

Is the internet making you stupid? - Find it hard to sit still and read a book? Unable to concentrate? Feel overloaded and at the mercy of your e-mail? The internet is not only changing the way we behave, argues Nicholas Carr, but also the way we think - rewiring our brains, with disastrous consequences

(Carr, 2011)

Over the past few years I've had an uncomfortable sense that someone, or something, has been tinkering with my brain, remapping the neural circuitry, reprogramming the memory. My mind isn't going - as far as I can tell - but it's changing.

I'm not thinking the way I used to think. I feel it most strongly when I'm reading. I used to find it easy to immerse myself in a book or a lengthy article. My mind would get caught up in the twists of the narrative or the turns of the argument and I'd spend hours strolling through long stretches of prose. That's rarely the case anymore. Now my concentration starts to drift after a page or two. I get fidgety, lose the thread, begin looking for something else to do. I feel as though I'm always dragging my wayward brain back to the text. The deep reading that used to come naturally has become a struggle.

I think I know what's going on. For more than a decade now I've been spending a lot of time online. The web's been a godsend to me as a writer. Research that once required days in the stacks or periodical rooms of libraries can now be done in minutes. Even when I'm not working I'm as likely as not to be foraging in the web's data thickets.

The net has become my all-purpose medium, the conduit for most of the information that flows through my eyes and ears and into my mind. The advantages of having immediate access to such an incredibly rich and easily searched store of data are many, and they've been widely described and duly applauded. "Google," says Heather Pringle, a writer with *Archaeology* magazine, "is an astonishing boon to humanity, gathering up and concentrating information and ideas that were once scattered so broadly around the world that hardly anyone could profit from them."

The boons are real. But they come at a price. What the net seems to be doing is chipping away my capacity for concentration and contemplation. Whether I'm online or not, my mind now expects to take in information the way the net distributes it: in a swiftly moving stream of particles. Once I was a scuba diver in the sea of words. Now I zip along the surface like a guy on a jet ski.

Maybe I'm an aberration. But it doesn't seem that way. When I mention my troubles with reading to friends, many say that they are suffering from similar afflictions. All things considered, though, they say, the benefits they get from using the net make up for the loss of their ability to sit still and turn the pages of a book or a magazine. For some people, the very idea of reading a book has come to seem old-fashioned,

maybe even a little silly - like sewing your own shirts or butchering your own meat. In 2008 a research and consulting outfit called nGenera released a study of the effects of internet use on young people. The company interviewed about 6,000 members of what it calls "Generation Net" - kids who have grown up using the web. "Digital immersion," the lead researcher wrote, "has even affected the way they absorb information. They don't necessarily read a page from left to right and from top to bottom. They might instead skip around, scanning for pertinent information of interest."

In a talk at a recent Phi Beta Kappa meeting, Katherine Hayles, a professor at Duke University, North Carolina, confessed: "I can't get my students to read whole books anymore." Hayles teaches English; the students she's talking about are students of literature.

People use the internet in all sorts of ways. The net has become essential to their work, school or social lives and often to all three. There are, of course, people who don't use the internet at all, either because they can't afford to or because they don't want to. What is clear, though, is that for society as a whole the net has become the communication and information medium of preference. The scope of its use is unprecedented, even by the standards of the mass media of the 20th century. The scope of its influence is equally broad.

By choice or necessity, we have embraced the net's uniquely rapid-fire mode of collecting and dispensing information. We seem to have arrived at an important juncture in our intellectual and cultural history, a moment of transition between two very different modes of thinking. Calm, focused, undistracted, the linear mind is being pushed aside by a new kind of mind that wants and needs to take in and dole out information in short, disjointed, often overlapping bursts - the faster the better.

For the past five centuries, ever since Gutenberg's printing press made book reading a popular pursuit, the linear, literary mind has been at the centre of art, science and society. As supple as it is subtle, it's been the imaginative mind of the Renaissance, the rational mind of the Enlightenment, the inventive mind of the Industrial Revolution, even the subversive mind of Modernism. It may soon be yesterday's mind.

Now comes the crucial question: what can science tell us about the actual effects that internet use is having on the way our minds work? Dozens of studies by psychologists, neurobiologists, educators, and web designers point to the same conclusion: when we go online, we enter an environment that promotes cursory reading, hurried and distracted thinking, and superficial learning. It's possible to think deeply while surfing the net, just as it's possible to think shallowly while reading a book, but that's not the type of thinking that the technology encourages and rewards.

