HOW THE BRAIN LEARNS LANGUAGE, AND WHAT DOES IT MEAN FOR TEACHING?"

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June 2021

Mofet webinar

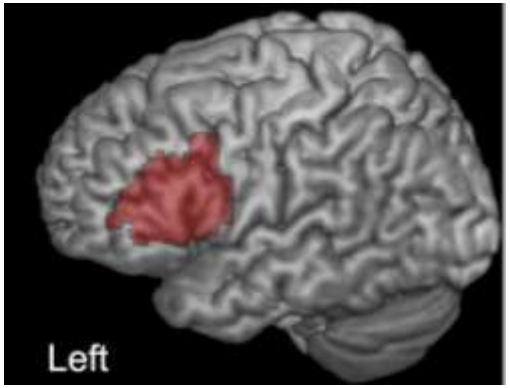
This webinar

- NSF-BSF joint grant on the
  "Effects of L1 on the neural processes involved in learning of L2"

- Bring scientifically acquired knowledge to the awareness and use of professionals in the field of education

How we study language processing in the brain?

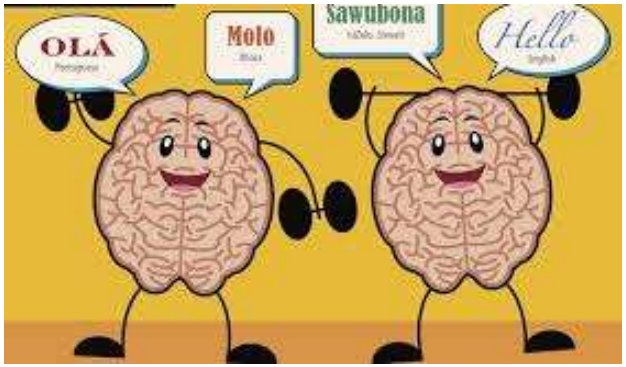
- People with brain lesions
- Functional brain imaging with fMRI



Brain plasticity

- The brain *structure* and *function* changes following an individual's experience

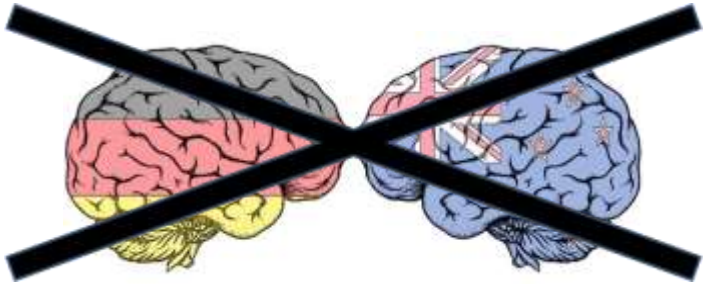
- A universal language & reading network
  - With cross-linguistic differences in brain structure and function



