

Featured, Health - *Written by Lianne George on Thursday, November 6, 2008*

Dumbed down

The troubling science of how technology is rewiring kids' brains

Tags: children, Digital Natives, learning disabilities, school, teaching



For almost three decades, the Arrowsmith School, a small Toronto private school housed in a converted mansion on the edge of Forest Hill, has been treating kids with learning disabilities. When its founder, Barbara Arrowsmith Young, developed the school's patented program in the late '70s, it was with a first-hand knowledge of the frustration and stigma of living with cognitive deficits. Growing up, Young struggled with dyslexia. She had difficulties with problem-solving and visual and auditory memory. Finding connections between things and ideas was a challenge, and telling time was impossible—she couldn't grasp the relationship between the big hand and the little hand. Traditional learning programs taught her tricks to compensate for her deficits, but they never improved her ability to think. "I walked around in a fog," she says. But as a young psychology graduate, Young came across the brain maps created by the Russian neuropsychologist Alexander Luria, who studied soldiers who had suffered head wounds. Using these maps, she identified 19 unique learning dysfunctions and the brain regions that control them. Her theory was that a person can transform weak areas of the brain through repetitive and targeted cognitive exercises, and she was right. Today, this notion of brain plasticity—which she intuited three decades ago—is established wisdom in neuroscience.

Over the past decade, the Arrowsmith program has been proven so effective that schools throughout Canada and the U.S. have adopted it. In 2003, a report commissioned by the Toronto

Catholic District School Board found that students' rate of learning on specific tasks like math and reading comprehension increased by 1½ to three times.

These days, though, Young has noticed a new development: increasingly, she's seeing a great many young people having difficulties with executive function, which involves thinking, problem-solving and task completion. "It looks like an attention deficit disorder," she says. "The person has a job or a task and they start doing it but they can't stay oriented to it. They get distracted and they can't get reoriented. When I started using the programs, I really didn't see a lot of this. I would say now, 50 per cent of students walking through the door have difficulty in that area." The second thing she's noticing is more frequent trouble with non-verbal thinking skills. These kids struggle to read facial expressions and body language—which can make dating and friendships, and indeed, most social situations, tricky.

Both of these skill sets relate to areas of the prefrontal cortex, or what Young calls "mental initiative." It's the area of the brain that drives us to go out and investigate the world, she says. When a person has deficits there, it's hard to participate in the world. When they try, a wall comes up.

Young's students face more extreme problems than the average teen, but her observations mirror what neurologists and educators are seeing in the general youth population—those in their 20s and younger, often called Digital Natives. The first to be born into and come of age in the digital age, they use their brains differently than any generation in history. At any given moment—or so the cliché goes—they're wielding an iPod and a cellphone; they're IMing a friend, downloading a Rihanna video from iTunes, and playing Resident Evil 4 with their thoughts. And that cartoonish caricature isn't that far off: a study from the California-based Kaiser Family Foundation found that young people absorb an average of 8½ hours of digital and video sensory stimulation a day. By the age of 20, the average teen has probably spent more than 20,000 hours on the Web, and over 10,000 playing video games, according to Toronto-based business strategist Don Tapscott's new book *Grown Up Digital: How the Net Generation is Changing Your World*.

The average youth brain is accustomed to a continuous bombardment of information bites. And in the process of navigating so much frenetic brain activity, kids are rewiring their brains, customizing them for speed and multi-tasking. But in reinforcing the neural pathways for these skills, some neuroscientists suspect they've been suppressing others—creating the very kinds of problems, albeit in a subtler form, teachers are seeing at the Arrowsmith School.

Every new technology—from books to television—has brought with it fears of a resulting mind-melt. The difference, in the case of digital technologies, says Dr. Gary Small, a renowned neuroscientist at the University of California, Los Angeles, is the unprecedented pace and rate of change. It is creating what he calls a "brain gap" between young and old, forged in a single generation. "Perhaps not since early man first discovered how to use a tool," Small writes in his new book, *iBrain: Surviving the Technological Alteration of the Modern Mind*, "has the human brain been affected so quickly and so dramatically."

Earlier this year, Small and his colleagues devised an experiment to determine what the adult brain looks like on Google. Using fMRI imaging, they studied the brains of two types of computer users —"savvy" ones who've spent lots of time online, and "naive" ones who've spent

virtually none—as they conducted simple Web searches. Among the savvy users, they observed plenty of activity in the dorsolateral area of the prefrontal cortex, a region associated with decision-making, integrating complex information and short-term memory. In the naive users this area of the brain was quiet. For five days, one hour a day, both groups repeated the simple exercise. On day five, the savvy group’s brain looked more or less the same. But in the naive group, something amazing had happened: as they searched, their circuitry sprang to life, flashing and thundering in exactly the same way it did in their tech-trained counterparts.

“Five hours on the Internet, and the naive subjects had already rewired their brains,” Small marvels. The experiment serves to highlight how quickly the brain can be trained. But while Digital Immigrants—those over 30, who came to the Web with brains fully formed—can acquire attributes of the New Brain, becoming quite proficient, the impact is limited because their early wiring was different.

