Science is Culture:

Neuroeconomics and Neuromarketing. Practical Applications and Ethical Concerns

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1 Introduction

Neuroeconomics is a relatively new transdisciplinary field, which developed out of Neuroscience. This burgeoning discipline analyses our brain activity when we calculate risks and evaluate rewards, and utilizes brain-scanning technology to study how people make decisions, evaluate personal choices and even decide which products to buy. Since the late 1990's a group of interdisciplinary scholars have begun to combine social and natural scientific approaches in this emerging discipline, combining both theoretical and empirical tools from neuroscience, psychology and economics into a single approach. The resulting synthesis has provided insights valuable to all three parent-disciplines, which recently conducted studies, seem to support. Often utilizing a variety of neuroimaging techniques and interventions such as fMRI, PET, MEG and EEG, ERP and SSPT, scientific researchers in this new field have sought to better understand the decision-making processes of individuals in order to build more precise economic behavioral models. These combined theories have already begun to restructure our neurobiological understanding of the decision-making process, and concurrently a number of recent neurobiological findings have provided great insight into some of the already existing theories in the psychological and economic branches of this discipline.

Since the 1990's however, a newer and more radical branch of Neuroeconomics has been born called Neuromarketing, which is aimed at revealing consumer preferences using these same brain-imaging techniques. Rather than simply trying to use science to better understand the decision-making processes of individuals, these neuromarketing studies test subjects' reactions to certain stimuli, which are then recorded with the aim of revealing consumer preferences. The results of these experiments are aimed at building targeted

advertising campaigns, designing new consumer products and shopping environments and even determining the reasoning behind subjects' preferences to certain brands such as Coke or Pepsi.

While this may be good news for Madison Avenue and the billion dollar advertising and marketing industries, as well as those corporations who employ these companies to help sell their products, the very idea of using brain scans to determine our private and personal predilections for the purpose of selling us more products seems rather invasive, if not Orwellian to say the least. Not only are there ethical concerns surrounding this new area of study, regarding the practical applications and their likely implications for individuals and society, but even more alarming, is the gusto with which the press, marketing firms, and Big Business have embraced the idea of "peering inside peoples heads" in order to better pin point their needs, desires and preferences as consumers. The idea of a "hard science," which can be utilized to uncover the holy grail of marketing or a magic "buy button" in our brain, is just too good for these industries to pass up, not to mention the scientists who have much to gain from peddling, what some call, pseudoscience for profit. At this stage neuromarketing is far from a "hard science" and the public should maintain a healthy dose of skepticism with regard to the practical applications of these neuroimaging techniques, which require many layers of signal processing, statistical analysis and a complex set of assumptions in order to interpret the psychological significance of these brain scans. But the public should also be aware of the ethical implications of this new type of neuroscience: how it is utilized; what its applications are; whether or not these new techniques are invasive and what the possible implications for society may be.

Hailed by some leading market researchers as the most important advance in their industry for a century, Neuromarketing has already been dismissed by skeptical neuroscientists as verging on a pseudo-scientific scam. A recent editorial in *Nature Neuroscience*, for example, suggested that many cognitive scientists who had watched colleagues in molecular science grow rich were now 'jumping on the commercial bandwagon,' adding that, "According to this view, neuromarketing is little more than a new fad, exploited by scientists and marketing consultants to blind corporate clients with science." Despite this, interest in Neuromarketing is growing rapidly. In 1998 less than 20 papers a year were published that examined the brain and decision-making, however, by 2008 nearly 200 articles relating to this particular area of study had been published. As reported in *Advances in Clinical Neuroscience and Rehabilitation* magazine there has been a marked increase in the number of articles in scientific journals and congresses organized around this new topic; entire issues have been devoted to neuromarketing in advertising and marketing trade publications; and it has even been reported that several new fMRI facilities, intended for Neuromarketing rather than medical purposes were opened in 2005 alone, in the United States. This is evidence enough to sound the alarm, however, while the public seems well aware of the ethical issues surrounding new scientific advances in molecular genetics, there has been little public awareness with regard to the ethical implications of neuroscience and neuromarketing.

