
**This Is Your Brain on
Technology:
Update on The Technology
Exposure Effect**

Deborah A. Gagnon, Ph.D.

Wells College (Aurora, NY)

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- Cognitive Science
 - Brain Science
 - Computer Science
 - Library Science
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Intersectionalities

- Borrowed from sociological theory and cultural studies
 - Synergy
 - Systems are *inter*-dependent, *inter*-related
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Intersectionalities

- The various *information sciences* – computer, cognitive, brain, library – are inter-related and do not act independently of one another, but instead create a functional system that reflects the interaction – or “intersection” -- of multiple sources of influence.
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Technology

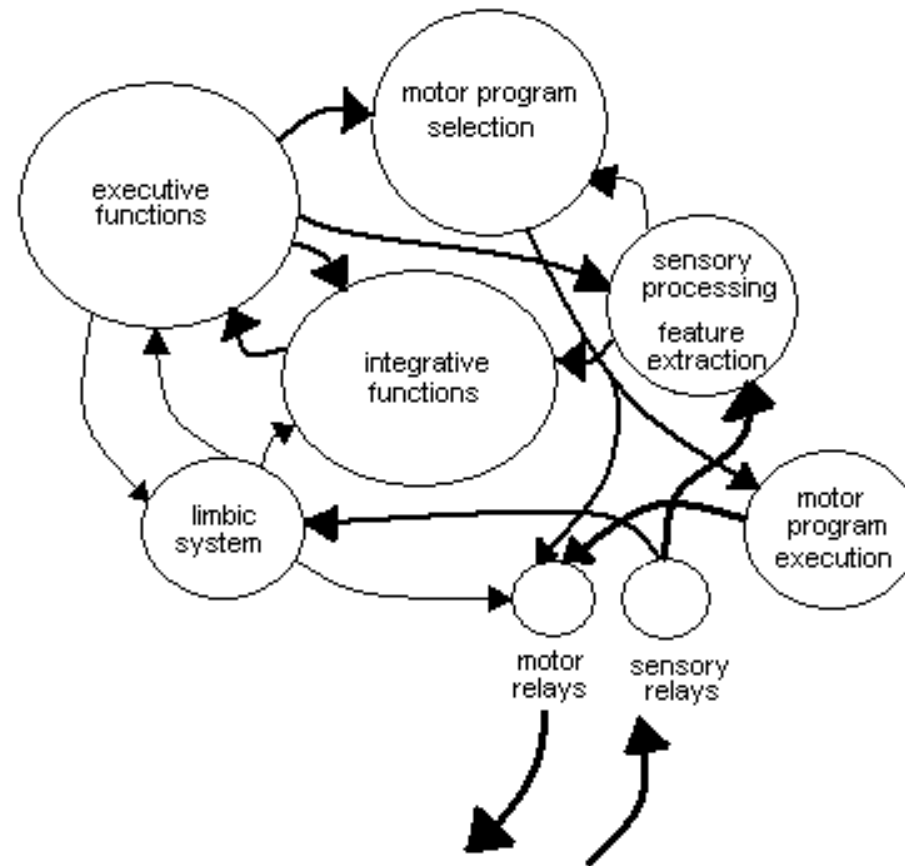
- ...the application of scientific knowledge to the practical aims of human life, or... to the change and manipulation of the human environment
- perhaps to the change of the human organism itself

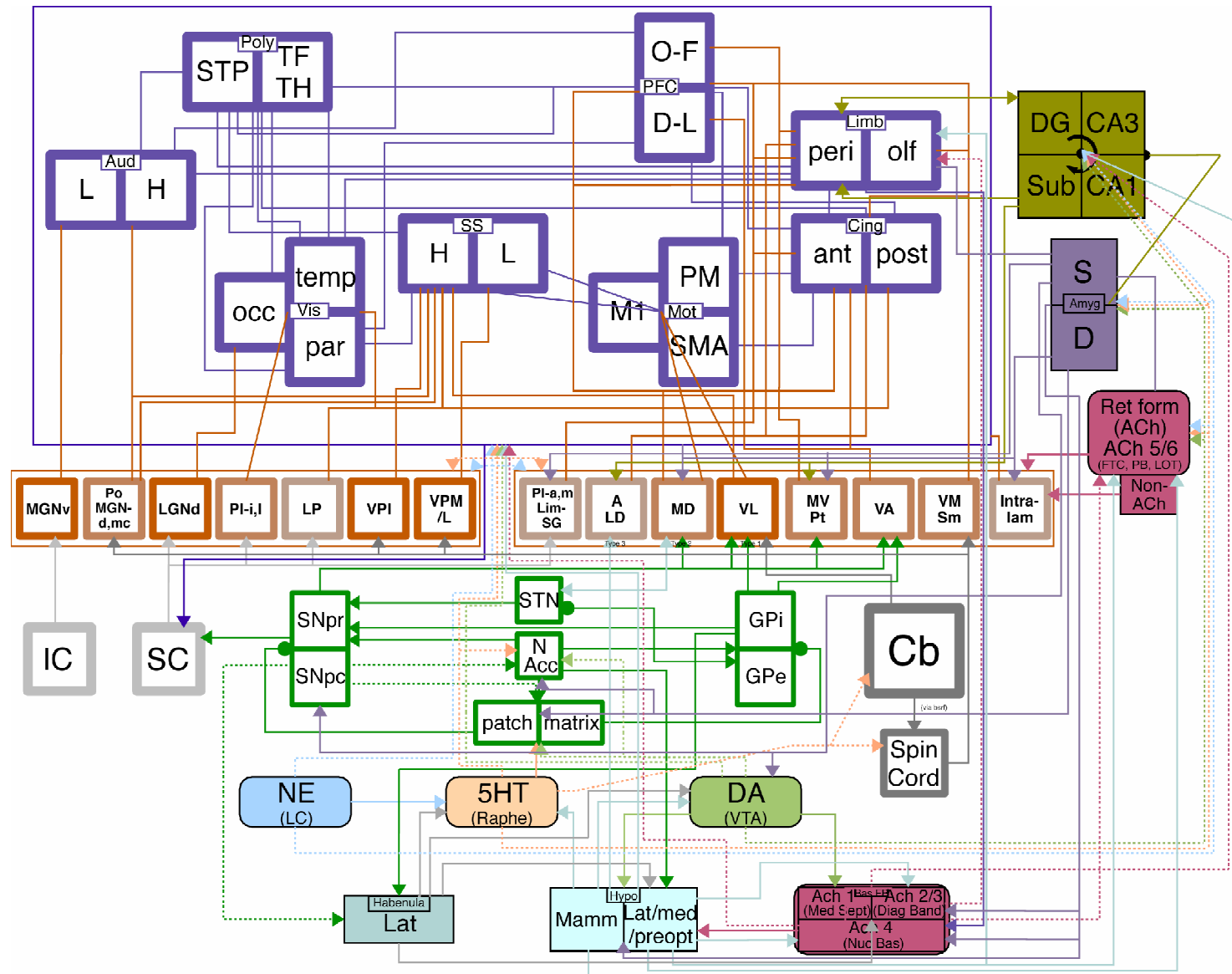
(*Encyclopedia Britannica*; Lawrence, 2011)