Teenagers’ brains are much more vulnerable. There’s a reason we don’t let 14-year-olds vote or drive or drink vodka, and it goes beyond their apparent physical or emotional maturity. “Normal” adolescent cognitive development follows a certain arc. During the teen years, empathy skills (the amygdala region in the temporal lobe) and complex reasoning skills (the frontal lobe) are not yet fully developed. This is why, physiologically anyway, teens are predisposed to being self-centred, seeking instant gratification and not being able to always put themselves in others’ shoes—an attribute they develop over time, through social contact.

But brain scientists are speculating that too much technology may get in the way of normal frontal lobe development and stunt this maturation process—ultimately freezing them in teen brain mode. A controversial 2002 study out of Tokyo’s Nihon University found that the more time teens spend playing video games, the more they suppress key areas of the frontal lobe associated with learning, memory, emotion and impulse control. The study’s author, Dr. Akio Mori, a cranial nerve specialist, says chronic players—identified as those who play two to seven hours a day—can sometimes develop what he calls “video game brain,” a condition that essentially turns off the frontal lobes, even when kids aren’t gaming. In other words, because their brains are still maturing, an excessive amount of stimulation in one area can literally leave them lopsided.

And so the so-called brain gap is not just about intergenerational name-calling (although there is some of that going on, too). Instead, it’s about what the human brain of the future will look like—and whether or not we’re making good cognitive trades. “Are we developing a generation with underdeveloped frontal lobes—unable to learn, remember, feel, control impulses,” asks Small, “or will they develop new advanced skills that poise them for extraordinary experiences?”

In *Grown Up Digital*, one of several new books that explore this question, Tapscott takes the optimistic view. He sees young people using technology to develop ingenious and hyper-efficient new ways of finding, synthesizing and communicating information. New technologies present Digital Natives with “a giant opportunity,” Tapscott writes, “an opportunity to fulfill their intellectual potential and be the smartest generation ever.”

And if we understand intelligence as the ability to react quickly to visual stimuli, sift through large amounts of information, and decide, quickly, what’s useful and what isn’t, then he’s right; Digital Natives are miles ahead. Studies have shown that regular use of the Internet, video games

and other digital technologies can even improve these cognitive abilities in adults. Groups from the military to laproscopic surgeons have turned to video game training to improve their peripheral vision and reaction time, and reduce error. Some brain scientists believe technological facility has contributed to the Flynn effect—the phenomenon that has seen young people’s IQ test scores climb steadily every decade since the Second World War.

But the important question we have to ask ourselves, according to Dr. Michael Merzenich, an international expert in brain plasticity and co-founder of San Francisco-based brain fitness company Posit Science, is this: if I’m spending lots of time doing these sorts of online activities, what am I not doing? Am I not reading a book (engaging the hippocampus, involved in learning and remembering)? Am I having fewer face-to-face interactions (engaging the area linked to empathy skills, the amygdala region)? “What are the cognitive tasks we’re ignoring?” he asks. “And what are the consequences of not doing those things?”

As techno-skeptics are quick to point out, among the great paradoxes of modern life is that people have more information at their fingertips than at any other time in history, and yet we’ve never known less. Examples of just how little the average person knows abound. Last year, Ipsos Reid and the Dominion Institute conducted a survey comparing what Canadians know now to what we knew in 1997. The results were dismal: 10 years ago, 72 per cent of us could name all four political parties then represented in Parliament. Last year, only 38 per cent could.

In *The Dumbest Generation*, Mark Bauerlein has compiled a host of such studies and reports to build his case that “kids today” are the dumbest ones ever despite a wealth of external resources. Bauerlein, an English professor at Emory University, says that compared to previous generations of students, “they don’t know any more history or civics, economics or science, literature or current events. They read less on their own, both books and newspapers, and you would have to canvass a lot of college English instructors and employers before you found one who said that they compose better paragraphs.”

Does this matter? Or is it Old Brain thinking? In *Grown Up Digital*, Tapscott writes: “It’s not what you know that counts anymore; it’s what you can learn.” Until now, he says, “the educational model was to cram as much knowledge into your head as possible to build up your inventory of knowledge before you entered the world of work where you could retrieve that information when needed.” Now, information becomes obsolete quickly—and because it’s always retrievable at the click of a mouse, a well-educated person is not necessarily one who stores great amounts of knowledge, but rather one who knows where to find what he needs when he needs it.

The problem, Merzenich says, is that memory is a crucial part of learning. “It’s only when your memory is engaged in the learning process that your brain is really challenged,” he says. “It’s when I’m dealing with the details and really struggling with it that I learn it.” In other words, the more we depend on machines to do our thinking for us, the less we’re able to rely on our own mental resources. While we’ve always engaged in some forms of mental outsourcing—jotting down a grocery list so you don’t forget to buy milk, say—the extent to which we now depend on computers and other digital devices to find, store, analyze and communicate information for us is unprecedented.

