

# How do writing systems shape reading and reading acquisition?

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[www.rastlelab.com](http://www.rastlelab.com)

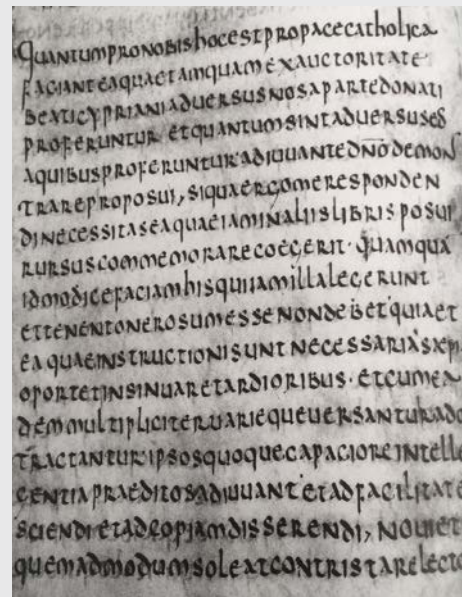
# Writing and reading across timescales



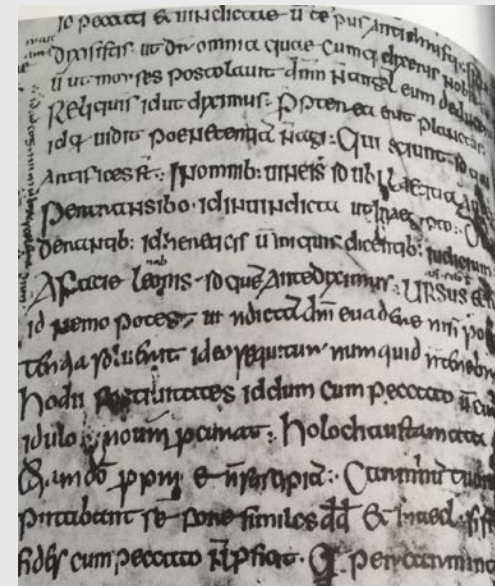
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Italy, 5<sup>th</sup>  
century



Spain, 7<sup>th</sup>  
century



Ireland, 7<sup>th</sup>  
century

The way that we read and the way that we write  
are intimately linked.

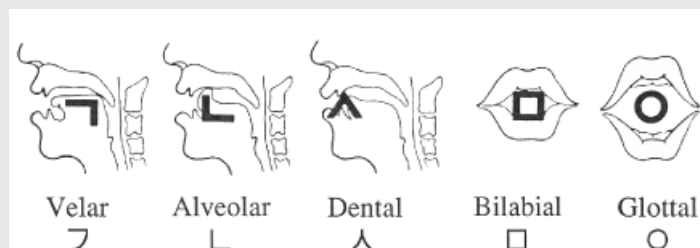
# Writing systems



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가 ga	나 na	다 da	라 ra	마 ma	바 ba	사 sa	아 a
가 gya	냐 nya	다 dya	랴 rya	마 mya	바 bya	샤 sya	야 ya
거 geo	너 neo	더 deo	러 reo	머 meo	버 beo	서 seo	어 eo
겨 gyeo	nyeo	데o	려 ryeo	મેo	베o	세o	예o
고 go	노 no	도 do	로 ro	모 mo	보 bo	소 so	오 o
교 gyo	뇨 nyo	도 dyo	료 ryo	묘 myo	보 byo	쇼 sya	요 yo

K	L	M	N	O	P	Q	R	S	T
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
U	V	X	Y	Z	and	for	of	the	with
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
ch	gh	sh	th	wh	ed	er	ou	ow	W
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮



