Virtual Reality and Neuroimaging Technologies: Synergistic Approaches in Neuromarketing

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ABSTRACT

Marketers have long been fascinated by the possibility of understanding how consumers think and what factors stimulate favorable reactions to marketing stimuli. Marketers are now beginning to utilize neuromarketing techniques to map patterns of brain activities to ascertain how consumers evaluate products, objects, or marketing messages. Neuromarketing is relatively a new field of marketing that utilizes computer-simulated environments, such as Virtual Reality (VR) or Immersive Virtual Reality (IVR) technologies combined with neuroimaging technologies, such as Functional Magnetic Resonance Imaging (fMRI), Quantitative Electroencephalography (QEEG), Magnetoencephalography (MEG), and other means of studying human neurological responses. Marketers need this information to help gain favorable reactions to their marketing stimuli and to predict which product designs and marketing messages will appeal most and be on consumer's minds when the prospects are ready to buy.

Key Terms: Brain scan, CAVE, COCOON, EEG, fMRI, Immersive Virtual Reality (IVR), Neuroimaging, Neuromarketing, Neurosciences, Virtual Environments, Virtual Reality

Introduction

Marketers spend billions of dollars each year on relatively crude methods such as focus groups, questionnaires, and measurements of eye movements in the attempt to understand how the human brain makes decisions and what motivates consumers to spend. However, with advances in the fields of virtual reality and neurosciences, marketers can now predict with relative accuracy which design or marketing message will appeal most to consumers by mapping out which parts of the brain are active when consumers look at certain products or marketing messages. These relatively new field is aptly termed as 'neuromarketing', which has stimulated significant innovations in marketing in general and in marketing research in particular. Neuromarketers combine virtual reality technologies with neuroscience, brain scanning, or neuroimaging technologies to help predict which marketing stimuli or marketing messages will appeal most to consumers by mapping out which parts of the brain are active when respondents look at certain stimuli or marketing messages. However, critics of this approach are concerned with the ethical and philosophical issues related to marketers' ability to probe mechanisms behind people's decision-making processes coupled with the dilemmas these advances in brain science present and who should be allowed to peek into consumers' brains.

This chapter reviews neuromarketing technologies such as computer-simulated environments combined with neuroimaging technologies utilized in neuromarketing. This chapter gives an overview and focuses on the advances in the fields of virtual reality and neuroimaging and the ability to use brain responses to ascertain how consumers evaluate marketing stimuli.

Neuromarketing

Marketers in the past relied on traditional market research methods such as surveys and focus groups, indirect and often inaccurate methods such as observing how consumers behave in stores, or tracking how purchases rise or fall in response to promotional campaigns or changes in pricing. However, these methods are often fraught with bias and imprecision and fail to predict consumers' thoughts and feelings. Although brain-scanning devices have been available for decades, new scanning technologies and computer processing algorithms can pinpoint more precisely which brain regions are active as people respond to products, makes, and brand choices, or are exposed to marketing stimuli such as advertisements. Neuromarketing, according to Sutherland (2007) is relatively a new field of marketing that utilizes neurosciences, computer-simulated environments, medical technologies, and other scientific means of studying human consumers' neurological, sensorimotor, cognitive, and affective responses to marketing stimuli. Lesley Stahl, a 60 Minutes correspondent recently reported on neuroscience research into how we think and what we are thinking is advancing at a stunning rate, making it possible for the first time in human history to peer directly into the brain to read out the physical make-up of our thoughts, some would say to read our minds (Columbia Broadcasting System (CBS), 2009). Some of the medical technologies used in neuromarketing include functional magnetic resonance imaging (fMRI), magnetoencephalogram (MEG), and quantitative electroencephalogram (qEEG). Of the three, according to Kenning et al. (2007) and Kenning, Plassmann, & Ahlert (2007), fMRI, to try to figure out what we want to buy and how to sell it to us, has captured the greatest interest among market researchers and enjoyed the widest publicity.

