



Our need for web speed:

It's about neuroscience, not entitlement.

Introduction: The 100-millisecond goal

The web performance industry is built on the idea that faster websites aren't just nice-to-have — they're need-to-have. Our industry's goal is 100-millisecond load times, which sounds audacious to some. Skeptics feel that pages today are "fast enough" and that any attempt to say otherwise is just a sales gimmick.

We want you to be able to flick from one page to another as quickly as you can flick a page in a book.



SO WE'RE
aiming very, very
HIGH
...at something like
100
MILLISECONDS

Urs Hölzle,
Senior VP Operations, Google

We created this report to illustrate why page speed is crucial for user happiness and online success — whether that success is performing research, completing a transaction, downloading a report, or uploading a photo.



HOW FAST ?
is fast enough ?



57%

of online consumers
WILL ABANDON A



AFTER 3
SECONDS

What is “web stress”?

Slow pages cause “web stress”, agitation, and poor 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.¹

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.



slow websites lead to
WEB STRESS

Studies show that we have to

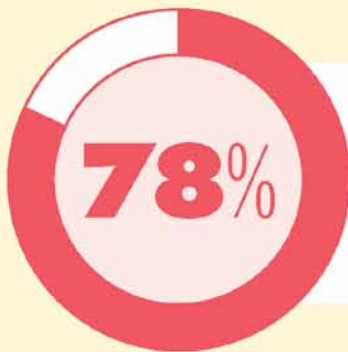
CONCENTRATE UP TO

50% HARDER

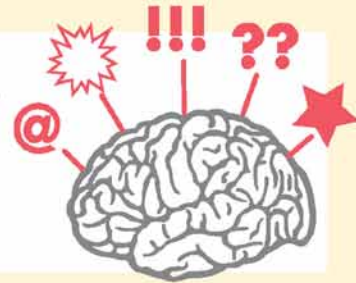
..... when using

SLOW WEBSITES

¹Web Stress: A Wake-Up Call for European Business, Foviance, February 2010



78% of users say they've felt
STRESS OR ANGER
while using a slow website.



44% of users say that slow online
transactions make them
ANXIOUS
about the success of the transaction.



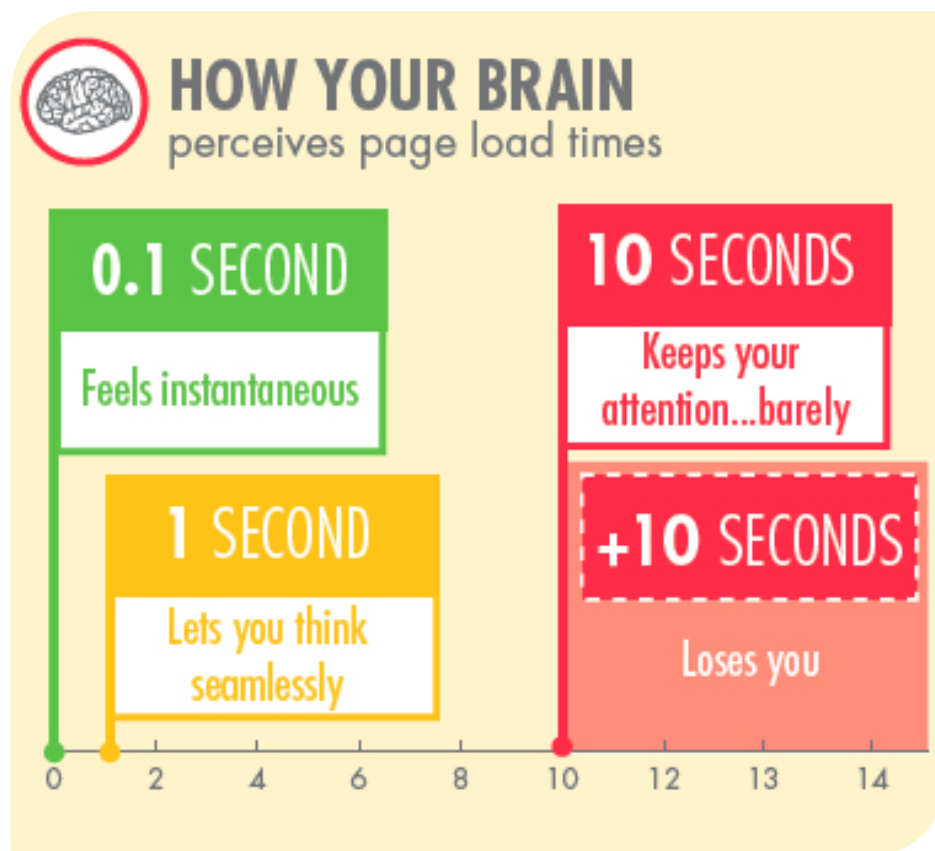
4% of people have
THROWN THEIR PHONE
while using a slow mobile site.