Upper case  
ABCDEFGHIJKLMNOPQRSTUVWXYZ

Lower case  
abcdefghijklmnopqrstuvwxyz

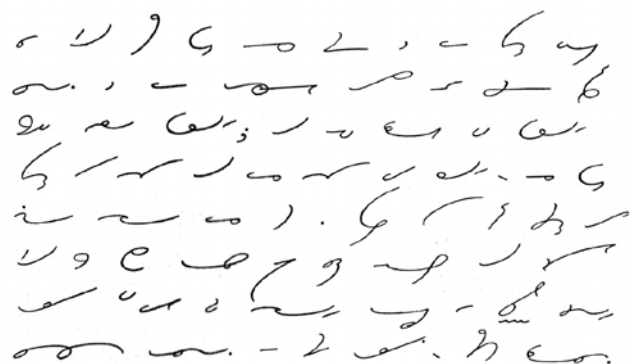


# Writing systems



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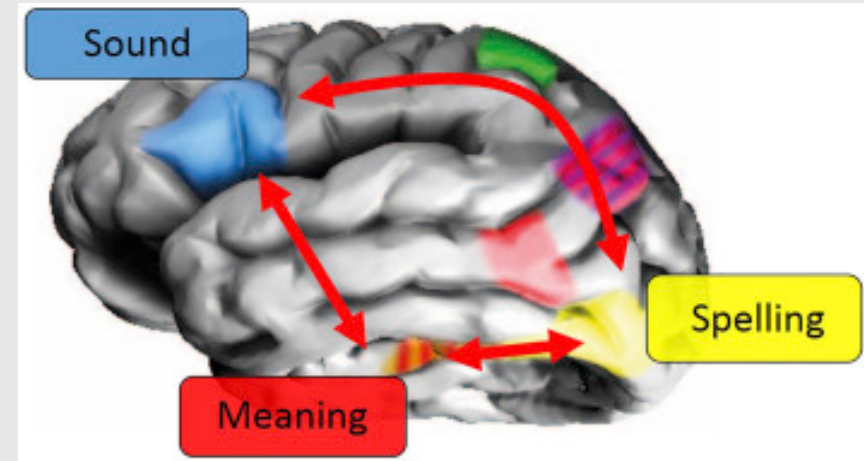
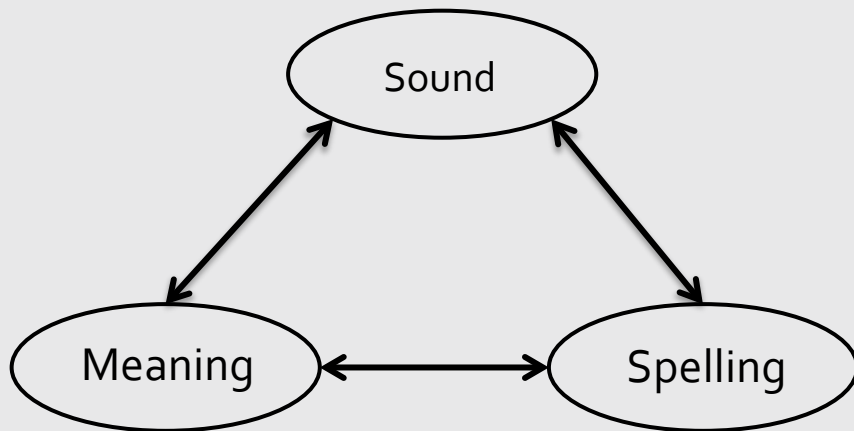
zhège chéngshì wánquán biàn le nǐ bùzhīdào  
这个 城市 完全 变 了。你 不知道  
wèntí yě kěnéng shì yīnwèi rénmen zhījiān de  
问题，也 可能 是 因为 人们 之间的  
chéngshì hè yǐqián wánquán bù yíyàng le dào  
城市 和 以前 完全 不一样 了。到  
shù yě dōu sǐ le yǐqián zài zhèlǐ shēnghuó  
， 树 也 都 死 了， 以前 在 这里 生活  
shēnghuó zàidìxià qítā rénxiàng nǐ yíyàng zhù  
生活 在 地下。其他 人 像 你 一样 住  
shǎo yìxiē hái kěyǐ hūxī dào gānjìng de kōngqì  
少 一些， 还 可以 呼吸 到 干净 的 空



# Dual pathway model of reading



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“the study of reading and reading acquisition is the study of how information transmitted through writing becomes represented in the minds and brains of individuals, through an accumulation of instruction and text experience” (Rastle, 2019)

The skilled product is always a reflection of these ingredients.

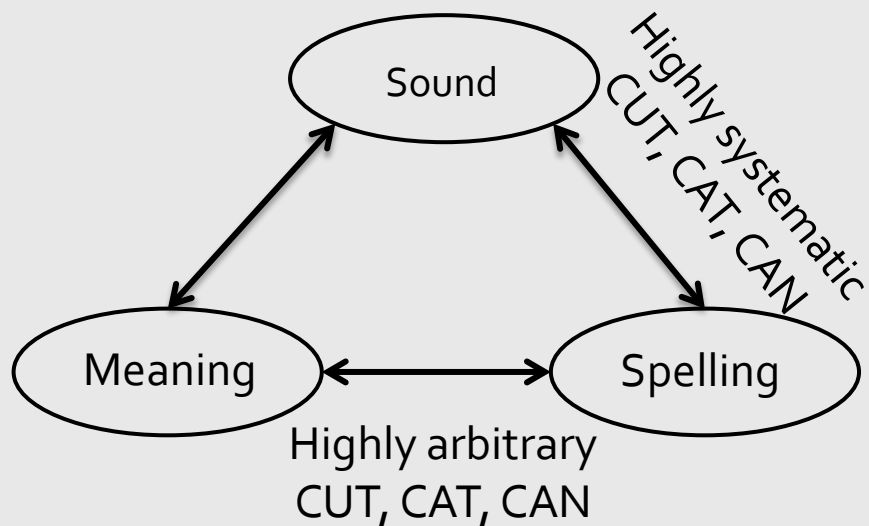


# Initial experiences with alphabets



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English-speaking children encounter  
~5,000 words in the first year of  
reading instruction.