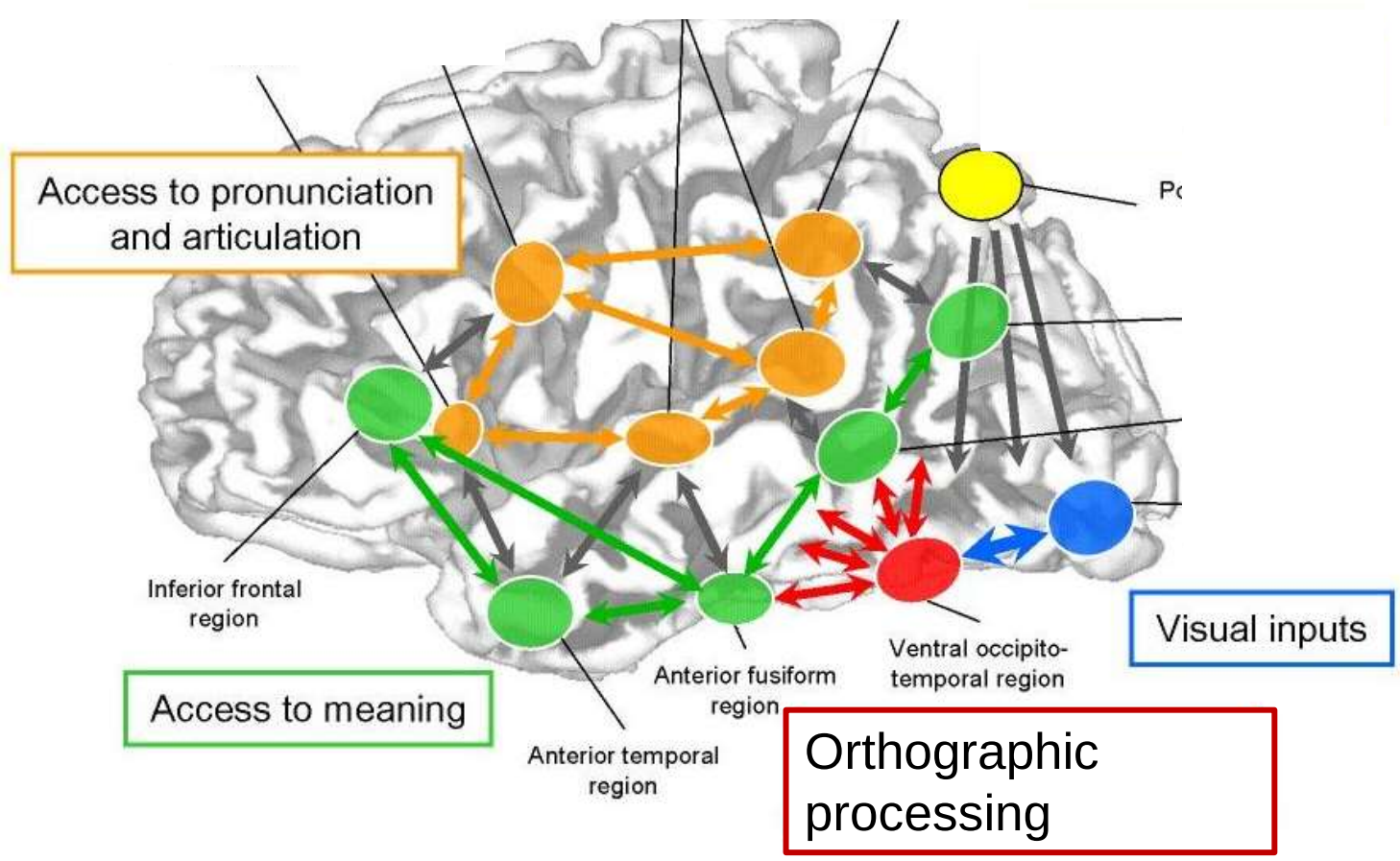
Multiple languages in one brain

- How are languages represented in the bilingual brain?
  - Proficiency and exposure
  - Order and age of acquisition (?)
  - Immersion/ instruction (?)
  - Structure of the language & orthography

  - No hemispheric division

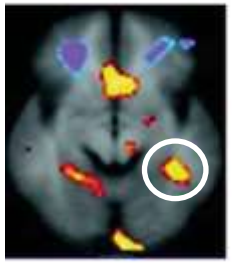


A model of reading in the brain (Dehaene, 2009)

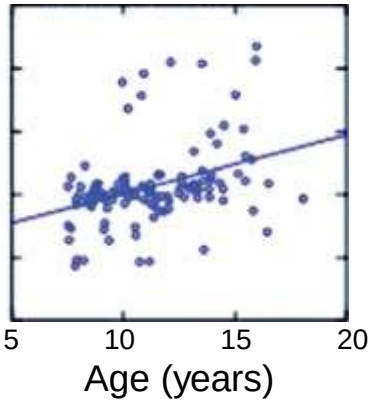


Changes in brain activation during reading acquisition in children

- Increased activation and specificity in orthographic processing (VWFA)

