Why does writing help reading in Chinese learning: Evidence from an fMRI study

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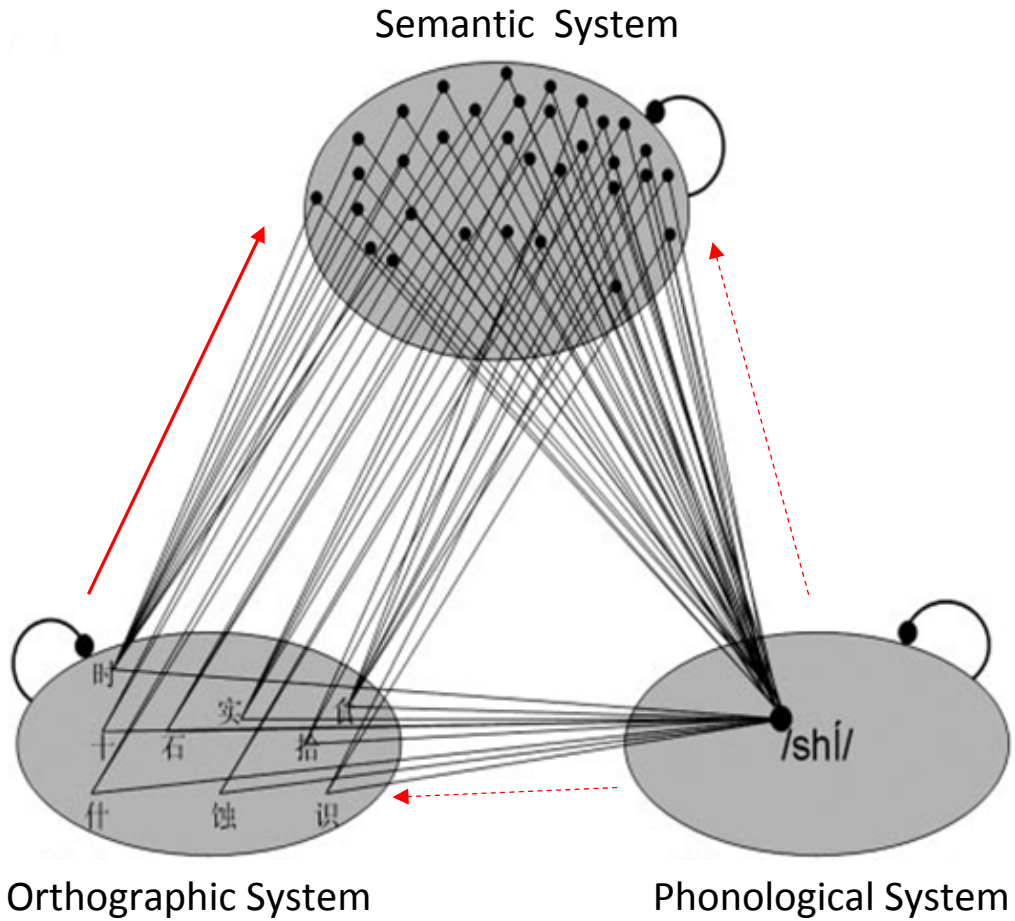
Visual forms of Chinese

Complex spatial relationships

- left-right, 吐/tu4/
- up-down, 杏/xing4/
- inside-out, 困/kun4/

Mapping systems of Chinese



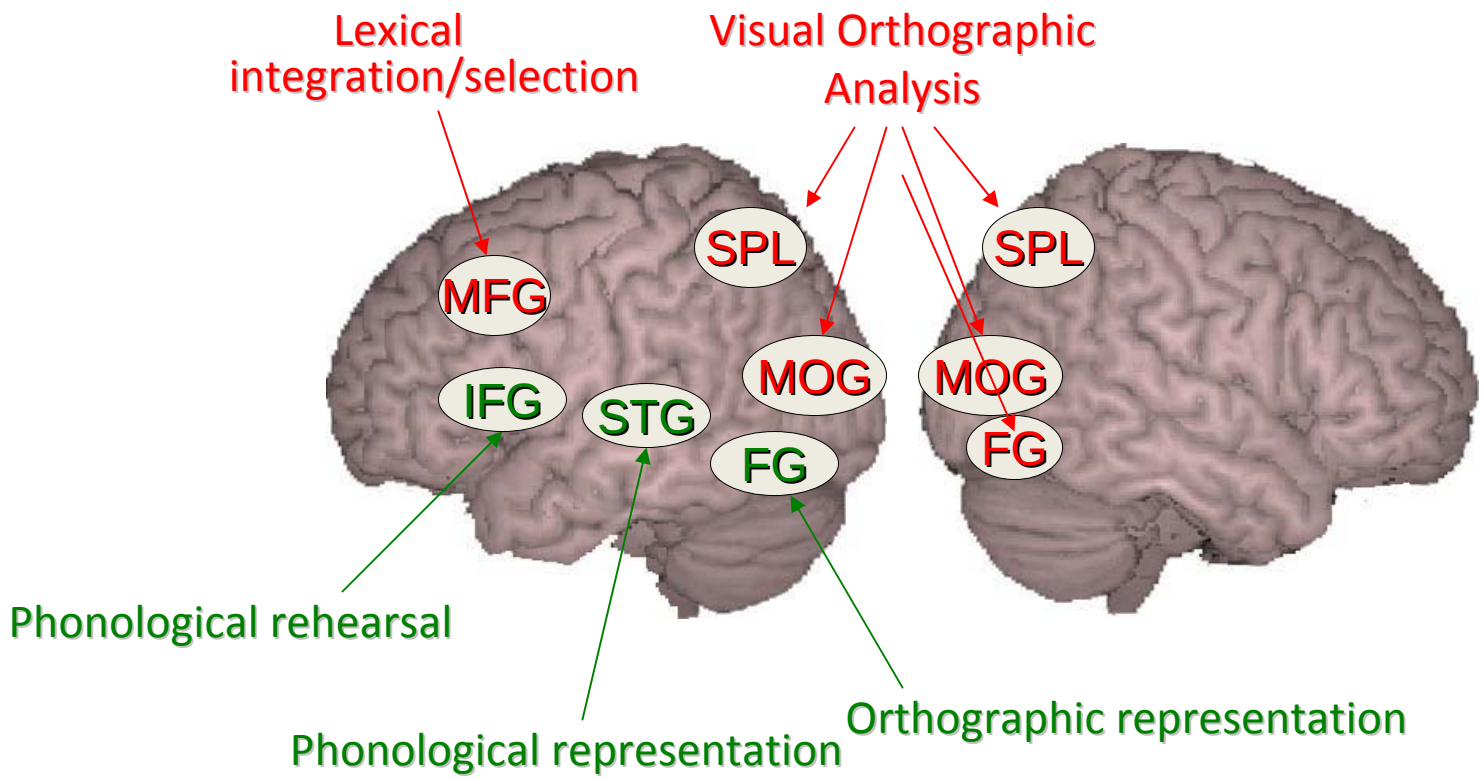
(Tan, et al., 2005)

Predictors of reading achievements

- Visual-orthographic skills have a greater unique contribution than phonological skills in Chinese reading acquisition
  (Huang & Hanley, 1995; Siok & Fletcher, 2001; Ho & Bryant, 1999; McBride-Chang, 2005; Ho & Chan, 2007).

- Reading depends on writing (Tan, 2005).