Why the stress?

Blame it on your shoddy short-term memory.

Usability guru Jakob Nielsen tells us that our negative response to poor load times is due to our poor short-term memory.² **Information stored in the 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.



²Website Response Times, Jakob Nielsen, June 2010

This is your brain on a slow website

It's beyond our control...

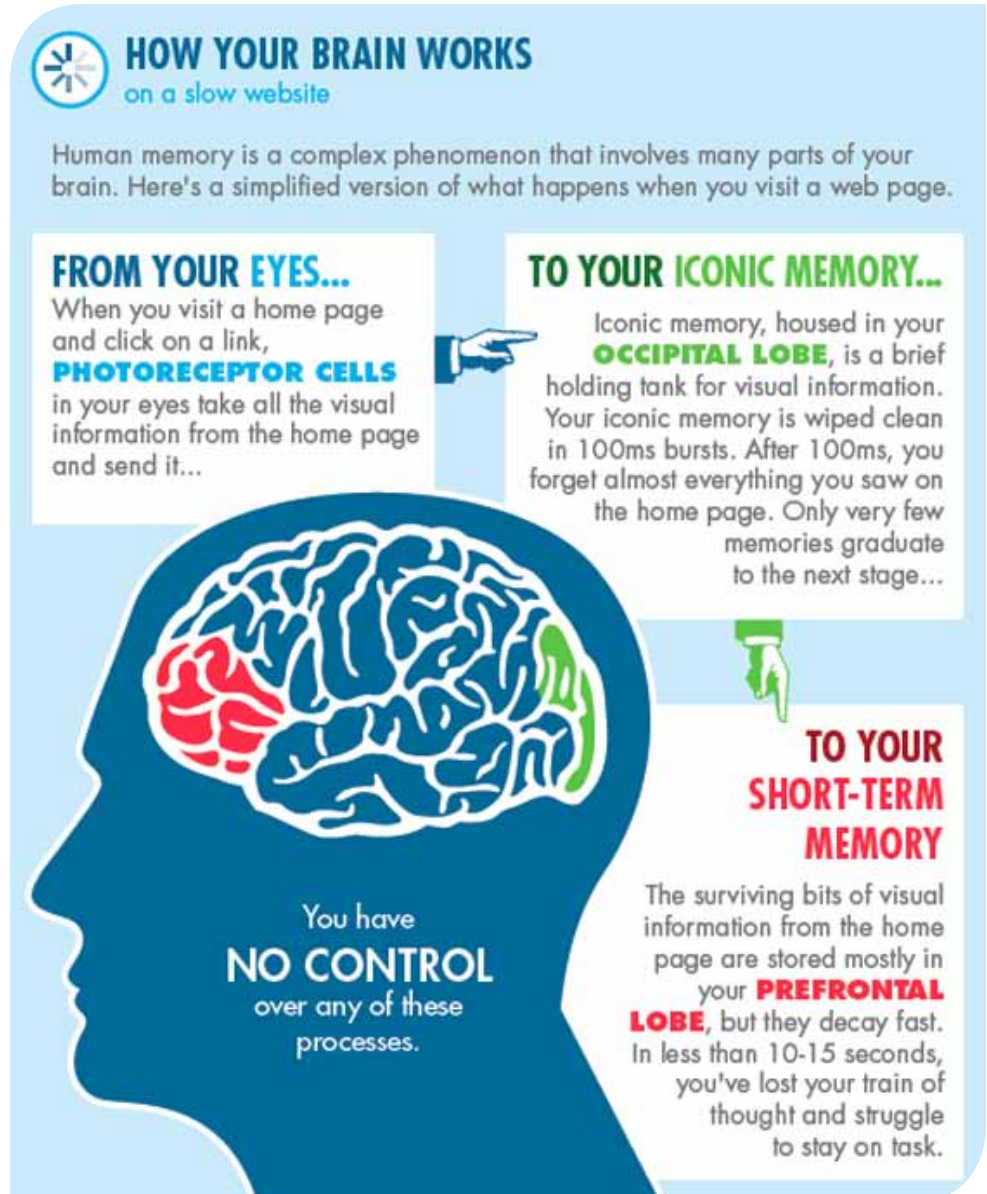
But why do we react so poorly to slow pages? This is where things get really interesting.

