

Rewired – The Next Generation:

How Electronic Media Causes Changes In the Brain and Social Skills of Technology Users

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Thesis Statement

The wide-spread uses of contemporary electronic media tools are replicating the process of *synaptogenesis* (the creation of synapses, or neuron pathways) in users by altering the neural circuitry in the brain, and these synaptic alterations produce corresponding changes in the socialization skills and cognitive abilities of tech users that then creates a pressing need to identify and implement new strategies of educational and medical treatment guidelines that are geared towards enhancing the most effective uses of technology while minimizing any potential harm.

Rewired – The Next Generation

Introduction - The Problem

As Walter J. Ong recognized, we are now in the process of moving from the sensate world into an exciting age of human development with regards to the explosion of new forms of electronic media tools and venues of communication technology. Ong called this world “secondary orality” and he emphasized its reliance on the immediate present moment, formulaic frames of references and consciously chosen community bonds (Ong 133-34). The transition from orality to print was a process which occurred over many centuries, but in just one generation we have moved from the basic tools of communication technologies , the telephone, TV, movies and print media into the explosive new age of digital media technology. Although some people will argue that present-day electronic media technology, which developed after the advent of the computer, simply provides an additional tool for humankind, I present the contention that a qualitative change is occurring in the human biological, social and cognitive realms within the framework of one generation, caused by the rapid rise and integration of electronic media as the primary means of communication in our modern life. Further, I will posit that these changes are lasting and evolutionary in nature. Due to the prospective consequences of these changes on human behavior and cognition, an urgent need has developed to restructure professional disciplines, such as education, medicine,

psychology and sociology, in order to evaluate electronic media technology in terms of its usefulness and potential benefits, along with providing protection from harm for the individual user and society at large. The relationship between technology and the physical brain is foreshadowed in Ong's references to Kerckhove...[that] "more than other writing systems, the completely phonetic alphabet favors left-hemisphere activity in the brain, and thus on neurophysiological grounds fosters abstract, analytical thought" (Ong 89).

Throughout history, whenever a controversial subject is introduced into the public domain, it often becomes the subject of much debate before enough evidence is produced that will begin to sway the minds of the masses. Take, for example, the subject of global climate change: a subject that was considered part of the lunatic fringe of activist thinking only a generation ago. While the general public and politicians ridiculed the idea that humans could have anything more than the mildest of impacts on the environment, scientists began to do what scientists do best, namely, research a theory by compiling and analyzing data. As the scientists performed their research, the forces driving climate change continued to build: more and more pollution was produced by man-made factories and automobiles, CO² levels continued to increase, weather began to grow warmer with each passing year, tree lines started to move northwards, ice shelves began to melt, and storms began to destroy cities. Now, all but the opposing lunatic fringes of doubters recognize the science that corroborates the fact that climate change is real.

The technological world is facing a similar type of problem today in recognizing the effects caused by having humans increasingly tied to the use of electronic forms of communication technologies. In this paper, we will start with an overview of the basic workings of the brain, then present a description of the types of changes that are taking place in the brain, including which areas are being affected and why, and will then expand our examination to study the effect that these changes have on the development of social skills in tech users.

Dissecting the Brain

Prior to beginning an analysis of the available research on this subject, it is important to have a basic idea of how the brain processes information. The information that will be used in this description of the brain was primarily taken from an excellent interactive resource sponsored by the Canadian Institutes of Health Research, entitled “The Brain from Top to Bottom” (DuBuc). The brain is an extremely sensitive organ and is influenced by the environment at all stages of development, including the embryonic stages. After a child is born, every exposure to new sensation creates new neuronal activity in the brain. The formation of neuronal development via the creation of synaptic connections and pathways accelerate at an astonishing rate until about the age of two years (Dubuc). At that point, the brain starts to ‘fine-tune’ its connections, getting rid of the ones it doesn’t need to make room for more specialized connections that it will need in the future. There are three primary divisions of the brain, the reptilian, the limbic and the neo-cortex, and each section is responsible for specific functions in the brain

