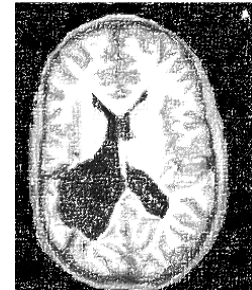
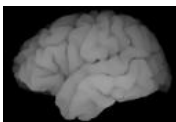


FUNCTIONAL RECOVERY OF LANGUAGE FUNCTIONS AFTER PERINATAL STROKE



Clément François
Laboratoire Parole et Langage
CNRS, AMU, ILCB



NeoBrain3
02/06/2025



Dr. Antoni Rodriguez-Fornells



Dr. Laura Bosch

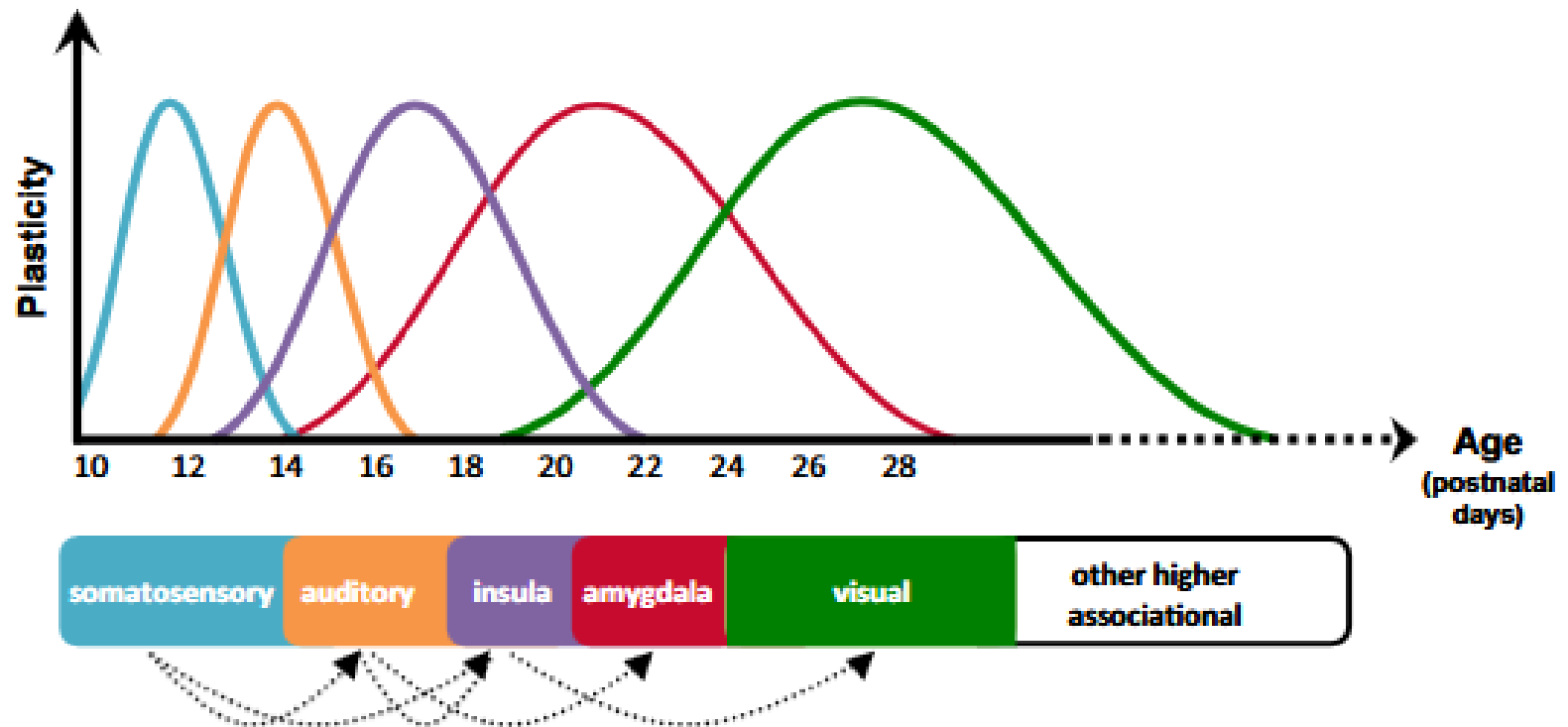


Dr. Alfredo Garcia-Alix

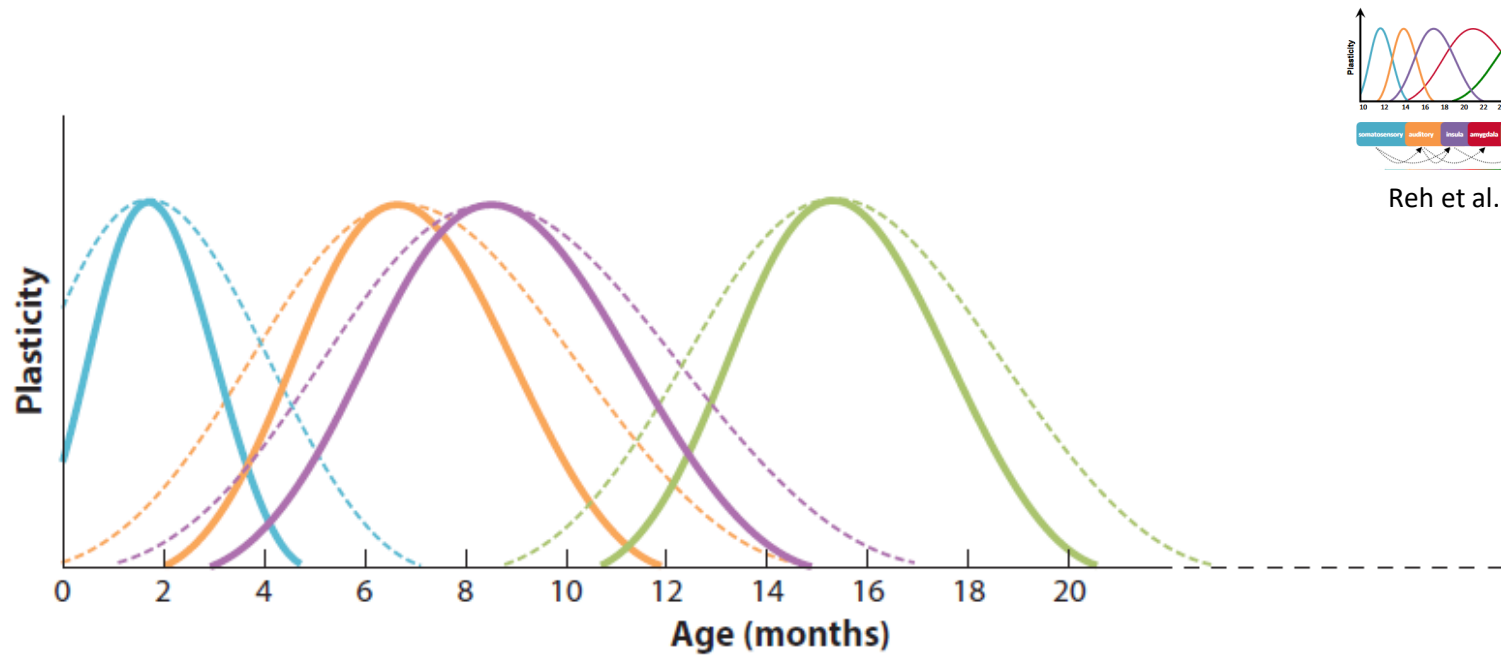


Dr. Pablo Ripollès