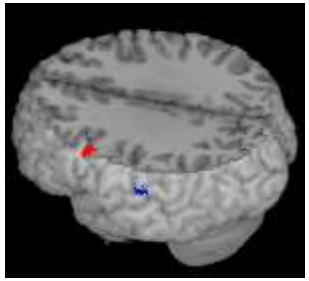


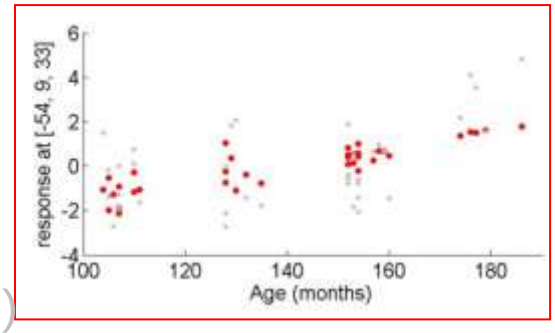
(Shaywitz, et al. 2007)



- Increased activation in phonological processing (IFG and STG)

IFG (BA 9)

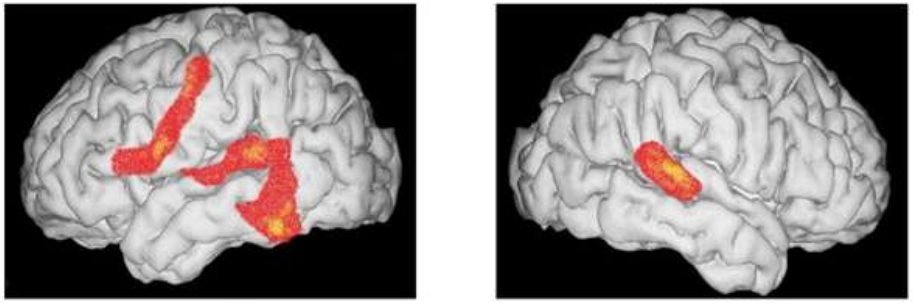




Bitan, … & Booth, NImage (2007)

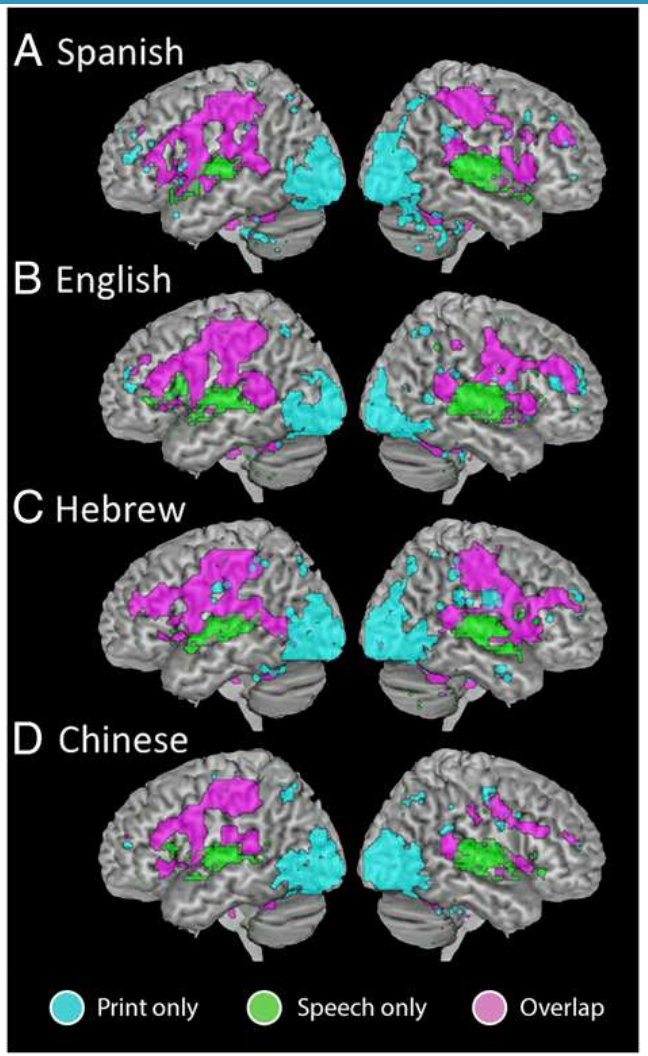
Common brain reading mechanisms across orthographies

