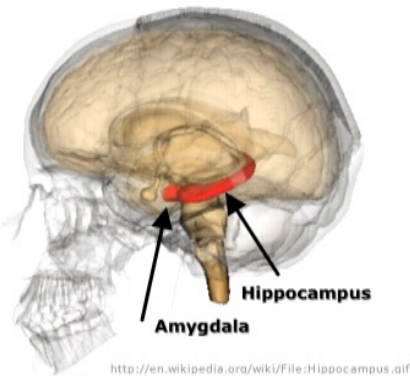


Temporal Lobe Function

(Kolb & Whishaw, 2009, pp. 402 ff; et al.)



Comprised of

- Superior, medial, & inferior temporal gyrus
- Hippocampus
- Amygdala

Connections

- Hierarchical Sensory Pathway: visual (ventral) & auditory (ventral)
- Auditory pathway (dorsal): to posterior parietal cortex
- Polymodal pathway: auditory & visual projections into polymodal region of superior temporal sulcus (inferior of Brodmann 22).
- Medial temporal projection: to hippocampal formation & amygdala. Crucial for memory.
- Frontal lobe projection

Theory of Temporal-Lobe Functioning

Basic Sensory Functions

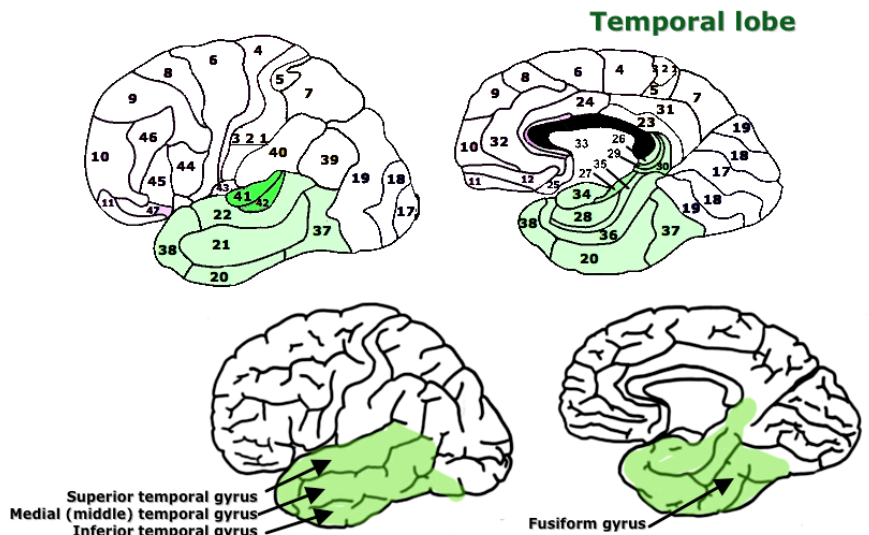
1. Processing auditory input
2. Visual object recognition ("ventral visual stream")
3. Long-term storage of sensory input (= memory)

Sensory Processes

- Object Recognition (ventral visual pathway): color, shape, size
- Categorization (superior temporal sulcus): ≠ identification: what group
- Cross-modal matching: sound & vision + names

Affective Responses

- Association of sensory input with emotion (role of amygdala)
- Reactivity to stimuli

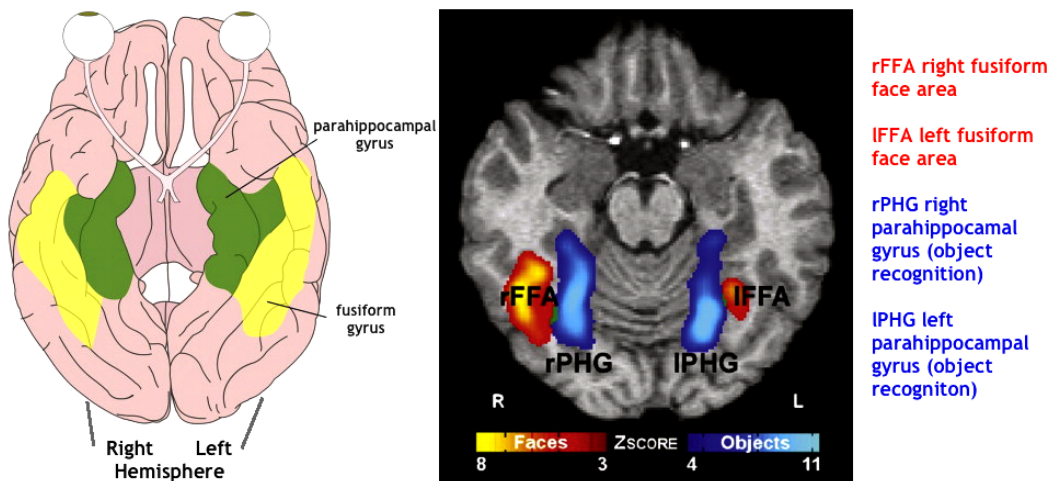


Superior Temporal Sulcus & Biological Motion

- Biological Motion = movements which have relevance to species, e.g., social movement of mouth, eyes, face, etc.
- Multimodal input into STS to permit analysis of biological motion
- Hypotheses about intentions of others => theory of mind => social cognition