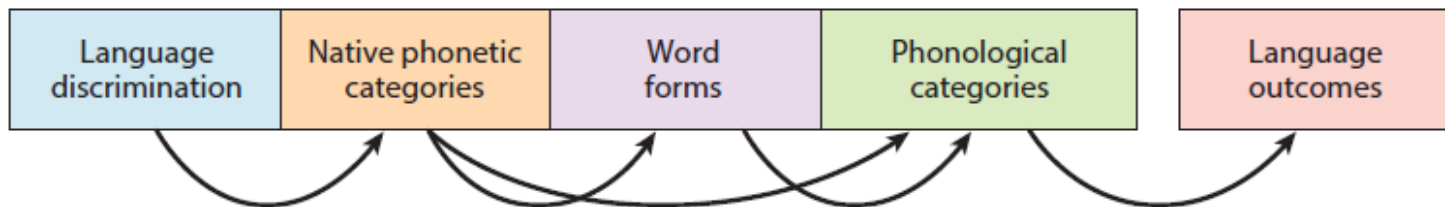
Critical periods of brain plasticity during early development



Critical periods of brain plasticity during early **language** development

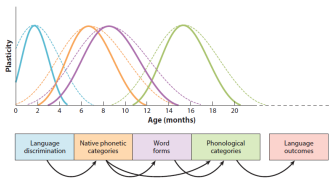


Reh et al. (2020). *PNAS*

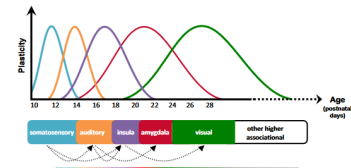


Werker & Hensch. (2015). *Ann. Rev. Psychol.*

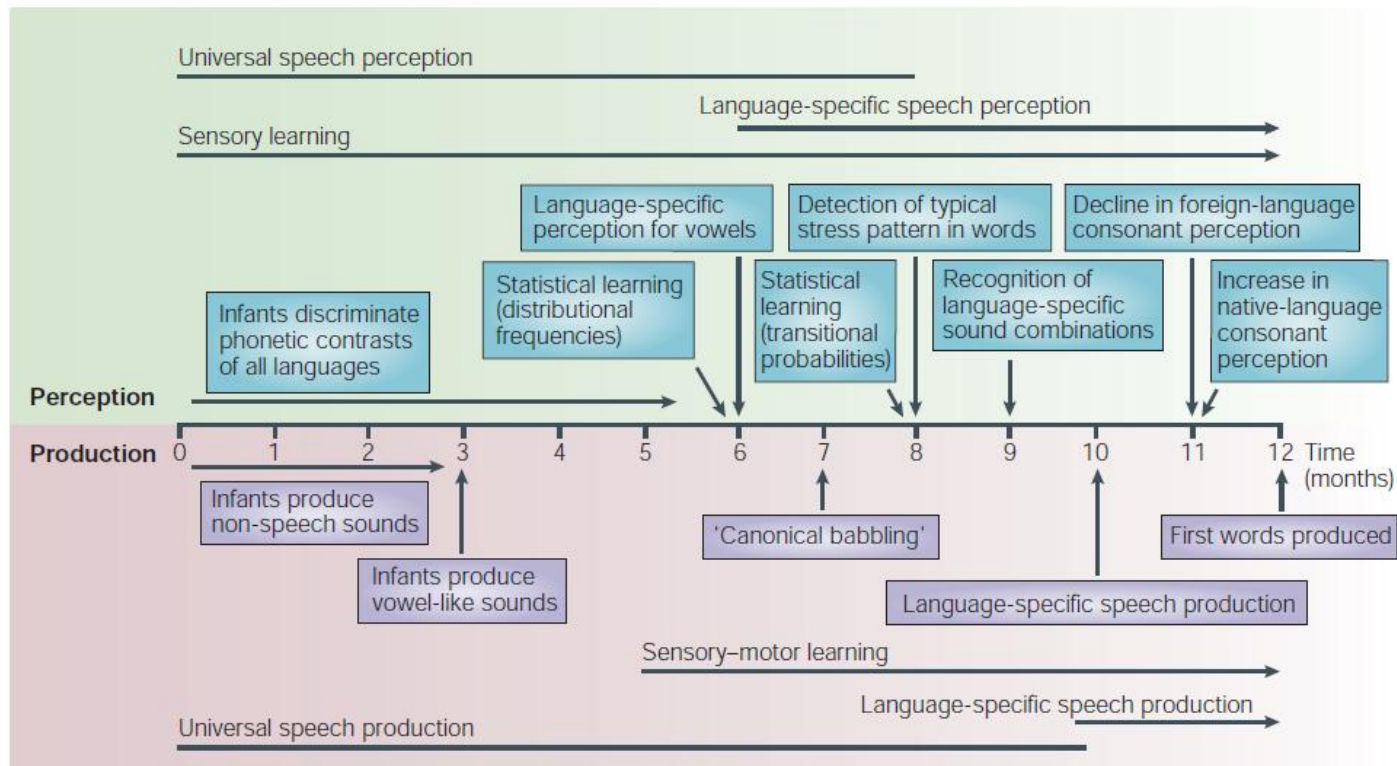
Critical periods of brain plasticity during early **language** development