2 Short History of Neuroeconomics

The first paper to explicitly combine neuroscientific data and a rigorous mathematical theory from the social sciences was Peter Shizgal and Kent Conover's 1996 review in Current Directions in Psychological Science: "On the neural computation of Utility." This paper sought to describe the neurobiological substrate for choice in rats using a normative economic theory. In 1999 this was followed by Michael Platt and Paul Glimcher's publication of "Neural correlates of decision variables in parietal cortex" which described a formal economic-mathematical approach for the physiological study of the sensory-motor process, or decision-making. This paper demonstrated that the activity of individual neurons in the posterior parietal cortex encoded both the probability and magnitude of reward, as would be predicted by most economic theories if these neurons participated in decision-making. This was rapidly followed by a multitude of papers uniting both economic and psychological theories with measurements in human and animal brains.

The first of these neuroeconomic studies in humans were a pair of papers published in 2001, which reflected collaboration between the fMRI pioneers Hans Breiter, Shizgal, and the Princeton psychologist/economist Daniel Kahneman (who would win the Nobel prize for his contribution to behavioral economics the following year). That paper employed the psychological Prospect theory of choice developed by Kahneman. The second of these papers reflected collaboration between the economists Kevin McCabe, his colleague Vernon Smith and a team that included economists, a psychologist and a biomedical engineer (McCabe et al., 2001). This study represented the first use of game theory in a human neurobiological experiment. In that paper, subjects played a trust game either against anonymous human opponents or against a computer. The neurobiological data revealed that in some subjects the medial prefrontal cortex is more active when subjects play a cooperative strategy than when they show a lack of trust in their game theoretic opponent.

Since the publication of these studies, perhaps the most critical insight has been evidence that the decision-making systems of the brain can be viewed as a two-part system. The first of these two parts are made up of the frontal cortex and the basal ganglia, the areas that learn and compute the values of available actions. The outputs of these structures are subsequently passed to the second part of the system; the fronto-parietal circuits, which then decide between the options and pass this information along to the motor system for execution. These are the areas that ultimately contribute to our decision making process.

With this plethora of research, Neuroeconomics has seen a steady growth. Today, a number of Centers for the study of Neuroeconomics have emerged at Universities throughout the world. In addition to these research centers, The Society for Neuroeconomics established itself as the main center for this emerging discipline in 2005. In 2009 the Society published, in collaboration

with Academic Press, "Neuroeconomics: Decision-Making and the Brain," which now serves both as a textbook for many graduate courses in Neuroeconomics, as well as a Handbook of Neuroeconomics for researchers in the field.

3 Short History of Neuromarketing

Neuroeconomics is a purely academic discipline concerned with the basic mechanisms of decision-making. In contrast, Neuromarketing is a more applied field concerned with the application of brain scanning technology to the traditional goals and questions of interest of the marketing industry. While the notion of Neuromarketing has been around for some 30 odd years, Professor Ale Smidts from Erasmus University is said to have first coined the term in 2002, and the first marketer to use fMRI was Gerry Zaltman at Harvard University beginning in 1999. The first marketing conference, which focused on the burgeoning field of Neuromarketing in 2004, was held at Baylor College of Medicine in Houston. While the most utilized and well recognized brain-imaging techniques are fMRI (functional magnetic resonance imaging), QEEG (Quantitative electroencephalography) and MEG (magneto encephalography), earlier forms of these techniques were being utilized as early as the late 1960's.

Before the development of these more sophisticated technologies researchers used pupilometers – devices that measure spontaneous pupil dilation as indicators of peoples' interest while they were looking at advertising or print advertisements. During this time, researchers also employed the use of GSR (Galvanic Skin Response) as a possible indicator of people's emotional response to advertisements. Later, new technology for eye tracking was developed which revealed exactly where on the page (or TV screen) people's eyes were focused. And finally, in the 1970's Herbert Krugman and Flemming Hansen began to explore processes that occur in the right/left brain hemispheres using electroencephalograph (EEG) brain wave technology. Each of these technologies was heralded at the time as groundbreaking, however none of these found widespread use for the purpose of marketing.