Marketers need this information to help gain favorable reactions to their marketing stimuli and to predict which product designs and marketing messages will appeal most and be on consumer's minds when the prospects are ready to buy. With breakthroughs in neuroscience, neuromarketers can hope to see what goes on inside consumers' minds when they shop by hooking people up to functional magnetic resonance imaging (fMRI) machines to map how their neurons respond to products and pitches (Carr, 2008). The relatively new approach that combines neurosciences with marketing techniques is aptly termed neuromarketing. Gemma Calvert, co-founder of a London company called Neurosense told Leslie Stahl, a CBS's 60 Minute correspondence, that companies such as Unilever, Intel, McDonald's, Proctor & Gamble, MTV, or Viacom are already using neuromarketing techniques to predict what consumers want to buy and how to sell their desired products to them (Columbia Broadcasting System (CBS), 2009).

Some of the roots of neuromarketing go back to neuroscientist Damasio's (2005) assertion that human beings use the emotional part of the brain when making decisions, not just the rational part, which is a departure from René Descartes's Cartesian idea of the human mind as separate from bodily processes. Damasio draws on neurochemistry to support his claim that emotions play a central role in human decision-making. This claim is based on human emotions, decision-making, memory, and communication, from a neurological perspective. Damasio uses brain imaging techniques (e.g. advanced magnetic resonance scanning), and cognitive, psychophysiological, and psychophysical techniques in conjunction with virtual reality techniques in his research.

With the help of brain-scanning or neuroimaging technologies combined with Immersive Virtual Reality (IVR) technologies, such as a pair of specially adapted Sony virtual-reality goggles, a neuromarketer can predict which marketing stimuli will appeal most to consumers by mapping out which parts of the brain are active when the respondents look at certain products or marketing messages.

Another example is research conducted by Brown University professor John Donoghue, in which he used multielectrode recording arrays and fMRI techniques of brain-scanning or neuroimaging technologies in capturing brain signals (as cited in Ortiz, 2007). Donoghue and his research team then used digital signal processors (DSPs) and algorithms to translate these brain signals into a format that a computer can understand and process. Using scientific methods and advanced technologies, researchers are coming to understand how human beings process feelings that affect our decision-making processes such as purchasing decisions.

The goal for using this technology in neuromarketing is to decode which purchasing choices go into buying (Wilchalls, 2004) a particular product and to understand better how consumers make emotional connections with brands. The result can be the ability to pinpoint the preference areas of the brain. Using this data, marketers can help design better products and a more effective marketing campaign. However, because of the restrictions of the MRI scanning process, and the time required for a response to be registered in the brain and transferred to an fMRI image, other neural scanning technologies are also being investigated for their contributions to neural marketing. Several of these neural scanning technologies have the potential to use lightweight wearable sensors that would enable marketing studies in environments such

as the CAVE (CAVE Automatic Virtual Environment, 2009). Other neural scanning technologies involved in research are magneto-encephalography (MEG), and quantitative electroencephalography (qEEG). Neuromarketers are beginning to combine neural scanning technologies with virtual reality technologies to get better results.

Virtual Reality

One of the computer technologies being incorporated into neuromarketing, Virtual Reality (VR), initially coined by Jaron Lanier in 1989 (as cited in Heim, 1993), is an artificial environment, created using multiple technologies, in which individuals immerse themselves and feel that this the artificial reality really does exist. Other related computer technologies include Artificial Reality (Krueger, 1991), Cyberspace (Gibson, 1984), and, more recently, Virtual Worlds (Beier, 1990). Virtual Reality, also known as the Virtual Environments (VE) has drawn much attention in the last few years and extensive media coverage caused interest to grow rapidly. However, few people really know what VR is, or what its basic principles and unresolved problems are.

According to Youngblut, Johnson, Nash, Wienclaw, and Will (1996), the idea of VR began well before the advent of the computer; however, VR, in the sense we have come to know, occurred during the past 40 years. VR pioneers such as Ivan Sutherland, Michael Noll, and Myron Krueger all had their parts to play in the creation of modern-day VR. Popular culture and science fiction both have also had profound effects on the social implications of VR.