- Across alphabets, abjads and morpho-syllabic writing systems
  - Across orthographic transparency



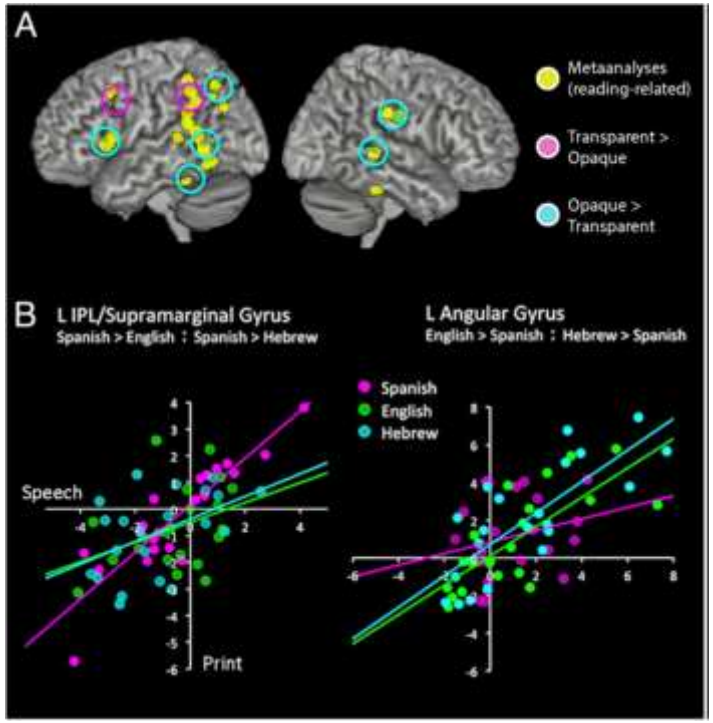
Network common to reading in Italian and in English

Paulesu et al. 2000)

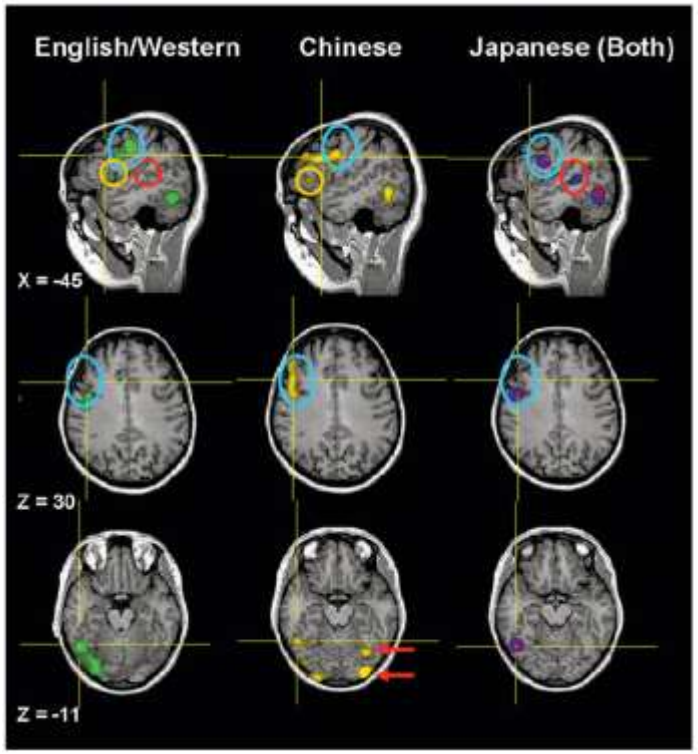


Rueckl et al. 2015)

Differences in brain reading mechanisms across orthographies



Rueckl et al. 2015)



Bolger et al. (2005)

