Defining language nutrition — medically (and as a human right)

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nutrients

Primary: necessary to survive

Secondary: necessary to thrive

(also includes touch, interaction, bonding,…)

Nutrient:

Anything that sustains an organism so it can grow, thrive, and reproduce.

Language nutrition:

Linguistic interaction rich in quality and quantity as a nutrient for human brains.

Brain structures vary in size and strength with language exposure:

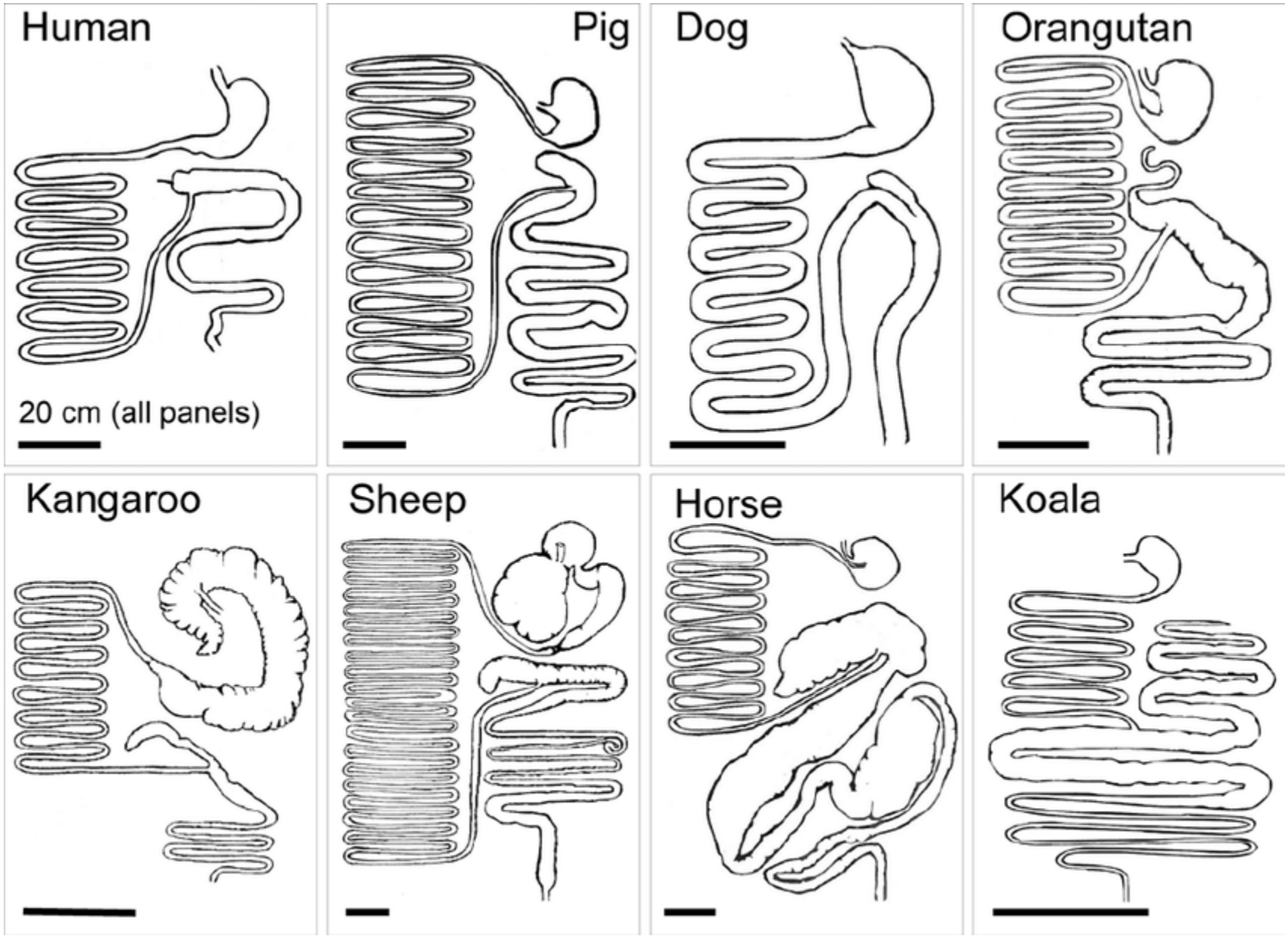
- pathway connecting auditory cortex to motor cortex
- cortical surface incl. “language areas”
- pathways connecting “language areas”
- pathway connecting visual word form area to anterior cingulate cortex
- thalamus

The human body adapts to nutrients physiologically:

Cooking: shorter digestive tracts, metabolic changes to deal with toxins generated through cooking, differently shaped teeth

Agriculture: carbohydrate-rich grains led to a change in insulin signaling, metabolism, enzymes, appetite control

cf.: Luca, F., Perry, G. H., & Di Rienzo, A. (2010). Evolutionary adaptations to dietary changes. *Annual review of nutrition*, *30*, 291–314. DOI: 10.1146/annurev-nutr-080508-141048



Furness, John, Jeremy Cottrell, and David Bravo. 2015. ‘Comparative Physiology of Digestion.’ *Journal of Animal Science* 93. DOI 10.2527/jas2014-8481