Werker & Hensch. (2015). *Ann. Rev. Psychol.*

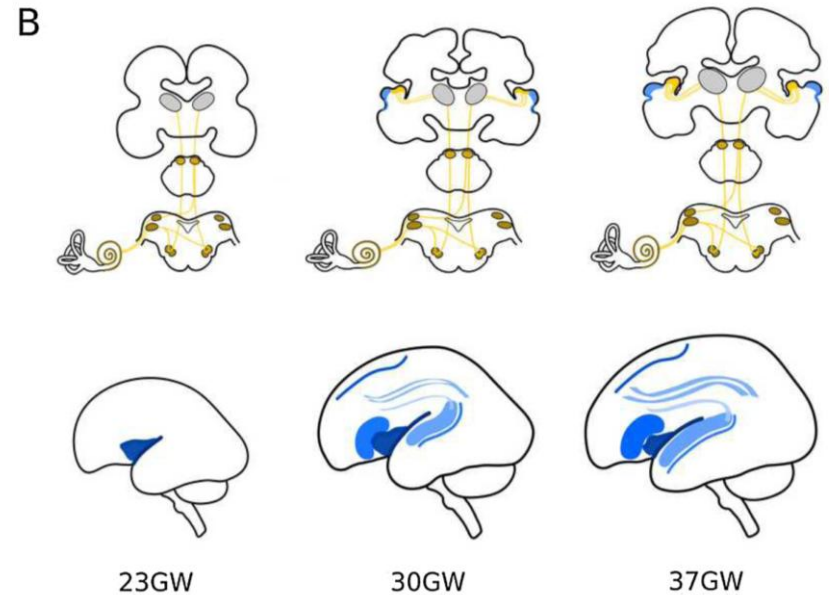
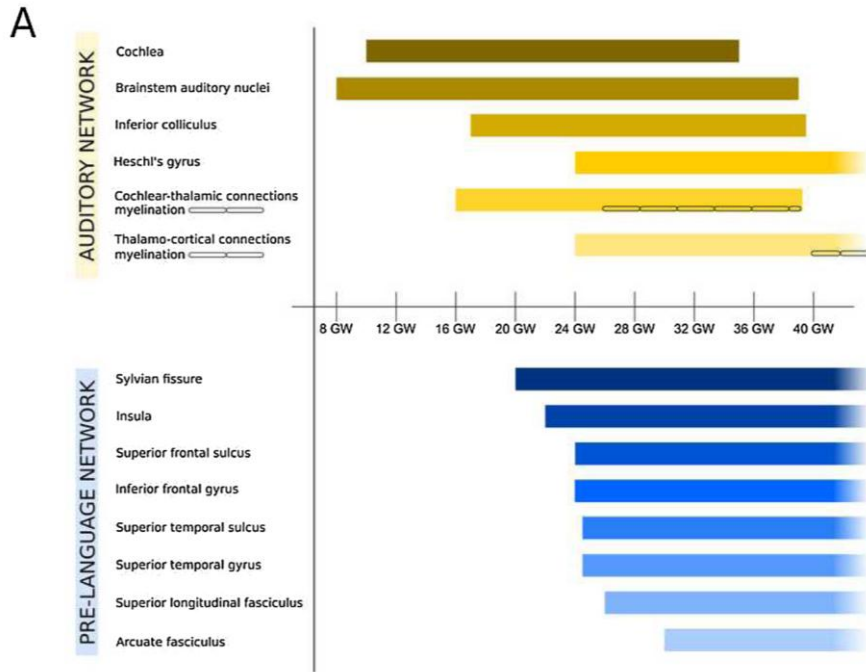


Reh et al. (2020). *PNAS*

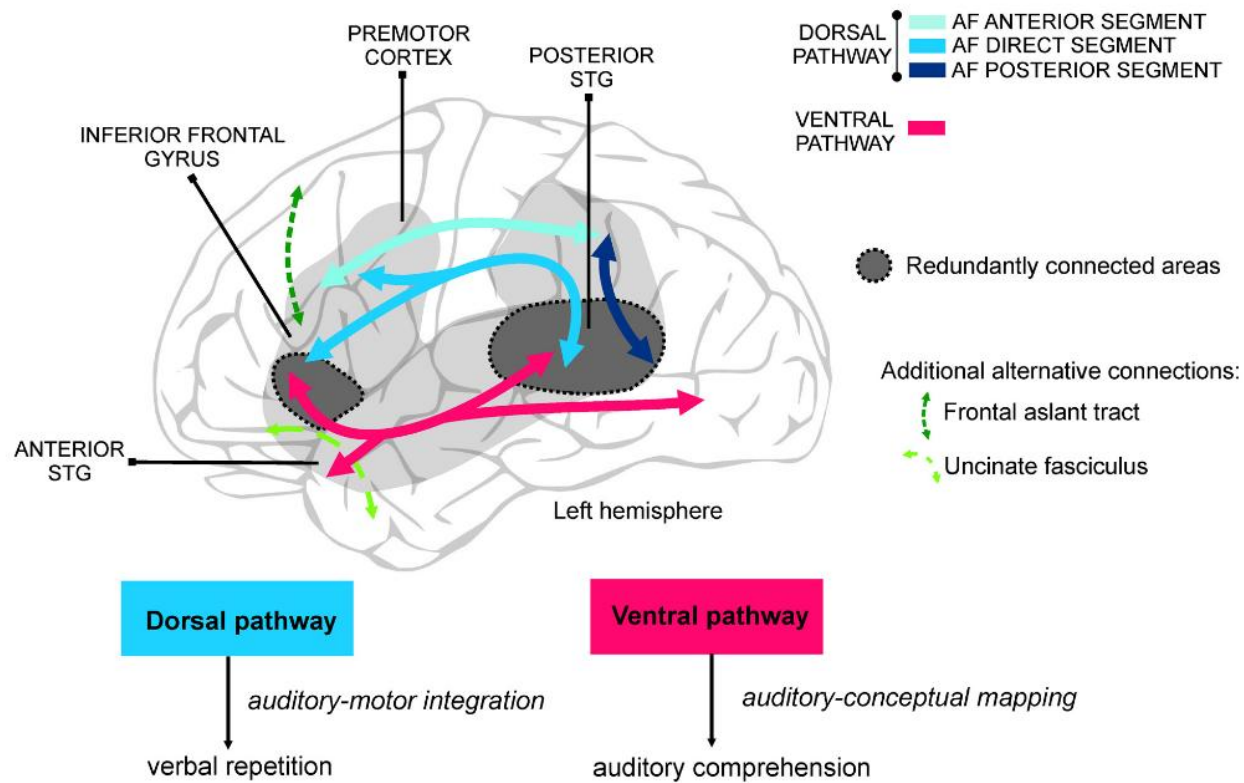


Kuhl. (2004). *Nature Reviews Neuroscience*

Language network before birth

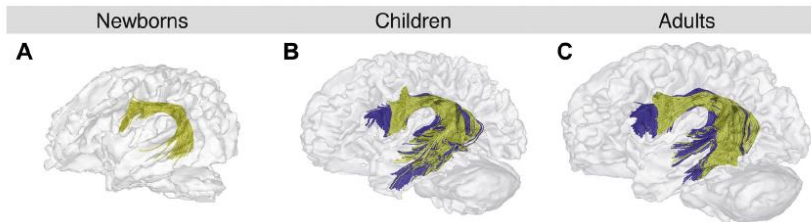


Dual-stream model of language processing



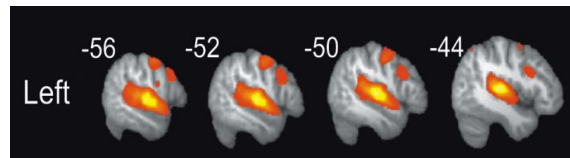
López-Barroso, D., & de Diego-Balaguer, R. (2017).