- More ortho-phono correspondence in alphabetic/ transparent
- More orthographic bi-laterality in morpho-syllabic

Reading acquisition in different languages and orthographies

- **Tali Bitan**

  The development of a Hebrew reading brain: coping with missing vowels and a rich morphology

- **James R. Booth**

  Differences between languages in the brain basis of reading acquisition: English vs. Chinese

- **Vedran Dronjic**

  What research can teach us about teaching second language vocabulary

THE DEVELOPMENT OF A HEBREW READING BRAIN: COPING WITH MISSING VOWELS AND A RICH MORPHOLOGY

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June 2021

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- Laurice Haddad

- Prof. Tami Katzir

<u>Funded by:</u>

- *Israel Science Foundation grant no.1142/11 to Bitan & Katzir*
- *Israel Foundation Trustees grant no. 34/2011 to Bitan*

Unique properties of Hebrew orthography

- Transparent (with diacritics) vs. non-transparent (no nikud)
  - Transition ~ 3rd grade
  - Vowel letters: א, ה, ו, י
    - Ambiguous: /o//u//v/- ו ; Partial; Optional
    - But highly *familiar* even for adults

sefer סֵפֶר

sefer/ safar/ sapar/ sfar/ ספר

- Rich Semitic morphology- most words have roots

תלמיד

Outline

1. Effects of orthographic transparency on brain reading mechanisms
   in skilled & beginning readers

2. Reliance on morphological segmentation in transparent and non-transparent scripts
   in skilled & beginning readers

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1. Effects of orthographic transparency on brain reading mechanisms
   in skilled & beginning readers

2. Reliance on morphological segmentation in transparent and non-transparent scripts
   in skilled, dyslexic and beginning readers

Questions

- Do skilled adult readers process / benefit from diacritics?
  - More/ less/ same as from vowel letters?
- How are children brains affected by orthographic transparency?
  - Where is the transition happening?

Participants- native Hebrew speakers

Behavioral:

- 25 adult typical readers
- 26 adult with dyslexia
- 29 typical 2nd grade
- 29 typical 5th grade

fMRI study:

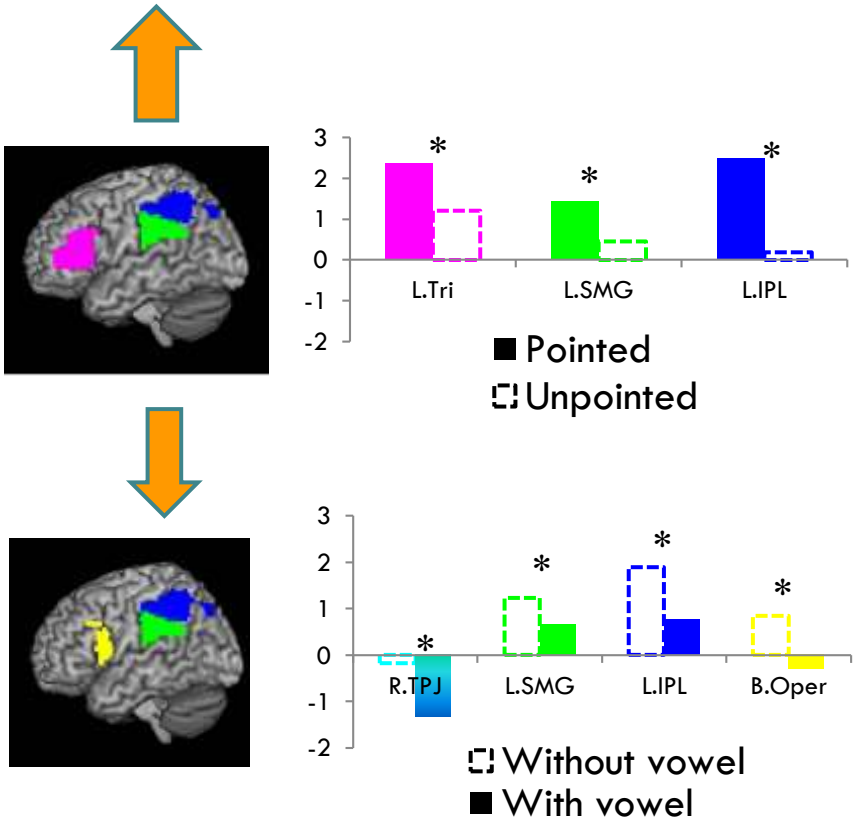
- 22 adult typical readers
- 21 adults with dyslexia
- 16 typical 2nd-3rd grade
- 9 typical 5th-6th grade