Journal of Phonetics
Volume 53, November 2015, Pages 79-87

Biology, culture, evolution and the cognitive nature of sound systems

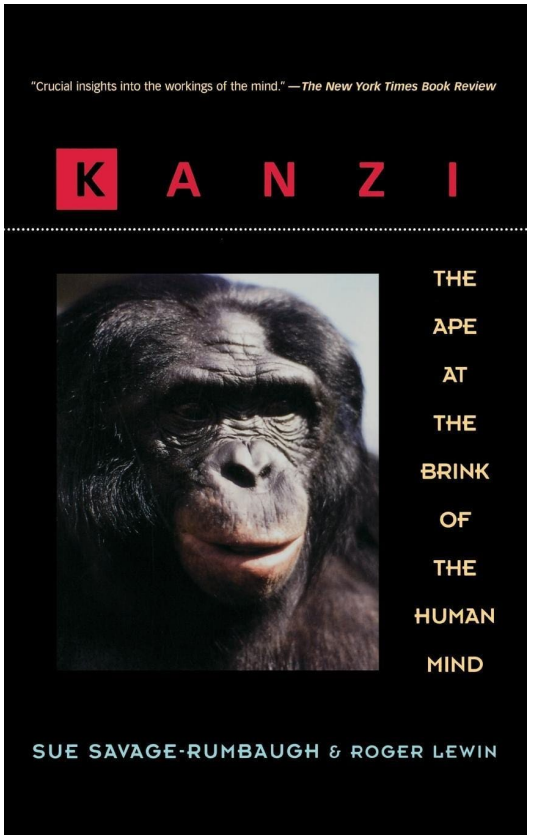
Bart de Boer ✉

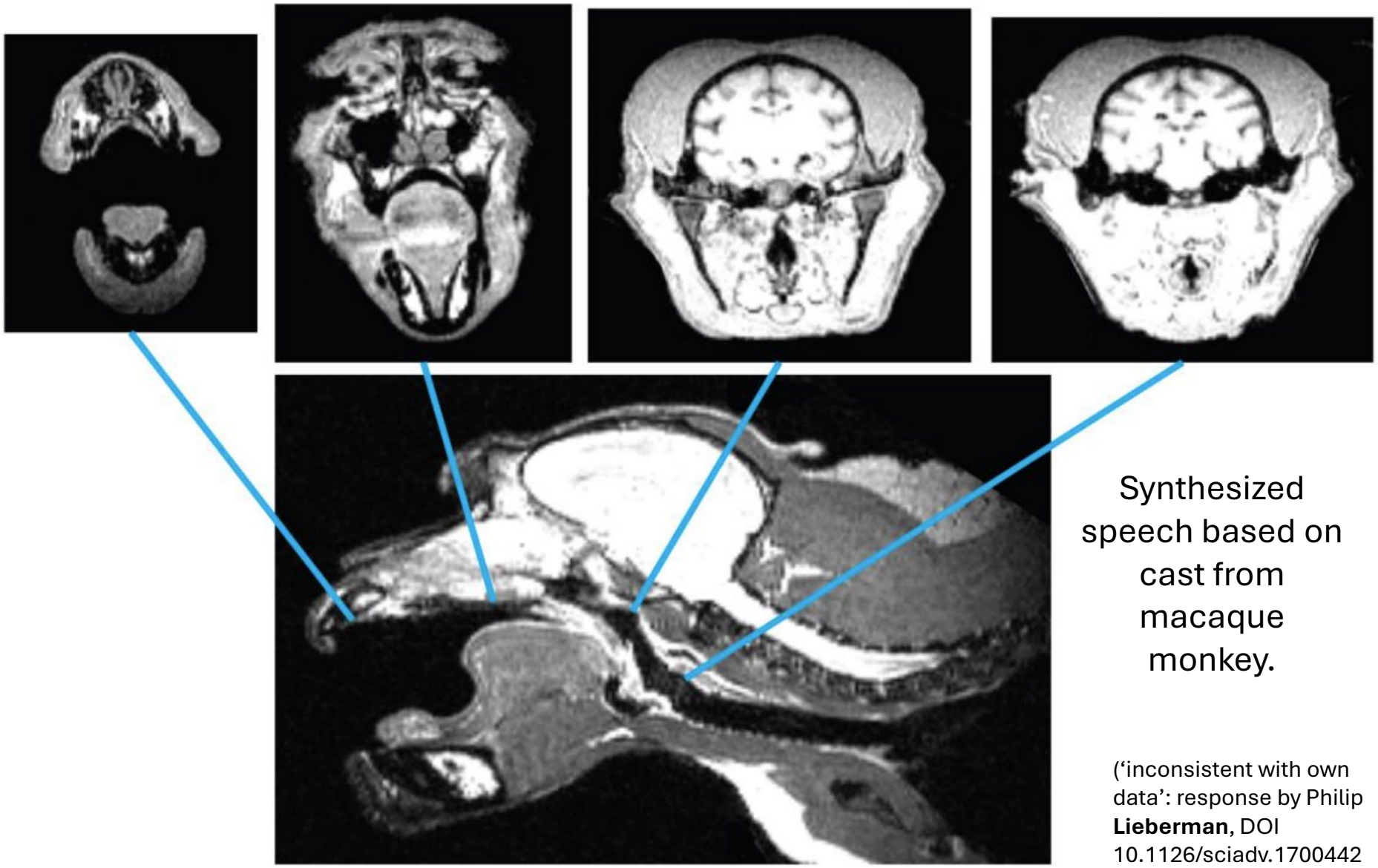
It is often a matter of debate whether biological adaptations are speech-specific or not (…). However, from a truly evolutionary point of view this is a meaningless question: as (biological) evolution needs to work with what is already there, everything involved in speech was used for something else before the advent of language and speech.

DOI 10.1016/j.wocn.2015.07.001

Primates share much of our genetic and cortical makeup, but they do not grow up with a steady language diet. If they do, their brains can adapt to language as well:

Great apes who understood spoken English and responded with signs / icons.





Synthesized speech based on cast from macaque monkey.

('inconsistent with own data': response by Philip **Lieberman**, DOI 10.1126/sciadv.1700442

W. Tecumseh Fitch, Bart de Boer, Neil Mathur, and Asif A. Ghazanfar, 2016. 'Monkey Vocal Tracts are Speech-ready.' *Science Advances* 2(12). DOI 10.1126/sciadv.1600723.

Some adaptations of the human ***body*** to speech and language:

Simplified laryngeal anatomy (no air sacs, no vocal membranes) provide a stable vocal source to be filtered by rapidly changing formant frequencies.

Takeshi Nishimura et al., 2022. 'Evolutionary Loss of Complexity in Human Vocal Anatomy as an Adaptation to Speech.' Science 377.6607 (12 August): 760-63. DOI 10.1126/science.abm1574.

Increased agility of the tongue associated with cortical mapping of articulatory targets.

Ekström, Axel, and Jens Edlund. 2023. 'Evolution of the Human Tongue and Emergence of Speech Biomechanics.' *Frontiers in Psychology* 14 (30 May). DOI 10.3389/fpsyg.2023.1150778.

NewScientist

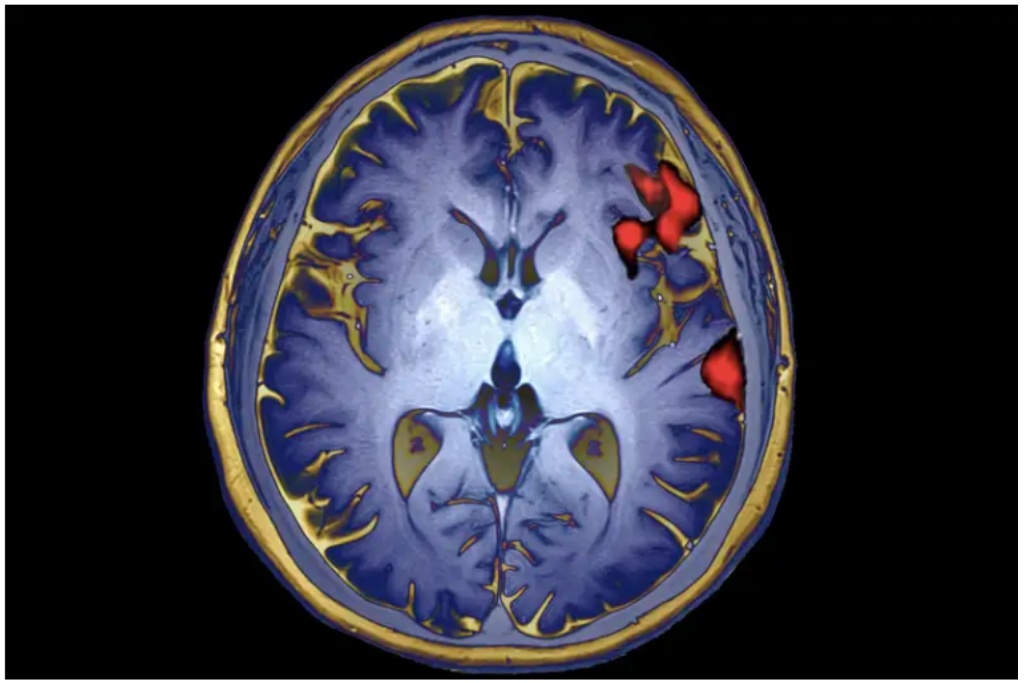
Mind

The entire brain may be involved in language, not just a few regions

Brain regions identified as "language centres" are actually hubs that coordinate the processing of language throughout the brain, argues a controversial new study