One thing is very clear: if, knowing what we know today about the brain's plasticity, you were to set out to invent a medium that would rewire our mental circuits as quickly and thoroughly as possible, you would probably end up designing something that looks and works a lot like the internet. It's not only that we tend to use the net regularly, even obsessively. It's also that the net delivers precisely the kind of

sensory and cognitive stimuli - repetitive, intensive, interactive, addictive - that have been shown to result in strong and rapid alterations in brain circuits and functions. With the exception of alphabets and number systems, the net may well be the single most powerful mind-altering technology that has yet come into general use. It's certainly the most powerful that has come along since the book.

During the course of a day, most of us with access to the web spend at least a couple of hours online - sometimes much more - and during that time we tend to repeat the same or similar actions over and over again, usually at high speed and often in response to cues delivered through a screen or a loudspeaker. Some of the actions are physical ones. As we go through these motions, the net delivers a steady stream of inputs to our visual, somatosensory, and auditory cortices. The net engages all our senses - except, so far, those of smell and taste - and it engages them simultaneously.

The net commands our attention with far greater insistency than our television or radio or morning newspaper ever did. Watch a kid texting his friends or a college student looking over the roll of new messages and requests on her Facebook page or a businessman scrolling through his e-mails on his BlackBerry. What you see is a mind consumed by a medium.

When we're online we're often oblivious to everything else going on around us. The real world recedes as we process the flood of symbols and stimuli coming through our devices. That's true for everyone, but it is particularly true for the young. Today's teenagers typically send or receive a message every few minutes throughout their waking hours. As the psychotherapist Michael Hausauer notes, teenagers and other young adults have a "terrific interest in knowing what's going on in the lives of their peers, coupled with a terrific anxiety about being out of the loop." If they stop sending messages, they risk becoming invisible.

Our use of the internet involves many paradoxes, but the one that promises to have the greatest long-term influence over how we think is this one: the net seizes our attention only to scatter it. We focus intensively on the medium itself, on the flickering screen, but we're distracted by the medium's rapid-fire delivery of competing messages and stimuli. The net's cacophony of stimuli short-circuits conscious and unconscious thought, preventing our minds from thinking either deeply or creatively.

What we're not doing when we're online also has neurological consequences. Just as neurons that fire together wire together, neurons that don't fire together don't wire together.

Gary Small, a professor of psychiatry at UCLA and the director of its Memory and Aging Centre, has been studying the physiological and neurological effects of the use of digital media. "The current explosion of digital technology not only is changing the way we live and communicate but is rapidly and profoundly altering our brains," he says. The daily use of computers, smartphones, search engines and other such tools "stimulates brain cell alteration and neurotransmitter release, gradually strengthening new neural pathways in our brains while weakening old ones".

Book readers have a lot of brain activity in regions associated with language,

memory, and visual processing, but they don't display much activity in the prefrontal regions associated with decision making and problem solving. Experienced net users, by contrast, display extensive activity across all those brain regions when they scan and search web pages. The good news here is that web surfing, because it engages so many brain functions, may help to keep older people's minds sharp. Searching and browsing seem to "exercise" the brain in a way that is similar to solving crossword puzzles, Small says.

But the extensive activity in the brains of surfers also points to why deep reading and other acts of sustained concentration become so difficult online. The need to evaluate links and make related navigational choices, while also processing a multiplicity of fleeting sensory stimuli, requires constant mental co-ordination and decision making, distracting the brain from the work of interpreting text or other information. Our ability to make the rich mental connections that form when we read deeply and without distraction remains largely disengaged.

Steven Johnson, in his 2005 book *Everything Bad is Good for You*, contrasted the widespread, teeming neural activity seen in the brains of computer users with the much more muted activity evident in the brains of book readers. The comparison led him to suggest that "reading books chronically understimulates the senses". But while Johnson's diagnosis is correct, his interpretation of the differing patterns of brain activity is misleading. It is the very fact that book reading "understimulates the senses" that makes the activity so intellectually rewarding. By allowing us to filter out distractions, to quiet the problem solving functions of the frontal lobes, deep reading becomes a form of deep thinking. The mind of the experienced book reader is a calm mind, not a buzzing one. When it comes to the firing of our neurons it's a mistake to assume that more is better.

There are many possible sources of cognitive overload, but two of the most important, according to John Sweller, an Australian educational psychologist, are "extraneous problem-solving" and "divided attention".

Those also happen to be two of the central features of the net as an informational medium. Using the net may, as Small suggests, exercise the brain the way that solving crossword puzzles does. But such intensive exercise, when it becomes our primary mode of thought, can impede deep learning and thinking. Try reading a book while doing a crossword puzzle; that's the intellectual environment of the internet.