According to Isdale (1993), originally the term VR referred to Immersive Virtual Reality (IVR) in which the user, using an electronic device such as the head-mounted display (HMD), becomes fully immersed in an artificial, three-dimensional world that is

completely generated by a computer. IVR combined with brain-scanning or neuroimaging technologies can stretch a marketer's understanding of what triggers a certain response by looking deep inside consumers' brains to reveal eventually the secrets of designing and selling a more universally appealing product.

Harris, Duffy, Smith, and Stephanidis (2003) suggest that there are numerous types of VR systems, but most can be classified into one of the following three categories: Desktop VR, Video Mapping VR, and Immersive VR. In Desktop VR, a computer user views a virtual environment through one or more computer screens and can then interact with that environment, but is not immersed in it. An example of Desktop VR would be Second Life, with which a user becomes part of a VR world. Video Mapping VR uses cameras to project an image of the user into the computer program, thus creating a 2-D computer character. Blue screens used by TV weathermen that allow them to stand in front of full-sized animated weather maps and satellite images typify this technique. Although fully immersed in the environment, it is difficult to interact with the user's surroundings. Immersive VR uses a HMD to project video directly in front of the user's eyes, plays audio directly into the user's ears, and can track the movements of the user's head. A dataglove (or datasuit) is used to track movements of the user's body and duplicate them in the virtual environment (Rheingold, 1991). When the user cannot distinguish between what is real and what is not, then immersive VR has succeeded.

Beyond the immersive environment of the VR glasses and headphones is the environment of the CAVE (ADLAB, 2006) or the Immersive Cocoon (Cocciardi, 2008). In these systems, the user is inside a room or sphere, the surface of which is a seamless display system. With 3-D glasses and hand feedback (gloves or 3-D mice), the user can

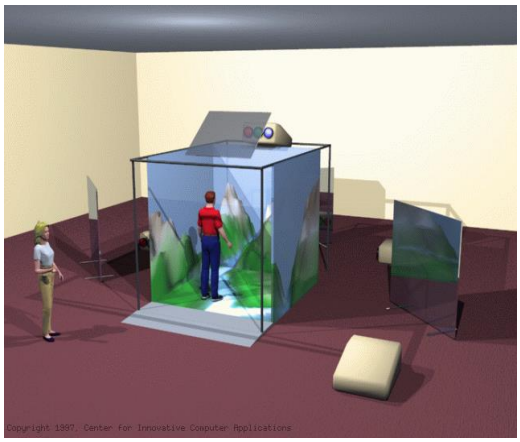
navigate inside a 3-D environment.

Military training and gaming industries have largely driven the rapid advances in the VR technologies and have concentrated on sight and sound, which are also major elements in marketing stimuli. In addition to sight and sound, smell and taste are also important to marketing stimuli. Virtual Reality allows users to see, hear, and will sometime soon allow the user to touch and smell objects and environments that exist only inside computers. Although not as well developed or commercialized as sight and sound, VR technology for smell and taste exists. The Smell-O-Vision system, a technique created by Hans Laube, released 30 odors during the projection of a film so that the viewer could smell what was happening in the movie *Scent of Mystery* (Smith & Kiger, 2007), and NAU is reportedly working on an immersive headset the will reproduce smells (Franklin, 2009).

The appeal of VR to a company marketing organization is its tremendous time and cost savings. No longer does an organization need to wait for an art department to make posters and no longer does it have to wait for the model makers to make handcrafted prototypes of products and store displays. With the click of a mouse, a new ad campaign or product appears, as if by magic, in a display before a prospective customer.

Potential customers can be shown advertising or products using desktop computer screens, LCD wall screen projectors, 3-D goggles, or immersive VR such as the CAVE **(**Cave Automatic Virtual Environment**.** 2009) or the Cocoon (Cocciardi, 2008).

In one recent use of VR technologies in studying buyer habits and reactions, Procter & Gamble, the U.S. multinational, used a CAVE-like environment to study the behavior of English shoppers in VR recreations of their local shops (ADLAB, 2006). Since CAVE-like environments utilize an Artificial Reality (AR) system, which does not require wiring human beings to use an interface, and computerized sensors perceive human actions in terms of the human body's relationship to the simulated world (Heim, 1998), the shoppers could be studied as they moved around the virtual shops. The marketers then got reactions to what the customer seesaw; they could ask questions pertaining to products, services, and other marketing stimuli; or they could watch responses such as clenching of fists, jaws, narrowing of eyes or pupils, crossing of arms, or leaning forward.