Dorsal pathway for language learning and production

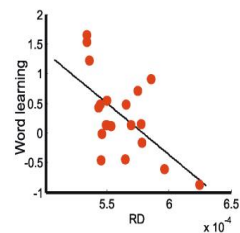


Brauer et al., (2013). *Brain & Language*

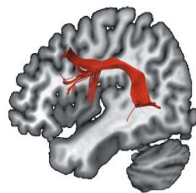
Arcuate Fasciculus matures slowly
(no termination in the IFG @ birth)



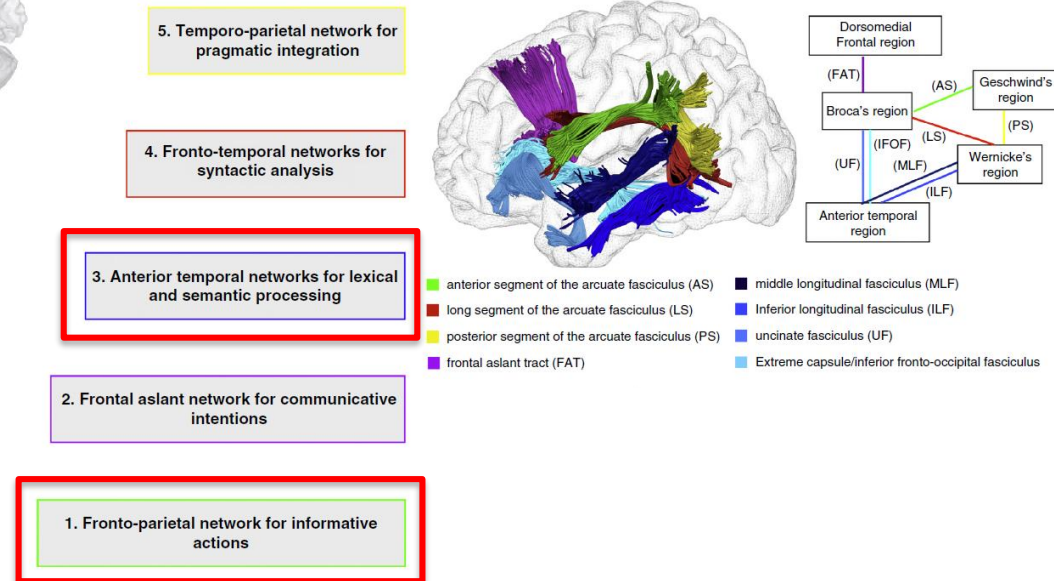
Left



Lopez-Barroso et al. (2013). *PNAS*.



AF integrity linked to word learning in adults



Catani & Bambini. (2014). *Current Opinion in Neurobiology*.

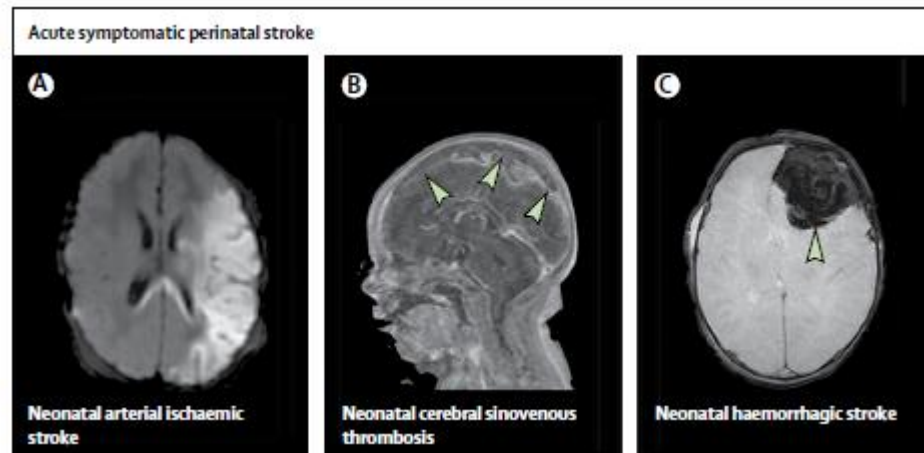
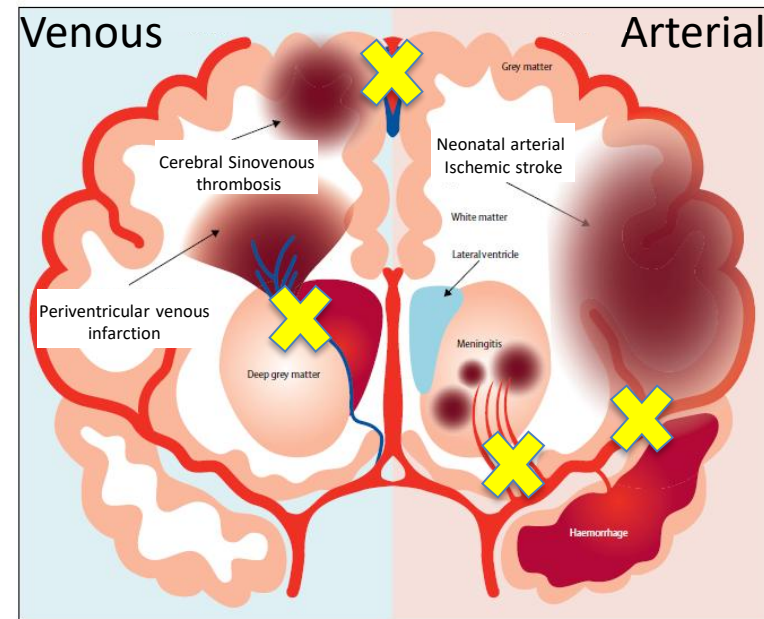
AF necessary for early audio-motor integration



Babbling / Learning / Work. Mem.

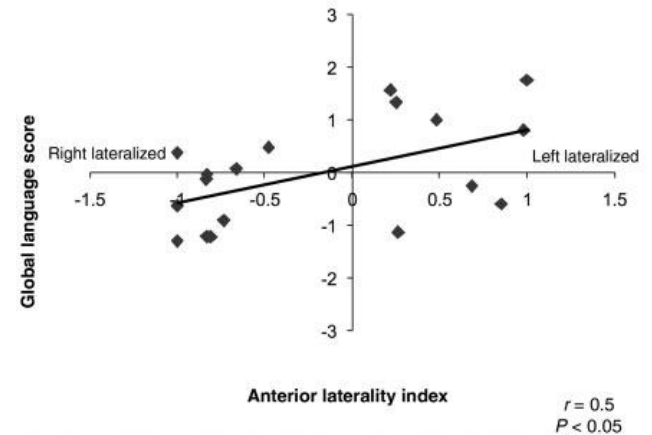
Perinatal Arterial Ischemic Stroke (PAIS)

- PAIS = stroke occurring between birth and 1 month of age
- Increasingly recognized form of neurological injury (Chabrier et al., 2011)
- Leading cause of congenital hemiplegia & epilepsy (Lee et al., 2005)
 - 60% cerebral palsy
 - 30-60 % epilepsy
 - **25 % language delays**
 - 22% behavioral abnormalities
- Large variability in language recovery (Fuentes et al., 2014; Murias et al., 2014; Anderson et al., 2011).
- Deficits for complex cognitive/linguistic functions (Murias et al., 2014)



Impact of left stroke on language functions

- Induces aphasia in adults (Kümmerer et al, 2013)
- Sometimes induces developmental aphasia (Northam et al., 2018)
- Hypothesis for functional recovery after PAIS
 - Spared perilesional areas (Raja-Beharelle et al., 2010)

