Top o’ the Mind: The Brain’s Frontal Lobes and their Role in Memory

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Please take out some paper and a pen or pencil
PLAN

✧ What makes our frontal lobes different – and also similar – to other primates’ frontal lobes?
✧ Working memory
✧ Long-term memory
✧ Normal memory changes with aging
  ✧ Including some tricks your memory can play on you
  ✧ Effects of stress on memory
✧ How to preserve your memory
Homo erectus
1.7 million years ago

Homo sapiens
200,000 years ago to present
Behavior freed from hard-wired patterns
Guided by internal rules
Self-regulation of impulse, mood & behavior
Symbol formation = freedom from the immediate
Orderly execution of complex plans
Complex social organization
Transmission of culture
Lobes of the brain
Prefrontal cortex: regulation of behavior, movement, mood & thought

- Ant. cingulate
- Orbitofrontal
- Dorsolateral ("executive")

Mega and Cummings (1994)
“Executive” functions

- **Memory search**
- **Working memory**
- Planning, organization and execution of complex sequences
- Flexible responses to changing environmental demands
- Selective attention
- Persistence in a task despite distraction
- Creative problem solving
- Flexible thinking
- Abstract reasoning
Working memory

- Immediate, “scratchpad” memory - seconds to minutes
- Persistence in a task despite distraction
- Enables abstraction & concept formation
- Enables cognitive flexibility: modification of behavior to fit novel contexts
  - maintenance of the serial order of information
  - organization of information
  - integration with previously learned material
A picture of a face is presented for 3 s, followed by a 9-s delay, and by a 3-s presentation of two faces.

*Which face did you see previously?*
Executive system trouble

✧ Failure to manage medications
✧ Failure to adhere to diet or exercise
✧ Failure to keep appointments
✧ Cooking, shopping, driving, using public transportation, handling personal finances

....
Did Working Memory Spark Creative Culture?

A provocative model suggests that a shift in what and how we remember may have been key to the evolution of human cognition.
Memory Quiz
Did Working Memory Spark Creative Culture?

A provocative model suggests that a shift in what and how we remember may have been key to the evolution of human cognition. As designing an airplane, and as imaginative as creating works of art and music. Psychologists and neuroscientists consider working memory essential to the capacity for language, planning, and conscious experience. “Any symbolic processing, such as language, requires it,” says David Linden, a psychologist at Bangor University in Gwynedd, U.K. Working memory is “the blackboard of the mind,” as the late Patricia Goldman-Rakic of Yale University put it.
Tiny stone arrowheads from Pinnacle Point Cave in South Africa are the oldest known projectile weapons dated at 71,000 years ago. Image: Simen Oestmo
Pinnacle Point cave, South Africa. Artifacts and fossils from 50,000 to 90,000 years ago were washed onto the beach after a storm
Excavating at Pinnacle Point
Heating the quartz-silica grains
Replicas of microlith blades glued to wooden handles
High technology in the stone age

✧ Locate and gather silcrete
High technology in the stone age

✧ Gather wood for fuel and transport it to the furnace site
High technology in the stone age

✧ Get the temperature just right for melting
High technology in the stone age

✧ Shape the blades
High technology in the stone age

✧ Mount the blades onto wood
High technology in the Stone Age

扒 Projectile technology lasted 100,000 years and was widespread across the region, suggesting that people were transmitting the recipe among one another and from one generation to the next.

扒 The transmission was oral.

扒 Meanwhile, they had to survive cold, beasts, hunger, enemies, and disease.
 Projectile technology allows attack from a safe distance

 Many other potential uses: cutting meat, scraping skins, chopping wood, digging holes, hammering, self-defense

 Gave our ancestors an edge during hunting and war

 May have contributed to success of H. sapiens over H. Neandertalis equipped with handheld spears

 Members of the remote Memberamo tribe in Papua New Guinea continue to produce stone axes

http://www.papuatrekking.com (permission requested)
Executive function: “The ability to hold and manipulate operations and images of objects in memory, and to execute goal-directed procedures over space and time”

Memory Quiz
Long term memory

http://dml.ucdavis.edu
Long-term memory step 1: pluggin’ it in

www.burgessbiz.com

Long-term memory step 2: writin’ it down

Long-term memory step 3: fishin’ it out

http://www2.rsna.org/timssnet/media/pressreleases/pr_target.cfm?ID=392
Memory search

verbal fluency
MEMORY & THE AGING BRAIN

http://www.brainbasedbusiness.com/author_profile/ (permission requested)
How much forgetfulness is too much?