(Dubuc). The reptilian brain consists of the brainstem and the cerebellum and controls the respiration, heartbeat, and the body's vital functions; the limbic brain contains the amygdala, the hippocampus and the hypothalamus and is responsible for emotions, memories that are tied to emotion and it is where value judgment capability resides in the brain (Dubuc). The neocortex is the section of the brain containing the two cerebral hemispheres. It is where language, vision and hearing reside in the brain, along with abstract thought, imagination and consciousness. The cerebral cortex is also able to maintain the greatest degree of plasticity throughout the human lifetime, as opposed to other parts of the brain (Dubuc). Electronic media technology is processed by the brain using three primary senses; the optical, which has been found to process visual input in terms of activity and brightness (Howard), the auditory, and the tactile senses, all primarily governed by the cerebral cortex. Since the cerebral cortex has continued to develop through the course of evolution, it contains the greatest percentage of neurons in the brain; therefore, information relating to this area of the brain will be the primary focus of this paper.

As far back as the 1980's, Howard Rheingold, a noted technology futurist, wrote of "the idea that people could use computers to amplify thought and communication, as tools for intellectual work and social activity"(Rheingold, par1), an apt description of how computer based electronic technology is used today. However, Rheingold recognized that the initial creators of the technology would not be the ones to explore the possibilities of its uses (Rheingold, par 1). Today, many researchers recognize this distinction between people who were born before the age of the computer and those

born after statement to represent a basic truth when examining the different ways in which technology is used by younger and older generations.

Who is affected by the Problem?

Everyone who engages in the use of electronic media is being affected by that interaction. Recent research on how cognitive processing is affected by the use of electronic media technology has shown that there are three primary areas of influence that help determine the strength of the effect. The first factor is the age of the individual. As we will see in later discussions of this topic, the brains of young people who were born into this technology develop differently from people who were exposed at later stages. The second factor is the length of exposure, or the amount of time spent using a particular technology tool. The third factor is the types of technologies that are being used. Let us now take a look at some of the types of research being conducted, followed by explanations of the research discoveries and an examination of the conclusions.

Research Review

In the book, *iBrain*, the author defines the two main groups of electronic technology users as Digital Natives, those who are now in their teens and early twenties, and who have never known a world without computers and electronic communications technologies, and all other users are defined as Digital Immigrants (Small 3). While the

author recognized that many Digital Immigrants may be as proficient in their use of a given technological tool as a Digital Native, the fundamental difference between the two groups lies in how their brains are wired, a condition that is determined by their age of exposure to technology (Small 4). Studies performed by researchers in the field confirm this difference to be significant in the manner in which the brain processes new information.

A recent study conducted by experts from UCLA and other institutions illustrates how the brain can be rewired at any age to process electronic media ((Small 14-17). The experiment was performed on adult women in their 50's and 60's who were divided into two groups; regular users of computer technologies versus a second group of computer virgins, women who had never used computers. The women were fitted with specially designed MRI-compatible computer access technology and were asked to first read passages from a book, and then conduct a specific information search on the computer using Google (Small 16). The two groups showed no difference in performing the reading task, as both groups were experienced readers. During the baseline Google phase of the project, where both groups were given the task of searching specific pages on Google for accurate information on given topics, the results were quite different. The experienced group showed significant activity in the dorsolateral prefrontal cortex, an area of the brain that controls working memory and the ability to make decisions and assimilate complex information, while the inexperienced group showed no activity in this region. Next, the two groups were sent home with instructions to perform one hour of Internet use daily for five days. At the end of the five days, the virgin techno-women

showed a similar level of activity in the same areas of the brain as the experienced group, and those areas remained active upon re-testing, demonstrating how even limited exposure to computerized technologies can re-wire the brain. If we extrapolate from these results that even limited exposure to electronic technology can shape the adult brain, how might it be affecting the brains of the young user?