Neural correlates for Chinese and English



(Cao, 2009, 2010; Bolger, Perfetti, 2005; Tan, Laird, 2005; Kuo, 2001; Chee, 1999; Booth, Lu, 2006)

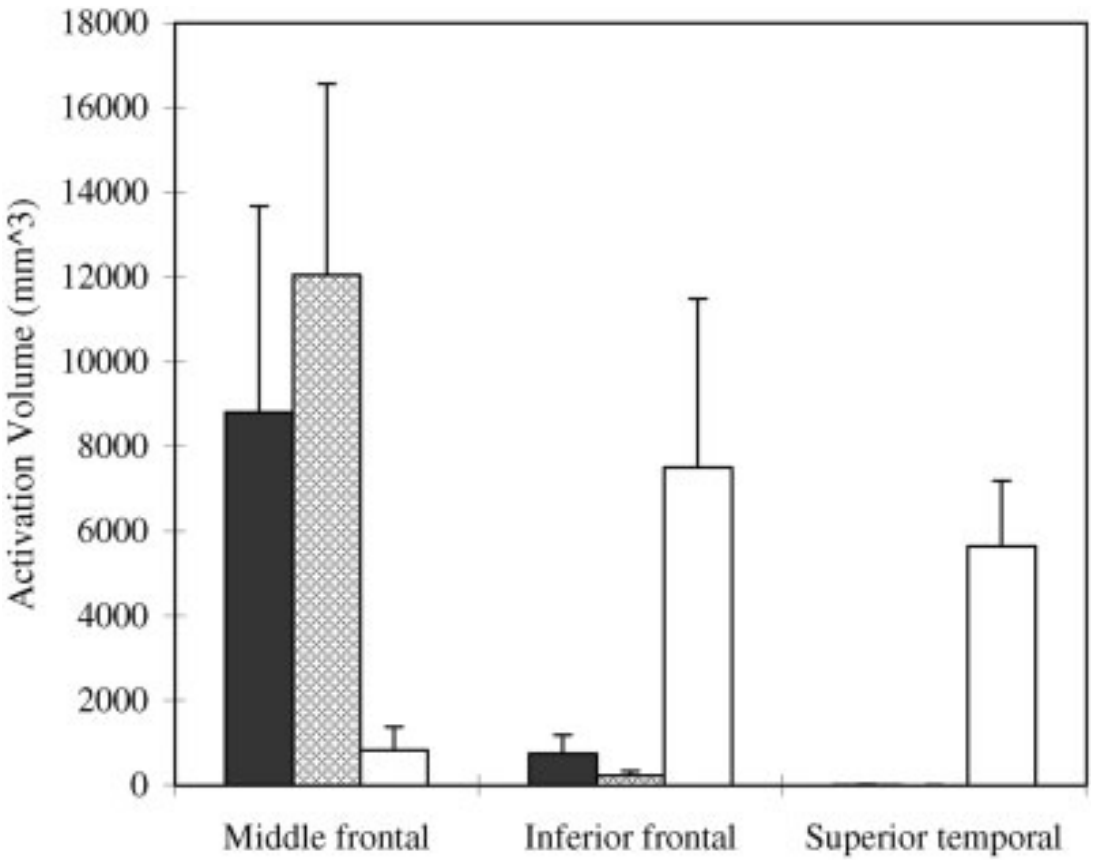
Regions identified using meta-analysis as greater for Chinese as compared to alphabetic languages in Tan et al., 2005.

Anatomical Region	H	BA	x	y	z
Inferior Occipital Gyrus	L	18	-32	-84	-5
Middle Frontal Gyrus	L	9	-46	17	31
Premotor Cortex	L	6	-44	5	18
Cingulate Gyrus	Cingulate	32	-2	19	45
Inferior Occipital Gyrus	R	18	36	-84	-19
Fusiform Gyrus	L	19	-34	-52	-6
InferiorParietal Lobe	L	40	-36	-46	50
Fusiform Gyrus	R	37	34	-61	-25
Precentral Gyrus	L	6	-46	0	48

How about second language learning?

- Use L1 network– assimilation?
- Use L2 network – accommodation?
- Both but depends on what L1 and L2 are?

Assimilation



- Chinese speakers in Chinese task
- Chinese speakers in English task
- English speakers in English task

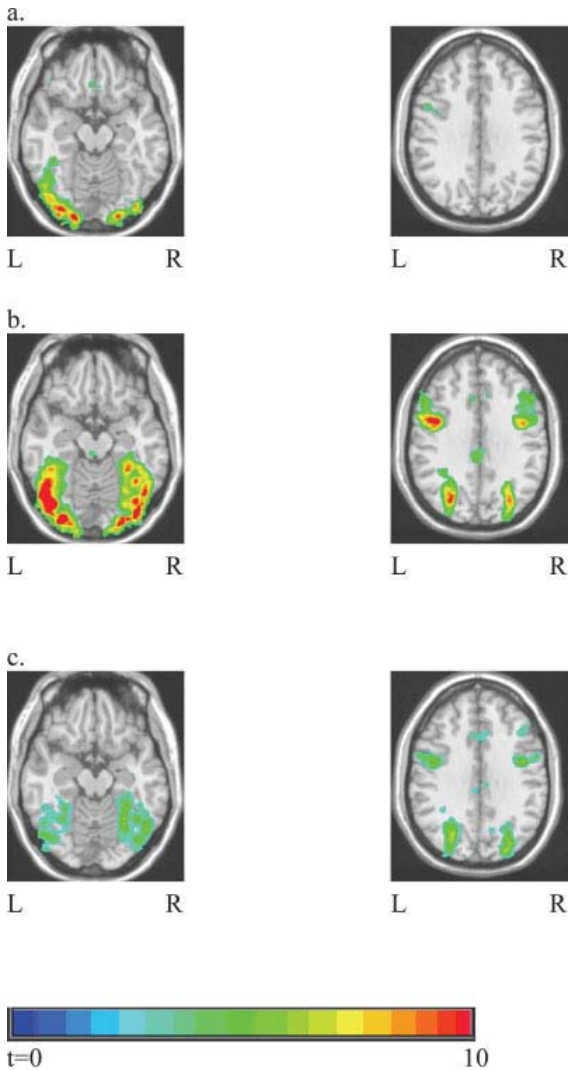
(Tan, 2003)