In 1981 SST (Steady State Topography) was utilized by Professor Richard Silberstein at Swinburne University, where he used this technology in clinical applications for possible use in marketing. The latest, and perhaps most widely known technologies are fMRI (functional magnetic resonance) and MEG (magneto-encephalography) which are both utilized as brain scanning devices. Both technologies show which areas of the brain "light up" when stimulated, producing a snapshot of the subjects brain. While there has been a great deal of hype surrounding these technologies and their potential applications for marketing, very few studies in peer reviewed journals have actually been published, deploying them for the use of marketing. One of the earliest studies conducted, utilizing these newer technologies was one performed by Professor Ambler and his colleagues at the London Business School. This study asked subjects who were placed in a MEG scanner, which of 3 brands they would purchase when given a choice. The results indicated that familiar

brands stimulate the right parietal cortex in the brain. The authors thus, theorized that this area of the brain was a possible "location of brand equity."

In 2000, Rossiter et al used SST to monitor brain waves while people watched TV ads. They were able to predict what scenes people would recognize a week later. They found they could predict this from activity in the left-brain at the time of exposure in the posterior region of the frontal cortex. Prior to this, it was thought that the crucial processing for pictures would be in the right hemisphere of the brain. Since 2000, many other similar studies have been conducted, which have resulted in relatively minor findings, most likely, due to the subjective and highly interpretive nature of this type of research. While each of these techniques has its strengths and weaknesses, there is also a great deal of detailed interpretation which goes into understanding the meaning of increased brain activation and in specifying what mental process is signified by an activation.

Most imaging studies report activations arising from the difference between two tasks. For each brain area, the signal during the task is compared to the signal at rest; those areas of the brain with stronger signals during the task are presumed to be processing the information. A very recent breakthrough however, may be able to detect the activity of an individual neuron in the future. At this stage however, the smallest brain area that can be represented - a voxel, is the size of a grain of rice and contains tens of thousands of neurons. It is interesting to note that there are about 100 billion neurons in the typical brain, but current fMRI resolution is only about 150,000 voxels. The changes in blood flow in a voxel thus, indicate increased activity of not a single neuron but a huge pod of tens of thousands of neurons.

4 Practical Applications: A Dubious Aim

In addition to some of the earlier Neuromarketing studies and applications already described herein, there are several other case studies that are of interest. These studies offer us a glimpse into exactly what these new technologies are being adapted for and how they are being applied, which is more often than not, for the sole purpose of marketing products to consumers. One such example is a study employed by Daimler Chrysler utilizing fMRI technology to see how consumers perceive their cars. These scans concluded that many sports cars activated the ventromedial prefrontal cortex, or what is called the "reward" centre of the brain, which is also reportedly activated by alcohol, drugs and sex. When shown a frontal view of these cars, the area of the brain that processes human faces was also shown to "light up." Boston based Ad agency Arnold Worldwide, hired by Jack Daniels employed similar brain imaging studies recently carried out at Harvard's McLean Hospital. These studies use fMRI scans to measure subjects' emotional responses to images associated with the activity of drinking in 25-34 year olds. The scans "help give us empirical evidence of the emotion of decision-making," says Baysie Wightman, head of Arnold's new science-focused Human Nature Department. These results apparently helped shape Jack Daniel's 2007 ad campaigns geared towards this particular demographic.

According to an article in the *Journal of Advertising Research* in 2001, another Australian study of TV commercials using brain wave technology (Steady-state Probe Topography) indicated that the left-brain was crucially involved in long-term memory for pictures. This was contrary to expectation, as it was previously thought that crucial processing of pictures was located in the right brain. Using the newer brain scanning technologies, the first studies of brands started to appear in 2002. One study performed in 2002 at the Psychology Department at the University of Los Angeles looked at exactly where brand names are processed in the brain and found more activity in the right brain than the left. Another study performed that same year at the London Business School examined people making a choice between brands and brand familiarity. Indicators showed up mostly in the right brain, in a place called the parietal cortex. Researchers apparently have their fingers crossed that this will turn out to be where brand equity resides, which no doubt will fuel a slew of additional studies in this specific area.