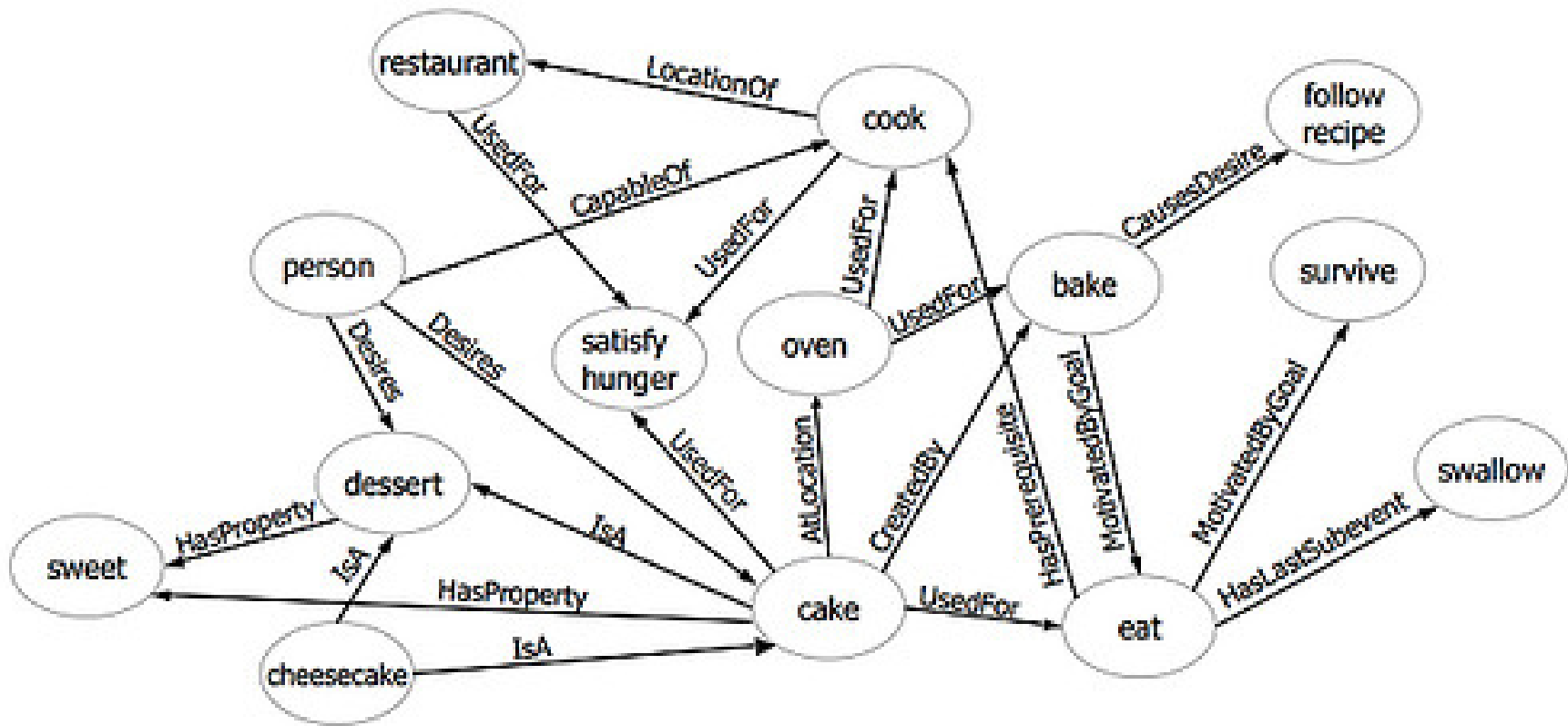
Information

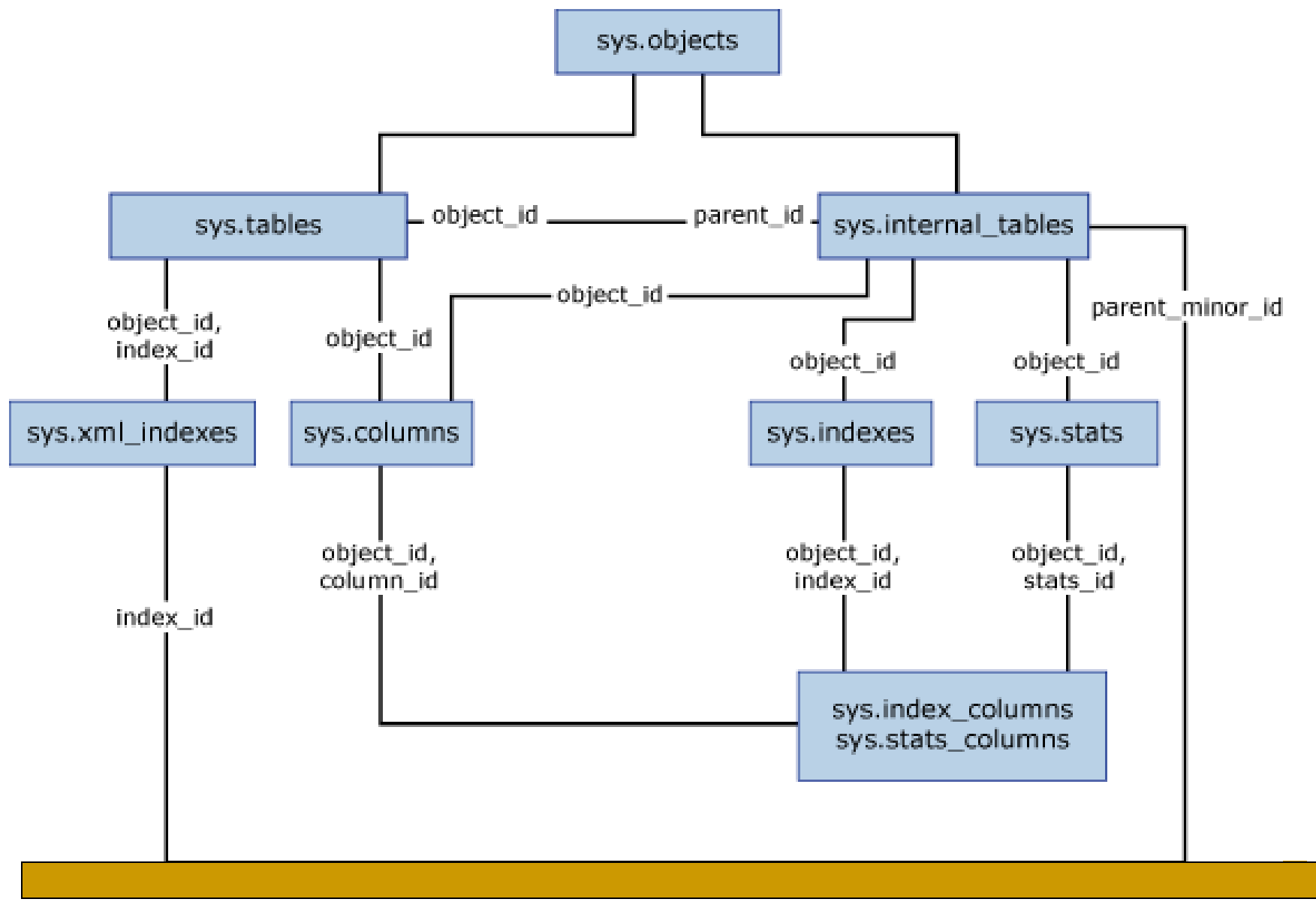
Models: Information Flow





Semantic Networks, Metadata Structures





Terminology

- Interoperability
 - Access
 - Metadata