Inferior Temporal Cortical Region

Visual Recognition Areas of the Inferior Temporal Cortical Region



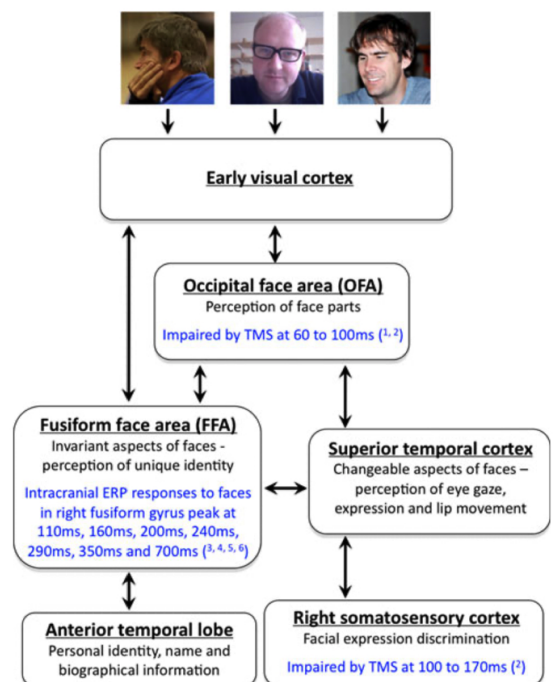
Facial Analysis & Recognition (see diagram above and on right; Haxby et al. 2000; Pilcher et al., 2011).

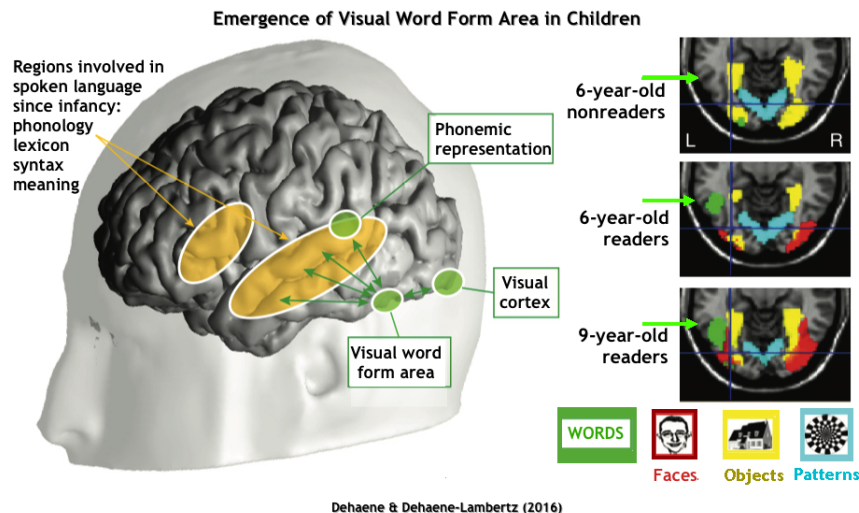
- Fusiform gyrus: Invariant aspects of face; perception of unique identity, i.e., fusiform facial area (FFA)
- Superior temporal sulcus: Changeable aspects of faces: eye gaze, expression, & lip movement

Object Recognition

- Parahippocampal gyrus (L & RH)

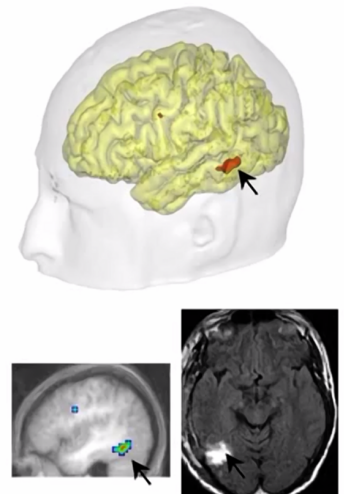
A Cortical Model of the Face Processing Network





Reading (Dehaene, 2009; Dehaene & Cohen, 2011; Dehaene & Dehaene-Lambertz, 2016)

- The *Visual Word Form Area* (VWFA) is found in the left occipital-temporal sulcus
- The human brain did not evolve to read (writing was invented less than 5 thousand years ago, far too short a time period for an evolutionary change in the brain). But, we do read. How? Dehaene & Cohen (2011) as well as other researches explain the emergence of the VWFA with a “neuronal recycling hypothesis”. As they explain, “...pre-existing cortical systems are harnessed for the novel task of recognizing written words” (p. 254)
- In the image above on the right side, notice that the VWFA actually emerges and grows as young children begin to learn to read (ages 6 to 9)



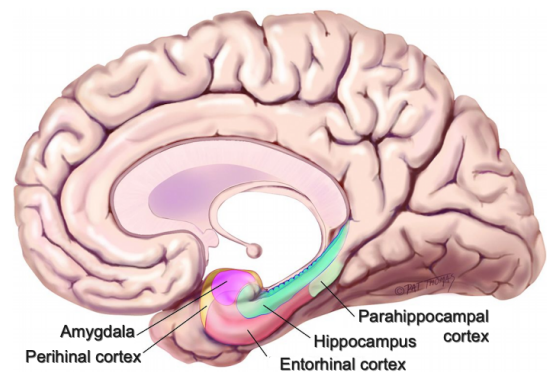
Medial Temporal Cortical (MTC) Region aka Medial Temporal Lobe (MTL)