While much of the research is still mostly academic, many experts anticipate that that it's just a matter of time before these findings become a routine part of every competitive corporation's marketing plans. Some findings, such as the aforementioned discovery, which focuses on how the brain interprets brand names, are already enticing advertisers. Take, for example, the classic taste test. P. Read Montague of Baylor College of Medicine, who performed his version of the Pepsi Challenge with the use of an fMRI machine in 2004. In this study researchers repeated the famous Pepsi/Coca-Cola blind taste test challenge while scanning the brains of volunteers. When ignorant of which beverage they were sampling, the subjects favored Pepsi with their scans revealing activation of the ventromedial prefrontal cortex (a reward centre). However, when Montague repeated the test and told them what they were drinking, three out of four people said they preferred Coke. When aware of which brand they tasted, the scans revealed activity in the hippocampus, midbrain and dorsolateral prefrontal cortex – areas associated with memory, emotions and emotional information processing. This led the researchers to conclude that a preference for Coke is more influenced by the brand image than by the taste itself. Montague states that, "This showed that the brand alone has value in the brain above and beyond the desire for the content of the can."

Various studies have used verbal reports (e.g. scene recognition, brand preference); behavior (e.g. purchase vs. non-purchase); and even different segment reactions (e.g. Democrats vs. Republican brains are said to react differently to advertisements) to evaluate video clips and TV advertisements, study decision making among shoppers and even to investigate the likely impact of political advertising during the recent presidential elections. A study at the University of California, Los Angeles, for example reported differences in the neural responses of Democrats and Republicans to commercials depicting the 9/11 terrorist attacks. For the most part however, studies have been focused thus far, on the so-called 'known centers' such as: the rewards center, self-referencing center; and face recognition center. This has resulted in numerous

neuromarketing studies, which increasingly focus on the various 'known centers' in the brain, however the actual scientific data about these 'known centres' is very limited. A number of findings converge on the prefrontal cortex located in the lower forehead but no-one is clear yet as to precisely what all this means, thus, this should be considered more speculative at this point than anything else.

While the implications for marketing are problematic and mostly in the realm of speculation for the moment - we can, no doubt, expect a continuing accumulation of these studies in the near future. In any new scientific field, there is often a period where there is more speculation than proven research. This, coupled with the increasingly commercial nature of science, has resulted in a proliferation of pseudo experts in marketing, whose exaggerated claims and "powerful new marketing services," may do injustice to the real scientific research being conducted within this new discipline.

5 Critiques & Potential Ethical Concerns

Within the realm of Neuroeconomics and Neuromarketing there are a number of causes for concern. These are not only ethical, but also practical in nature. Concerning the applications of neurotechnology, there are a host of implications for individuals and society which should be considered carefully before these are put into wide spread use. Other potential implications may be considered more philosophical in nature, concerning the way we think about ourselves as persons, moral agents and even spiritual beings. In fact, there has already been a campaign organized against one such research project at Emory University. A national watchdog group headed by Ralph Nader called Commercial Alert has objected to Emory allowing Brighthouse, an Atlanta marketing consultancy, to use the university's neuroscience facilities for neuromarketing research. Commercial Alert has asked the Office for Human Research Protections, a division of the U.S. Department of Health and Human Services, to investigate whether the project violates federal guidelines for medical research.

Commercial Alert contends that it is wrong to use medical research for marketing instead of for the improvement and well being of humankind. The University has reviewed and approved the research, and states that the studies are making important contributions to Science, which will soon be published in scientific journals. However, it has been recently revealed that the university now no longer conducts this neuromarketing research on campus. Instead, Joey Reiman, who is an adjunct professor at Emory's business school and the proprietor of Brighthouse marketing consultancy, says that the university studies how the brain reacts to preferences, and then passes this information over to his consulting company, which is then hired by corporate clients. This raises many ethical questions about how this research is being used and such conflicts of interest are clearly a cause for concern. This type of research in the name of scientific knowledge is common, however selling this information to corporations whose job it is to manipulate people for profit is a dubious enterprise at best.

Despite how this information is or is not used, a much more philosophical question might be, how such invasive neuroimaging techniques are breaching the privacy of the human mind. This technological progress is making it possible to monitor and manipulate the human mind with increasing precision and with these techniques it may be possible to not only infringe upon the privacy of the human mind, but to judge people based not only by their actions, but also by their thoughts and predilections.

Brief Description of Technologies

Positron Emission Tomography or **PET** scans, were developed in the mid- 1970s, PET was the first scanning method to give functional information about the brain. Both PET and FMRI provide information about neural activity in different brain regions as indicated by the level of cerebral blood flow. With FMRI, the magnetic consequences of blood oxygenation are measured, whereas PET measures blood flow by first injecting people with a liquid radioactive tracer and measuring changes in radiation.

