Functional Connectivity for Print and Speech Processing in Emerging Readers

Lynn Eickholt[1], Rebecca Marks[1], Florence Bouhali[2], Olga Kepinska[2,3], Nikola Vukovic[2], Jocelyn Caballero[2], Myriam Oliver[2], Roeland Hancock[2,3], Yuuko Uchikoshi[4], Ioulia Kovelman[1], & Fumiko Hoeft[2,3]

[1]University of Michigan, Ann Arbor, [2]University of California, San Francisco, [3]University of Connecticut, [4]University of California, Davis

What is the relationship between the **Visual Word Form Area** (VWFA) and language regions of the brain for 5-6 year old emerging readers?

The VWFA is part of the fusiform gyrus that…

- becomes specialized for reading words[1]
- is responsive to print and speech[2]

Anatomical connectivity between VWFA and language regions precedes literacy in young children[3]

Does functional connectivity between VWFA and **superior temporal language regions** (STS) also precede fluent literacy?

Results:

Activity in VWFA is associated with activity in left STS during auditory and visual conditions

- Strength of VWFA-STS connectivity during print processing is correlated with oral language skill (vocabulary and phonological awareness)
- VWFA-STS connectivity during speech is not associated with language proficiency, word reading, or rapid naming

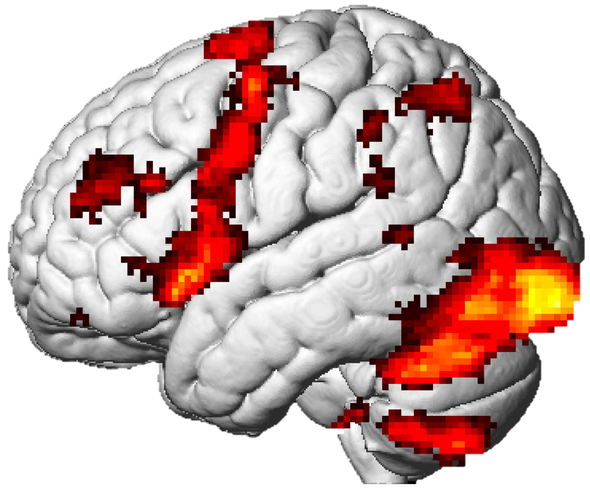
Findings suggest an early-emerging or pre-existing association between VWFA and language function

Correlations between task-related VWFA-STS connectivity and cognitive abilities

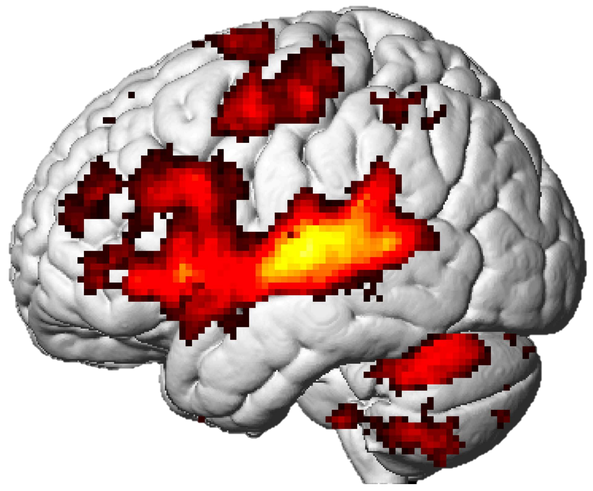
	Reading words	**Hearing** words
Receptive vocab	.31**	.07
Expressive vocab	.25*	.01
Phon. awareness	.27*	-.07
Word reading	.23†	-.06
Rapid naming	-.12	.13

Note: $N = 70$. †$p = .062$, *$p < .05$, **$p < .01$.