 - Pruning
 - Acquisition
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Brain, Hardware, Stacks



Does technology have a direct impact
on neural structure and function?

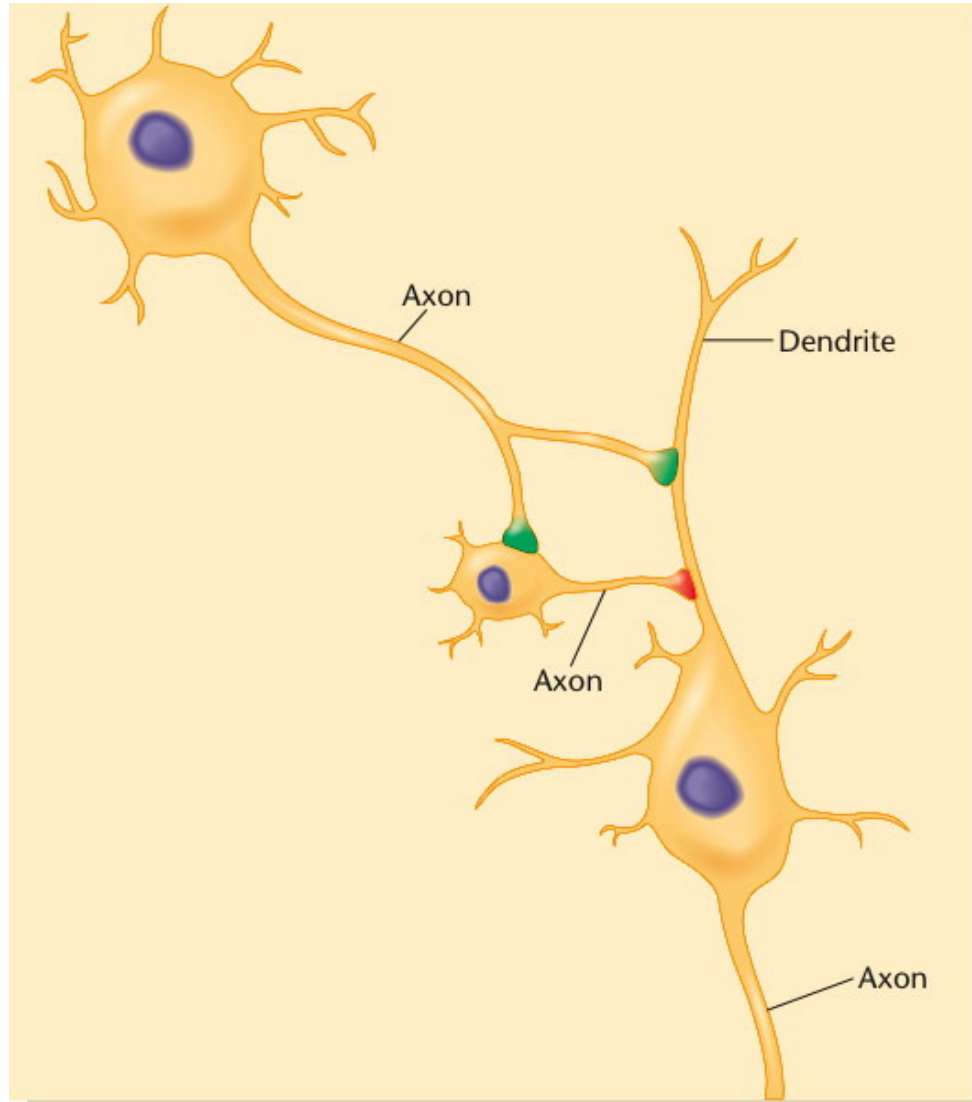
YES!