FMRI or **Functional Magnetic Resonance Imaging** and **MRI** or **Magnetic Resonance** Imaging require no radioactive materials and produce images at a higher resolution than PET. Originally used to take snapshots of what various brain injuries looked like, researchers realized that they could also use MRI machines to see which parts of the brain were being utilized in specific tasks, such as perception, language and memory – hence the term 'functional' MRI. This method involves very rapid scanning of the brain to see which areas of the brain are activated. When neural activity increases and the blood oxygenation in a region increases, this changes its magnetic properties. Increased neural action draws a bigger blood supply to support its work, which shows up—millisecond by millisecond —on an fMRI scan as magnetic changes. So, what fMRI detects is not neural activity directly, but magnetic changes that are blood-oxygen level dependent. The method is non invasive so multiple scans can be done on the same subject.

Magneto encephalography, or **MEG** is a very different brain scanning technique but used for similar purposes. The big advantage of MEG scans is that they are able to measure activity in the brain extremely quickly - every 1/1000 of a second, which is similar to the rate at which the brain works - essentially 'the speed of thought'. This method is closely related to electroencephalography or EEG, since they both try to measure the same neuronal currents. Electrical currents in the brain's neuronal circuitry give rise to very weak magnetic fields that can be picked up by superconducting detectors arranged around the outside of the head. The main disadvantages of MEG are that it is more expensive and not as good as fMRI at localizing, where, precisely in the brain, activity is taking place.

ERP – **Event Related Potentials,** also called **Evoked Response Potentials**
uses electrodes on the scalp to measure voltage fluctuations resulting from electrical activity in the brain. The "baseline" activity is then averaged out, leaving just the electrical responses evoked by each stimulus presentation. The location of where the activity is generated inside the brain has to be imputed mathematically. In animal studies and patients undergoing brain surgery, another way to localize ERP sources is to place electrodes directly on the brain.

SSPT or **Steady State Probe Topography** is used for monitoring activity during dynamic stimulus sequences, such as TV commercials. SSPT measures steady-state visually evoked potentials (SSVEP) and records at the rate of 13 times per second from 64 electrodes in a lightweight skullcap.

While important strides are being made in understanding the relation between the mind and the brain, our understanding of why people behave the way they do is closely bound up with the content of our laws, morals, social mores and religious beliefs. This is thus, a topic, which holds great philosophical weight for mankind and society as a whole.

We may also want to consider the physical invasiveness of some of these techniques, such as the PET scan, which utilizes radioactive tracers to detect brain activity in subjects, or even more invasive procedures carried out on patients in brain surgery, where electrodes are placed directly on the brain. We might also want to ask questions about the way in which many of these studies are conducted. Often subjects are lead to believe they are being tested for specific information, when in fact the tests being administered are employed for the purpose of obtaining other personal information surreptitiously, in studies designed for a completely different purpose. Perhaps it is not in an individual's best interest to have such personal information available to others, especially when considering that it will most likely be utilized by corporations and marketing firms who wish to use it to sell more of their products and make higher profits.

Another practical problem here is that the media, the public, the corporations and marketing firms interested in this new technology seem to think that it is completely full proof. For example, the general conception seems to be that brain scans "do not lie." This has created a great deal of misinformation and media reporting, which has outstripped any current scientific substance. This promotional hype has in turn, led some scientists, researchers and even universities to jump on the bandwagon in order to take advantage of the corporate dollars being spent by these dubious enterprises. Bearing these questions in mind, perhaps it is time we weigh the potential effects and possible ramifications of such research and how this may be used going forward in society at large. Will the research generated by this new discipline further our quest to better understand the mind and brain and add to the betterment of society as a whole? Or will it simply be usurped and corrupted by the all-powerful corporations who are already dictating so much of what is being funded in science now? Is it wise to allow precious funding dollars and University facilities to be used for the purpose of bolstering already ubiquitous and rampant consumerism? Wouldn't this funding be better used for the health and betterment of society rather than for capitalistic purposes? And will there be proper regulation for this type of research imposed, as in the case with biotechnology or stem cell research? These are the hard questions we must ask, not only for the preservation of the scientific community, but also for society at large.

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