Accommodation

English speakers viewing English

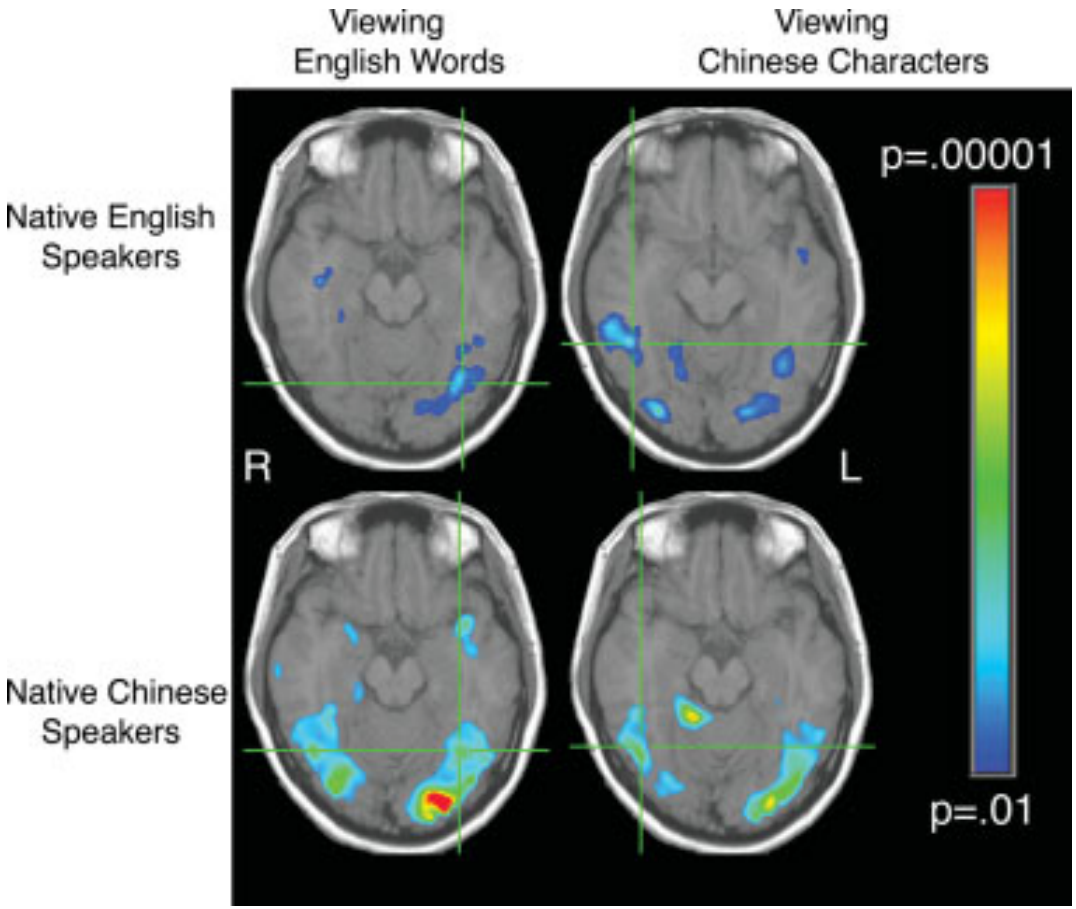
English speakers viewing Chinese

viewing Chinese-English



(Liu, 2007)

Assimilation and accommodation



(Nelson, 2009)

Assimilation and accommodation

- Chinese L1 learning English – Assimilation
- English L1 learning Chinese -- Accommodation

Study 2010 Spring

- The goal of this study was to find a training method that helps accommodation at both the visual form level and the mapping level in English speakers learning Chinese.

Methods

- Within-subject design

  Character writing – orthography

  Pinyin writing -- phonology
- 17 undergraduate students from CMU or Pitt

  English monolingual speakers

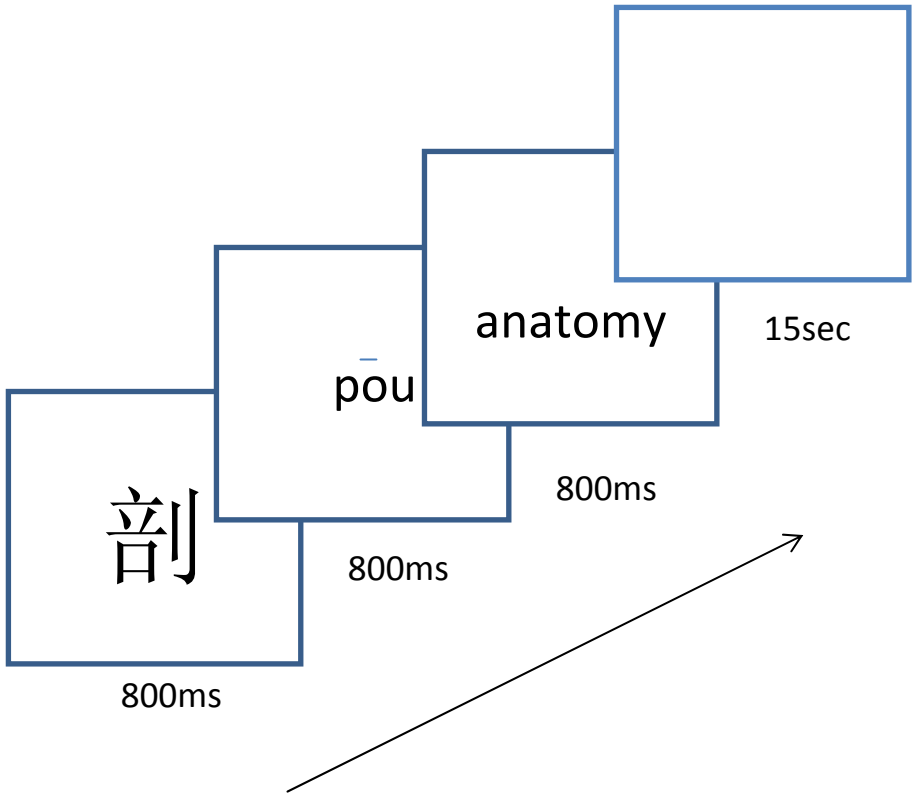
  taking Chinese level 1 class

  no exposure to Chinese before taking the class

Training Procedures

Day 1	Day 2	Day 3	Day 4	Day 5
Pre-test training	training	training	training	training
test	test	test	test	Test Post-test

Training Procedures



Tests

- lexical decision -- Orthography
- character-sound matching -- Phonology
- character-meaning matching -- Semantics

Post test before fMRI

	Character Writing	**Pinyin Writing**
Meaning	0.96	0.95
Pronunciation	0.92	0.96

fMRI tasks

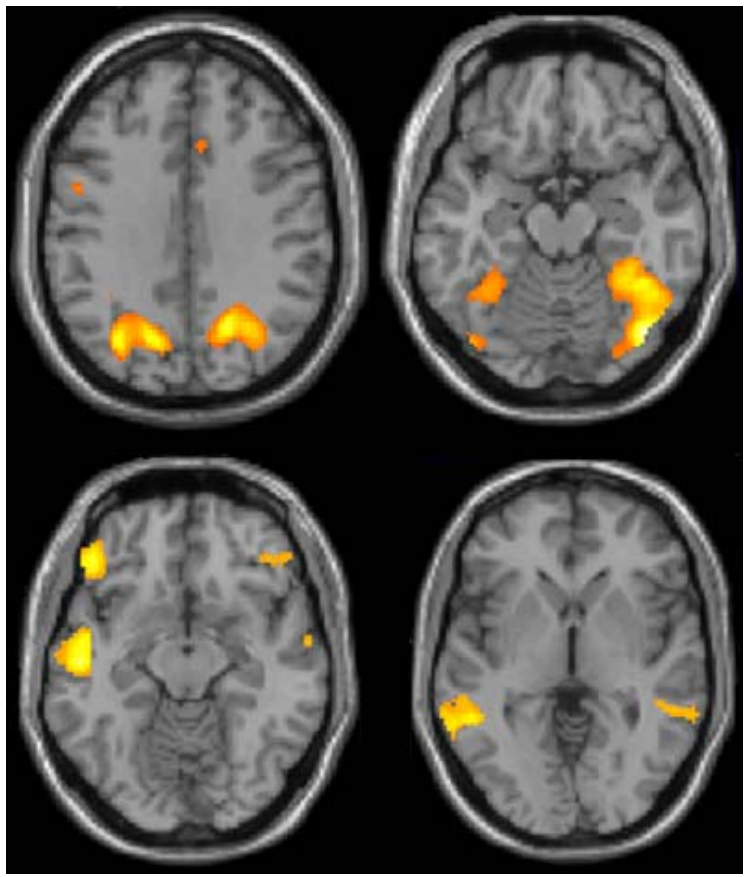
- Passive viewing
- Lexical decision
- Implicit writing