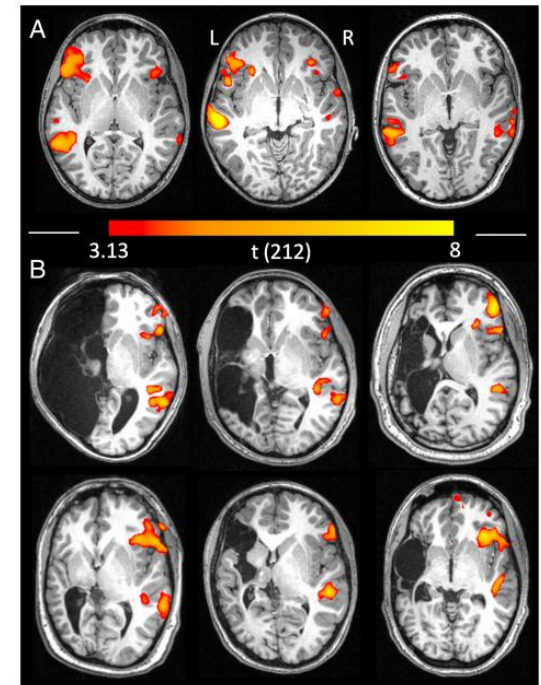


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 - Cortical reorganization to the right (Newport et al., 2022)



homologous right regions “take over” language functions (Staudt et al., 2002; Lidzba & Krägeloh-Mann, 2005; Tillema et al., 2008)



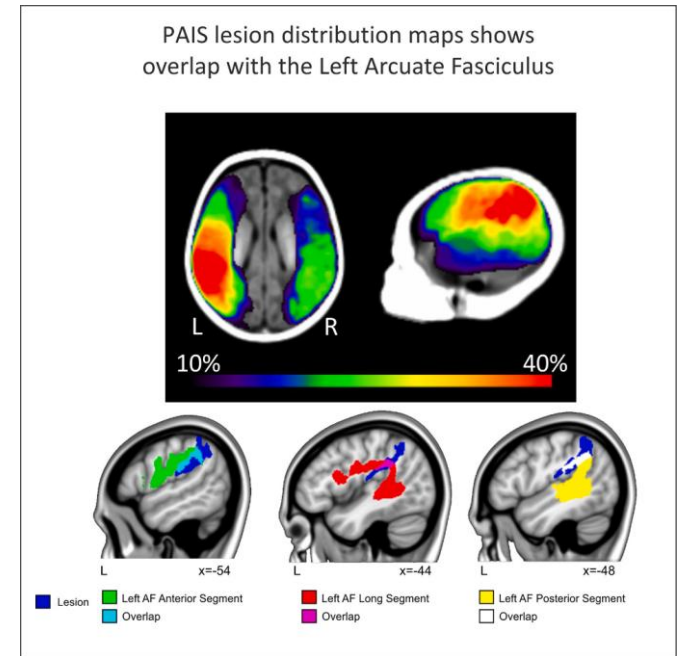
(Newport et al., 2022, PNAS)

Impact of left stroke on language functions

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- Sometimes induces developmental conduction aphasia (Northam et al., 2018)
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homologous right regions “take over” language functions (Staudt et al., 2002; Lidzba & Krägeloh-Mann, 2005; Tillema et al., 2008)



(François et al., 2021, Brain & Language)

What about the impact of PAIS on the Arcuate Fasciculus?

Very few studies at very young ages (i.e., before reading acquisition)

No studies combining fMRI, DTI and rs-fMRI

No studies assessing word-learning abilities

Impact of early brain damage on language functions



Neuropsychological assessment (@ 42 months)

- NEPSY-II
- Peabody Picture Vocabulary Test
- Phonological Development & Expressive Language complexity
- Word-learning ability: *Fast Mapping* task



Neuroimaging data (@ cca 42 months)

- **Structural**
 - High-resolution T1 and T2
 - FLAIR
 - DTI (29 directions, 1 x 1 x 2.5 mm³)
- **Functional**
 - Passive story-listening task
 - Resting state



Impact of early brain damage on language functions

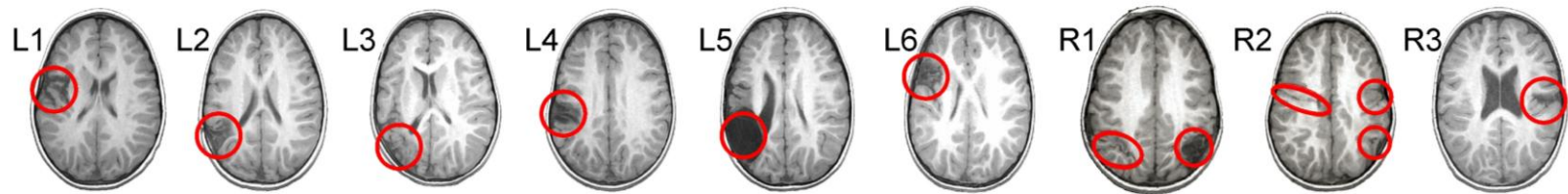
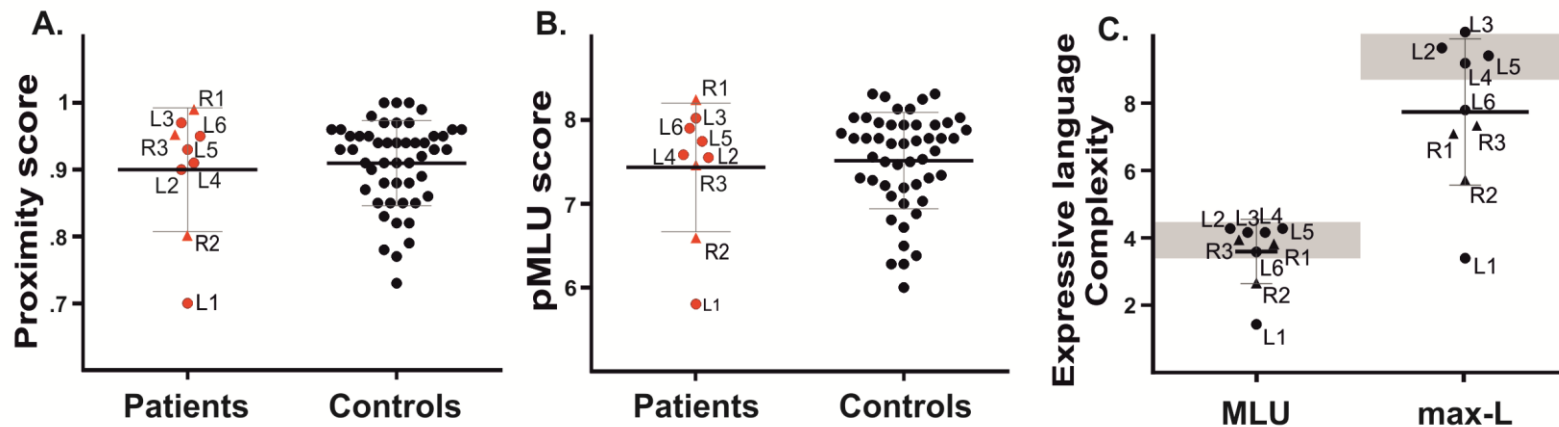
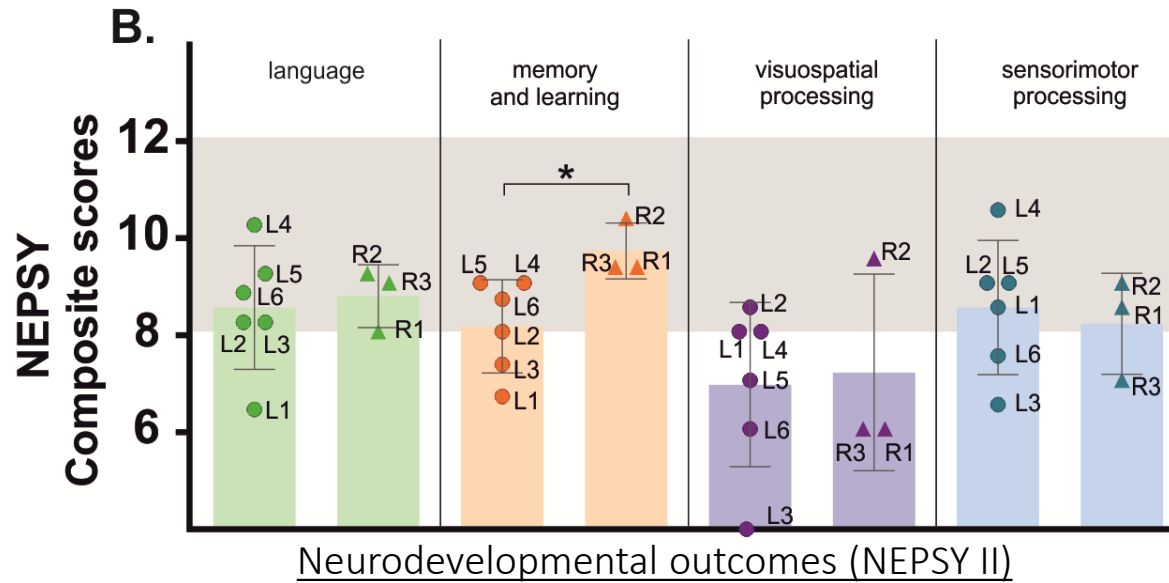


