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# Our need for web speed: It's about neuroscience, not entitlement

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It was inevitable.

In the past couple of weeks, web performance has gotten a lot of mainstream attention. The New York Times published an excellent piece about **why 250 milliseconds is enough to give a site an advantage over its competitors** [http://www.nytimes.com/2012/03/01/technology/impatient-web-users-flee-slow-loading-sites.html]. Mashable featured a set of infographics showing, among other things, that **one in four internet users abandon a page that takes more than 4 seconds to load** [https://mashable.com/2012/03/14/slow-website-stats-infographic/]. And Fast Company dove a little deeper into these infographics in their coverage, focusing on stats like the fact that **a 1-second page slowdown could cost Amazon $1.6 billion in sales each year** [http://www.fastcompany.com/1825005/impatient-america-needs-faster-intertubes].

Any time an idea goes mainstream, there's always a backlash. It's no surprise, then, that web performance has attracted some naysayers. When you read some of these articles, there's a recurring theme in the reader comments, ranging from the cranky…

> *People can't stand to wait anymore for anything. Now it's milliseconds that drive people nuts. To quote a certain big, tough TV star of years past, "I pity these fools".*

To the zen…

> *Nobody likes to wait. Yet patience is an inner order, a form of power that needs developing, nurturing, sustaining.*

To the really cranky…

> *Oh… pity the hyper-impatient web generation. Such busy lives with so many important things to do — like post the latest drivel onto their Facebook pages or download the You Tube viral video of the day. Oops sorry — of the minute.*

In short, some folks are saying that we should suck it up and be happy with the web speed we have. I'm all for developing patience and other inner virtues, but it's not that simple.

In his comment on this post, Michael Howell summed up the situation precisely:

*Why oh why are these sites being flooded with people complaining about sites taking minutes to load, and others decrying the downfall of patience?* ***This is about neuroscience and rhythm, not entitlement and overt frustration.***

The human factors side of web performance is one of my favourite topics. It seems like a good time to give an overview of exactly why we crave faster pages.

## Slow pages cause “web stress”: increased agitation and poorer concentration

A 2010 study at Glasgow Caledonian University found that slowing down web pages during an online transaction led to increased agitation and poorer concentration in the study’s participants. The participants wore an EEG (electroencephalography) cap to monitor their brain wave activity. The experiment also used EOG (electrooculograph) technology to track eye movements and facial muscle movements. Participants completed tasks using either a 5Mb web connection, or a connection that had been artificially throttled to 2Mb.

Brain wave analysis from the experiment revealed that **participants had to concentrate up to 50% more when using badly performing websites**. EOG technology and behavioral analysis of the subjects also revealed greater agitation and stress in these periods.

## Why the stress? Basically, it’s because our short-term memory sucks.

Usability guru Jakob Nielsen states that human responses to poor load times is, in a large part, due to our poor short-term memory. Information stored in our short-term memory decays quickly, which is why we don’t perform as well when we have to wait, even for just a few seconds. And after 10 seconds? You can pretty much forget about it. Literally.

But why is this? This is where things get really interesting.

At any given moment, there are three basic types of memory processing at work in your brain:

- Sensory memory
- Short-term memory
- Working memory

There's also long-term memory, but it doesn't really come into play here. So first up, let's look at sensory memory…

## Sensory memory: Your occipital lobe (AKA "the memory store") works in 100ms bursts.

Every time you see something, this visual information is taken in by photoreceptor cells in your eyes and then sent to the occipital lobe in your brain. This is called the "iconic memory", which is just one of our three types of sensory memories. (The other two govern sound and touch.)

People have been studying how iconic memory works for almost 300 years. In one of the earliest studies, performed in 1740, a glowing coal was attached to a cart wheel and the wheel was rotated faster and faster until observers perceived an unbroken circle of light. The study concluded that the glowing coal had to perform a complete cycle in 100 milliseconds or less in order to achieve persistence of vision. **After 100 milliseconds, the "memory store" runs out.** This number has remained fairly consistent throughout the centuries.

Interestingly, and not coincidentally, 100 milliseconds is Google's stated goal when it comes to page load times.

## We have no control over how our sensory memory works.

Iconic memory, along with the other sensory memories, is primitive. **We can't consciously choose what information is stored in our iconic memory, and we can't will it to last longer.** If we could, we'd probably go crazy or accidentally walk in front of a bus. Some sensory memory does stick, of course, provided it's used quickly and eventually consolidated into the long-term memory.

## Short-term memory and working memory: Working together to keep you from walking in front of a bus.

If our sensory memory's role is to provide comprehensive information on our entire sensory experience, it's our short-term memory's job to extract the relevant bits and throw them into the hopper of our working memory. **Your short-term memory can store information for 10-15 seconds, at most**, enough time for your working memory to process, manipulate, and control it.

So the goal in getting page load times down to 100 millisecond is to keep information from falling through the cracks in our iconic memory, while also giving our short-term and working memory ample time to do all the parsing they need to do before they start losing information.

This is where we get into the idea of "flow".

## Flow: We're hard-wired to perform tasks seamlessly.

Human beings have evolved to perform actions in beautiful, sequential flows. For hundreds of thousands of years, our day-to-day tasks — building a fire, hunting antelope, baking bread, milking a cow — have been a series of minute actions that flow more or less seamlessly into the next. This is hard-wired. **It's only in the past 40 or so years that we've imposed an entirely new way of processing information on our unsuspecting brains.** And simply put: we aren't wired to deal with the fits and starts of human-computer interaction.

## "The doorway effect": Why walking through doors makes us forget, and why this is analogous to using the web.

On the topic of flow, there's an interesting article in Scientific American about why walking through a doorway makes us more forgetful [http://www.scientificamerican.com/article.cfm?id=why-walking-through-doorway-makes-you-forget]. If you've ever walked into a room to do something, only to forget what you were there to do, you'll find this interesting. It's also relevant to online navigation, in my opinion.

**A team of researchers tested their hypothesis using "rooms" in computer games, virtual environments, and real-world environments, and found that the results were consistent: our memories are worse when we enter a new environment through a doorway.** They call this, logically, "the doorway effect" and the Scientific American article sums it up pretty well:

> *"…some forms of memory seem to be optimized to keep information ready-to-hand until its shelf life expires, and then purge that information in favor of new stuff. Radvansky and colleagues call this sort of memory representation an "event model," and propose that walking through a doorway is a good time to purge your event models because whatever happened in the old room is likely to become less relevant now that you have changed venues. That thing in the box? Oh, that's from what I was doing before I got here; we can forget all about that. Other changes may induce a purge as well: A friend knocks on the door, you finish the task you were working on, or your computer battery runs down and you have to plug in to recharge."*

The noteworthy aspect of this study is that the doorway effect persists in computer simulations. **The act of going from virtual room to room is directly analogous to the act of navigating from page to page.** It's easy to conclude that the visual stimulus of watching a page refresh could purge the previous page's "event model".

## Conclusion: In an increasingly networked world, we have two choices.

1. We can speed up the web.
2. We can speed up evolution.

Which sounds easier?

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