Brain Activity When Reading Words
PRINT > REST

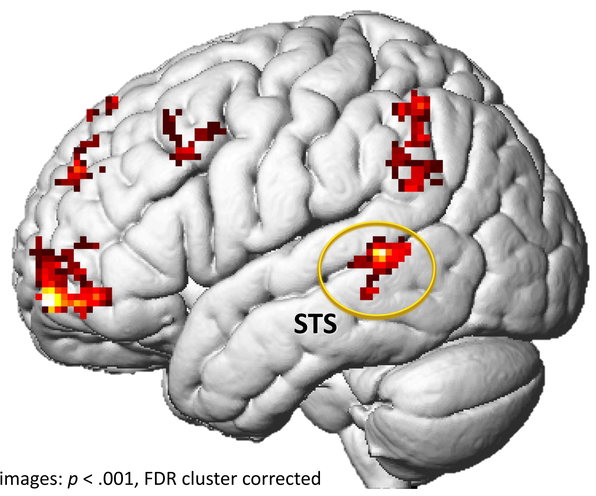


Brain Activity When Hearing Words
SPEECH > REST

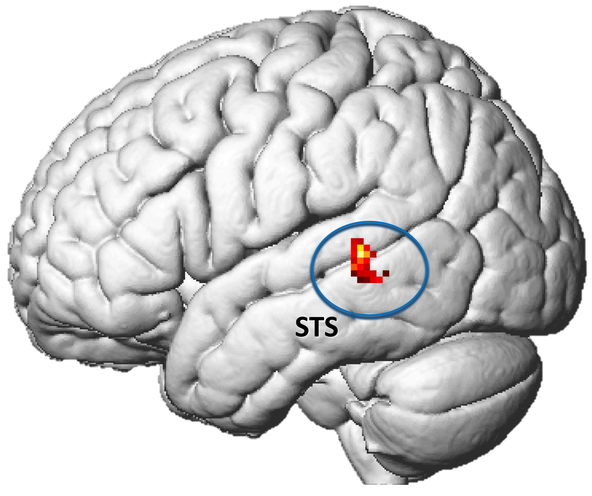


Both when **reading** and **hearing** words, beginning readers show task-related connectivity between **visual** and **auditory** word processing regions.

VWFA Functional Connectivity For PRINT



VWFA Functional Connectivity For SPEECH



All images: $p < .001$, FDR cluster corrected

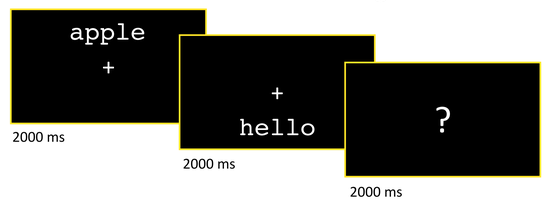
Method:

Descriptives	M	(SD)
Participants	*N* = 70	
Gender (M:F)	34:36	
Age (years)	5.73	(0.33)
Non-verbal intelligence [a]	105.47	(14.57)
Vocabulary [b]	106.01	(12.41)
Word identification [c]	97.24	(13.54)

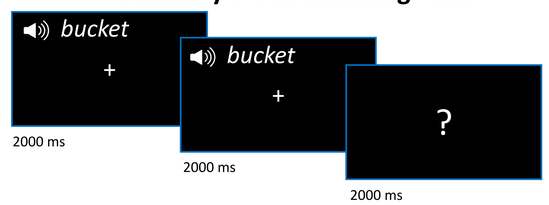
[a] KBIT matrices (SS), [b] W-J Picture Vocab (SS), [c] W-J LWID (SS)

- Kindergarteners completed visual and auditory word matching tasks during fMRI
- 5 mm VWFA regions of interest were anatomically defined based on a meta-analysis of word reading in adults[4]
- Functional connectivity (PPI) analyses in SPM revealed a network of brain regions that were correlated with activation in the VWFA ROI during visual and auditory tasks

Visual Word Matching Task



Auditory Word Matching Task



References: 1. Dehaene-Lambertz, Monzalvo & Dehaene (2018), *PLOS Biol*. **2** Wang, Joanisse & Booth (2018), *Dev. Cogn. Neurosci.* **3.** Saygin et al. (2016), *Nat. Neurosci*. **4.** Jobard, G. et al, (2003), *NeuroImage.*

Acknowledgements: We thank the National Institutes of Health (R01HD-078351 PI: Hoeft; R01HD-09249801, PI: Kovelman), the UCSF Department of Psychiatry, the Hoeft Laboratory for Educational Neuroscience, and the University of Michigan Department of Psychology.

NIH brainLENS HOEFT Laboratory for Educational NeuroScience