Table 1. Children demographic data and lesions main features.

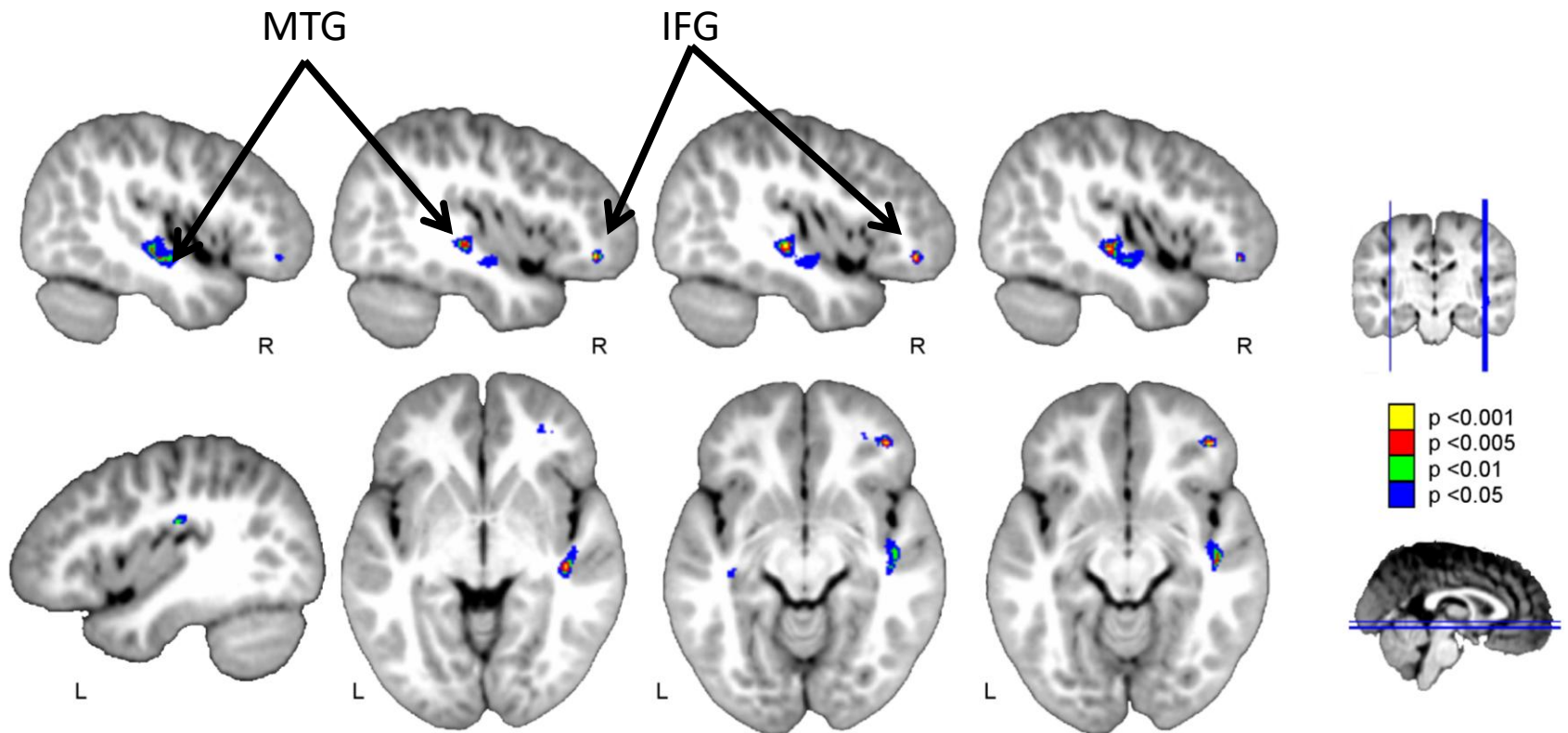
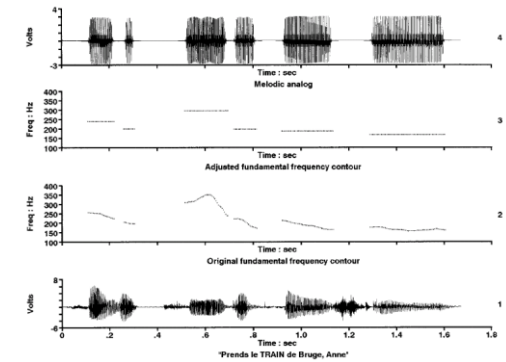
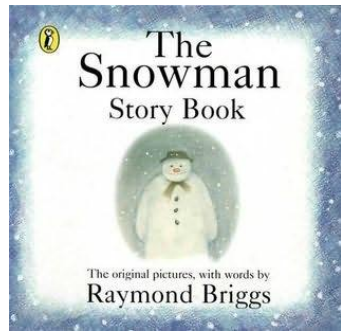
Patient code	Age at test (months)	Gender	Gestational age at birth (weeks)	Birth weight (g)	Clinical debut (hours of age)	Age of MRI diagnostic (days)	Vascular territory	Stroke Volume at birth (mL)	Motor impairment (Hemiplegia)	Epilepsy*
L1	48	M	41	3160	Clonic Seizures at 12 hours	4 days	M2 L	18890	No	No
L2	48	F	41	2960	Clonic Seizures at 26 hours	10 days	M4 L	47428	Si	No
L3	50	M	40	3560	Clonic Seizures at 48 hours	20 days	M1 Post-bifurcation L	17588	No	No
L4	41	F	41	2600	Clonic Seizures at 18 hours	4 days	M2 sup L	27882	No	No
L5	42	M	39	3340	Clonic Seizures at 24 hours	5 days	M1 Post-bifurcation L	36512	No	No
L6	49	M	40	3025	Clonic Seizures at 41 hours	5 days	M1 Post-bifurcation L	23509	Si	No
L/R1	41	M	39	3000	Clonic Seizures at 16 hours	8 days	M3 bilateral post	30637	No	No
L/R2	41	M	39	3240	Clonic Seizures at 24 hours	6 days	M1 Post-bifurcation R & M4 sup L	15332	No	No
R1	41	M	41	3045	Clonic Seizures at 72 hours	5 days	M2 sup R	7063	Si	No