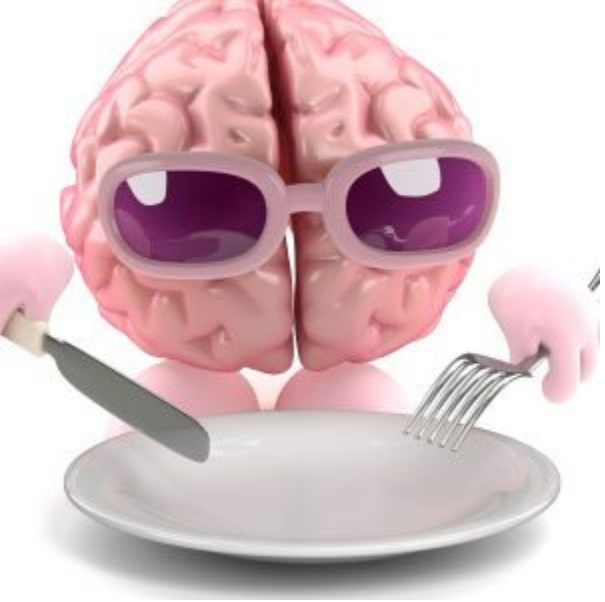
By Michael Marshall

20 September 2023



When we speak, brain activity spikes (red) in regions near Broca's area
ZEPHYR/SCIENCE PHOTO LIBRARY

Similarly, the human ***brain*** has adapted to processing language and speech by superimposing language and speech functions.



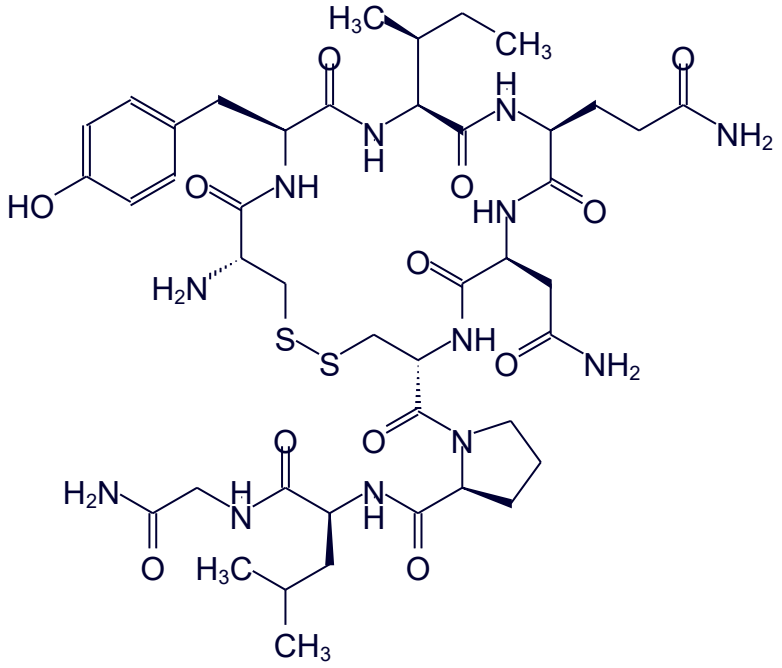
Language nutrition supercharging ancient faculties:

- **Bonding**

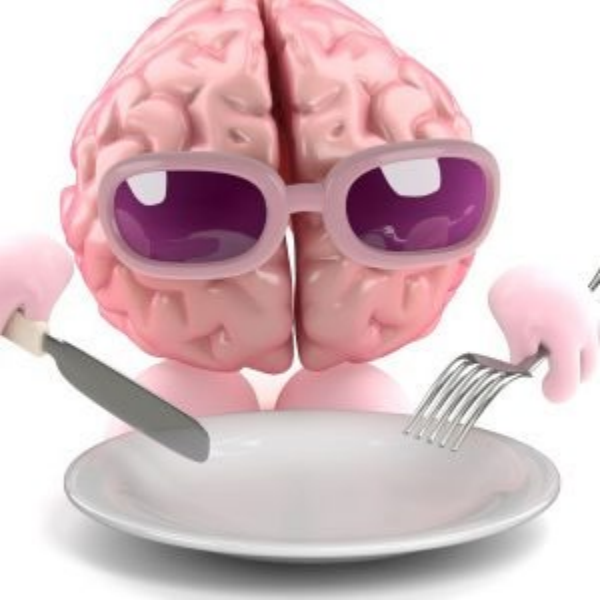
Example: Bonding is strongly associated with oxytocin. Higher levels of oxytocin are measured in interactive reading sessions between an adult and a young child.

The auditory cortex is packed with oxytocin receptors. Interactive reading with infants accelerates phonemic discrimination.*

