Print-to-sound not print-to-meaning training helps decoding and comprehension: Orthographic learning and fMRI

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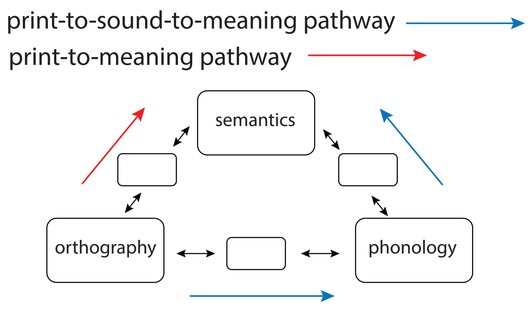
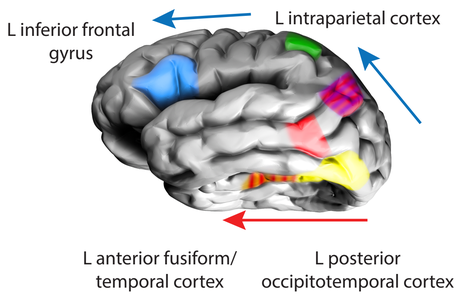
1. Background

Models of reading propose two ways to comprehend written text
Plaut et al., 1996



Corroborated by brain imaging data
Taylor, Rastle, & Davis, 2013



Simple Questions (Box 3)
Does print–sound training improve reading aloud?
Does print–meaning traning improve comprehension?

Transfer Questions (Box 4)
Does print–sound training improve comprehension?
Does print–meaning traning improve reading aloud?

2. Method

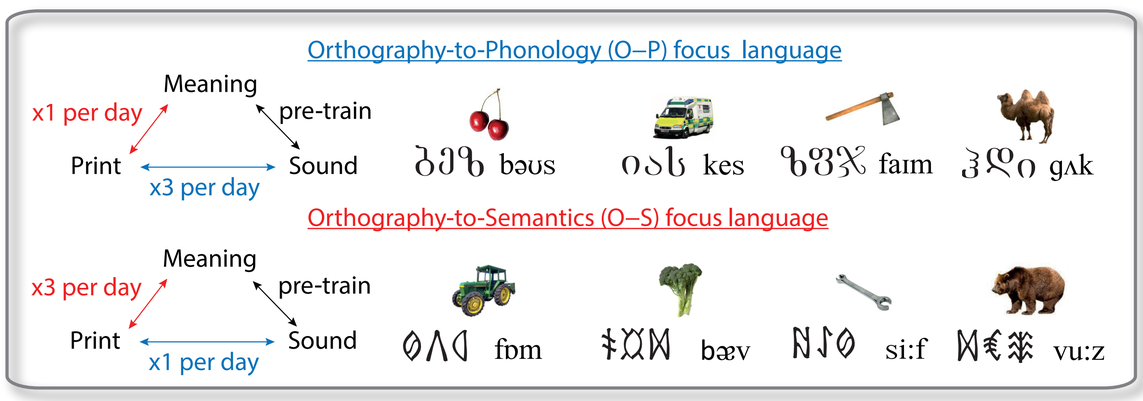
24 adults each learn to read two different artificial orthographies, each consisting of 24 novel words

Manipulate focus of training within subjects:

Orthography-to-Phonology focus: for one orthography, more training on systematic print–sound mappings

Orthography-to-Semantics focus: for other orthography, more training on arbitrary print–meaning mappings

Orthography-to-Phonology (O–P) focus language



Orthography-to-Semantics (O–S) focus language

Training procedure

Day 0
Sound–Meaning pre-exposure

Days 1-4 and 6-9
Print-to-sound tasks
O–P focus language x3 per day
O–S focus language x1 per day

Print-to-meaning tasks
O–S focus language x3 per day
O–P focus language x1 per day

Days 5 and 10
Test Sessions

Day 11: fMRI scan
Reading aloud
Saying meanings
English word reading

Task Details

See → Say "gʌk"
Hear "faɪm" → Say "axe"

Reading aloud: See ɸʌɖ Say "fɒm"
Spelling: Hear "fɒm" Select ɸ-ʌ-ɖ
Rhyme Judgement: Hear "lɒm" Select ɬʊɱ ɸʌɖ ɳɻɸ

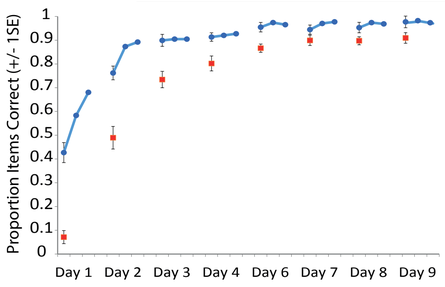
Comprehension: See ʒʭo Say "camel"
Orthographic Choice: See  Select ʒʭo from all 24
Semantic Categorisation: See ʊɔl (vehicle) ʒʭo (animal) ɓɟɓ (animal) Select odd-one-out