Typical CAVE 1

Just as computers have been making VR possible and increasing the speed of marketing studies, they have also been advancing medical imaging, both in terms of the kinds of images that can be collected and the accuracy and speed with which the computer can process the raw data into a usable image.

Neuroimaging

One of these imaging technologies, Magnetic Resonance Imaging (MRI), has revolutionized the way doctors visualize conditions ranging from tumors to ruptured tendons and is considered safe and noninvasive, but requires expensive machines and facilities. To help pay for MRI facilities, researchers have been looking for other applications that could help share the cost, and marketing is one such application.

Magnetic Resonance Imaging was first used to scan a full human body in 1977 (Clare, 1997). By the early 1990s, continued improvement in the technology and research into applications of MRI scanning resulted in the realization that blood flow to the brain could be imaged. Neuroscientists adapted standard MRI scanners to produce three-dimensional images of brain activity at any particular moment. It has been known since 1890 that mental processes cause an increased flow of blood to the active area of the brain (Roy & Sherrington, 1890). MRI scans showed the part of the brain that was active (or functional), and the new technique was called fMRI for Functional MRI (Belliveau et al., 1991). The first applications of fMRI were in precise diagnoses of stroke and other brain disorders such as schizophrenia (Weinberger et al., 1996). Continued development of improved MRI equipment and processing software led to much more precise location of the active areas in a brain scan, measured precise locations of small changes in blood flow identifying what the subject was thinking at the instant an MRI image was taken, and began to correlate active brain locations with particular thoughts. MRI or fMRI do not scan brains for the words or images, but correlate the active brain area with likes or dislikes in response to marketing stimulus such as a picture.

In one example of such brain scanning or neuroimaging technologies, according to Peck (2008), neuroscientist Paul Sajda of Columbia University, uses an EEG cap taped into the brain's vision system to tell which images grabbed an individual's attention even if they are moving too fast to notice consciously.

Virtual Reality and Neuroimaging in Neuromarketing

Neuromarketing represents the latest extension in the use of a series of technological means to capture involuntary human responses to marketing stimuli. Brain imaging, a widely used technique in neuromarketing permitted by the latest technologies, is simply the latest in a long line of marketing research efforts used to understand better consumer reactions to marketing stimuli and messages. However, this understanding is markedly different from that obtained with traditional survey or focus group efforts in which the respondent knowingly interacts. The marketing information collected by neuromarketing might be more accurate than information collected in conventional marketing studies. According to Rowan (2004), multinationals such as Unilever and Ford are paying scientists to scan volunteers' brains. In addition, Hollywood studios are testing brain responses to film trailers, and food manufacturers are using neuro-imaging to fine-tune multi-million-dollar product launches. Several auto manufacturers such as Jaguar, Mercedes-Benz use these techniques to design and crash test their automobiles.

According to Berns, a psychiatrist at Emory University (as cited in Park, 2007), marketers can use brain imaging to gain insight into the mechanisms behind people's decisions in a way that is often difficult to get at simply by asking a person or watching his or her behavior. The high costs have somewhat limited the use of Virtual Reality and neuroimaging technologies such as fMRI and CAVE in neuromarketing. However, once

market barriers of tight research budgets, complexity of the instruments, and high costs of brain-scanning or neuroimaging technologies are resolved, the neuromarketing industry is expected to develop further. With technology developers exploring many new applications, especially those involving neuroimaging, it is inevitable that brain-scanning or neuroimaging technologies would evolve into a highly sophisticated neuromarketing tools. Some of the improvements made to the technology have further enhanced the modality and many applications have adopted these systems.