oxytocin



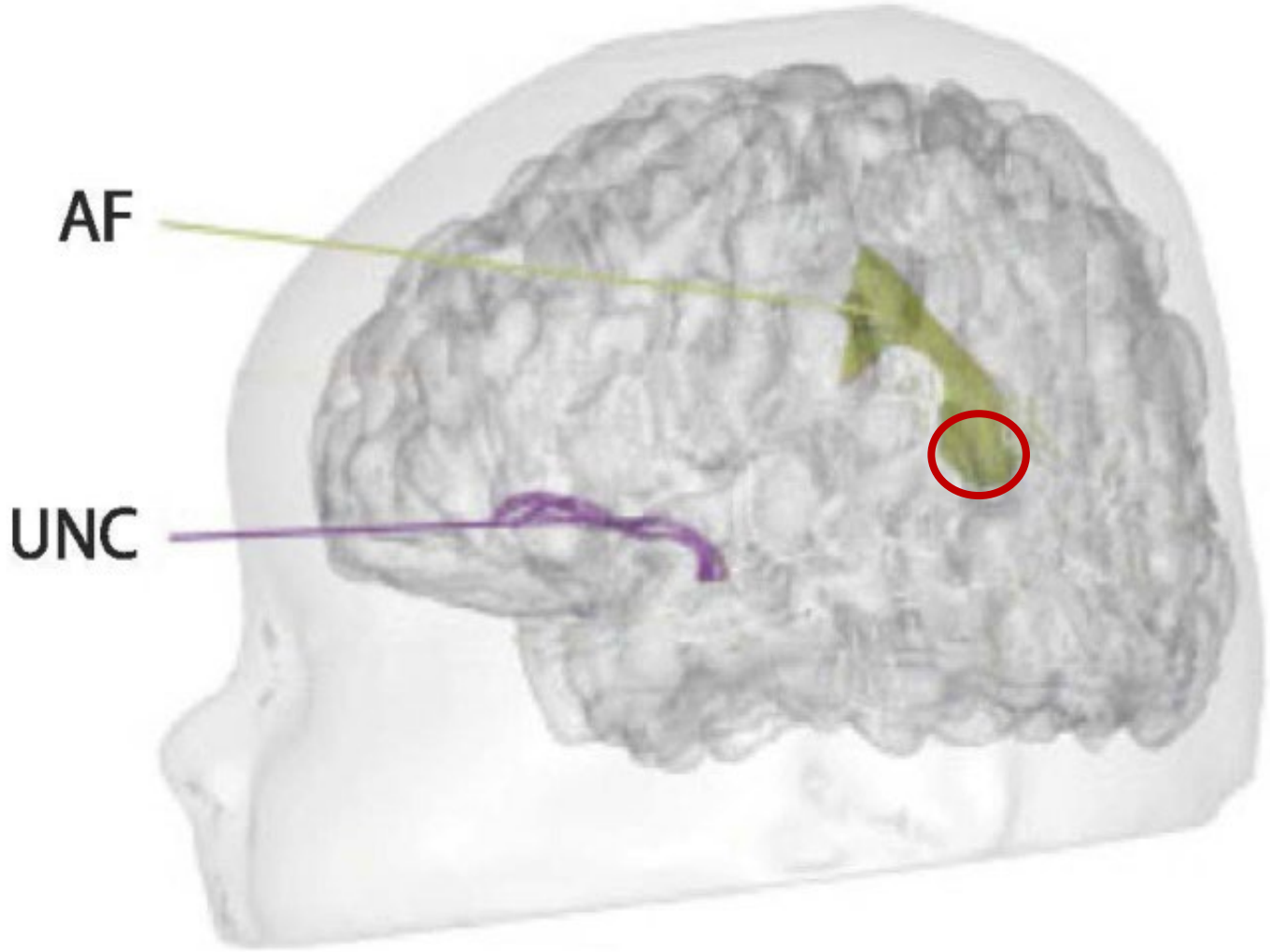
*__Ralf Thiede__, 2019. *Children's Books, Brain Development, and Language Acquisition*. Routledge.



Language nutrition supercharging ancient faculties:

- Bonding
- **Motor activity**

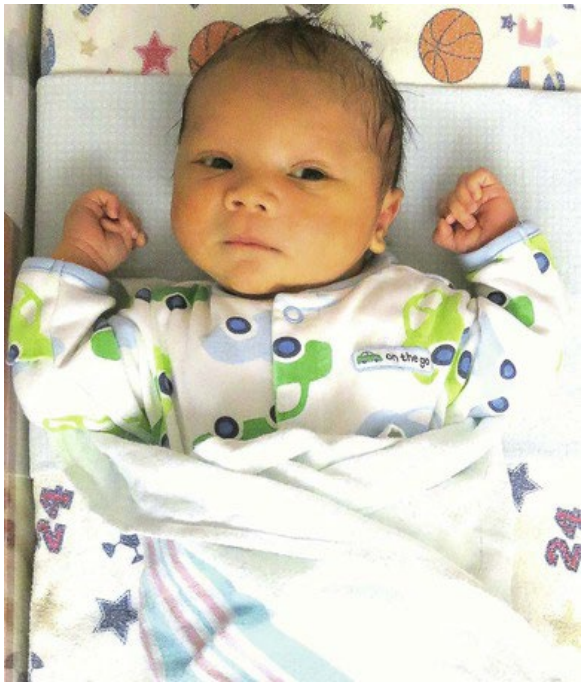
Motoric processing pressed into service for language.



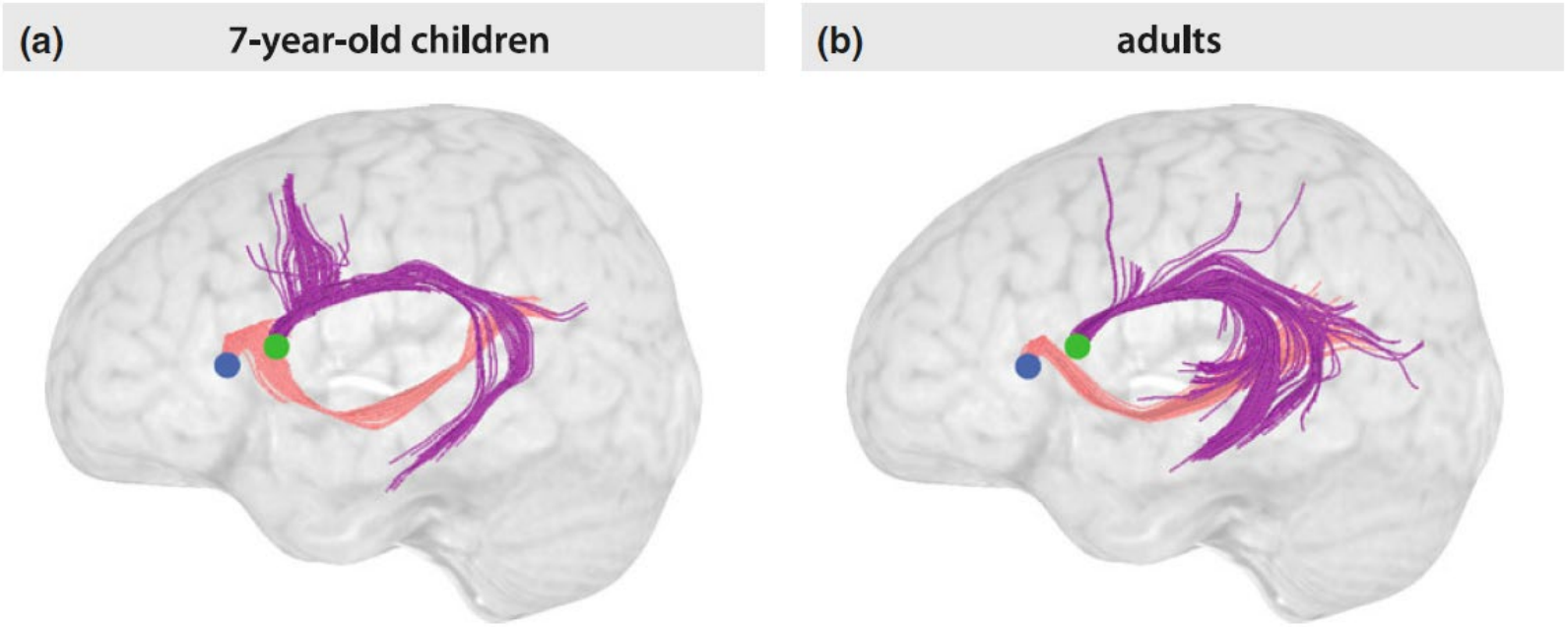
The green pathway (AF) connects auditory cortex and motor cortex.

[It will later develop into a much larger structure, the arcuate fasciculus.]

Newborns move their bodies to the rhythm of adult speech.