Study 1: Stimuli

Word Length		Short (3 consonants)		Long (4 consonants)	
Vowel letters		0	1	0	1
Diacritics	Pointed	דֶלֶת	תִּירָס	אַרְנָב	לִיפְתָן
	Un-pointed	דלת	תירס	ארנב	ליפתן
Pronunciation (Meaning)		/delet/ (door)	/tiras/ (corn)	/arnav/ (rabbit)	/liftan/ (dessert)

- 24 words per conditions
- **Task:** oral reading

Skilled readers: transparency

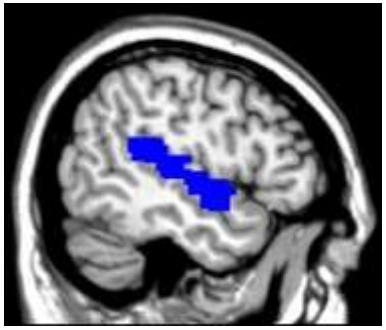


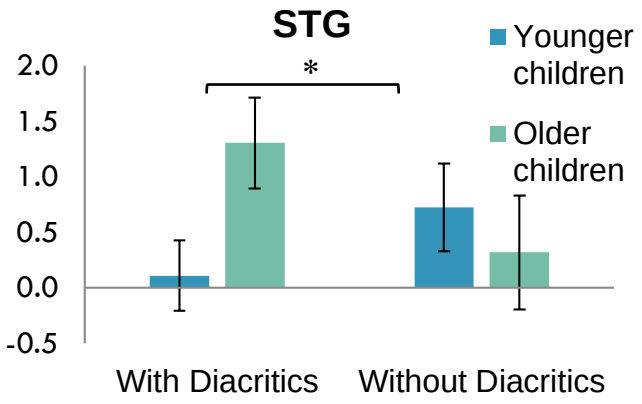
- Diacritics:
  - No beh. benefit
  - **Higher load** on letter-sound mapping & lexical access
- Vowel letters:
  - Facilitate reading
  - **Lower load** on ortho-phono mapping & lexical access

Familiarity overrides transparency

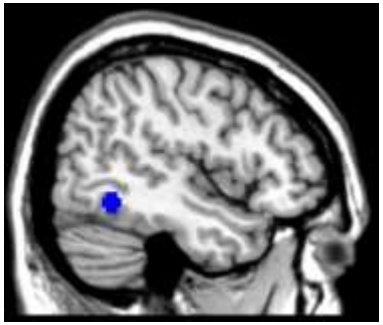
Weiss, Katzir & Bitan, 2015, 2016

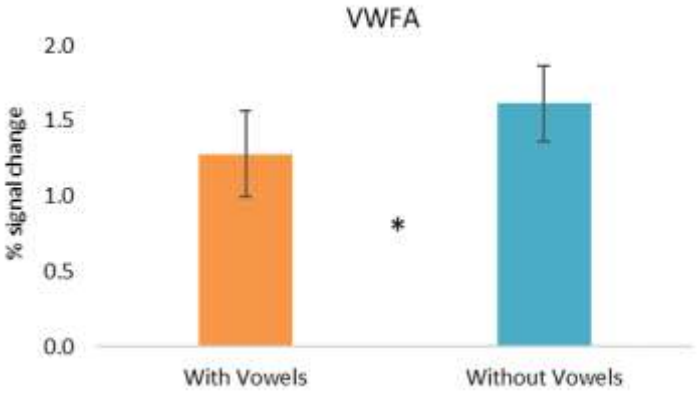
Children: transparency





- Diacritics
  - Facilitates reading in young children
  - Enhanced phonological processing in older children





- Vowel letters:
  - Facilitates orthographic processing

Outline

1. Effects of orthographic transparency on brain reading mechanisms
   in skilled, dyslexic and beginning readers

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Questions

- Do adults + children rely on morphological segmentation more when reading an opaque, un-pointed, word, as compensation for the missing vowels?