According to Addison (2005), Zaltman of Harvard, toward the end of the 1990s, reported the first use of fMRI as a marketing tool. The idea of seeing what people think using fMRI was first called neuromarketing by Ale Smidts of the BrightHouse Institute for Thought Sciences, working out of the neuroscience wing of Emory University Hospital in Atlanta, Georgia (Lewis & Brigder 2005). Carr (2008) and Rowan (2004) describe neuromarketing as an approach with which marketers combine neuroscience and marketing techniques to predict how consumers will react to stimuli in the marketplace, from prices to packages to advertisements. In the words of *Forbes* magazine, the researchers at Emory's School of Medicine and Hospital are experimenting on human subjects in order to find the buy button inside the skull (Wells, 2003). The *New York Times* called the neuroscience wing at Emory University the epicenter of the neuromarketing world (Thompson, 2003).

The potential payoff of neuromarketing is that combining the ability of VR to produce products and environments with the ability of fMRI or other brain-scanning technologies to read subconscious reactions greatly enhances the accuracy and reliability of marketing studies. These neuroimaging technologies, combined with VR in which the

user is fully immersed in an artificial, computer generated three-dimensional world, can stretch marketers' understanding of what triggers a certain response by looking deep inside consumers' brains to reveal the secrets of designing and selling a more universally appealing product.

According to Sutherland (2007), since it is the unconscious mind that drives how consumers respond to marketing stimuli, consumers do not really know why they buy what they buy, which is why traditional market research falls short. Sutherland reports that according to neuroscientists, there are three main parts to the brain: the human brain or cortex, the mammalian or the middle brain, and the reptilian or old brain. Of the three, the human brain, the most evolved part of the brain, is responsible for logic, learning, language, conscious thoughts, and our personalities. According to Chaudhuri (2006), the reptilian brain drives consumers' buying decisions, which neuromarketers strive to measure to predict how consumers will react to stimuli in the marketplace, from prices to packaging to advertisements. With breakthroughs in brain sciences, neuromarketers can hope to see what goes on inside consumers' minds when they shop by hooking people up to functional magnetic resonance imaging (fMRI) machines to map how their neurons respond to products and pitches (Carr, 2008). To change the content presented and to measure the response within fMRI environment, stereo goggles and headphones (Resonance Technology Inc., 2009) and stereo displays designed specifically to (Cambridge Research Systems, 2009) operate within the intense magnetic field of an MRI was all that was necessary.

The understanding gained from neuromarketing methods is also different from that obtained with observational studies in which behavior is examined, but without the ability to trace the internal roots that prompted the action. Neuromarketers believe that well-designed neuromarketing studies can provide involuntary responses, free of the biases introduced by other marketing study collection methods. Therefore, the assumption is that neuromarketing using brain images could possibly tell the marketers, which brand images, trigger the strongest subconscious responses, and which commercials or logos touch us most deeply. If these assumptions were proved correct, marketers would not have any further need for unscientific focus groups.

Marketing studies performed using neuromarketing are just the beginning. Recently, Knutson a Stanford scientist, conducted a test to measure anticipatory emotions, which are the intuitive and emotional regions of the brain that prime the decision-making process even before the cognitive areas of the brain are brought in to assess options, such as the value of a product and its price, which triggers an anticipation of pleasure or pain (Park, 2007). To test his theory, Knutson presented his subjects, while they were in the fMRI machine, with pictures of products, each followed by a price with the option of purchasing each item on display. As subjects viewed products they preferred, Knutson saw activity in the nucleus accumbens, a region of the brain involved in anticipating pleasant outcomes. If, on the other hand, the subjects thought the price of these items was too high, there was increased activity in the insula—an area involved in anticipating pain. “The idea is that if you can look into people’s brains right before they make certain decisions, you can get a handle on these two feelings and do a better job of predicting what they are about to do”(Knutson, Rick, Wimmer, Prelec, and Loewenstein

(2007) suggest anticipatory emotions not only bias but also drive decision making.

Knutson et al., in their article titled “Neural Predictors of Purchases,” described how they used brain imaging to monitor the mental activity of shoppers as they evaluated products and prices on computer screens. By using event-related fMRI, the authors investigated how people weigh consumer preference and price factors to make purchasing decisions. The authors posit that by watching how different neural circuits light up or go dark during the buying process, they could predict whether a person would end up purchasing a product or passing it up. According to the authors, consistent with neuroimaging evidence suggesting that distinct circuits anticipate gain and loss, product preference activated the nucleus accumbens (NAcc), while excessive prices activated the insula and deactivated the mesial prefrontal cortex (MPFC) prior to the purchase decision. Activity from each of these regions independently predicted subsequent purchases beyond self-report variables. These findings suggest that activation of distinct neural circuits related to anticipatory affect precedes and supports consumers’ purchasing decisions.