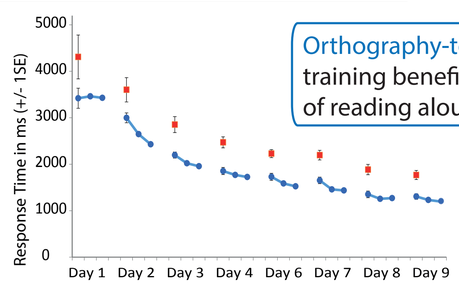
Sparse imaging design - silent intervals between scans
O–P: See ɸʌɖ Say "fɒm" O–S: See ʒʭo Say
O–S: See ʒʭo Say "camel" O–P: See ɸʌɖ Say "gʌk" "tractor"
Read aloud English words and pseudowords

3. Learning to read aloud and comprehend

Orthography-to-Phonology Focus — Orthography-to-Semantic Focus

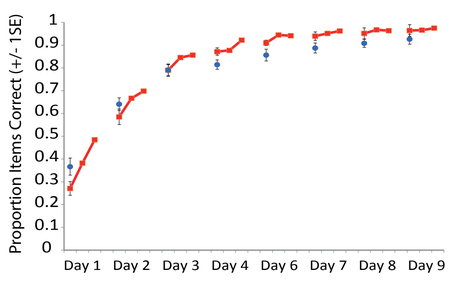
Reading Aloud: See trained word ɸʌɖ Say pronunciation "fɒm"

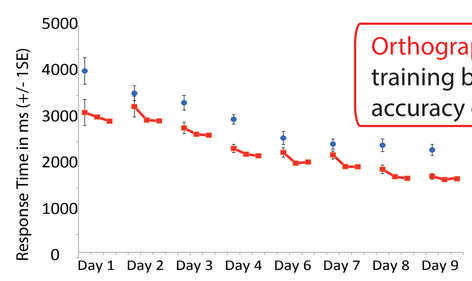




Orthography-to-Phonology focused training benefits accuracy and speed of reading aloud.

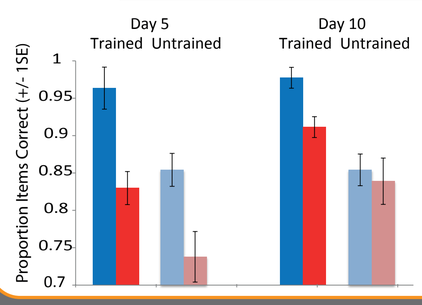
Comprehension: See trained word ʒʭo Say meaning "camel"

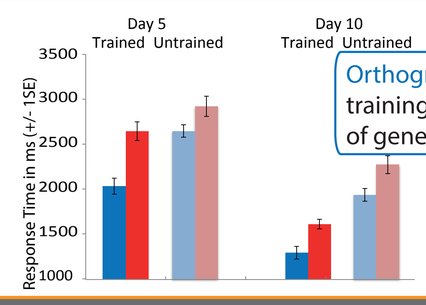




Orthography-to-Semantic focused training benefits speed but not accuracy of saying meanings.

Generalisation: See untrained word ɖʌʬ Say pronunciation "mɒv"





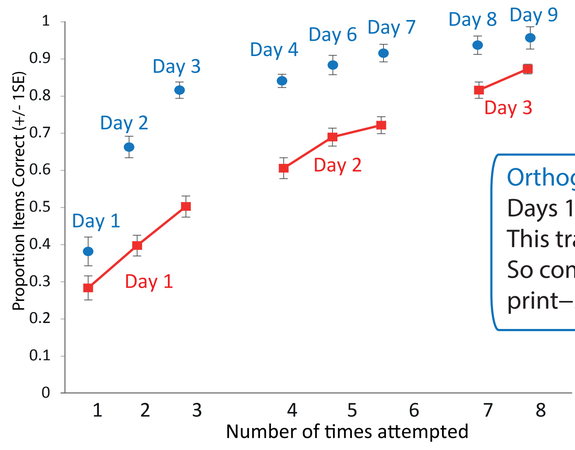
Orthography-to-Phonology focused training benefits accuracy and speed of generalisation to untrained words.

4. Print–sound training benefits comprehension

If we equate practice on the specific task, does learning transfer to the alternative mapping?

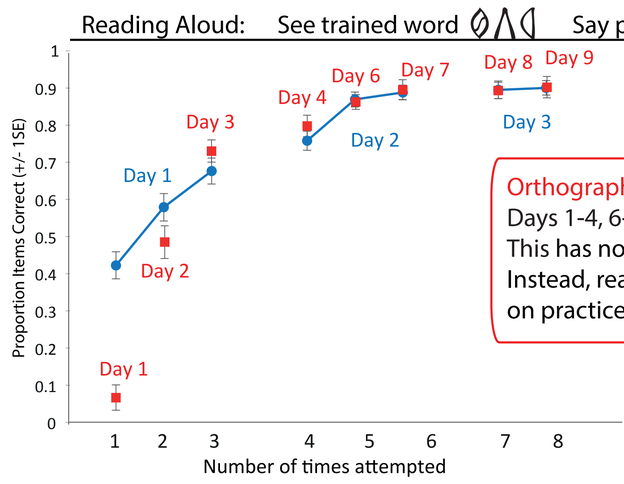
Orthography-to-Phonology Focus — Orthography-to-Semantic Focus

Comprehension: See trained word ʒʭo Say meaning "camel"



Orthography-to-Phonology training transfers:
Days 1-4, 6-9 also involved 3 x print–sound tasks.
This transfers and improves saying the meaning.
So comprehension accuracy depends more on print–sound than print–meaning practice.