Let us explore the possibilities by looking at a similar study, cited by Dr. Sarah-Jayne Blakemore of the Institute for Cognitive Neuroscience (Blakemore 40-49) shows how neuronal development continues and may even accelerate as children move into adolescence. During the initial formation of neurons, a myelin layer of fatty tissue forms around the axon of the neuron. This myelin sheath acts to help protect and to conduct the electrical impulses that travel along the neurons through the synaptic pathways of the brain. Results cited in the study indicate that neuronal myelin formation does not end after the first few years of life, but continues to be myelinated in the frontal cortex well into adolescence, opening the possibility that teen's brains are responding in 'real-time' to active stimulation of this area of the brain.

How does this information translate from the theoretical into practical developments in the embodied world? A recent study conducted at the University of California - San Diego, using 792 antisocial male teens diagnosed with RADI (reactive-aggressive defensive-impulsive disorder) as test subjects gives us insight into how changes in the structure of the brain affect the way in which anger and aggression are handled by teens (Neuroscience, nPag). Although it is common knowledge in scientific circles that brain damage, particularly to the prefrontal cortex, often results in behavior that is violent or

aggressive, the UCSD study started with data from prior studies that showed which neural circuits are associated with good moral judgment in normal individuals. The researchers then used that information to test how the parts of the brain that govern decision making compared in the antisocial teens and with a control group of 704 normal teen boys. The results of the study found that the RADI teens tended to have an exaggerated hyper- response in the amygdala, the area of the brain that translates information pertaining to threats and fear, with a simultaneous decrease in activity in the frontal lobe, one of the areas involved in decision making and control of impulsive behavior (Neuroscience, nPag)

In a related area of study, researchers at Indiana University School of Medicine show how the activity of playing violent video games by teens that have already been diagnosed with disruptive behavior disorders differ from normal teens in the way the brains respond to the stimuli (Indiana, nPag). Again, as in the UCLA study, investigators found a decrease in frontal lobe activity in the teens with disruptive behavior disorders. A decrease in frontal lobe activity correlates with decreases in working memory and conflict resolution ability, making it more difficult for the hypo-responsive teens to control their impulsive tendency towards aggressive responses, even to mild stimuli. These facts are important in light of the amount of time teens spend playing video games, as other studies (Matsuda 706-11) have shown that video game playing leads to decreases in oxygenated hemoglobin in the blood circulation of the pre-frontal portion of the brain in game players.

A study at the UT Southwestern Medical Center in Dallas, Texas (Green nPag) gives valuable insight into the role that chemicals play in the brain's ability to process new information; finding that dopamine, an important neurotransmitter, gives brain cells the ability to become more plastic and enables the brain better capability in processing new information. This finding is important in light of studies (Sigman 13-14) which show that dopamine rewards the brain with 'feel-good' chemistry whenever we stimulate the brain with new and exciting stimuli, such as screen entertainment. This study also demonstrates the relationship between decreases in the dopamine receptors in the brains of children with ADHD and suggests that more research needs to be done to evaluate the effects of the dopamine reward system with that of childhood exposure to electronic visual stimuli and possible connections with ADHD and autism spectrum disorders (Sigman 14).

Susan Greenfield is a British scientist and writer whose specialty is the physiology of the brain. She argues that modern technological devices are not only changing the brain, they are creating a generation of people who are socially inept and in the process of retrogressive development. Her primary thesis is based on research that suggests an 'infantilizing' of the teen brain after prolonged exposure to social media communication technologies, specifically Face Book, MySpace and Twitter. Dr. Greenfield suggests that teens using these technologies in an excessive manner are effectively rewiring the brain to mimic the brains of babies, who seek "constant reassurance" that they exist (Greenfield, S. nPag). She postulates that this will create shorter attention spans, make teens more self-centered and will create a generation that is addicted to instant

gratification. Greenfield believes that our interactions with our environments, including the use of electronic technology, create “a personalization of the brain” which creates a specialized custom-made network of neuronal connections and capabilities for each individual.