- Do beginning readers rely on morphological segmentation in Hebrew from a younger age?

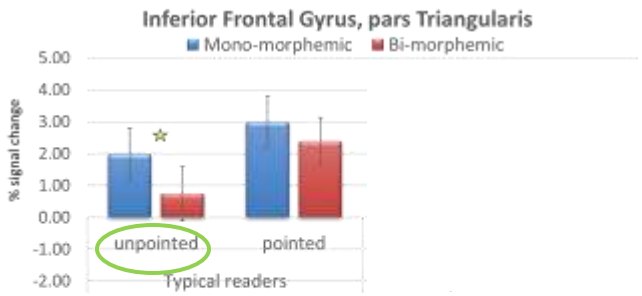
Stimuli

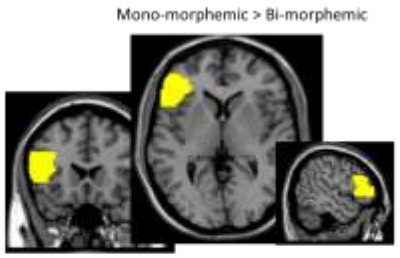
- 96 Hebrew nouns: 24 from each condition
- **Task:** oral reading

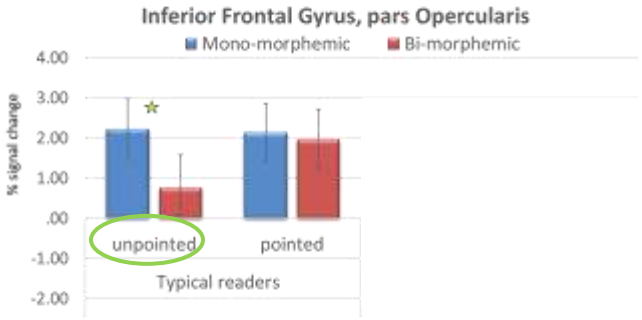
	One morpheme	**Two morphemes (root + template)**
With Diacritics - Pointed	סַנְטֵר <SNTR> /santer/ (chin)	מִכְשׁוֹל <MKŠWL> /mixŠhol/ (obstacle)
No Diacritics - Unpointed	סנפיר <SNPYR> /snapir/ (fin)	תלמיד <TLMYD> /talmid/ (student)

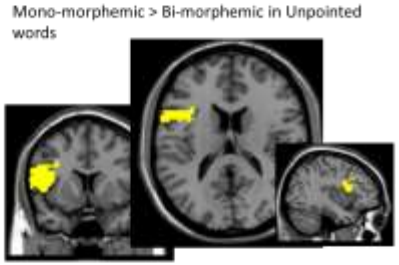
Adults: Morphology X Diacriticis

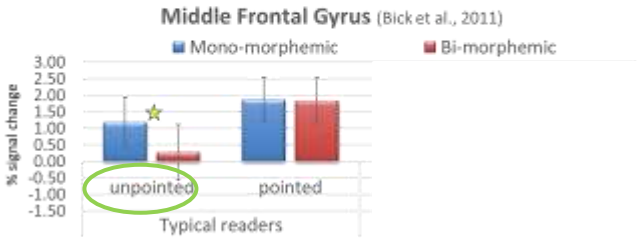
- Morphological effects, only in *un-pointed* words
  - In morpho-phonological processing regions