Plasticity

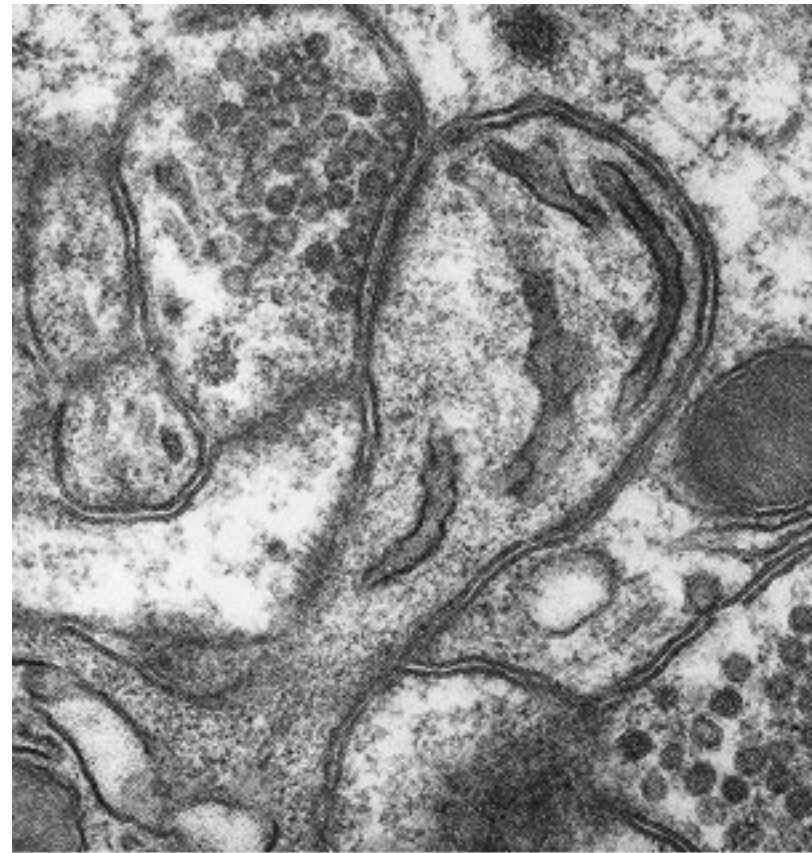
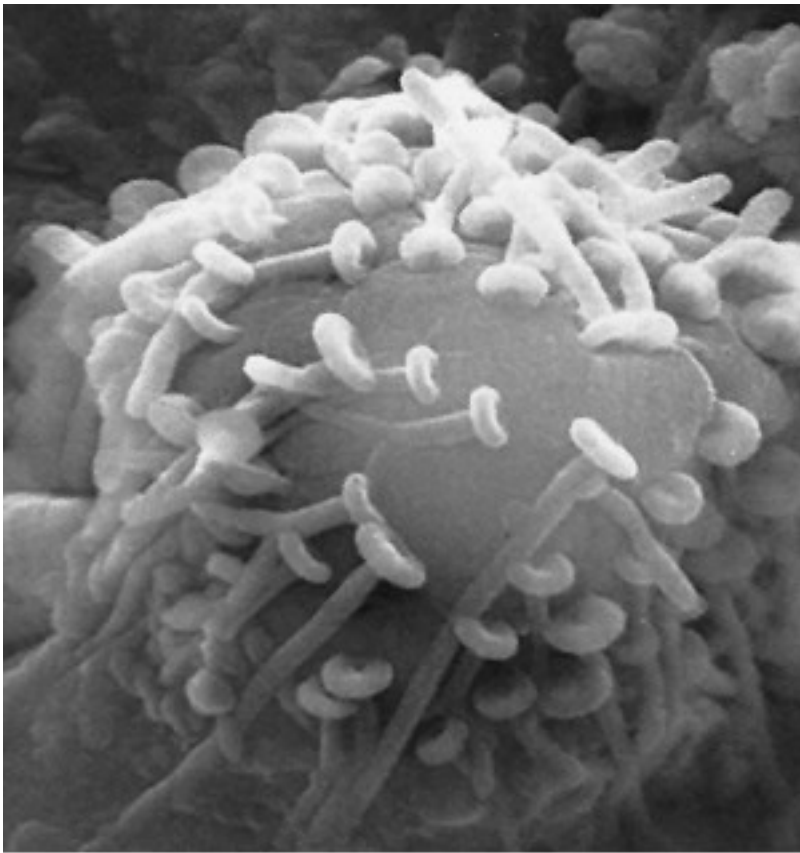
- The brain's ability to adapt to *stimulated* change
- As a function of experience, exposure, learning



Cellular Level



Micron Photographs



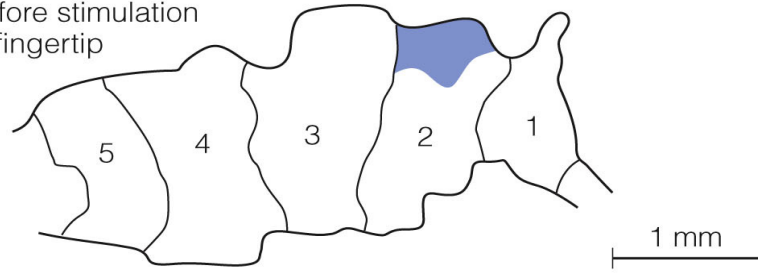
Effect of Exposure



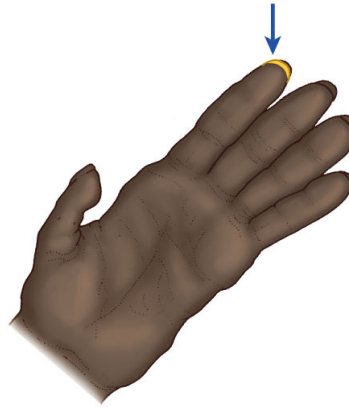
(a)

(b)

Before stimulation
of fingertip

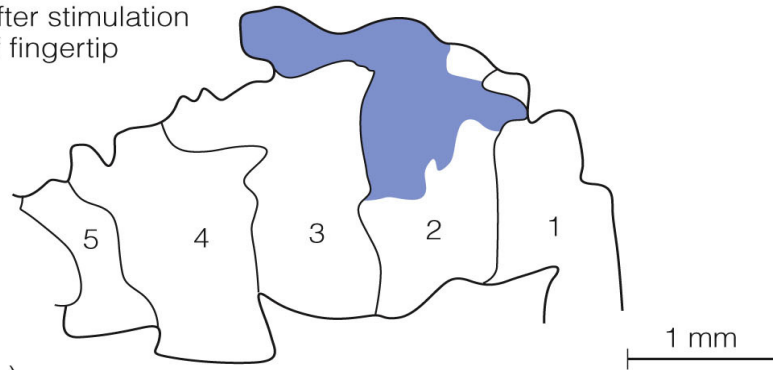


(a)



(b)