Studies focusing on the correlation between teen loneliness (Subrahmanyam 659-67) and the use of internet communications applications showed no significant relationship between the amount of time spent online and a user’s level of loneliness, but it did show a direct correlation between the gender of the teen user, the level of attachment and trust placed in online acquaintances and their score on the loneliness scale. The study found that male subjects who stated that they would trust an online acquaintance enough to contact them as their first resource in an emergency scored higher on the loneliness scale than all other subjects. The author of this study supports the concept of The Displacement Theory (Nie 2) to explain how electronic media technology affects social development in users.

The Displacement Theory (Nie 2) states that because time is a “finite quantity” any time spent on activities other than face-to-face interpersonal interactions creates a quality time deficit in social interactions. The authors of the study measured the amount of time spent on internet use versus the amount of time spent on social activities with family and friends and found that the time spent on internet- related activities at home negatively impacted the time spent with family and friends (Nie 9).

The changes caused by the use of technology tools are not necessarily negative, and some research has shown multiple beneficial applications of these technologies in cognitive performance and social acceptance meters.

For example, in a study published in *Child Development* researchers found that merely the perception of popularity was enough to increase the self esteem of teen girls. This study followed 164 adolescent girls from the age of 13 to 14 and found that the teens' perception of their level of popularity was a more important factor in their self esteem and positive social functioning than their actual level of popularity (McElhaney 728-29). These findings allude to ways in which social networking technologies can be used to enhance social acceptance in teens.

Another study conducted on surgeons who perform laparoscopic surgery revealed that surgeons who had played video games at any time in their past for at least three hours a week were 27% faster and had 37% fewer errors than other surgeons during actual surgery (Rosser 1754-55).

In a summary of several studies reviewed by Dr. Patricia Greenfield of UCLA, she describes how visual intelligence has risen steadily over the past 50 years, reversing a previous tendency that saw visual performance decline steadily from the ages of 25 to 65. According to Dr. Greenfield, there is virtually no difference in visual IQ today between the ages of 25 to 65, presenting a strong argument linking the use and wide availability of electronic media technology to this metric (Greenfield, P 69-71).

Repercussions and Cultural Technology Comparisons

In contrast to yesterday's technology, we face a much wider range of technology options in our daily lives. We watch our digital TV's for 24 -hour, up to the minute news and satellite weather coverage, while we check our emails and instant messages from phones that have more sophisticated computing power than the computers of ten years ago. We use GPS technology to find shortcuts to work in cars that use sophisticated computers to run their engines. As we drive, we pass through electronic sensors that deduct money from our bank accounts for the tolls we pass and if we stop for a cup of coffee, we have the option of paying for it with electronic bank cards. At work we use sensors to record our presence with the press of a finger on a scanner and we have the ability to access data from anywhere in the world and transfer it to any other point at any given moment through the use of our computers. We operate via the use of electronic robotic technology and we even fight wars through the use of remote surveillance. We are surrounded by technology and it is rapidly becoming part of us. We are in the process of creating a new type of human, whose capabilities are dependent upon the positive or negative ways in which they engage in the use of today's media implements and affiliated appurtenances. Hayles calls this phenomenon "being post-human" and writes... "the post-human implies not only a coupling with intelligent machines but a coupling so intense and multi-faceted that it is no longer possible to distinguish meaningfully between the biological organism and the information circuits in which the organism is enmeshed (Post Human, 35)" and

continues by saying that “accompanying this change is a corresponding shift in how signification is understood and corporally experienced” (Post Human,35).

Now, we must evaluate the possible repercussions of a failure to act on this information, by examining areas that are ripe for intervention by the educational and medical disciplines mentioned in our introduction:

There exists a growing gap between proficient and inefficient users of technology that will only grow with expanded use (Rheingold 6). This can lead to discrimination in the workplace and in the educational system against inefficient users, and can create wider gaps between technophiles and novices in personal, family and work relationships (Lavallee 11).

In relationship to this problem, the use of electronic media technology, video games in particular, is much more prevalent among males than among females, presenting our aforementioned discipline professionals with a real gender gap, both in terms of the ability to use technology and the formation of differences in the way the brains of each gender are developing through the uses of these technologies (Small 91; Blakemore 48-9).