Results

Accommodation—Passive Viewing

Chinese>English

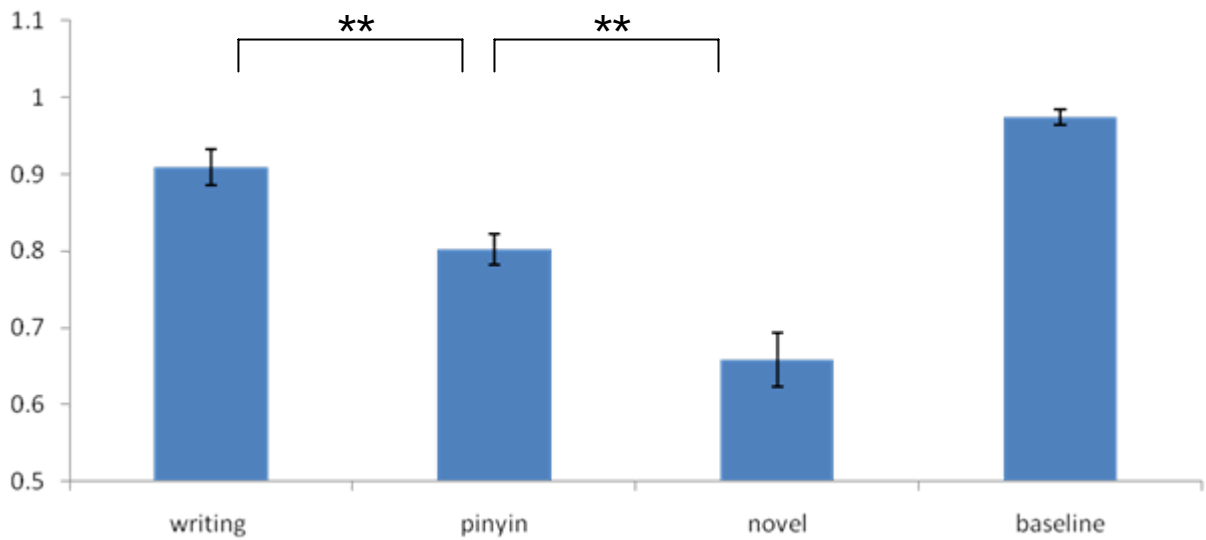
English>Chinese



Results

Behavioral—Lexical Decision

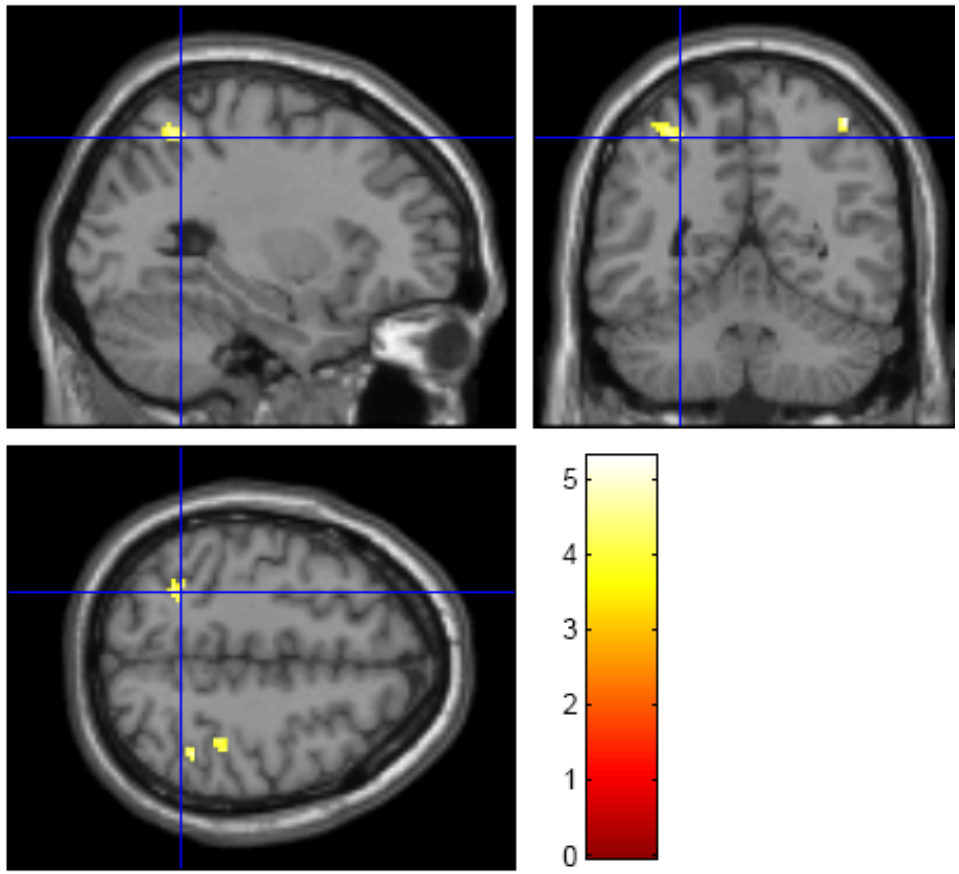
	Writing	Pinyin	Novel	Baseline
Acc	0.91 (0.09)	0.80 (0.08)	0.66 (0.14)	0.97 (0.04)
RT	755 (72)	759 (82)	781 (96)	563 (69)