After stimulation
of fingertip



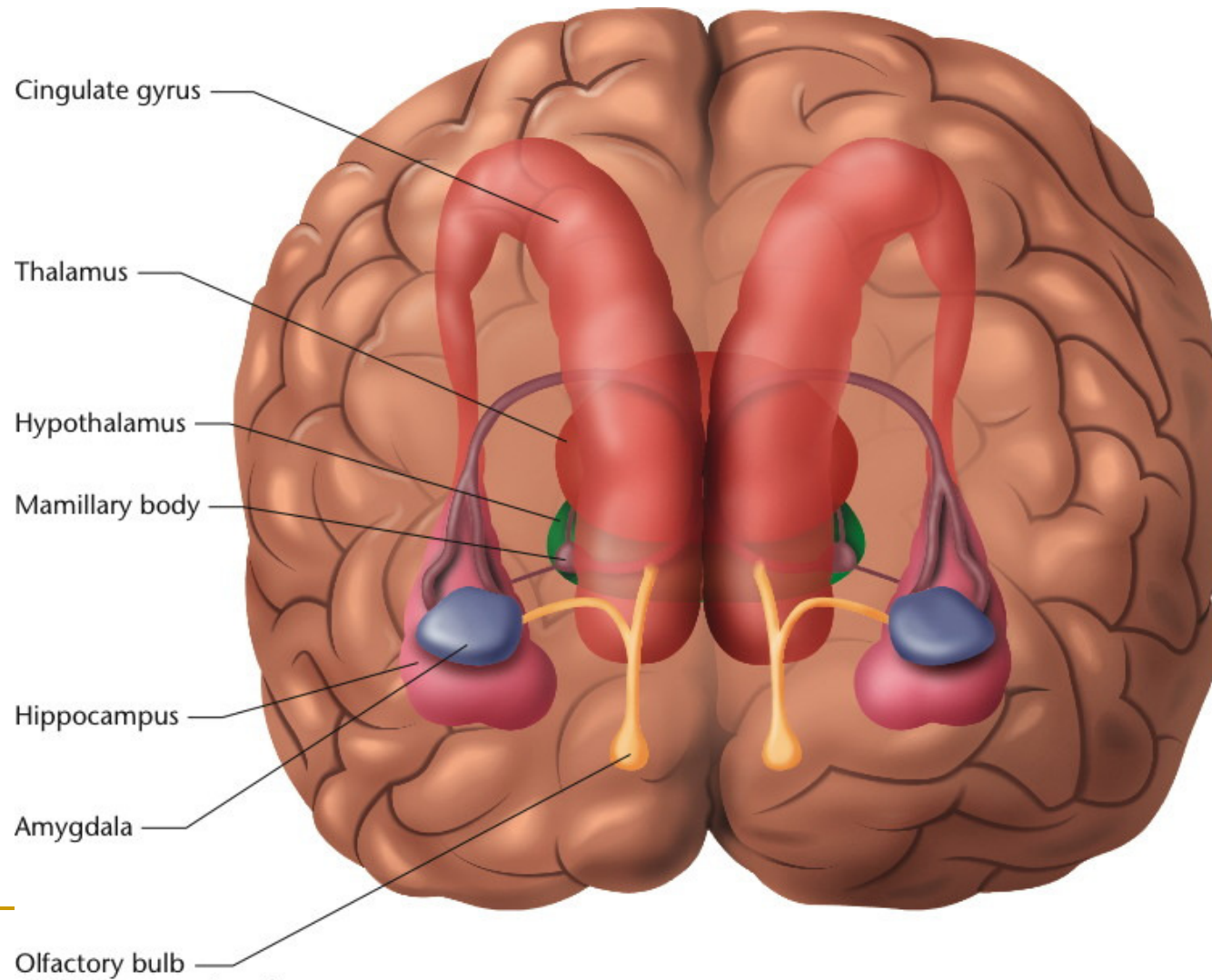
(c)

(Merzenich & Jenkins, 1996)

Can GPS use modify brain structure?



Hippocampus



Iaria, Bogod, Fox, & Barton (2009)

Enlarged posterior hippocampus in London taxi drivers (but at the price of a smaller anterior hippocampus...)

Developmental Topographical Disorientation (DTD)

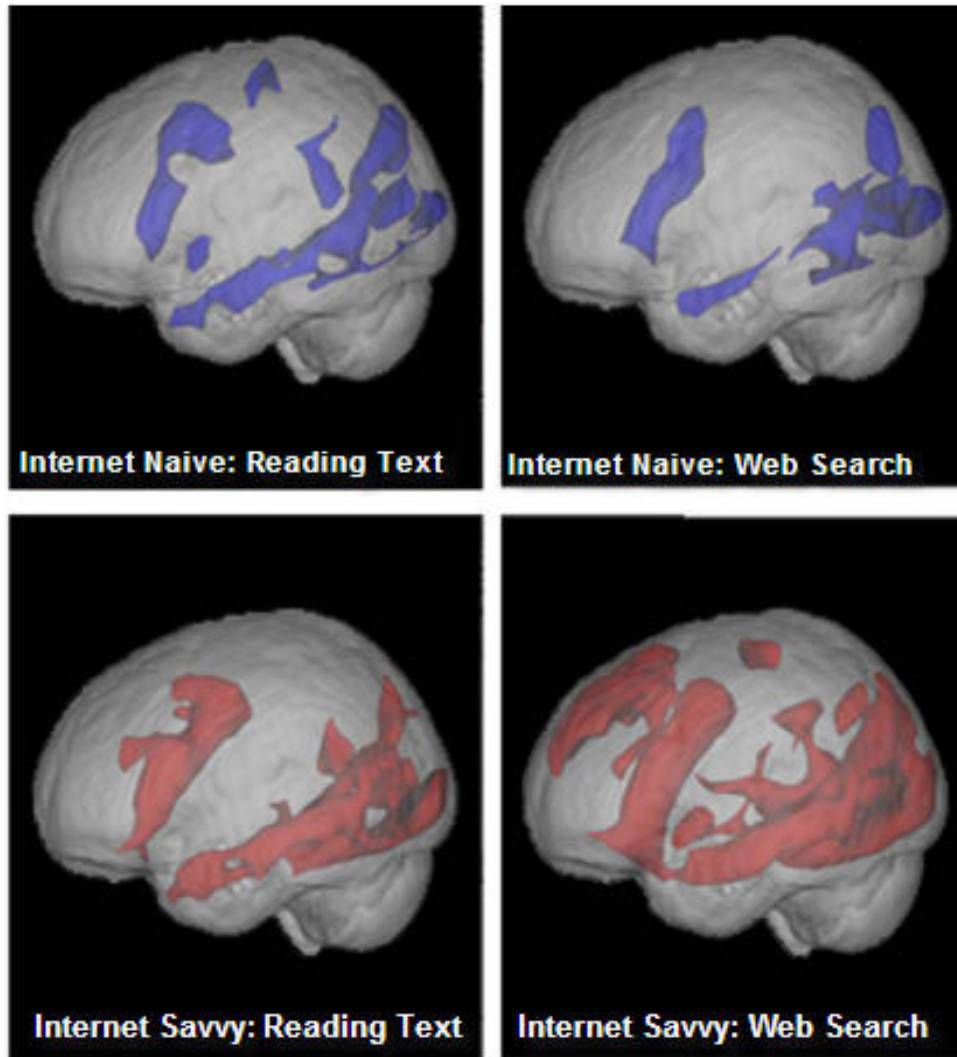
An inability to form cognitive maps despite perfectly fine memory, mental imaging, and intelligence



Acquired Topographical Disorientation (ATD)?

Evidence that GPS use allows one to turn off their hippocampus, literally: We are worse at navigating areas that were GPS-directed for us.

