

The Spelling Brain

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Questions

How is it that we spell the thousands of words that we know?
Does the brain process the spelling of all words in the same way?

Background & Significance

Controversy exists as to whether regular words (BLINK), irregular words (YACHT), and nonwords (SHELM) are processed in the same way or different ways

Same - single route model - memory (regular, irregular), particular difficulty with nonwords¹

Different - dual route model - memory (irregular) and phonological assembly (regular and nonwords)²

Significance - first investigation of regular, irregular, and nonword spelling in healthy adults to test single vs. dual route models behaviorally and neurally

Hypotheses

Single route model - Same across all words

Behavior - Similar accuracy & RT

Neural activation - Similar classic LH language, word form areas (IFC, temporal/insula, fusiform, SMG); no semantic activation for nonwords

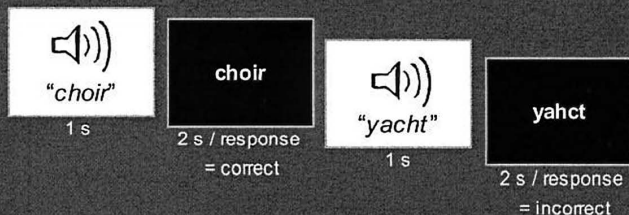
Dual route model - Different for regular/irregular/nonwords

Behavior - Different accuracy & RT

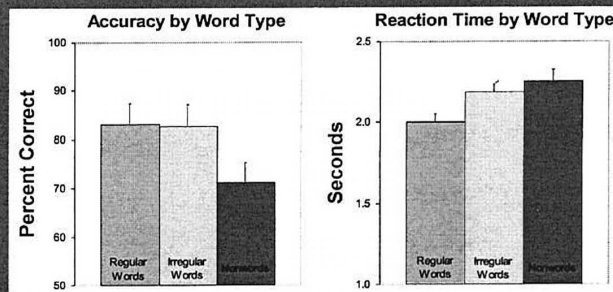
Neural activation - Different for regular vs irregular words in classic LH language areas and other RH brain sites involved in attention, decision making, error detection (cingulate, caudate, IFC); nonwords similar to regular words, except for semantics

Methods

- 15 Subjects - 6 women/9 men, mean age 21 yrs
- fMRI scan - Auditory word; visual possible spelling; decision with button press
- Spelling decisions - Low-frequency regular and irregular words, and nonwords



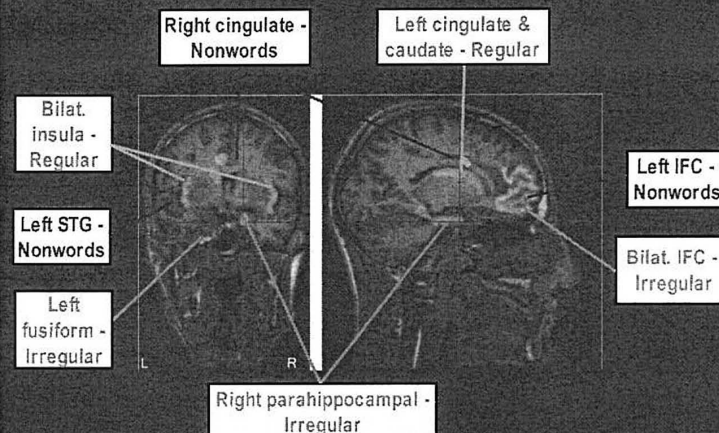
Behavioral Results



Accuracy - Equally high regular and irregular ($p > .05$); lower for nonwords, ($p = .055$)

Reaction Time - Faster for regular words than irregular ($p < .05$) and nonwords ($p < .05$).

Neural Activation/fMRI Results



Regular words > Irregular - Increased activation in bilateral insula (auditory and phonological processing³), Left anterior cingulate (BA 24) and caudate (attention allocation and error monitoring⁴)

Irregular words > Regular - Increased activation in bilateral IFC (BA 47; decision making⁵), Left fusiform gyrus (BA 19; visual word form area⁶), and Right parahippocampal gyrus (BA 36; lexical recall, orthographic and working memory⁷)

Nonwords > Real words - Significantly activated Left superior temporal gyrus (BA 22; phonological processing⁵), Left IFC (BA 47), and Right anterior cingulate (BA 24)

Conclusions

Evidence for a **dual route model** of spelling - behavioral and neuroanatomical **differences** for processing regular, irregular, and nonwords

Regular and Nonwords spelled using phonological assembly
- Similar, not identical

Irregular words spelled using memory

Implications

Skilled spellers use at least two strategies - one based on phonology, one on memory. This may have implications for how spelling is taught and how spelling deficits can be remediated in educational and clinical contexts

References

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Acknowledgments

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