The net is, by design, an interruption system, a machine geared for dividing our attention. Studies of office workers who use computers reveal that they constantly stop what they are doing to read and respond to incoming e-mails. It's not unusual for them to glance at their inbox 30 or 40 times an hour. Since each glance represents a small interruption of thought, a momentary redeployment of mental resources, the cognitive cost can be high.

Psychological research long ago proved what most of us know from experience: frequent interruptions scatter our thoughts, weaken our memory and make us tense and anxious. The more complex the train of thought we are involved in, the greater the impairment the distractions cause.

The near-continuous stream of new information pumped out by the web also plays to our natural tendency to "vastly overvalue what happens to us right now", as the Union College psychologist Christopher Chabris explains. We crave the new even when we know that "the new is more often trivial than essential".

And so we ask the internet to keep interrupting us. We willingly accept the loss of concentration and focus, the division of our attention and the fragmentation of our thoughts, in return for the wealth of compelling, or at least diverting, information that we receive. Tuning out is not an option that many of us would consider.

Websites routinely collect detailed data on visitor behaviour, and a 2008 study found that in most countries people spend, on average, between 19 and 27 seconds looking at a page before moving on. There's nothing wrong with browsing and scanning.

What is different, and troubling, is that skimming is becoming our dominant mode of reading. There are compensations.

Research suggests that certain cognitive skills are strengthened, sometimes substantially, by our use of computers and the net. These tend to involve lower-level, or more primitive, mental functions such as hand-eye co-ordination, reflex response and the processing of visual cues. It would be a serious mistake to look narrowly at the net's benefits and conclude that the technology is making us more intelligent.

Jordan Grafman, head of the cognitive neuroscience unit at the National Institute of Neurological Disorders and Stroke, says that the constant shifting of our attention when we're online may make our brains nimbler when it comes to multitasking but that improving our ability to multitask hampers our ability to think deeply and creatively: "The more you multitask, the less deliberative you become; the less able to think and reason out a problem."

You become, he argues, more likely to rely on conventional ideas and solutions rather than challenging them with original lines of thought.

David Meyer, a University of Michigan neuroscientist and one of the leading experts on multitasking, makes a similar point. As we gain experience in rapidly shifting our attention, we may "overcome some of the inefficiencies" inherent in multitasking, he says, "but, except in rare circumstances, you can train until you're blue in the face and you'd never be as good as if you just focused on one thing at a time." The Roman philosopher Seneca may have put it best 2,000 years ago: "To be everywhere is to be nowhere."

The net is making us smarter, in other words, only if we define intelligence by the net's own standards. If we take a broader and more traditional view of intelligence - if we think about the depth of our thought rather than merely its speed - we have to come to a different and considerably darker conclusion. Given our brain's plasticity, we know that our online habits continue to reverberate in the workings of our synapses when we're not online. We can assume that the neural circuits devoted to scanning, skimming and multitasking are expanding and strengthening, while those used for reading and thinking deeply, with sustained concentration, are weakening or

eroding. In 2009 researchers from Stanford University found signs that this shift may already be well under way. They gave a battery of cognitive tests to a group of heavy media multitaskers as well as to a group of relatively light multitaskers.

They found that the heavy multitaskers were much more easily distracted by "irrelevant environmental stimuli", had significantly less control over the contents of their working memory and were, in general, much less able to maintain their concentration on a particular task. Intensive multitaskers are "suckers for irrelevancy", commented Clifford Nass, the Stanford professor who led the research. "Everything distracts them." Michael Merzenich offers an even bleaker assessment.

As we multitask online, he says, we are "training our brains to pay attention to the crap". The consequences for our intellectual lives may prove "deadly".

The mental functions that are losing the "survival of the busiest" brain-cell battle are those that support calm, linear thought - the ones that we use in traversing a lengthy narrative or an involved argument, the ones on which we draw when we reflect on our experiences or contemplate an outward or inward phenomenon. The winners are those functions that help us to speedily locate, categorise and assess disparate bits of information in a variety of forms, that permit us to maintain our mental bearings while being bombarded by stimuli. These functions are not coincidentally, very similar to the ones performed by computers, which are programmed for the high-speed transfer of data in and out of memory.

The net grants us access to a library of information unprecedented in its size and scope and makes it easy for us to sort through that library-to find - if not exactly what we were looking for - at least something sufficient for our purposes.

What the net diminishes is the ability to know, in depth, a subject for ourselves, to construct within our own minds the rich and idiosyncratic set of connections that give rise to a singular intelligence.

Carr, N. (2011). *The Shallows: How the Internet is changing the way we think, read and remember*. Atlantic Books. [Online]. Available at: <http://www.amazon.co.uk/The-Shallows-Internet-Changing-Remember/dp/1848872275>