* Epilepsy = at least two recurrent and unprovoked seizures.



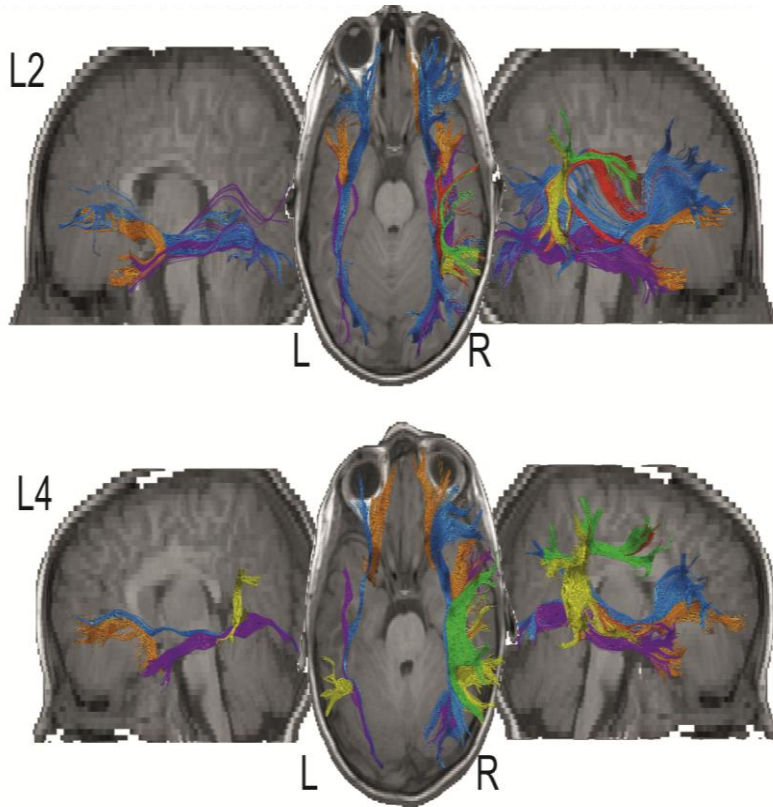
Phonological development & expressive complexity from children's spontaneous production

Functional activations despite sedation...

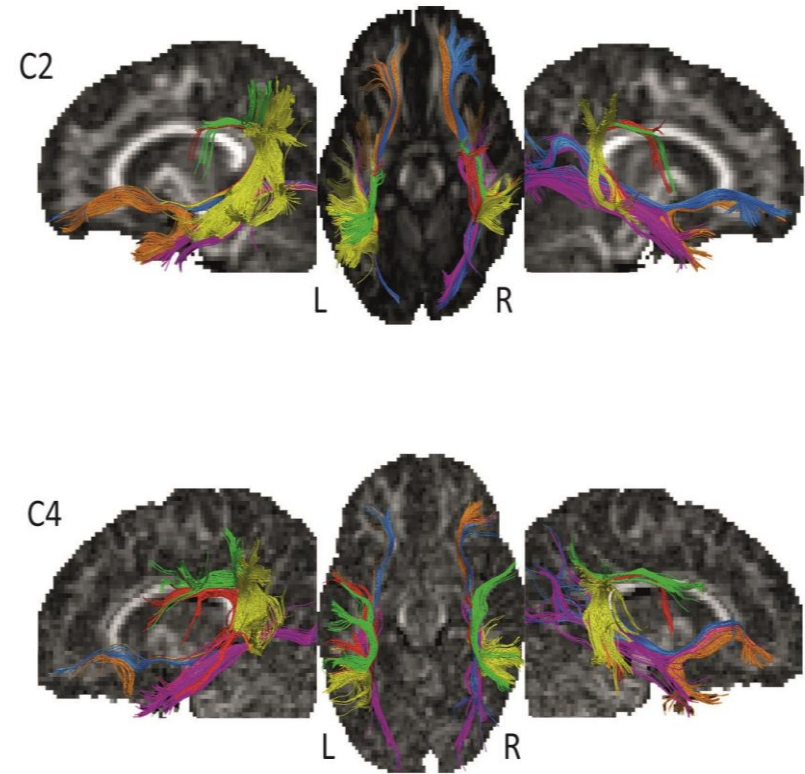


Deterministic tractography of dorsal and ventral pathways

PAIS



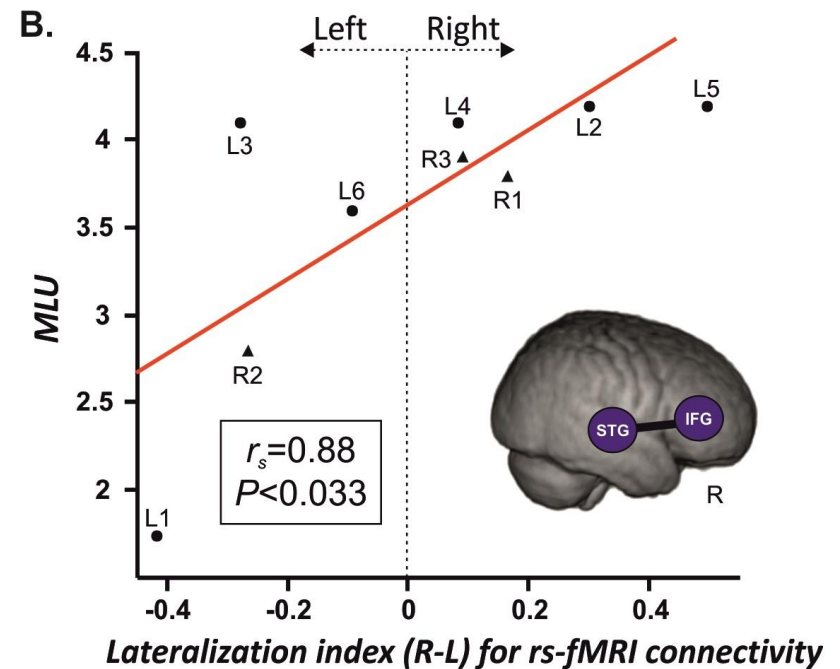
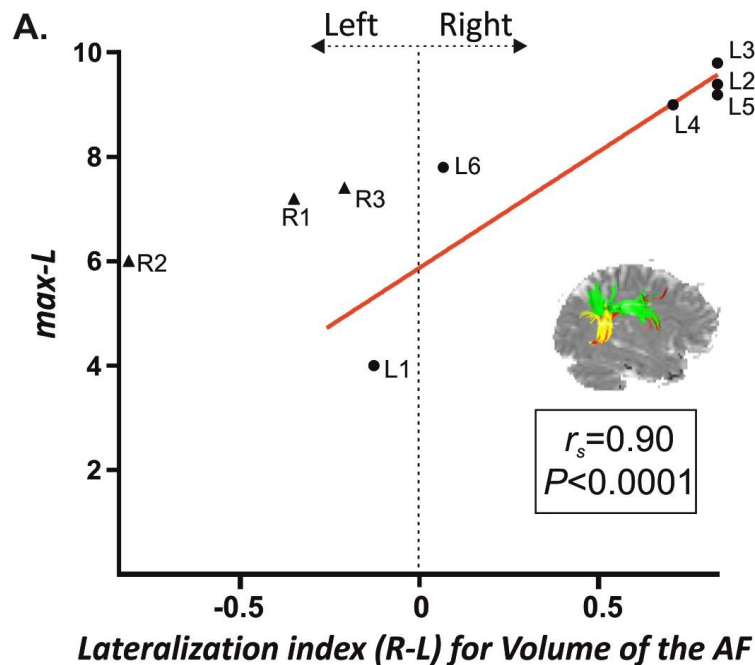
CONTROLS