Harvard Health Publications
HARVARD MEDICAL SCHOOL
Trusted advice for a healthier life

Forgetfulness — 7 types of normal memory problems

https://www.health.harvard.edu
1. **Transience**: the tendency to forget facts or events over time. Memories that are used frequently are least likely to be forgotten. Transience clears the brain of unused memories, making way for newer, more useful ones.
2. **Absentmindedness:** a result of not paying close enough attention. For example, forgetting where you just put your glasses because you didn’t focus on where you put it in the first place, so your brain didn’t encode the information. Another example is forgetting to take pills or keep an appointment.
3. Blocking ("tip of the tongue"): you just can’t think of someone’s name, or you think of the wrong word instead of the one you intend. Memory blocks become more frequent with age. Around half the time, the blocked memory returns within a minute.
4. **Misattribution:** you remember something accurately in part but mix in details of other details, like the time, place, or person involved. Another example is believing a thought you had was totally original when, in fact, it came from something or somebody else. This sort of misattribution explains cases of unintentional plagiarism. As the brain ages, it absorbs fewer details. Old memories are especially prone to misattribution.
5. **Suggestibility**: the vulnerability of your memory to the power of suggestion which fools your mind into thinking it’s a real memory.
Elizabeth Loftus and colleagues

College students given 1 false event (e.g., an overnight hospitalization for a high fever and a possible ear infection, or a birthday party with pizza and a clown at age 5. Followed by 3 interviews

First interview students recalled 0-false events

Second interview: 20% said they remembered something about the false even. One student recalled a male doctor, a female nurse and a friend from church who came to visit at the hospital.

In another experiment, subjects recalled details about accidentally spilling a bowl of punch on the bride’s parents at a wedding reception.

During the first interview one participant stated, “I have no clue. I have never heard that one before.” In the second interview the participant said: “It was an outdoor wedding and I think we were running around and knocked something over like the punch bowl or something and um made a big mess and of course got yelled at for it” (Elizabeth Loftus, Scientific American, 1997)
6. **Bias:** perceptions are filtered by personal experiences, beliefs, knowledge, and mood which affect the way memories are encoded and retrieved.

- Dr. Karim Nader recalled seeing TV footage of the first plane hitting the World Trade Center on September 11.
- He was surprised to learn that such footage aired for the first time the following day.
- A 2003 study of 569 college students found that 73% shared this misperception.

7. Persistence: some people are tormented by memories they can’t forget. The persistence of memories of traumatic events may be accurate; others may be negative distortions of reality. People suffering from depression and post-traumatic stress disorder are particularly prone to persistent, disturbing memories.
Post-traumatic stress disorder (PTSD)

- Learned ("conditioned") fear
- Highly resistant to unlearning
- Intrusive flashbacks
- Nightmares
- Hypervigilance
- Insomnia
- Avoidance
Hyperactivity during emotional processing: amygdalae, parahippocampal gyrus, insula, inferior parietal lobule, midcingulate, and precuneus. Similar to fear conditioning in healthy individuals & other anxiety disorders
Hypoactivity during emotional processing: widespread areas of prefrontal cortex are less active. Activity level correlated with severity of symptoms
Preserving memory

www.bigkitchen.com
126 older adults with memory concerns. Four groups. All did 1 hour of mental activity 3 times a week and 1 hour of physical activity 3 times a week:

- intensive computer work + aerobics
- intensive computer work + light stretching
- educational DVD + aerobics
- educational DVD + light stretching

After 12 weeks, scores on thinking tests improved across the board .... The amount of activity is more important than the type of activity
Protecting the brain

✧ People in their 70s showed who exercise the most have the least brain shrinkage

Older adults who exercise regularly reduce their risk of dementia by 40%

Regular exercise protects the brain by stimulating growth of blood vessels, growth factors, and new brain cells

The amount of mental activity (reading the newspaper, playing chess) correlates with the level of cognitive function 1 year later
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Newborn neurons in the adult hippocampus

*Portraits of the Mind* by Carl Schoonover
What you can do

✧ 150 minutes of moderate exercise a week
✧ Mental challenge (crossword puzzles, reading, building models....)

Watching TV doesn’t count!