N. Katherine Hayles alluded to these inequities of gender-specific training in her book *Electronic Literature* when describing the all-masculine world of the stock-market traders when she said “one need only advance such a proposal [a maternal female stereotype] to see how voraciously gender stereotypes reproduce themselves within this hierarchically controlled culture....the nuances of nurturing, selflessness, and caring for someone much smaller and weaker than oneself invoke an emotional calculus entirely at odds with the capitalist premises within which [the financial world] operates” (101).

Hayles summarizes this thought nicely by saying “other factors, particularly cultural models linked with masculine dominance are necessary to explain how the media function to “determine our situation” ” (Electronic, 101).

Many researchers have recognized the potential for misuse of electronic media technologies, whether from our ignorance as to the effects of the tools we use, to the idea that governments and institutions may use them against their own people for purposes of control. To this point, one of the technologies mentioned in my data analysis for this paper was a type of technology that has been patented by Microsoft Corporation that can use the skin and electrical impulses of the human body to power a computer network (Dennis, par). This type of technology would be easily recognized by Allucquere Rosanne Stone, as representing her concept of the idealized purposes for the cyborg, as she described thusly: “I want to see if cyberspace is a base camp for some kinds of cyborgs, from which they might stage a coup on the rest of ‘reality’” (Stone, 39).

Other technologies could have dual purposes that currently exist in theoretical or practical stages of development include a device patented by Sony that creates a pathway for sending sensory data directly into the brain using a process called transcranial magnetic stimulation (Dennis) and here again, Stone’s ideas resurface, as expressed in the following phrase, “When I look for new social forms in cyberspace, it is with this process in mind. I am seeking social structures in circumstances in which the technological is natural, in which social space is computer code, consensual and hallucinatory” (Stone, 38). Other products which were developed originally by NASA

are being used to provide learning and behavior modification through neuro-feedback computerized technologies (Dennis).

Summary

During the preparation of this paper, more than seventy-five studies were reviewed on the effects of electronic media technology on the brains and in the social development of technology users. Subject areas that were identified as related to technology use covered a broad spectrum, such as the incitement or exacerbation of violent tendencies in predisposed users, the inducement of technology-related ADHD and autistic symptoms, increased social isolation and social interaction awkwardness in chronic users, declines in critical thinking skills, enhancements in visual IQ capabilities, over-stimulation of the brain leading to pre-frontal cortex shut-down, increases in the brain's ability to process simultaneous tasking abilities, decreases in circulating oxygenated red blood cells in the brain and many, many other possible links to the use of technology. I found that much of the research on this topic elicits passionate counter-claims and arguments by opponents of specific theories, many rational and others, well, let us say, overly-emotional in tone. In the eleven studies chosen for this paper, I attempted to use information that showed measurable results and causal connections (with the exception of the ideas of one theorist, chosen for purposes of provocation) in order to present the reader with a balanced overview of the available research across a range of measures. This selection of analytical data allows for the presentation of several facts generally accepted by the majority of technological communications experts, and these include:

1. The exposure to modern electronic technological tools help to create the formation of new neural networks in the brain
2. The creation of these synaptic connections permanently change the response of the brain upon exposure to these technologies
3. The brains of technical people are different from non-technical people, in that this exposure creates a basic need for additional stimuli
4. Violence in technology does affect users in different ways, both good and bad
5. There is a gender difference in the uses and also in the responses to electronic media tools and technology
6. There are generational differences in both the brains and the socialization skills of users

Conclusion:

Our original thesis proposed the idea that the modern uses of electronic media tools are changing the brains and the socialization abilities of users through the process of new synaptic formation of neural connections in the brain and that this process has generated the need for a thoughtful, creative and appropriate stratagem by authorities in related disciplines to promote the optimal use of these technologies.