Even seven-year-olds still have a much stronger connection from listening to movement than adults do.

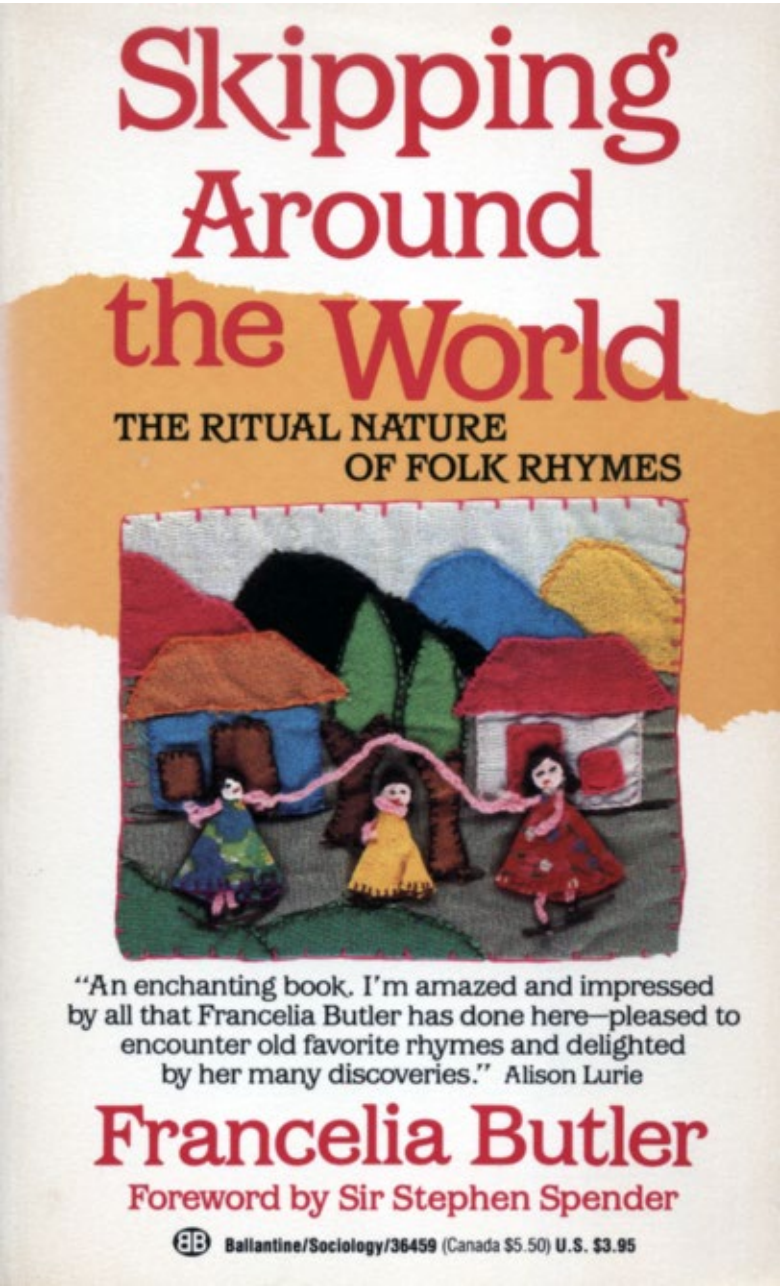


Psychological Research (2012) 76:204–211
DOI 10.1007/s00426-011-0357-0

REVIEW

Neurophysiological preconditions of syntax acquisition

Angela D. Friederici · Regine Oberecker · Jens Brauer



Physical activities supporting language nutrition

FINGER PLAY FUN

Violette G. Steiner

Roberta Evatt Pond

DO YOUR EARS HANG LOW?

(Also, a song)

Do your ears hang low?
(hands extending downward by ears)

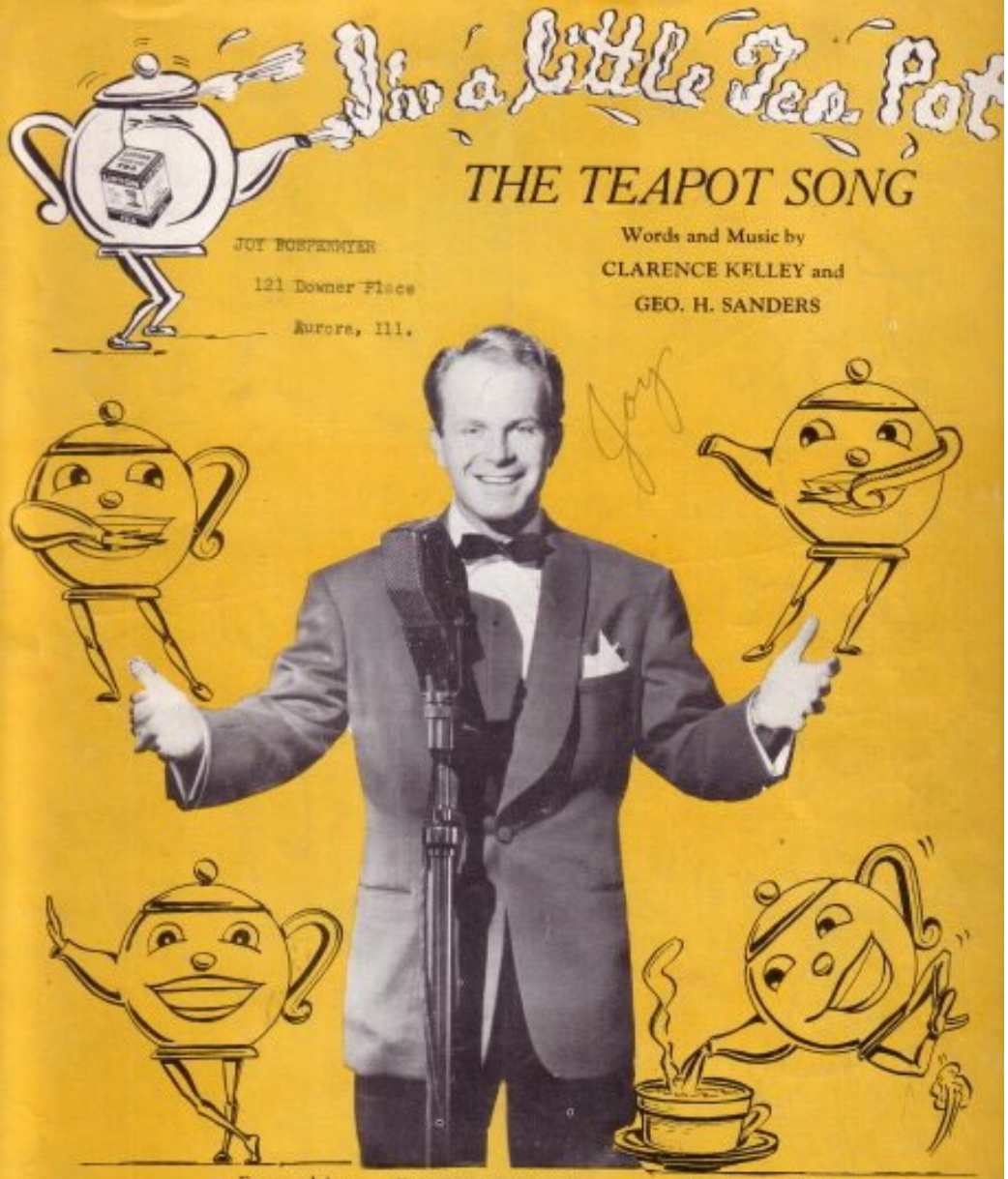
Do they wobble to and fro?
(hands wobble)

