **42**: 792–798.
- Kelly M. 2002. The science of shopping. In CBC's Marketplace (Canada).
- Knutson B, Rick S, Wimmer GE, Prelec D, Loewenstein G. 2007. Neural predictors of purchases. *Neuron* **53**: 147–156.
- Koenigs M, Tranel D. 2008. Prefrontal cortex damage abolishes brand-cued changes in cola preference. *Social Cognitive Affect Neuroscience* **3**: 1–6.
- Krugman HE. 1971. Brain wave measures of media involvement. *Journal of Advertising Research* **11**: 3–9.
- Kulynych J. 2002. Legal and ethical issues in neuroimaging research: human subjects protection, medical privacy, and the public communication of research results. *Brain and Cognition* **50**: 345–357.
- Mast FW, Zaltman G. 2005. A behavioral window on the mind of the market: an application of the response time paradigm. *Brain Research Bulletin* **67**: 422–427.
- McCabe DP, Castel AD. 2007. Seeing is believing: the effect of brain images on judgments of scientific reasoning. *Cognition*. **107**: 343–352.
- McClure SM, Li J, Tomlin D, Cypert KS, Montague LM, Montague PR. 2004. Neural correlates of behavioral preference for culturally familiar drinks. *Neuron* **44**: 379–387.
- Moore TE. 1982. Subliminal advertising: what you see is what you get. *Journal of Marketing* **46**: 38–47.
- Park A. 2007. Marketing to your mind. *JT Time*. <http://www.time.com/time/magazine/article/0,9171,1580370,00.html> [11 March 2008].
- Plassmann H, Ambler T, Braeutigam S, Kenning P. 2007. What can advertisers learn from neuroscience? *International Journal of Advertising* **26**: 151–175.
- Purves D, Fitzpatrick D, Augustine GJ, Katz LC. 2008. *Neuroscience*, 4th edn. Sinauer: Sunderland, MA.

- Racine E, Bar-Ilan O, Illes J. 2005. fMRI in the public eye. *Nature Reviews Neuroscience* **6**: 159–164.
- Reber AS. 1993. *Implicit Learning and Tacit Knowledge: An Essay on the Cognitive Unconscious*. Oxford University Press: New York.
- Renvoisé P, Morin C. 2007. *Neuromarketing: Understanding the “Buy Button” in Your Customer’s Brain*. T. Nelson: Nashville, TN.
- Roston E. 2004. The why of buy. *Time*. <http://www.time.com/time/insidebiz/article/0,9171,1101040308-596161,00.html>.
- Saletan W. 2007. Peering into the soul. *Washington Post*. <http://www.washingtonpost.com/wpdyn/content/article/2007/03/16/AR2007031602672.html> [11 March 2008].
- Schaefer M, Rotte M. 2007a. Thinking on luxury or pragmatic brand products: brain responses to different categories of culturally based brands. *Brain Research* **1165**: 98–104.
- Schaefer M, Rotte M. 2007b. Favorite brands as cultural objects modulate reward circuit. *Neuroreport* **18**: 141–145.
- Senior C, Smythe H, Cooke R, Shaw RL, Peel E. 2007. Mapping the mind for the modern market researcher. *Qualitative Market Research* **10**: 153–167.
- Sims R. 1997. When does target marketing become exploitation? *Marketing News* **31**: 10.
- Smith K, Dickhaut J, McCabe K, Pardo JV. 2002. Neuronal substrates for choice under ambiguity, risk, gains, and losses. *Management Science* **48**: 711–718.
- Tovino SA. 2005. The confidentiality and privacy implications of functional magnetic resonance imaging. *The Journal of Law, Medicine & Ethics* **33**: 844–850.
- Tovino SA. 2007. Functional neuroimaging and the law: trends and directions for future scholarship. *The American Journal of Bioethics* **7**: 44–56.
- Weisberg DS, Keil FC, Goodstein J, Rawson E, Gray JR. 2008. The seductive allure of neuroscience explanations. *Journal of Cognitive Neuroscience* **20**: 470–477.
- Weiskrantz L. 1990. The Ferrier lecture, 1989. Outlooks for blindsight: explicit methodologies for implicit processes. *Proceedings of the Royal Society of London. Series B, Containing papers of a Biological character. Royal Society (Great Britain)* **239**: 247–278.
- Zaltman G, Kosslyn SM. 2000. Neuroimaging as a marketing tool. USPTO, ed. (United States).