Small, Moody, Siddarth, & Bookheimer (2009)



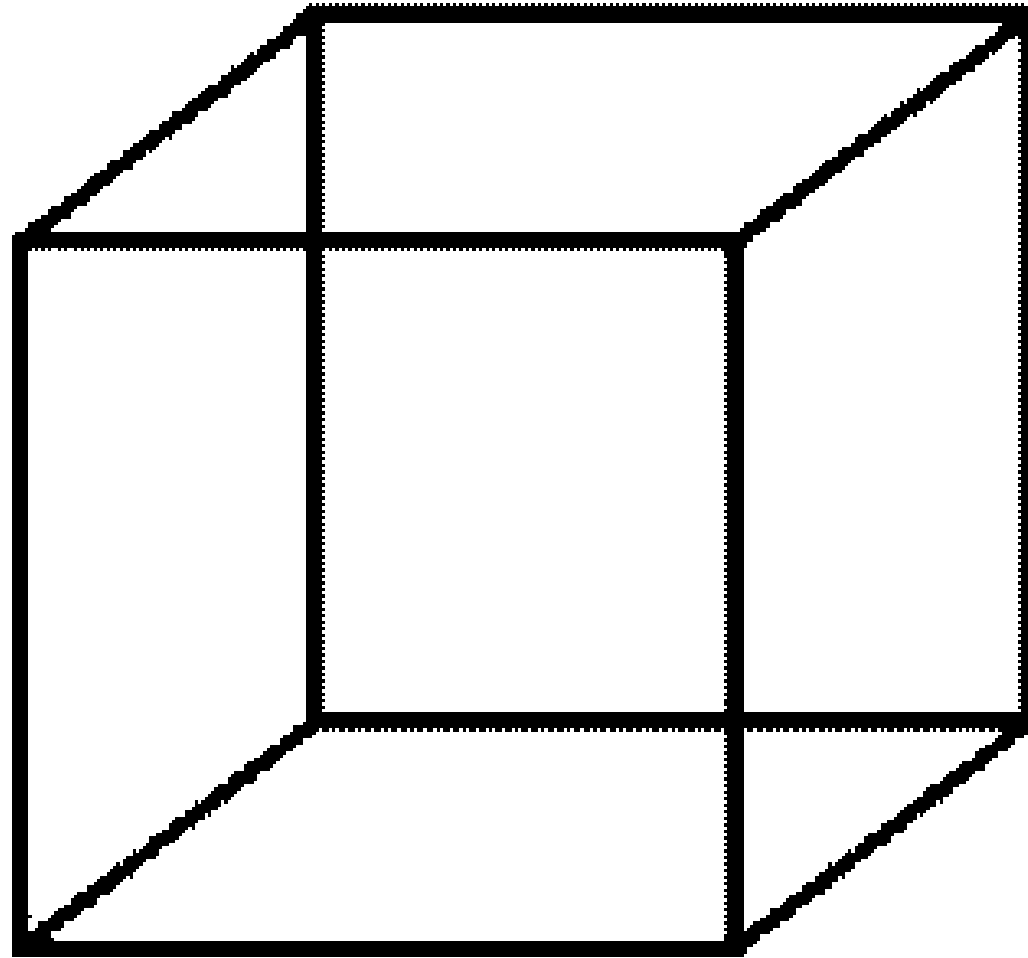
Eye Gaze Tracking

- <http://www.poynterextra.org/eyetrack2004/hp7.htm>
- <http://www.poynterextra.org/eyetrack2004/hp2.htm>

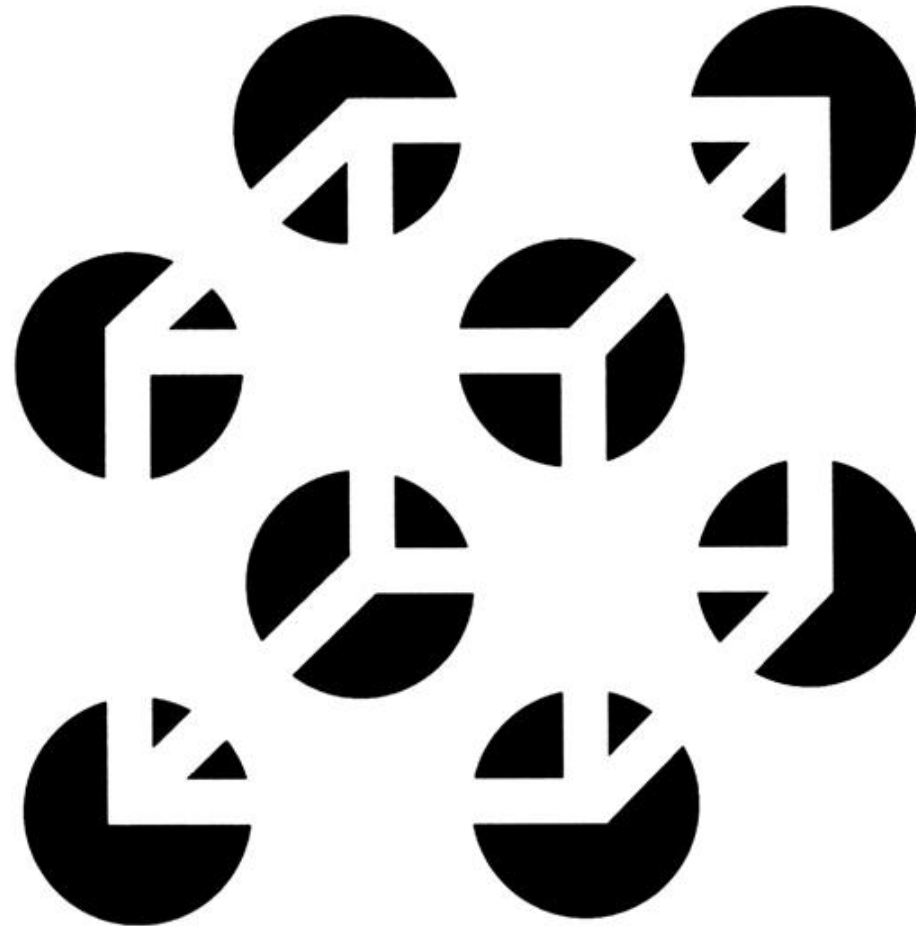
Cognitive Functions

- Perception
 - Pattern recognition
 - Attention
 - Memory
 - Categorization
 - Reasoning
 - Decision making
 - Problem solving
-

Necker Cube



Illusory Necker Cube



Multitasking



Media Multitasking



Credit: Dong Ngo/CNET 8/29/09 CRAVE

Ophir, Nass, & Wagner (2009)

Cognitive Cost to Multitasking:

<http://www.nytimes.com/2010/06/07/technology/07brain.html?src=me&ref=technol>

- Filtering Distractors
- Task Switching



Ophir, Nass, & Wagner (2009)

High multitaskers were worse than low multitaskers in terms of memory, focused attention (ignoring multiple distractors), and task switching

Foerde, Knowlton, & Poldrack (2006)

Digital multitasking makes learning less efficient and the knowledge gained less useful later on

General Conclusion

Empirical studies generally show that multitasking is not something that leads to successful completion of any task unless one of those tasks is *automatic* and requires *no attentional resources*

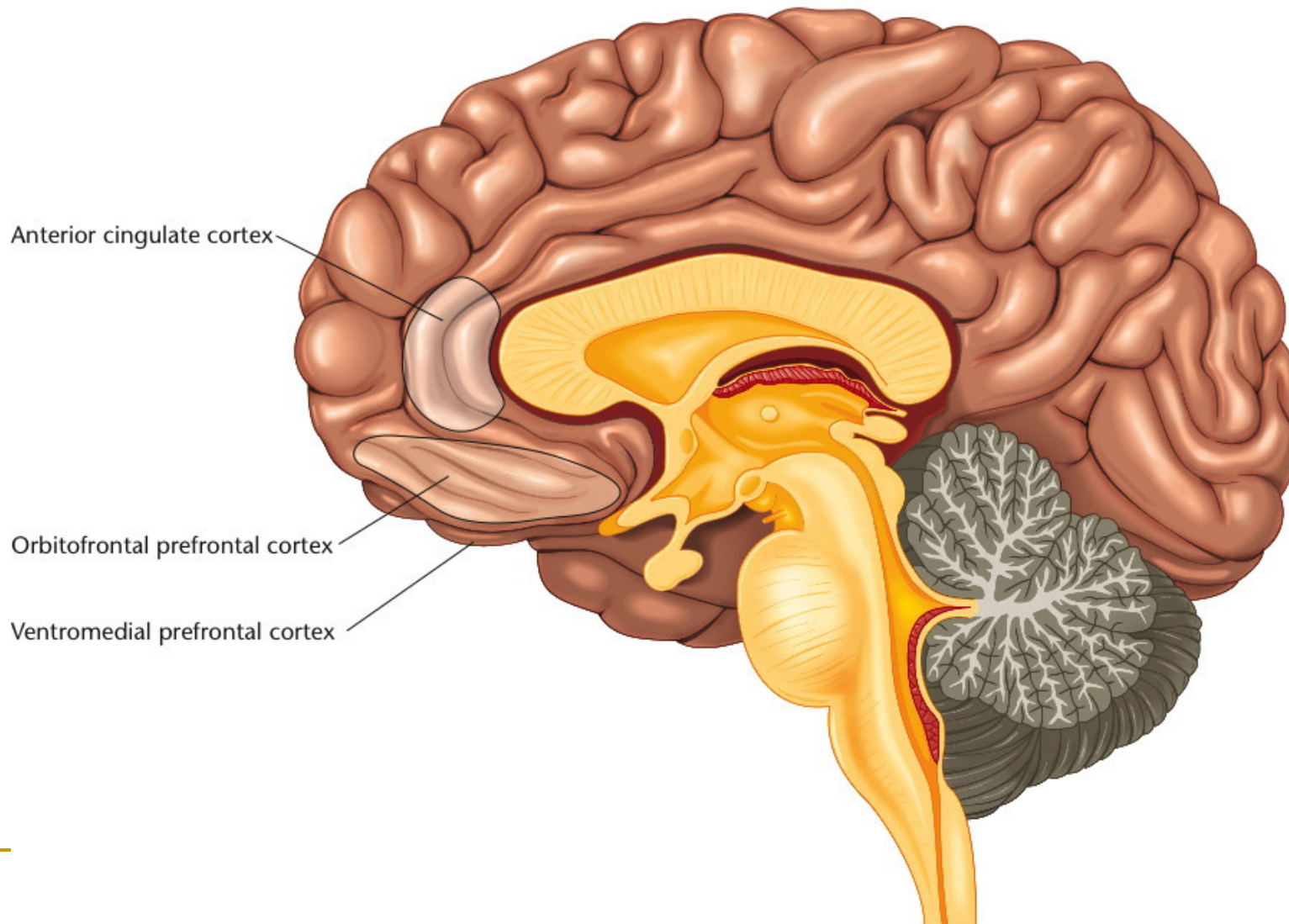


Practice

- Multitasking can be improved through training
- Increase speed of prefrontal cortical processing



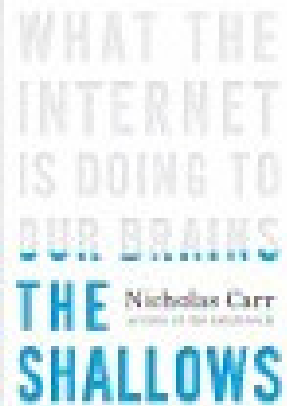
Prefrontal Cortex



Practice

- Suggests that those who are exposed more to digital multitasking are indeed better at it
- But the question remains: would overall cognitive function be better off in a one-at-a-time mode?





The Shallows (Carr, 2010)

- **Focused attention** -- a relatively new evolutionary adaptation
- **Divided attention** -- more common, evolutionarily older



Shallows vs. Deep Wading

- The internet reduces information consumption to byte sized (pun intended) chunks, as opposed to a 5-course repast
- This may be neither good nor bad but different...
- Wading in the shallows may be necessary to dive deeply and with focus into a topic...

(Grant, 2010)

Breadth Based vs. Narrow Based Information Processing (Lin, 2009)

- Narrow (~focused):
 - Limited capacity resource, tied to working memory
 - Effortful, depletable
 - Not necessarily evolutionarily newer, as this was required, e.g., in hunting/tracking, as well
-

Breadth Based vs. Narrow Based Information Processing (Lin, 2009)

- Broad (~vigilance):
 - Non-specific
 - Type needed for scanning the environment
 - Non-effortful, not resource dependent, not depletable
 - Attention is not focused *a priori* but is captured by salient (i.e., meaningful) stimuli
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Internet Uses Both

- Surfing the internet uses broad-based attention
- Writing e-mails, viewing videos, reading Wikis & blogs uses narrow-based



Is Technology an “Extension or an Amputation of Cognition?” (Lin, 2009)

- Digital multi-tasking can be a skill that can have great benefit if used properly.
- Self discipline is called for – knowing when to apply it