The mental shortcuts the Web lets us take, in other words, aren't always a good thing. A study of how we read online, conducted by Nielsen Norman Group, a consulting firm headquartered in California, found that only 16 per cent of subjects read text linearly online, word by word, sentence by sentence. Tracking their eye movement, Neilson found that users scan pages quickly, jump around, fixate on key words and phrases that interest them, and pass over the rest. In this sense, the Web promotes cut-and-paste learning. "It allows us on some level to be intellectually lazy," Young says, "because that's what's out there on the Internet—other people's information, pre-thought, pre-digested."

All of this is why Bauerlein insists his English classes memorize poems. "The students groan," he says, "but acquiring information means you store it in your mind. You think it through and you remember it. That's a slow reading pattern, a slow analysis process."

It's a very different process from the one involved in mental multi-tasking—having five applications open on your computer, with a cellphone standing by. By necessity, our attention in this mode is shallow and diffuse. Small and others call it "continuous partial attention," and it turns out to have costs of its own. "When paying partial continuous attention, people may place their brains in a heightened state of stress," Small says. "They no longer have time to reflect, contemplate or make thoughtful decisions. They exist in a sense of constant crisis—on alert for a new contact or bit of exciting news or information at any moment."

The brain isn't built for this sort of protracted strain and eventually, over the course of hours, a condition sets in which Small calls "brain fog." "Over time," he says, "[it can] actually impair cognition, lead to depression, and alter the neural circuitry in the hippocampus, amygdala, and prefrontal cortex—regions in the brain that control mood and thought. Chronic and prolonged techno-brain burnout, which we are all good candidates for, can even reshape the underlying brain structure." Without the continual mental rewards that accompany interactivity, it becomes hard to hold the attention of someone with perpetual, low-grade brain strain.

Not surprisingly, one-third of Digital Natives, according to Small, use other media—particularly the Internet—to stave off boredom while they're watching TV. Reading a book is even harder. "Why spend time staring at a dull and stagnant string of words," he writes, "when they could be entertained and informed with fast-paced visual and auditory computer images instead?" In fact, Bauerlein believes it's partly students' discomfort with single-focus learning that's created a generation of bibliophobes. In 2004, as director of research and analysis with the National Endowment of the Arts, he was involved in the report that found that leisure reading across all age groups had dropped significantly over 20 years in the U.S.; the biggest drop was among young people ages 18 to 24. In 2002, only 43 per cent voluntarily read anything outside of school, down from 60 per cent in 1982.

"They are entirely averse to books," he says. "The percentage of them that read more than four books in a year on their own time—and this includes Harry Potter, romance novels, sports books, anything—it's only 25 per cent. And 25 per cent of them don't read any books. And these are the best kids, not the ones who don't go to college or who drop out."

Of course, this implies that previous generations were reading Dostoevsky in their free time and not watching Happy Days. But the point is not that Digital Immigrants necessarily read more Dostoevsky, it may be that more of them had the mental capacity to get through it if they so

chose. Reading is something you need to practise doing, and Bauerlein says Digital Natives simply don't get enough practise slogging their way through difficult texts, particularly as more technology is integrated into classroom learning. "It's a big modern problem," says Merzenich. "Getting through an actual book requires a certain level of persistence. It's a long-term attention to something in which the rewards are maybe not coming every two seconds."

This is true of writing, too. James Côté, a professor of sociology at the University of Western Ontario and co-author of *Ivory Tower Blues: A University System in Crisis*, argues that the university essay is barely worth assigning anymore—even though the investigative skills and in-depth critical thinking skills it teaches are as relevant as ever. Students just can't do it, he says—their language skills are depleted, they are indiscriminate with source information, they have a hard time focusing on things for too long, and they don't particularly care to improve. As a teacher, it's demoralizing. "In the old technique of assigning the essay, the student would pick the topic, they would go to the library to research it to determine if it's a topic you can actually write something about," he says. "Now most students can't pick a topic. If you tell them what to do—okay, here's a selection of three topics, pick one—they can do it, but on their own, most cannot come up with a topic that they can write meaningfully about."

Technophiles say what we're losing in memory we're gaining in productivity. Every time we don't have to memorize a phone number or take a trip to the library to research, we're freeing up our brains for other tasks. But what other tasks? And are we even doing them? Studies tell us multi-tasking itself is a myth. We expend valuable time and energy transitioning from one interface to another. A recent study of Microsoft employees found that each time they responded to an email or instant message, it took them 15 minutes to return to the work they were doing.

All of the things that technology was supposed to make us better at—communicating, understanding, doing many things at once—we're doing worse. Even though Google will always be there to provide us with answers in a pinch, Merzenich says, "I still have to believe that the invention, the creativity, these fabulous human assets, are absolutely dependent upon having rich resources and content in our very own brains." The alternative would be to argue that we don't need to be intelligent anymore because we've got machines. "Is that what we want?" he asks. "Is our goal to create a brainless society?"