Virtual *in vivo* dissections

- Pre-processing with **FSL - FNIRT** / **Cost-function masking** / **LONI LPBA40 brain atlas**
- Fiber orientation distributions obtained with **StarTrack** using spherical deconvolution
- Trackvis for reconstructing the 3 segments of the AF, UF, IFOF, ILF (Catani et al. 2007)
- DTI data from 10 age-matched controls (Richards et al., 2015)

Functional and structural reorganization linked to language production



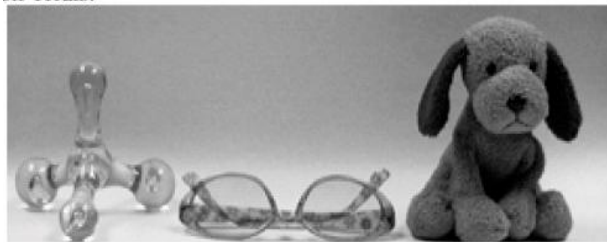
Transfer of language functions to the right hemisphere

Mecanism of functional recovery

Evaluating novel word learning abilities

Referent selection

(8 trials, 4 with one new, 4 with familiar only)



Gomi

Glasses

Dog



Cow

Cube

Flas



Duck

Kufeta

Car

Highly **supportive instructions** to maximize word learning
"Yes, this is a "flas". The "flas" is small and it makes some noise.
Can you name it?"



Fast Mapping refers to a child's ability to learn about a new word or concept with minimal exposure to it.

Immediate recall (8 trials)

2 novel objects / 1 fam.

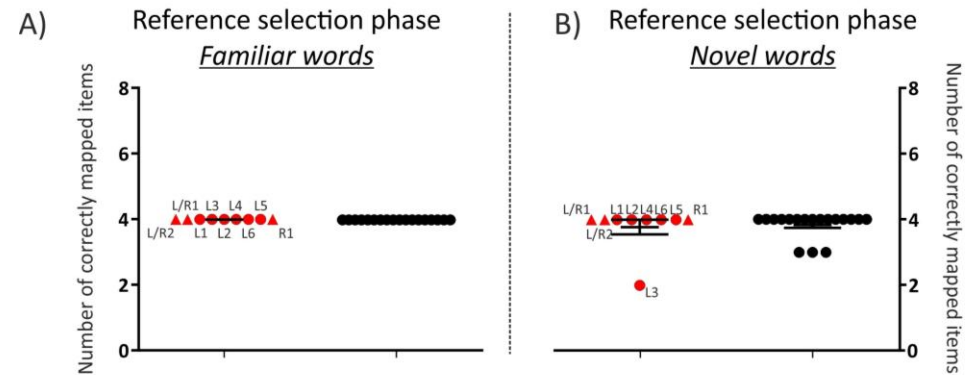
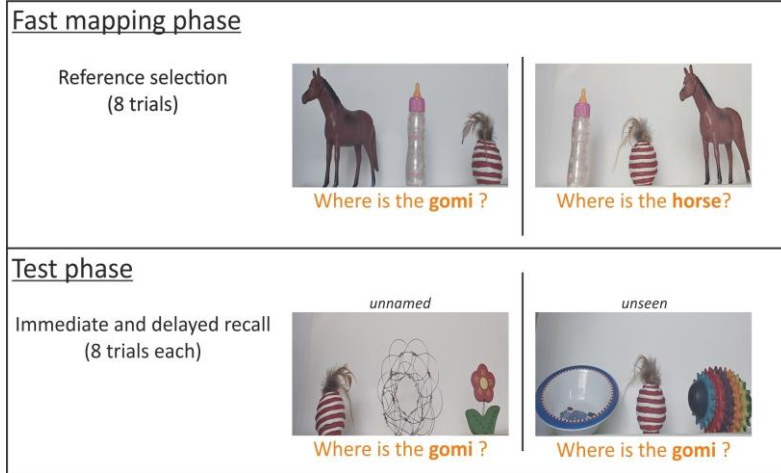
Where is the Gomi ?



Delayed recall

(after 5 min of drawing)

Novel word learning abilities and PAIS



No deficit in mapping but impaired in delayed recall test only

Negative impact of PAIS on memory processes involved during Fast Mapping?

Conclusions

Psychonomic Bulletin and Review (2018) 25:2083–2101
<https://doi.org/10.3758/s13423-018-1451-8>

THEORETICAL REVIEW

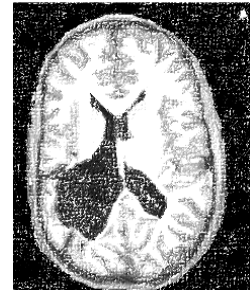


Small is beautiful: In defense of the small-*N* design

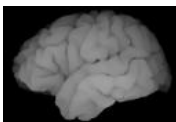
Philip L. Smith¹ · Daniel R. Little¹

- Relevance of small *N* designs for studying rare pathological populations
- Functional and structural lateralization of language functions to the right linked to language production @ 3.5 yo
- Memory deficits during the FM task @ 3.5 yo → “*Grow into your deficit hypothesis*”?
- Inter-hemispheric plasticity based on structural and functional hyperconnectivity as a viable recovery mechanism for functional recovery after PAIS??
- Multimodal neuroimaging & behavioural studies to better understand the impact of early brain lesions and dysmaturities on complex cognitive functions
- Role of additional variables (type of stroke, sex, lesion size/location)?

THANK YOU 😊



Clément François
Laboratoire Parole et Langage
CNRS, AMU, ILCB



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