Writing effects -- LD

Writing > Pinyin

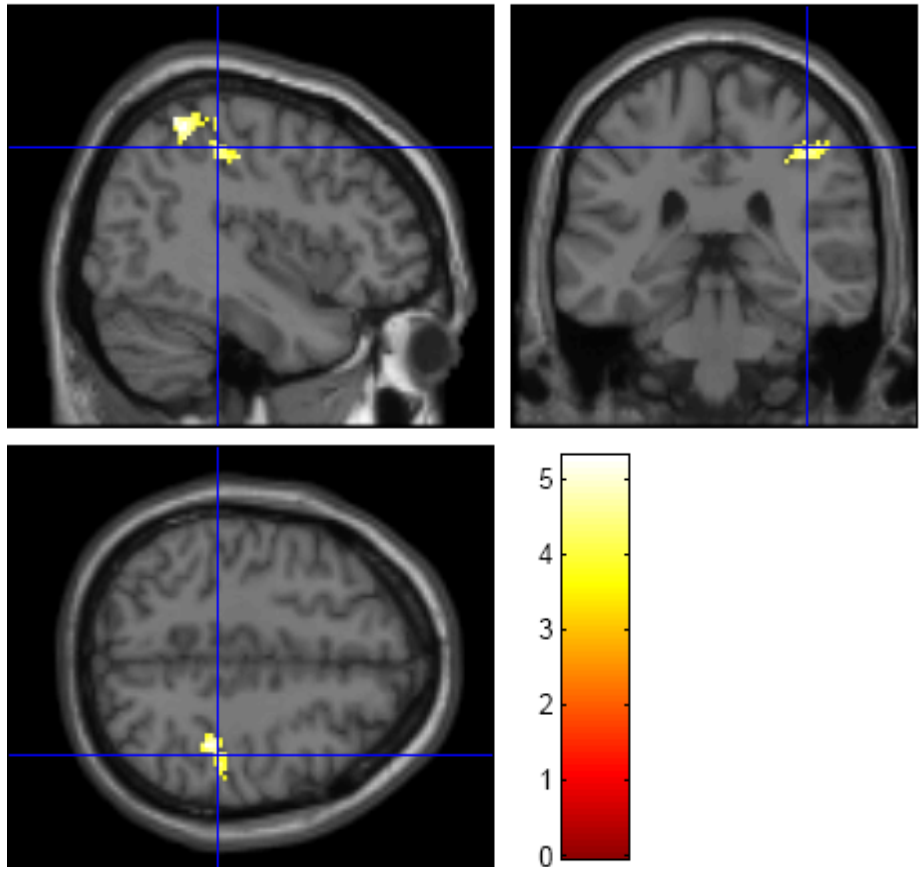
Bilateral SPL



Writing effects -- LD

Writing > Pinyin

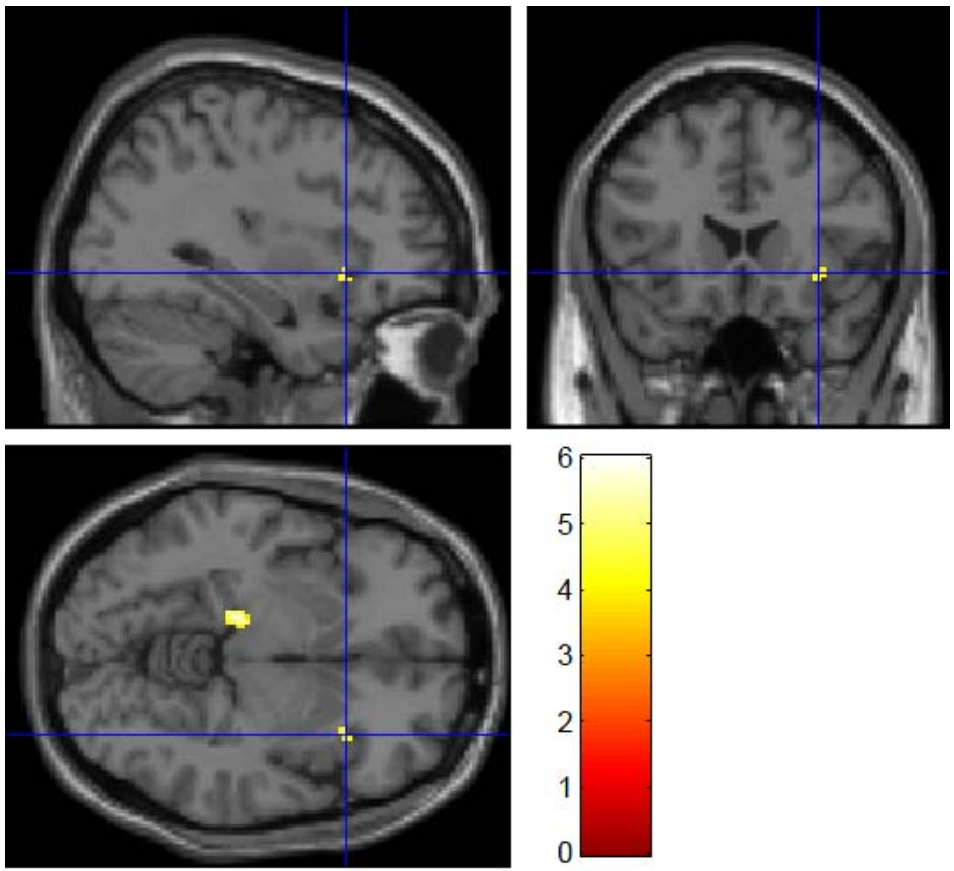
Right pre-motor, motor cortex



Pinyin effect -- LD

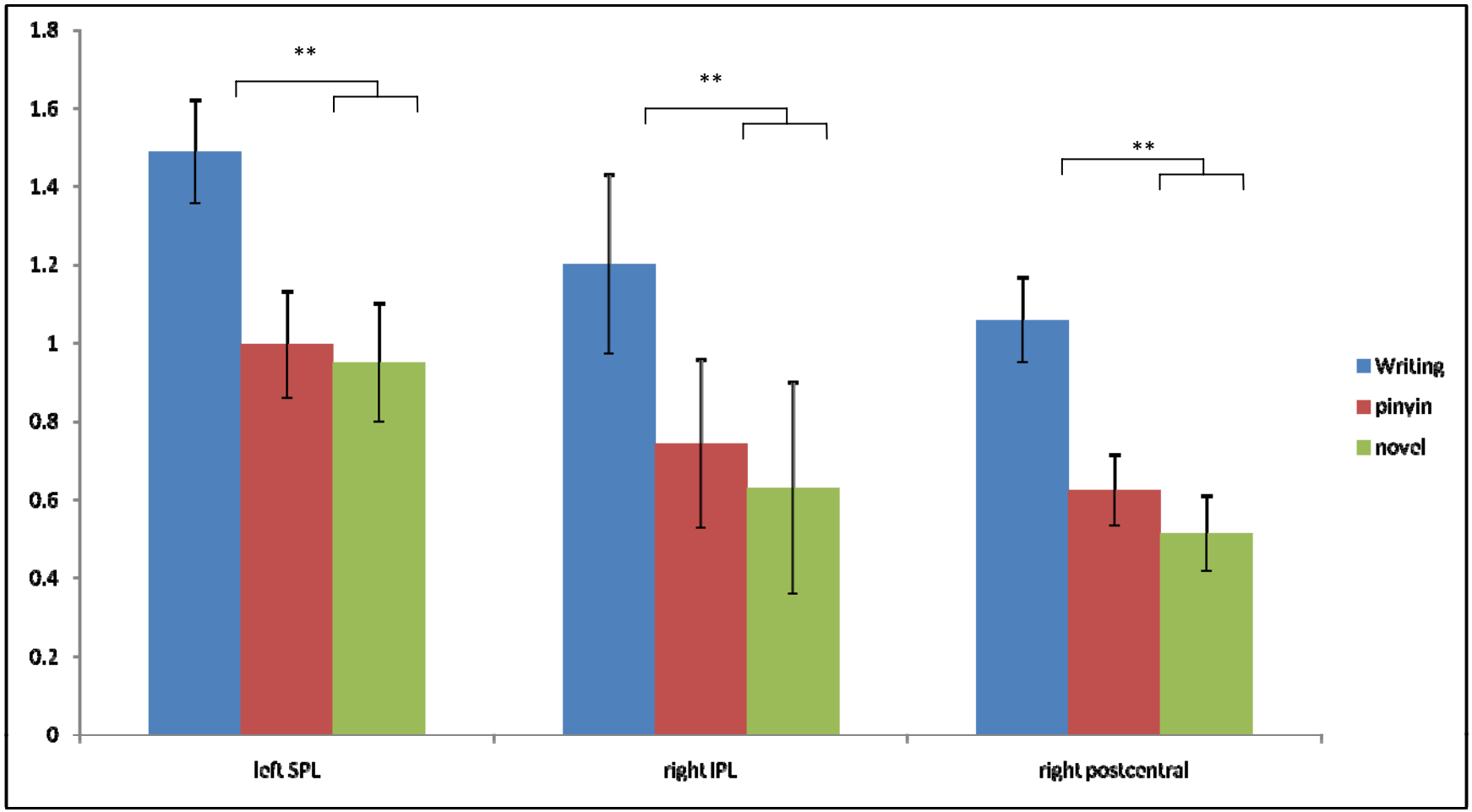
Pinyin > Writing

Right IFG



Writing effects -- LD

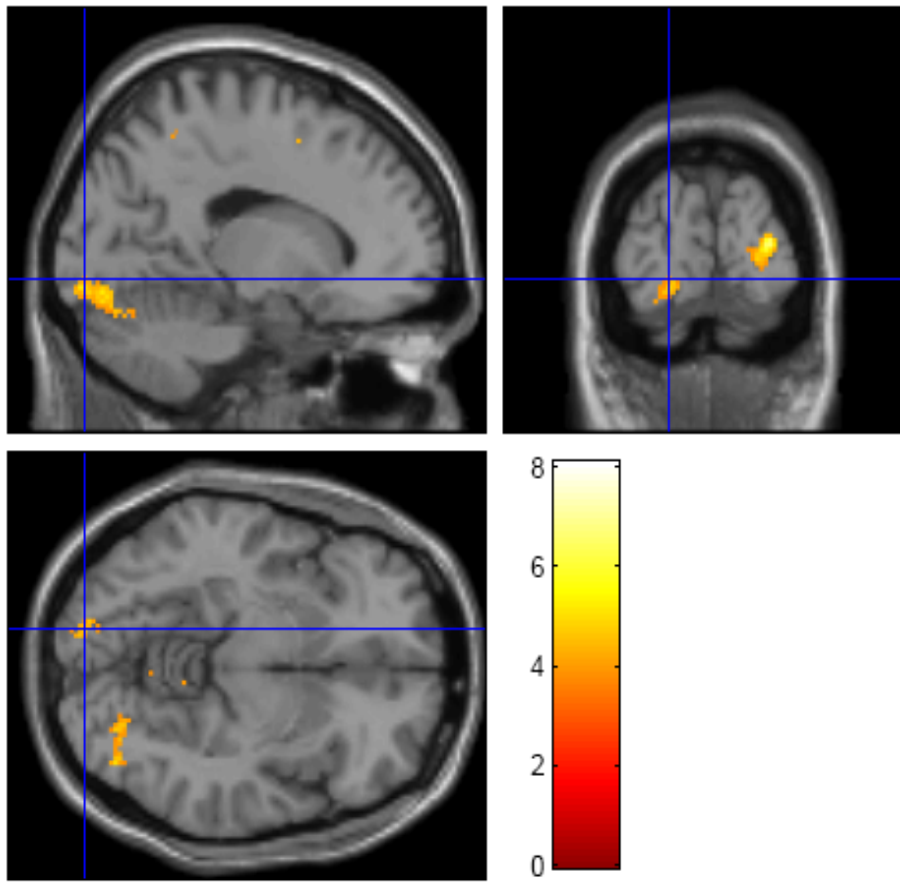