"The medial temporal lobe includes a system of anatomically related structures that are essential for declarative memory (conscious memory for facts and events). The system consists of the hippocampal region (CA fields, dentate gyrus, and subicular complex) and the adjacent perirhinal, entorhinal, and parahippocampal cortices" [Abstract, Squire et al. 2004]

Memory

- Declarative memory
- Spatial memory (where we were/are)

Medial Temporal Cortex (Lobe)



Raslau, Mark, Klein et al. (2015)
<https://doi.org/10.3174/ajnr.A4169>

Spatial Navigation

- Know/remember where we are = ability to move around our environment

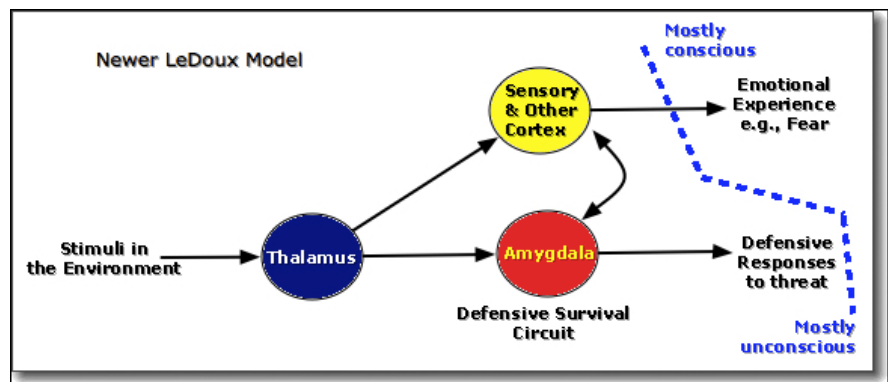
Amygdala

This almond shaped tissue is comprised of a collection of a dozen or more nuclei located within/surrounded by the temporal lobe of the brain. It is about an inch inward from each of our ears. Amygdala receives information from many sensory & other regions and sends out information to multiple areas as well. It has usually been assigned to be part of the limbic system.

For a long time, the amygdala was described as the source of the emotion fear. Many of these descriptions looked at the important work of NYU scientist, Joseph LeDoux. However, since 2016 LeDoux has

argued that, in human beings, after receiving information from the sensory systems of the body, the amygdala does not function itself as a "fear" circuit in the brain. It does not produce the emotions of fear or anxiety. Rather, he argues that the amygdala is one of several "defensive survival

circuits [that] are evolutionarily wired to detect and respond to innate threats and to respond to novel threats that have been learned about in the past....Defensive survival circuits indirectly contribute to the feeling of fear, but their activity does not constitute fear" (LeDoux & Brown, 2017) In LeDoux's argument, both fear (an emotion that responds to a threat NOW) and anxiety (an emotion that responds to a threat in the FUTURE) only become real when we become conscious of the threat and of our unconscious responses.



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Asymmetry

Left

- Verbal memory
- Processing speech sounds

Right

- Nonverbal memory (e.g., faces)
- Processing aspects of music

References

- Dehaene, S., & Cohen, L. (2011). The unique role of the visual word form area in reading. *Trends in Cognitive Sciences*, 15(6), 254–262.
<https://doi.org/10.1016/j.tics.2011.04.003>

- Dehaene, S., & Dehaene-Lambertz, G. (2016). Is the brain prewired for letters? *Nature Neuroscience*, 19(9), 1192-1193. <https://dx.doi.org/10.1038/nn.4369>
- Haxby, J. V., Hoffman, E. A., & Gobbini, M. I. (2000). The distributed human neural system for face perception. *Trends in Cognitive Science*, 4(6), 223-233. [https://dx.doi.org/10.1016/S1364-6613\(00\)01482-0](https://dx.doi.org/10.1016/S1364-6613(00)01482-0)
- LeDoux, J., & Brown, R. (2017). A higher-order theory of emotional consciousness. *Proceedings of the National Academy of Sciences*. <https://dx.doi.org/10.1073/pnas.1619316114>
- Pitcher, D., Walsh, V., & Duchaine, B. (2011). The role of the occipital face area in the cortical face perception network. *Experimental Brain Research*, 209, 481-493. <https://dx.doi.org/10.1007/s00221-011-2579-1>
- Raslau, F. D., Mark, I. T., Klein, A. P., Ulmer, J. L., Mathews V, & Mark, L. P. (2015). Memory part 2: The role of the medial temporal lobe. *American Journal of Neuroradiology*, 36(5), 846-849.
- Squire, L. R., Stark, C. E. L., & Clark, R. E. (2004). The medial temporal lobe. *Annual Review of Neuroscience*, 27, 279-306. <https://doi.org/10.1146/annurev.neuro.27.070203.144130>