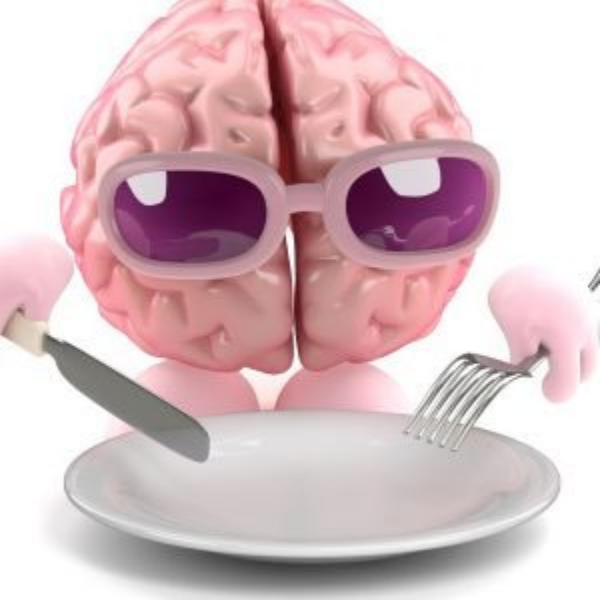
Can you tie them in a knot?
(pretend to tie knot)

Can you tie them in a bow?
(pretend to tie bow)

Can you toss them over your shoulder
(make appropriate motion)

Like a continental soldier?


I'm a Little Tea Pot
THE TEAPOT SONG
Words and Music by
CLARENCE KELLEY and
GEO. H. SANDERS
JUT BUSPENMYER
121 Downer Place
Aurora, Ill.
Featured by RONNIE KEMPER with the Horace Heidt Orchestra
KELMAN MUSIC CORPORATION
1674 Broadway, New York, N. Y.



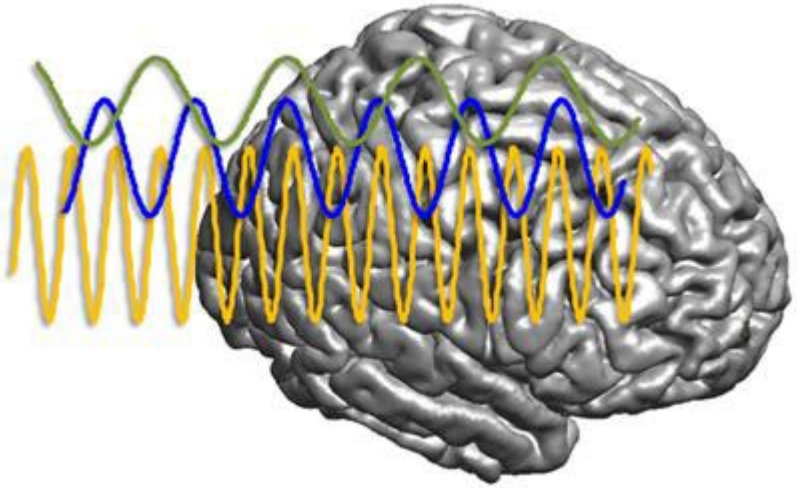
Language nutrition supercharging ancient faculties:

- Bonding
- Motor activity
- **Entrainment**

A listener entrains to specific oscillations in the ‘speech envelope.’

, ❶ , , ❶ , , ❶ , , ❶ , DELTA
Believe me, said Horton. I tell you sincerely, THETA

, ❶ , , ❶ , , ❶ , , ❶ , DELTA
My ears are quite keen and I heard him quite clearly. THETA



The oscillations themselves seem to have a predictive function and enhance speech perception.

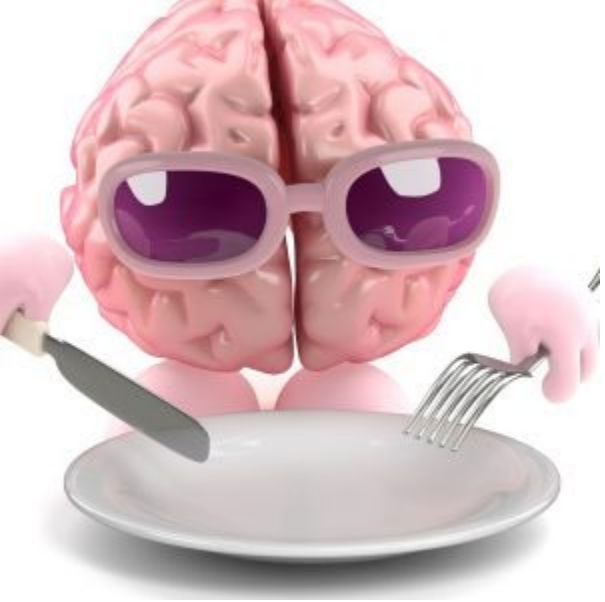
Listeners were asked to listen to a bunch of people at a cocktail party and make out what *one particular individual* was saying. Their perception improved when they received "speech-envelope-shaped-transcranial current stimulation" (envTCS) – *electrical currents in sync with the speaker* they were focusing on.

Lars Riecke, Lars, Elia Formisano, Bettina Sorger, Deniz Basxkent, and Etienne Gaudrain. 2018. Neural Entrainment to Speech Modulates Speech Intelligibility. *Current Biology* 28 (January 22) 161-69., 2018. doi.org/10.1016/j.cub.2017.11.033

Sustaining a rhythm, as Dr. Seuss typically does, establishes robust entrainment.

Entrainment to such a speech envelope does not abruptly stop when the speech stops, but continues on for a few cycles -- like a bicycle wheel: “even if the pedaling has stopped, the wheel continues turning” (Kösem & Wassenhove).