Our analysis of the various research studies and theories presented in this paper indicate that the problem is *not* the fact that we are using new technological tools to accomplish

our public and private goals, but rather that we are using tools that have not been evaluated for appropriateness and for the potential benefit or harm to the user. The research presented herein has already begun to identify problems associated with unregulated and indiscriminate use of electronic media technology and has opened up exciting opportunities for the future applications and potential uses of these technologies, even inadvertently at times.

The element that is missing from all of the research conducted on this topic is that of oversight; professional, knowledgeable guided oversight is the missing ingredient that could propel the use and development of electronic media and communications technology into achieving a pivotal role in the development of a healthy, productive integration of the body and the brain into a state of biological enhancement via the use of electronic technology.

Electronic media and communications technology is connected with many professional disciplines, all of whose members share in the responsibility to develop a usable template for this technology.

The considerations for creating a workable model that would enhance the benefits while limiting the negative potential of technology use is too complex to develop based on any one profession's priorities, therefore I propose the following approach as being one that takes all discipline concerns into consideration without undermining the needs of the individual user: each individual should be given a needs assessment analysis based on criteria presented from a cross-section of related disciplines. In turn, the needs assessment results would serve as a flexible prescription that would enable the user to

maximize their use of technologies on an ongoing basis. This would allow for a balanced use of electronic technology along with older technologies which still benefit the human condition in ways that electronic technology cannot yet do. One example of this approach would be to enhance the visual-spatial abilities of users through the use of electronic forms of technology while also compensating for a loss of critical thinking skills such as problem-solving, vocabulary and imagination by the inclusion of reading into the user prescription.

The effects of violence in media technology could be mediated by identifying risky neural profiles in hyper-reactive individuals and replaced with stimuli that would interest without inciting negative reactions. In conclusion of this paper, I would like to use the following quote as being representative of all of the negative aspects associated with our use of the tools of electronic media technology, while also underscoring the importance of a thoughtful and enlightened response to the issues discussed in this paper - On June 23, 1950, five years after the end of World War II and at the dawn of modern electronic media technology, the German Bundestag, equivalent to our House of Representatives, voted [to prohibit] the production and selling of war toys of any kind, [because] “War toys definitely have a war promoting effect, the protection of children constitutes a higher goal than the interests of the toy industry.” It is my belief that a failure to act on the underlying premises proven in this paper concerning the effects that technology can have on our brains and bodies would be detrimental to the cultivation and development of the world’s richest resource and most significant technology: people and their embodied selves.

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Media Resources. When the brain forms memories or learns a new task, it encodes the new information by tuning connections between neurons. MIT neuroscientists have discovered a novel mechanism that contributes to the strengthening of these connections, also called synapses. At each synapse, a presynaptic neuron sends chemical signals to one or more postsynaptic receiving cells. One of the biggest questions in the field of neuroscience is how the brain rewires itself in response to changing behavioral conditions an ability known as plasticity. This is particularly important during early development but continues throughout life as the brain learns and forms new memories. between media. Is the way we process the information we read also changing, depending on the media in which we view text? Naomi Baron (2008) emphasizes the importance of the content of reading as well as the context. The human brain is plastic and reading online is rewiring it. Reading is a learned skill, rather than a genetically inherited one; the human brain has evolved over millennia to interpret symbols or pictures as representative of language (Wolf, 2007). As you read a printed page, "your eyes and brain are converting the print medium into signals you. generation, benefits emerged, largely in the form of knowledge that could then be conveyed more easily and to a wider audience. Wolf writes of early record-keeping efforts: "With each of. It actually changes the brain. That may not come as a surprise. But exactly how that process happens has long been a mystery. Scientists have known that the brain continues to develop through our teenage years. But these experts used to think that those changes stopped once the brain matured. No more. Recent data have been showing that the brain continues to change over the course of our lives. Cells grow. They form connections with new cells. These changes in the brain allow for faster, stronger signaling between neurons as the brain gains new skills. But the best way to speed up those signals is to introduce new information to our noggins slowly. Many students instead try to memorize lots of information the night before a test.