Virtual reality, in its present forms, can greatly enhance marketing, and in particular marketing studies. The advent of future VR that can reproduce the feel and smell of products will only further improve the usefulness of VR for marketing. If the potential of neuromarketing hinted at by the studies performed to date can be realized, it is difficult to imagine marketers having any need of other marketing study tools. VR and neural imaging will have completely changed how marketing studies are performed and the accuracy of the resulting predictions.

Illustrative cases of successful use of neuroimaging, virtual reality, and neuromarketing

McConnon (2007), in his article titled "If I Only Had A Brain Scan" published in *BusinessWeek,* reports that an advertising agency recently sponsored an experiment to fine-tune an ad campaign for the maker of Jack Daniels. The experiment, conducted at McLean Hospital and managed by Harvard University, scanned the brains of half-a-dozen young whiskey drinkers to gauge the emotional power of various images, including college kids drinking cocktails on spring break, twentysomethings with flasks around a campfire, and older guys at a swanky bar.

According to Carter (2009), the carmaker Honda is one of the businesses using neuroscience to learn how and why consumers decide what to buy. Carter adds that Honda researchers use a smart garment called LifeShirt designed by US tech company VivoMetrics to monitor the emotions of buyers visiting car dealerships. Honda found the results so persuasive, Carter adds that it is remodeling showrooms and retraining staff to tailor pitches according to a potential buyer's state of mind. Carter cites yet another example of British broadcaster GMTV that uses the neuromarketing procedures to gauge receptiveness to adverts at different times of the day.

According to Lindstrom and Underhill (2008), Microsoft plans to use EEGs to record the electrical activity in people's brains to see what emotions they experience as they interact with their computers. Using brain-scanning technology, Unilever discovered not only why consumers enjoyed their best-selling Eskimo ice cream bars, but also that eating ice cream creates even greater visceral pleasure than either chocolate or yogurt.

Future research directions

According to Lee et al (2009), market researchers have an unparalleled opportunity to adopt cognitive neuroscientific techniques, including virtual reality and neuroimaging to redefine the new field of neuromarketing. The prohibitive factors slowing down the desired advances are the bulk, size, and cost of neuroimaging and virtual reality instruments and machines. However, neuroimaging instruments and machines manufactures such as Siemens, Sony, GE, and Philips are seeking smaller, less invasive, portable, or even mobile sensors for fMRI, EEG and other brain scanning functions. To map precise correlation of brain activity to locations within the brain, instrument makers are diligently working to increase the speed and resolution of scans. The speed improvements would enable the neuromarketers to complete a scan while the brain is still active with the response to a stimulus. The low-cost neuroimaging instruments and machines will make the equipment available to marketing researchers without the necessity to defray costs with medical scanning.

In virtual reality, manufacturers are seeking the ability for higher fidelity images, more seamless displays, and more senses simulated. In the combined area of VR and Neuromarketing research is being conducted on development of VR Neuromarketing suites, such as CAVE and COCOON and on what marketing protocols to use and what questions to answer using VR Neuromarketing.

Lindstrom and Underhill (2008) in their book *Buyology: Truth and Lies About Why We Buy* explain that companies will continue to turn to neuromarketing to better understand how consumers feel about their products. Authors predict that traditional market research will gradually take smaller role, and neuromarketing will become the primary tool companies use to predict the success or failure of their products.

Conclusions

The aim of this working chapter was to explore the use of numerous neuroimaging modalities in the emerging field of neuromarketing. In doing so, we presented a brief overview of the Use of Virtual Reality and Neuroimaging Technologies in the emerging field of Neuromarketing. It is our opinion that attempts, although limited to show correlations between brain activity signals and buying behaviors have proven successful. The research to increase the speed and resolution of neuroimaging instruments and machines is progressing that will allow commercialization of neuromarketing field allowing it to become an important marketing skill within a very few years.

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