Anne Kösem & Virginie van Wassenhove. 2017. Distinct contributions of low- and high-frequency neural oscillations to speech comprehension. *Language, Cognition and Neuroscience* 32:5, 536-544.
DOI: 10.1080/23273798.2016.1238495



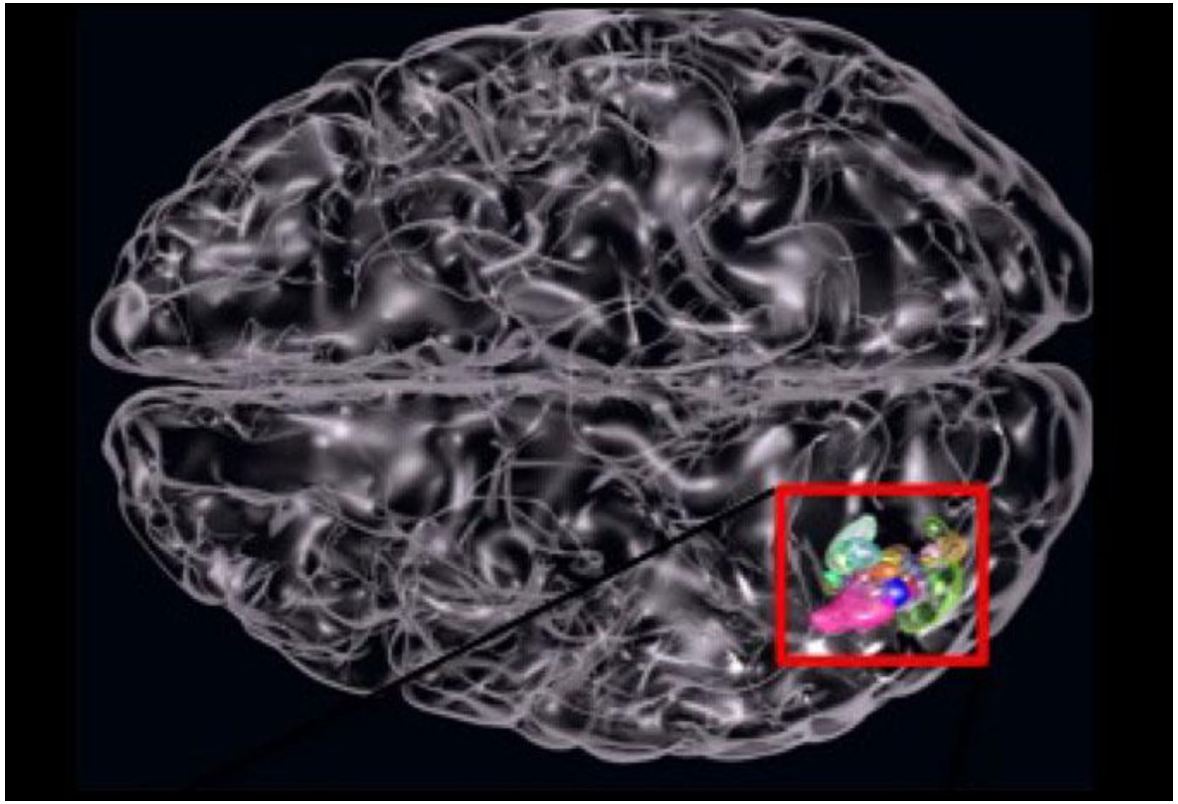
Language nutrition supercharging ancient faculties:

- Bonding
- Motor activity
- Entrainment
- **Social event modeling**

Visual Word Form Area (VWFA)

Normally processes faces and small objects (e.g. tools)