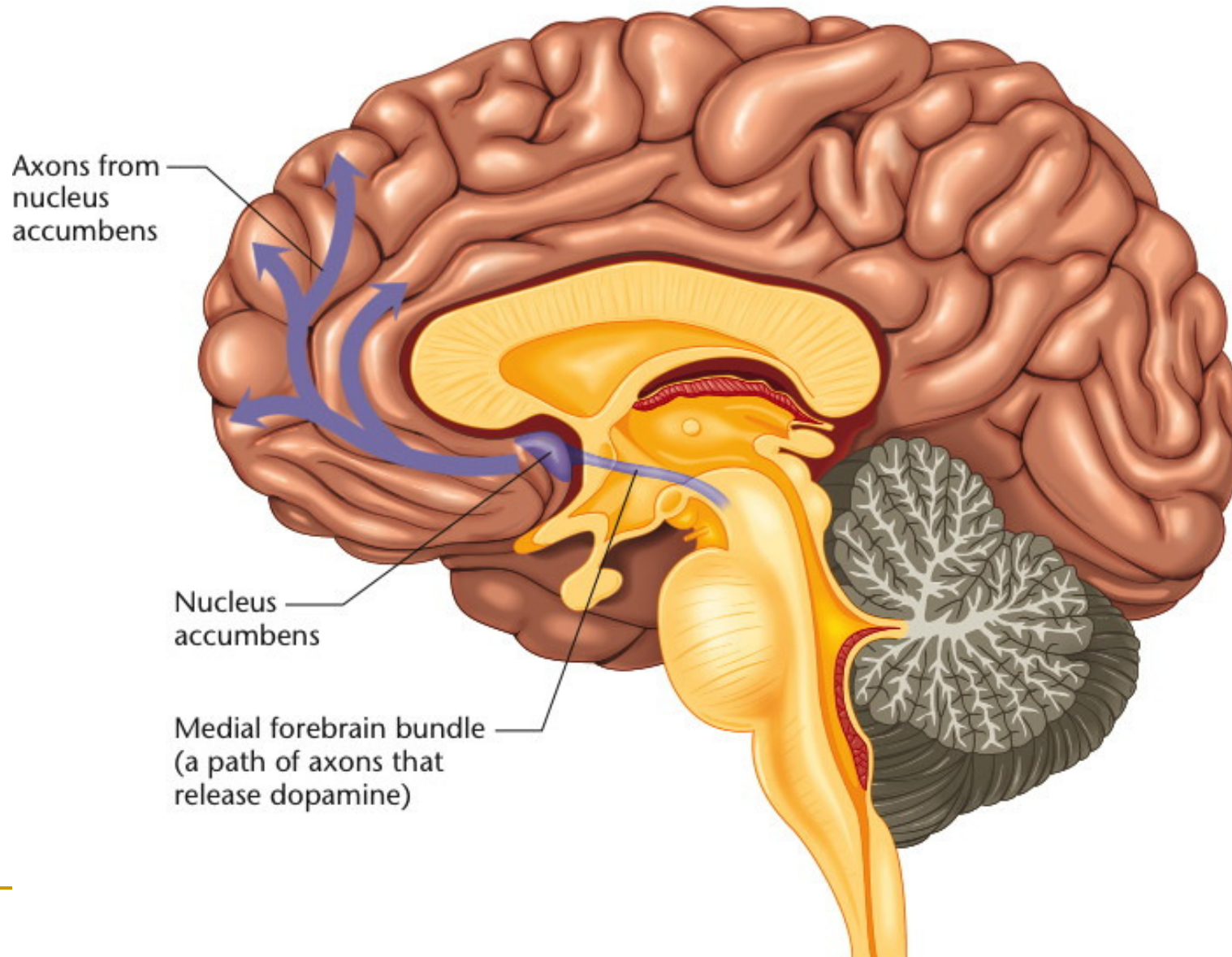
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- Most interesting assertion: moving into the broad based mode of attention allows restoration of the narrow type mode
 - Further assertion is that being in “nature” promotes the broad-based form of attention (EcoPsychology; Greenway, 1995)
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Addiction

Almost all abused drugs (as well as gambling, fast food, and Twinkies...) stimulate **dopamine** release in the **nucleus accumbens**

And the same neural mechanisms are activated when the internet becomes 'addictive'

Nucleus Accumbens



Technology is addictive in a real way –
nucleus accumbens is activated just as it is in
alcohol, gambling, and Twinkie addictions

Discipline, Moderation & Balance...

- Bottom line from the research is that multi-tasking is not 'good' from a processing standpoint (although one can get more efficient at it through practice) but broad-based processing is (but one has to impose some restrictions – through self-discipline – to ensure that it is done at appropriate times and levels and not to the detriment of squeezing out narrow-based processing)
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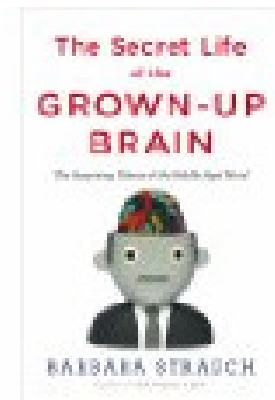
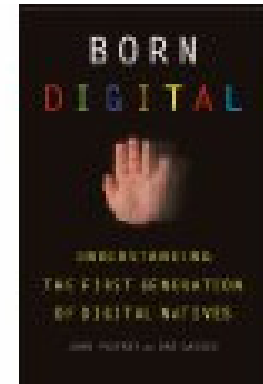
Application to Libraries

- What does the effect of technology on brain and cognition tell us about developing and delivering library services?



Individual Differences

- Brain, Cognitive Style, Behavior, Tech Exposure & Experience
- Generational Differences:
 - 40% of all social networking done by adolescents & young adults
 - But fastest growing segment is Baby Boomers and Gen X
- Diversity of Cognitive Styles:
 - Digital natives more practiced at digital multitasking
 - Digital immigrants more one-at-a-time



Applying Lin's Broad-Based vs. Narrow-Based Approach

- Browsing stacks/catalog to see what 'pops out' vs. reading/creating processes....both occur in academic libraries.
- Both need to be supported.



Information Literacy

- When we talk about multitasking, we are really talking about attention: the art of paying attention, the ability to shift attention, and, more broadly *the ability to exercise judgment about what objects are worthy of our attention.*
 - Judgment = Decision Making, about credibility, quality of sources, information
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Bottom Line: It's Not a Zero Sum Game

- The question is not *if* technology changes brain, mind, behavior, but *how...*
 - One type of attention is not inherently 'better' than another, but both need to be in balance
 - The question is not whether technology is good or bad but rather, how can it best be used to expand and enhance human capacities, not 'amputate' them.
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Contact Info:

*Deborah Gagnon
Wells College
170 Main St.
Aurora, NY 13026*

*dgagnon@wells.edu
315-364-3307*

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