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 in this discussion.)

So first up, let's look at sensory memory...



HOW YOUR BRAIN WORKS
on a slow website

Human memory is a complex phenomenon that involves many parts of your brain. Here's a simplified version of what happens when you visit a web page.

FROM YOUR EYES...
When you visit a home page and click on a link, **PHOTORECEPTOR CELLS** in your eyes take all the visual information from the home page and send it...

TO YOUR ICONIC MEMORY...
Iconic memory, housed in your **OCCIPITAL LOBE**, is a brief holding tank for visual information. Your iconic memory is wiped clean in 100ms bursts. After 100ms, you forget almost everything you saw on the home page. Only very few memories graduate to the next stage...

TO YOUR SHORT-TERM MEMORY
The surviving bits of visual information from the home page are stored mostly in your **PREFRONTAL LOBE**, but they decay fast. In less than 10-15 seconds, you've lost your train of thought and struggle to stay on task.

You have **NO CONTROL** over any of these processes.

Sensory memory: Your occipital lobe (AKA “the memory store”) works in 100-millisecond 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.³

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 either go crazy or accidentally walk in front of a bus. Some sensory memory does stick, of course, provided it’s used quickly and is 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 milliseconds 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”...

³Are your website’s performance goals audacious enough?, Web Performance Today, September 2010

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, harvesting crops, 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.

Simply put: we aren't wired to deal with the fits and starts of human-computer interaction.

“The doorway effect”: Why walking through a door — and watching a web page refresh — makes us forget.

On the topic of flow, there's an interesting article in *Scientific American* about why walking through a doorway makes us more forgetful.⁴ 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.

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.”

A noteworthy aspect of this study is that the doorway effect persists in computer simulations. The act of going from virtual room to virtual room is similar to the process of navigating from page to page. **The visual stimulus of watching a page refresh purges, or partially purges, the previous page's “event model”.**

⁴Why Walking Through a Doorway Makes You Forget, *Scientific American*, December 2011

Conclusion

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

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

At Strangeloop, we make web pages faster.

We can't control evolution (if we could, you'd be sporting wings right now), but we can apply our expertise in front-end optimization to your site or web-based application. As the leader in advanced FEO solutions, we accelerate companies like eBay/PayPal, Visa, and PETCO, making pages load up to three times faster for desktop and mobile visitors.

Questions about your website's speed?

Talk to one of our Performance Experts and get answers to all your performance-related questions.

www.strangeloopnetworks.com/talk-to-a-performance-expert