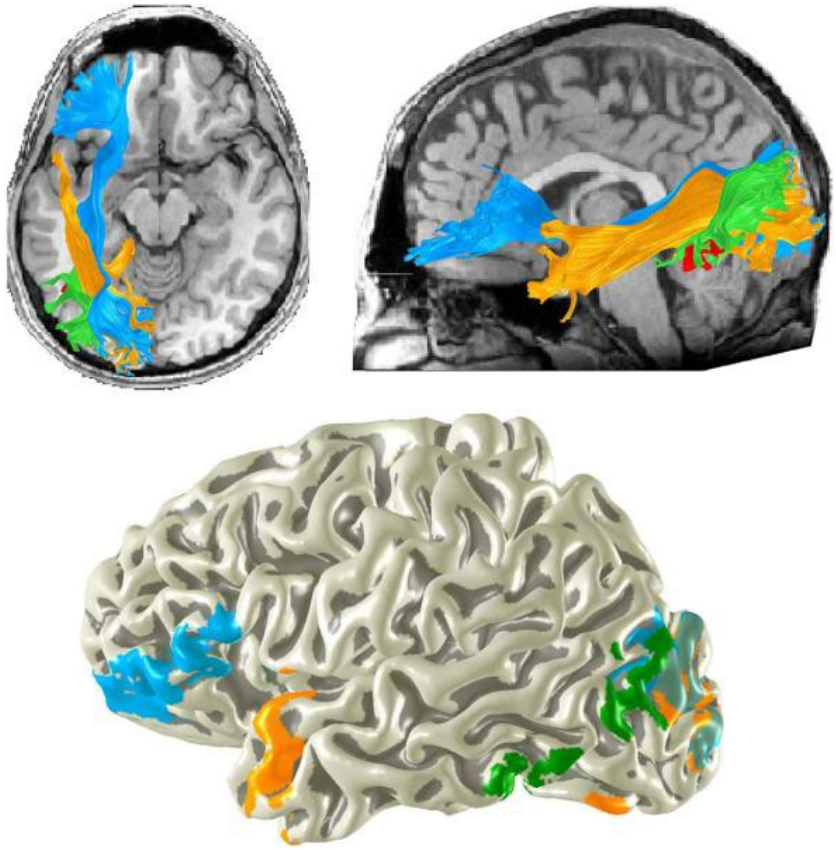
Handles reading as an overlaid function



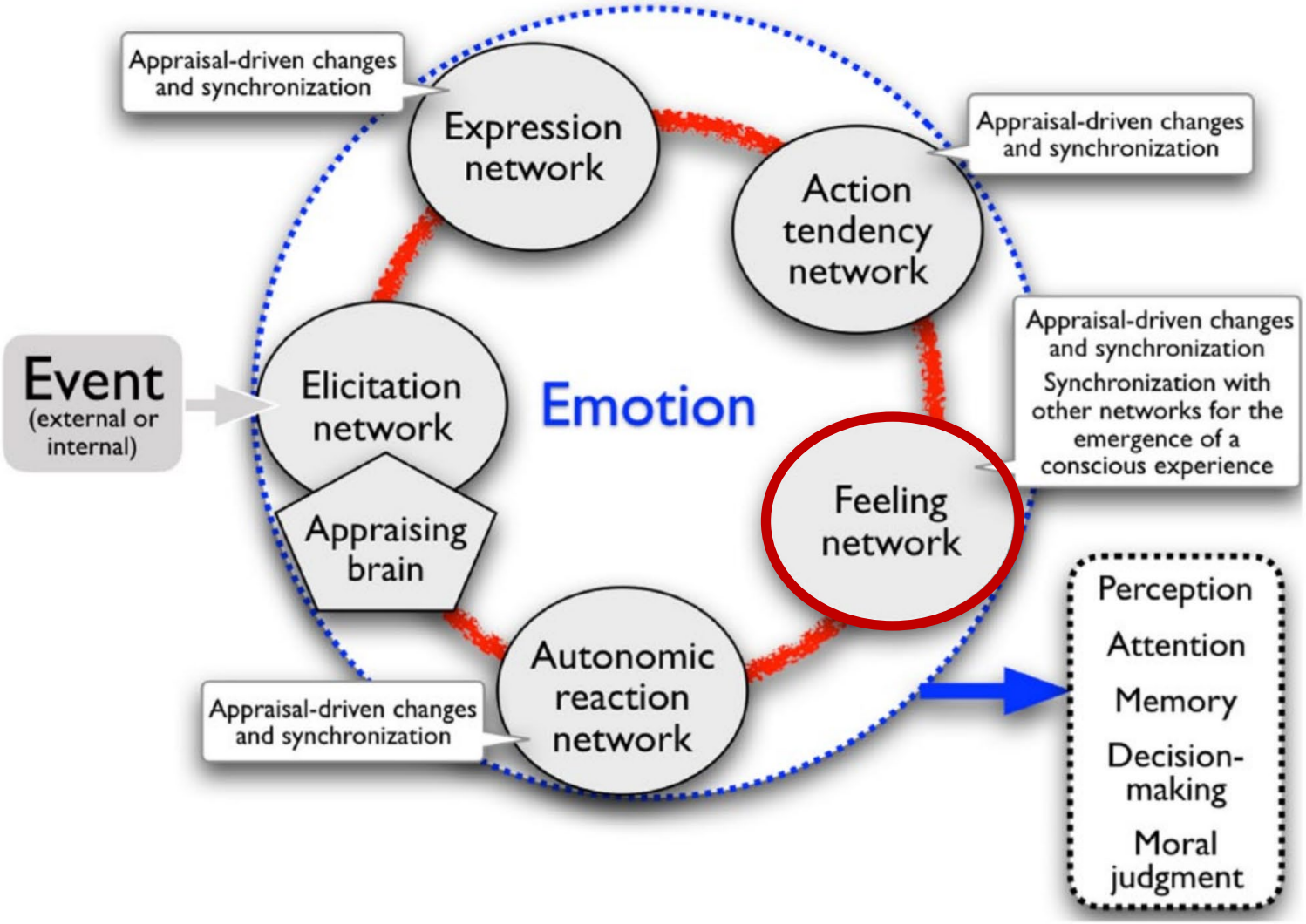
Pathways connecting the literate **Visual Word Form Area (VWFA)** to anterior cingulate cortex and anterior portions of the insula.

Literacy ***creates pathways*** connecting the VWFA to structures that are part of the 'feeling network,' enabling 'deep reading' and 'transportedness.'*

The VWFA also connects to speech areas in the left hemisphere, with effects on language processing in general.**



*Maryanne Wolf. 2016. *Tales of Literacy for the 21st Century*. Oxford UP.
**Stanislas Dehaene et al. 2010. 'How learning to read changes the cortical networks for vision and language.' *Science* 330: 1359-64.



Sander, David, Didier Grandjean and Klaus R. Scherer. 2018. ‚An appraisal-driven componential approach to the emotional brain.' *Emotion Review* 10(3).219-31. DOI: 10.1177/1754073918765653.

Brains thrive on language nutrition.

Supplemental language nutrition for brain building

Children's books -- especially in interactive reading sessions with an adult -- enrich, reinforce, and expand language processing with input over and beyond what children year at home (rhyme, meter, neologisms, amusing linguistic violations, etc.)*

The brain structures built during acquisition and put to use during second-language learning can be stimulated again in old age: Learning a foreign language in old age can delay Alzheimer's.**

*__Ralf Thiede__. 2019. 'Synesthetic entrainment in interactive reading sessions of children's books.' *Children's Literature Association Quarterly* 44.4: 381-400.

**Sujin Kim et al. 2019. 'Bilingualism for dementia: Neurological mechanisms associated with functional and structural changes in the brain.' *Frontiers in Neuroscience* 13: 1-15.

Brains suffer on language malnutrition.

The symptoms of **‘verbal stinting’** present clinically as early as 24 months of age.* One symptom is a smaller cortical surface area.**

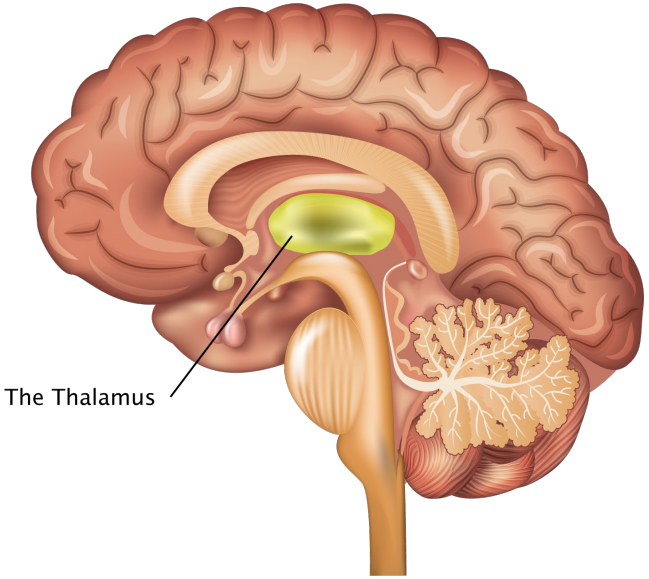
*Jenny S. Radesky, Judith Carta, and Megan Bair-Merritt. 2016. ‘The 30 million-word gap: Relevance for pediatrics.’ *JAMA Pediatrics* 170.9: 825-26.

** Cassidy L. Mcdermott et al. 2019. ‘Longitudinally mapping childhood socioeconomic status associations with cortical and subcortical morphology.’ *Journal of Neuroscience* 38.9: 1365-73.

The **thalamus** consists of nuclei that are connected via feedforward and feedback pathways to all areas of the neocortex. In their local interactions, those nuclei coordinate remote cortical areas (incl. language).*

The thalamus synchronizes cortical areas so they cooperate (e.g. on linguistic tasks) and hold mental representations.**

Children suffering from linguistic malnutrition have a lower thalamic volume.***



*Fabian Klostermann, Lea K. Krugel, and Felicitas Ehlen. 2013. 'Functional roles of the thalamus for language capacities,' *Frontiers in Neuroscience* 7:32.
**Mathieu Wolff, and Seralynne D. Vann. 2019. 'The cognitive thalamus as a gateway to mental representations.' *Journal of Neuroscience* 39.1: 3-14.
***Cassidy L. Mcdermott et al. 2019. 'Longitudinally mapping childhood socioeconomic status associations with cortical and subcortical morphology.' *Journal of Neuroscience* 38.9: 1365-73.

Implication: Adopt the Universal Declaration of Linguistic Rights (1996 Barcelona Declaration)*

Declare the human right to access to language in equal quantity and quality.**

* https://en.wikipedia.org/wiki/Universal_Declaration_of_Linguistic_Rights

Daniel R. Boisvert and **Ralf Thiede. 2020. *Language, Mind, and Power: Why We Need Linguistic Equality.* Routledge.

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Universal Declaration of Human Rights (UDHR) 10 Dec. 1948

includes some linguistic human rights (LHR):

- Article 2 – all individuals are entitled to human rights without discrimination based on language
- Article 10 – individuals are entitled to fair trials, which includes the right to an interpreter if needed
- Article 19 – individuals have the right to freedom of expression, in any language they choose
- Article 26 – individuals have the right to education, regardless of language