Reading Aloud: See trained word ɸʌɖ Say pronunciation "fɒm"



Orthography-to-Semantic training does not transfer:
Days 1-4, 6-9 also involved 3 x print–meaning tasks.
This has no benefits for reading aloud.
Instead, reading aloud accuracy depends only on practice with print–sound mappings.

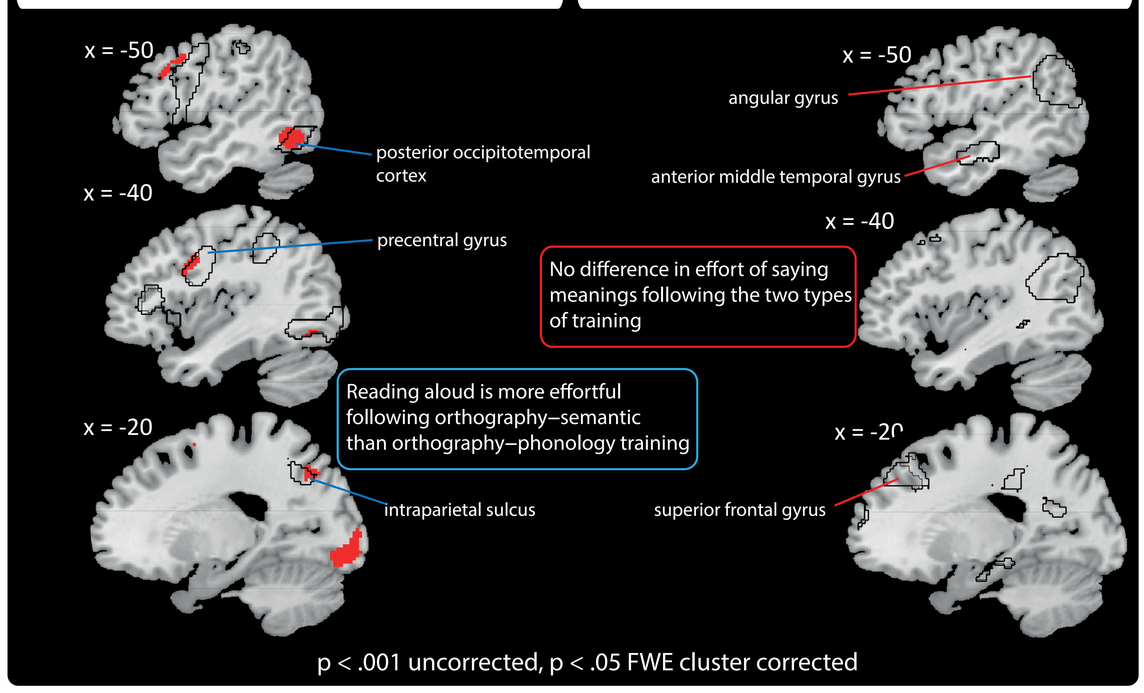
5. Asymmetric differences in brain activity

Differences in activity during reading aloud

[Orthography–Semantic > Orthography–Phonology Focus]
Within regions active for [pseudowords – words] in English
Implicated in print-to-sound mapping

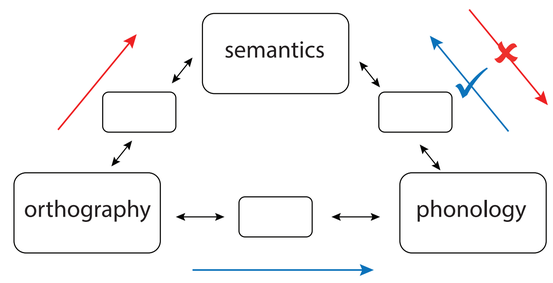
No difference in activity when saying word meanings

[Orthography–Semantic vs. Orthography–Phonology Focus]
No significant differences in activity
Within regions active for [words - pseudowords] in English
Implicated in print-to-meaning mapping



6. Conclusions

Asymmetric benefits of print–sound and print–meaning training



Participants received pre-training in phonology–semantic mappings (establish an oral vocabulary).

Following this, we found that:

Orthography–Phonology training was beneficial for both reading aloud and comprehension.

Orthography–Semantic training was a slower way to learn to comprehend and was detrimental for reading aloud as well as generalising to untrained words.

Thus, even with minimal oral vocabulary training, it was easier for learners to use print–sound knowledge to access word meanings, than to map from print-to-meaning directly.

Our precisely controlled experiment therefore supports existing UK teaching practice, which focuses on phonics (sounds and letters) in the early years.

7. References

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