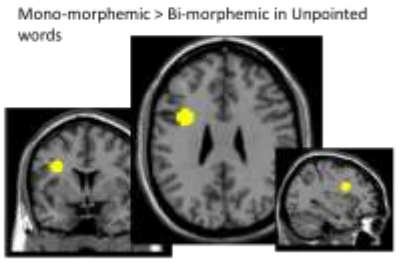








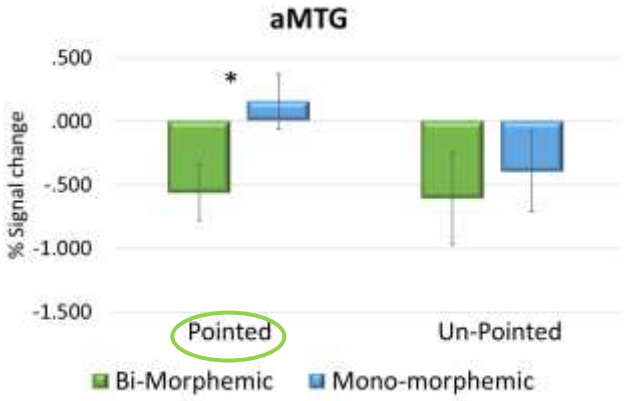


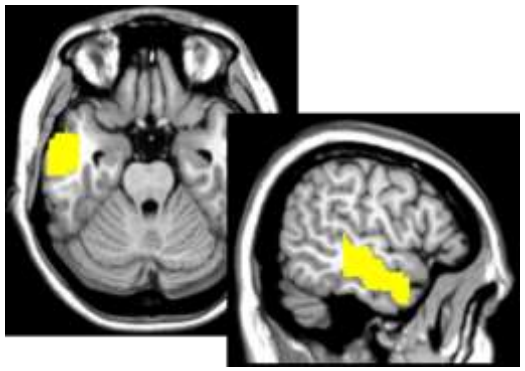


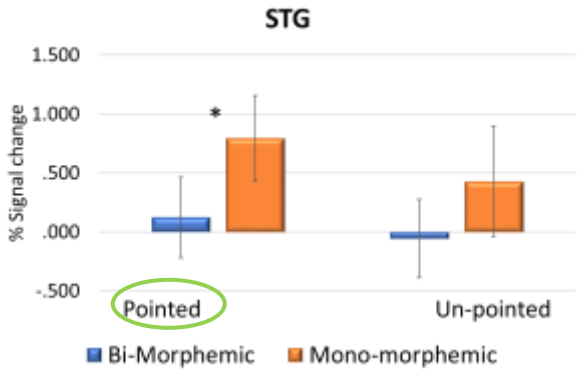
Morpho-phonological compensation for low transparency

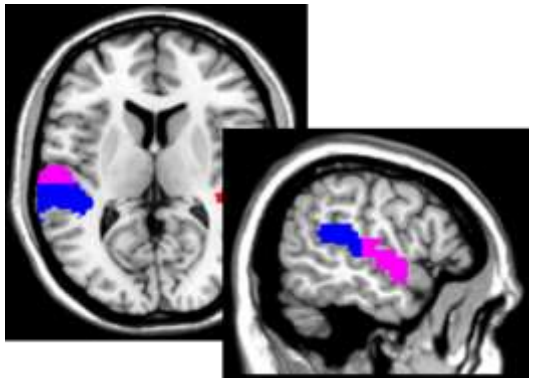
Children: morphology X Diacritics across ages

- Morphological effect in pointed words
  - In regions associated with morpho-semantic processing.









Early in reading acquisition, morpho-semantic processing facilitated by transparency

Conclusions:

- Developmental changes in brain activation involve adaptations to the unique properties of the language.
- The effects of transparency and morphology depend on the reader's skill and specific experience

Transparency

- In skilled adults familiarity (vowel letters) facilitates mapping of form to sound & lexical access, while transparency (diacritics) hinders it.
- In children, vowel letters facilitate orthographic processing and transparency enhances phonological processing.

Morphology

- Adults apply morpho-phonological processes for segmentation and rely on it to compensate for non-transparency.
- Children start segmentation early, compared to non-Semitic languages, and rely on semantic processes. Morphology does not compensate for the lack of transparency.

Thank you.