Writing > pinyin = novel



Learning effects -- LD

Writing = Pinyin > Novel

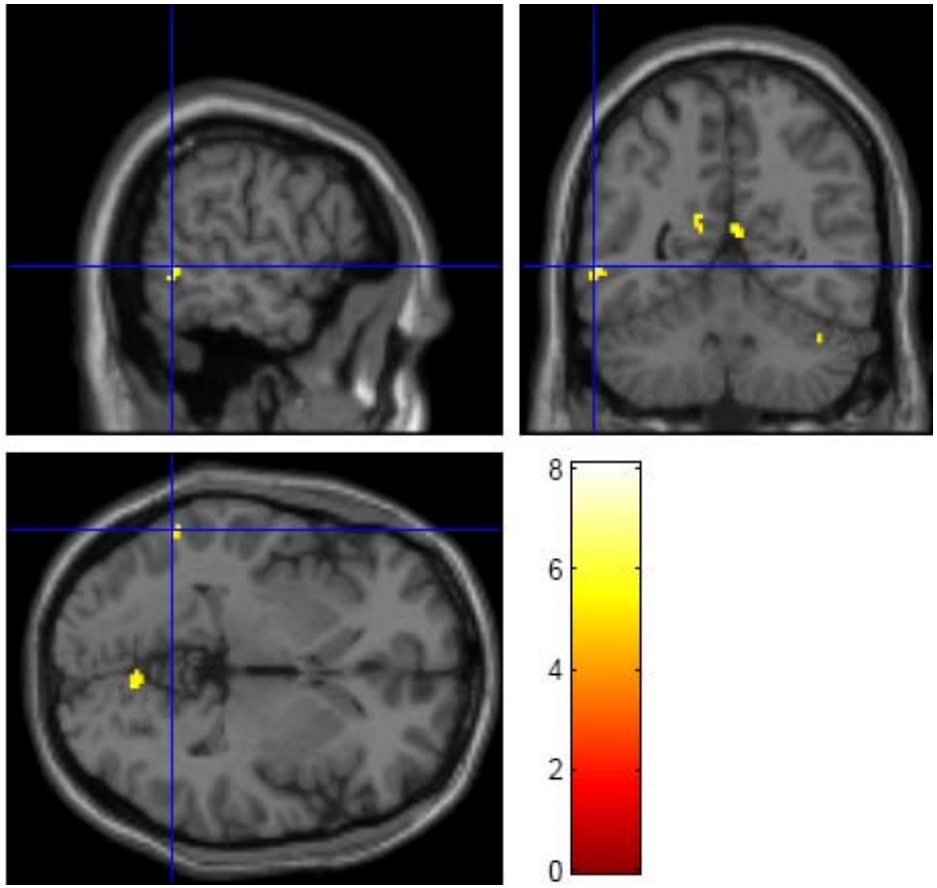
Bilateral occipital cortex



Learning effects -- LD

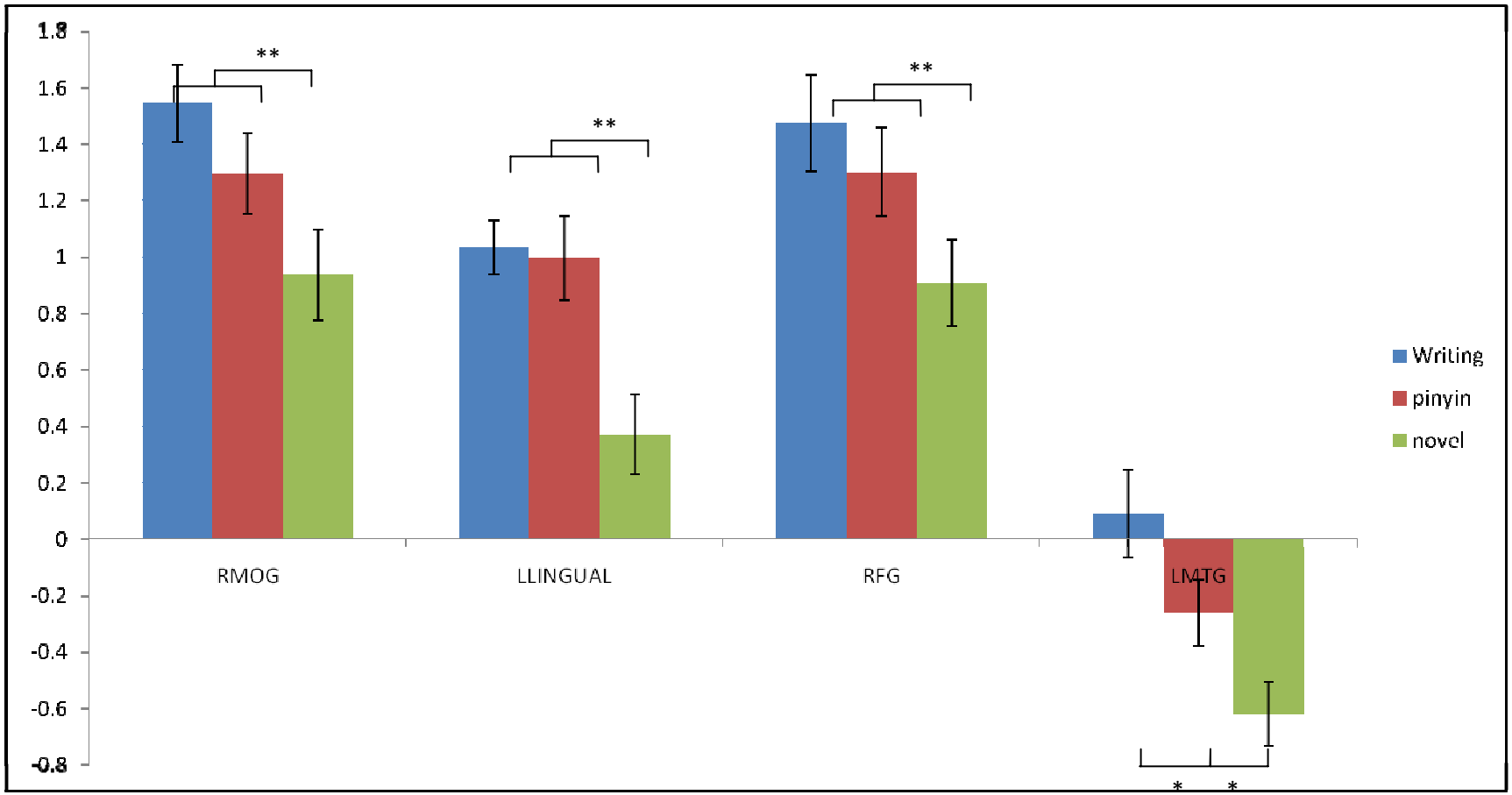
Writing > Pinyin > Novel

Left MTG



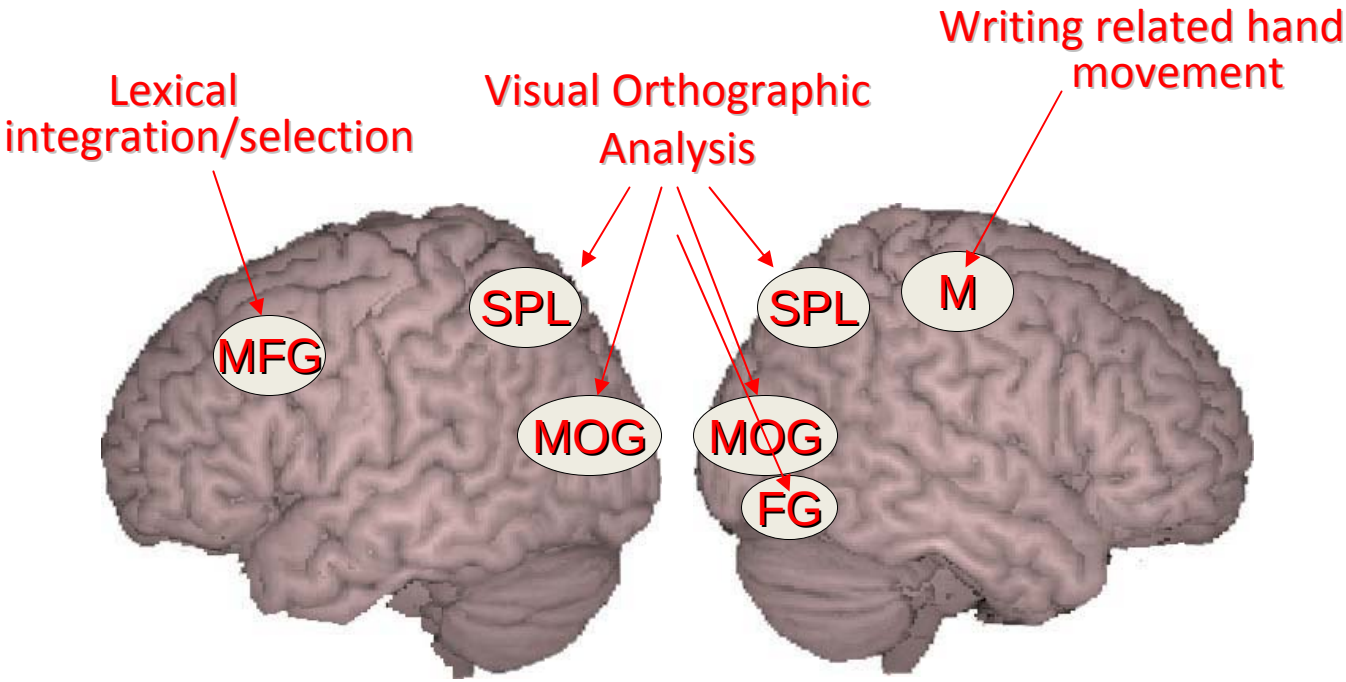
Learning effects -- LD

Writing = pinyin > novel



Summary

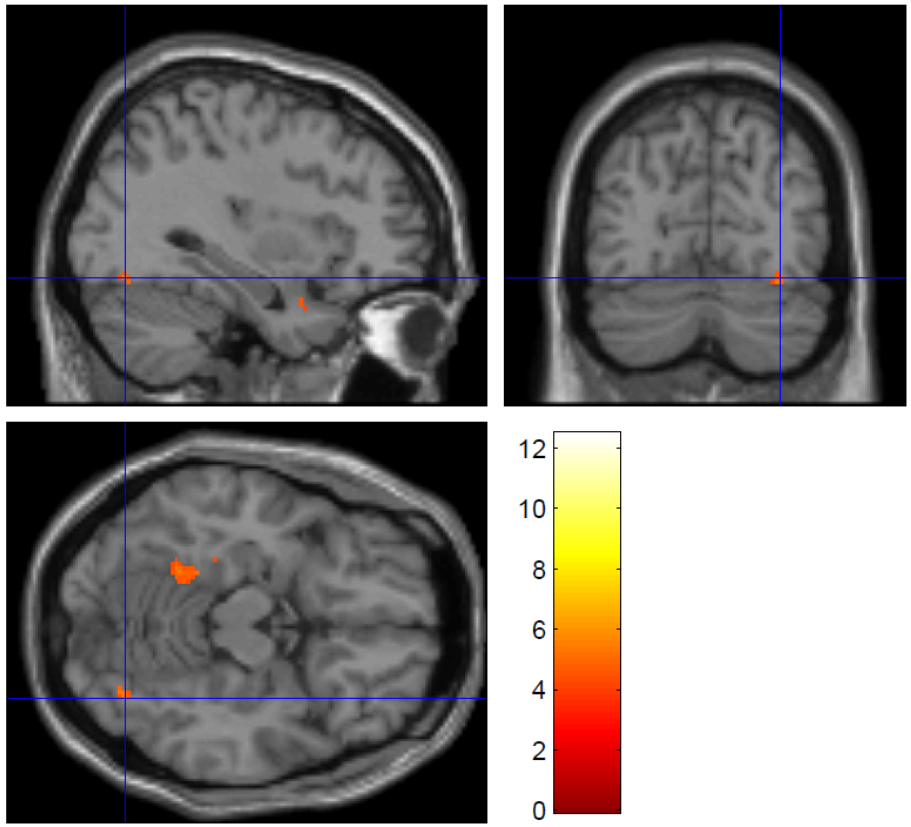
- Character writing enhances visual-spatial representation of characters
- Character writing add additional motor-related representation to the network
- Character writing enhances semantic representation
- Pinyin writing enhances phonological representation


Lexical
integration/selection
Visual Orthographic
Analysis
Writing related hand
movement
MFG
SPL
MOG
SPL
M
MOG
FG

Implicit writing task

Writing>pinyin

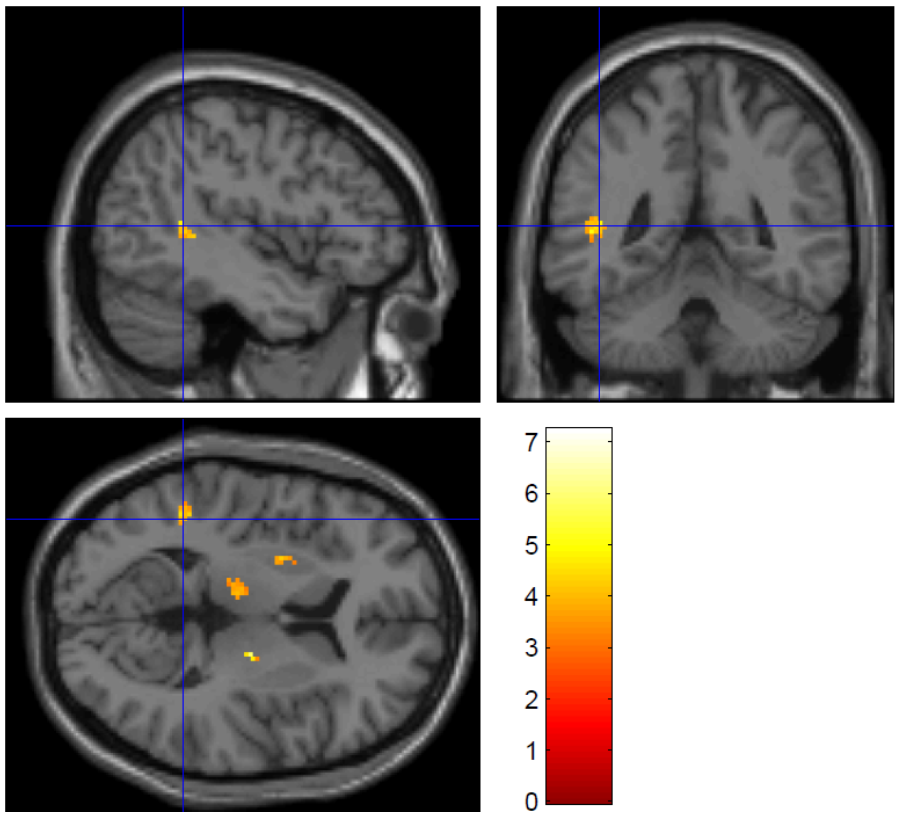
Right fusiform gyrus



Implicit writing task

Writing>pinyin

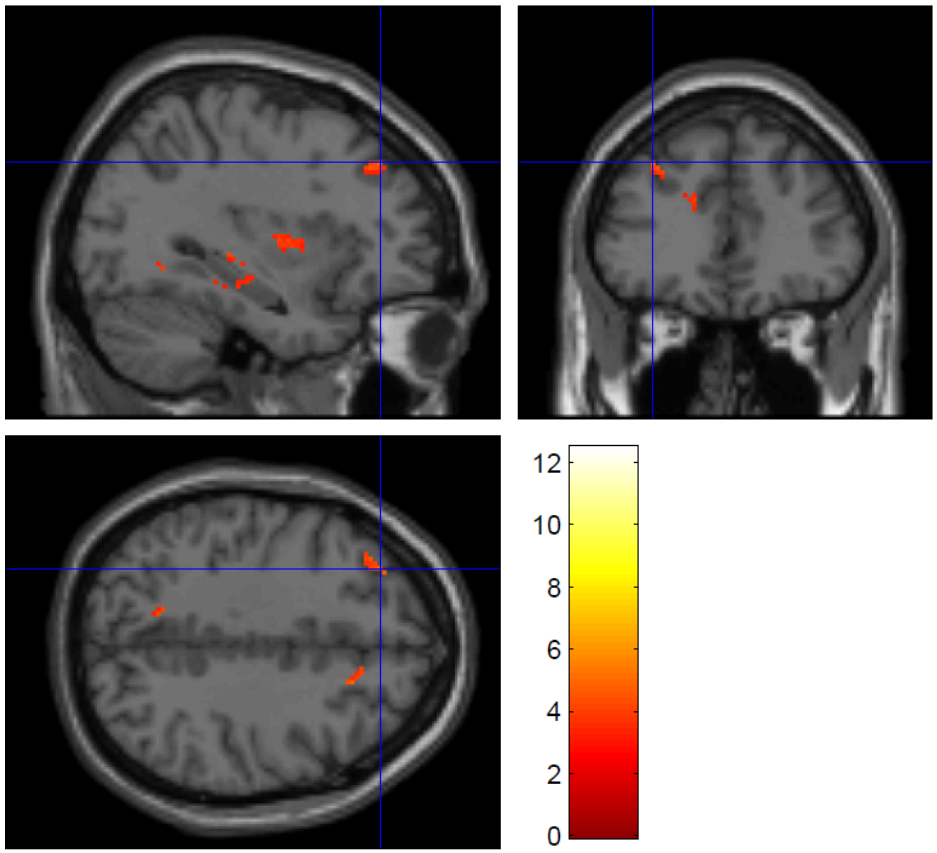
Left S/MTG



Implicit writing task

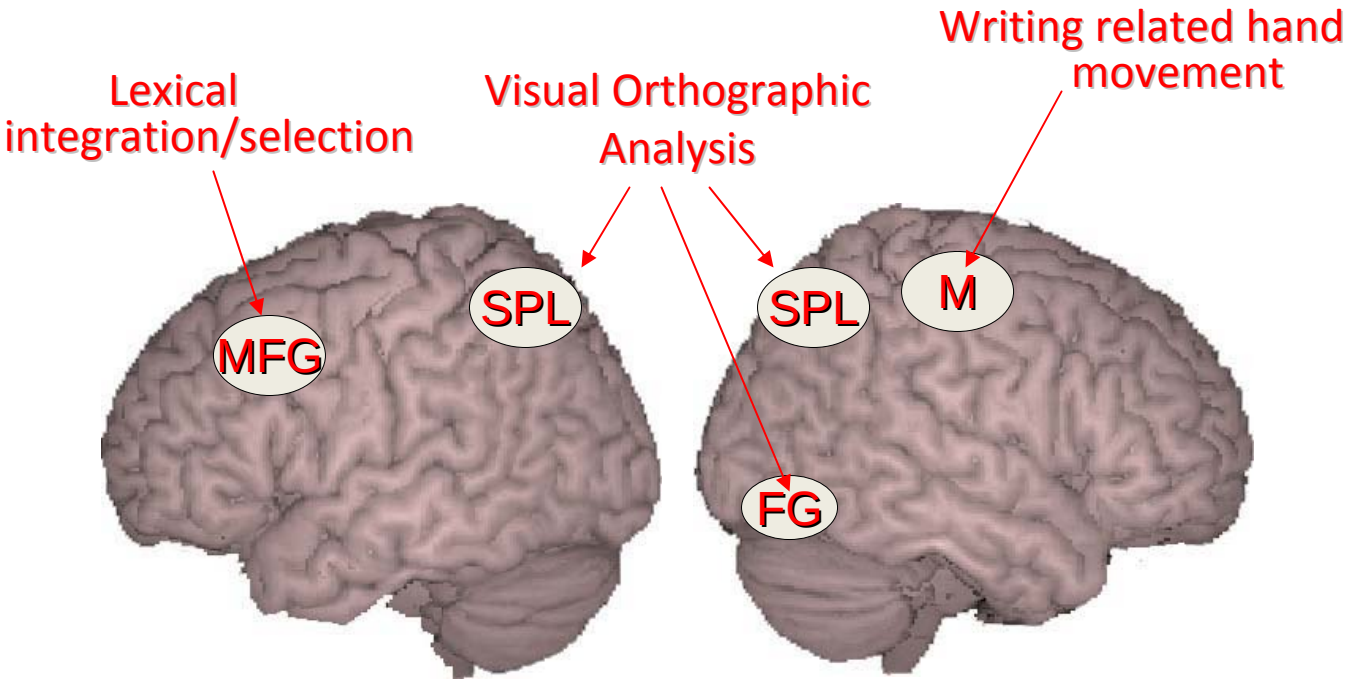
Writing>pinyin

Left MFG



Summary

- Writing helps to establish high quality representation of orthography, which facilitates the mapping to semantics and phonology and the integration between them as well.


Lexical
integration/selection
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movement
MFG
SPL
SPL
M
FG

Conclusions

- Character writing training invoked greater activation in the Chinese network (bilateral SPL, motor cortex, right FG, left MFG), suggesting greater accommodation.
- Pinyin writing training is more helpful with phonological representation.

Thanks!

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