CUT



CAT



CAN



Reading comprehension = decoding + oral language



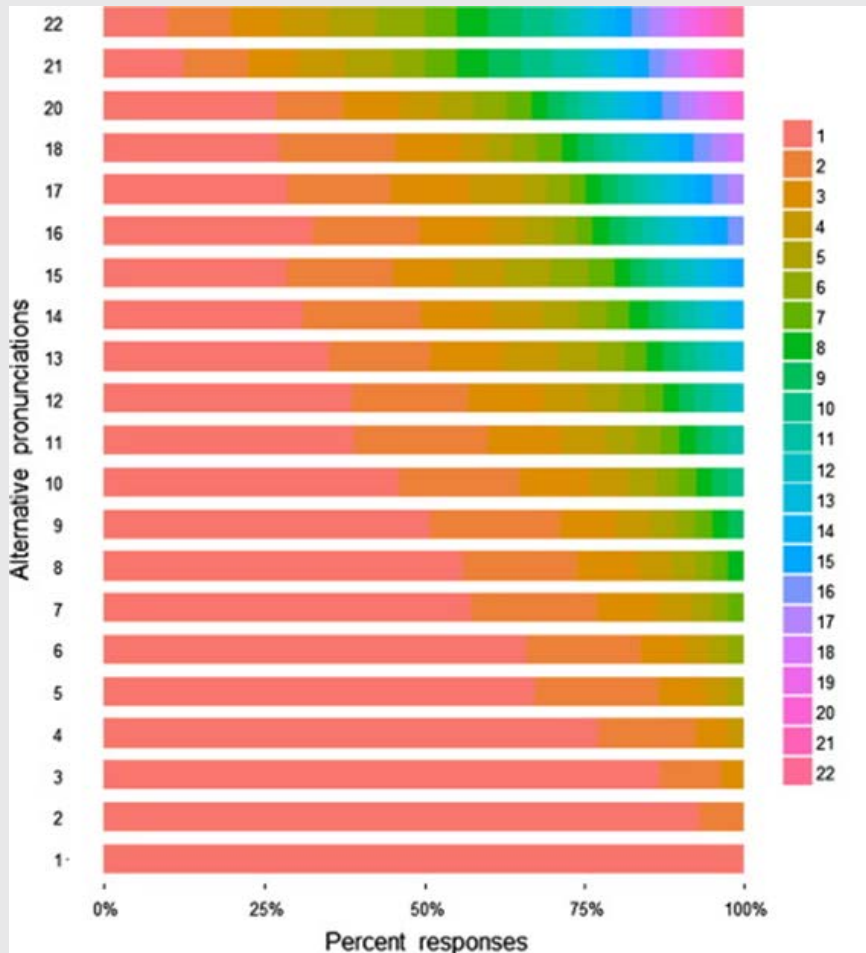
Computation of phonology is central to reading acquisition and skilled reading in alphabetic writing systems, but ...

# The limits of phonic knowledge



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prulli  
vundle  
diswaps  
congeave  
enplouch  
explave  
unbove  
bancing  
meapless  
laniff  
eluch  
shruttle  
ucide  
bamper



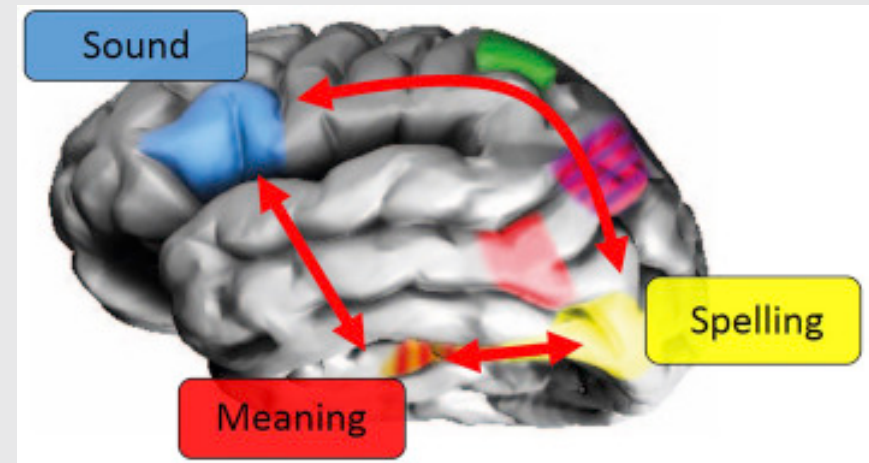
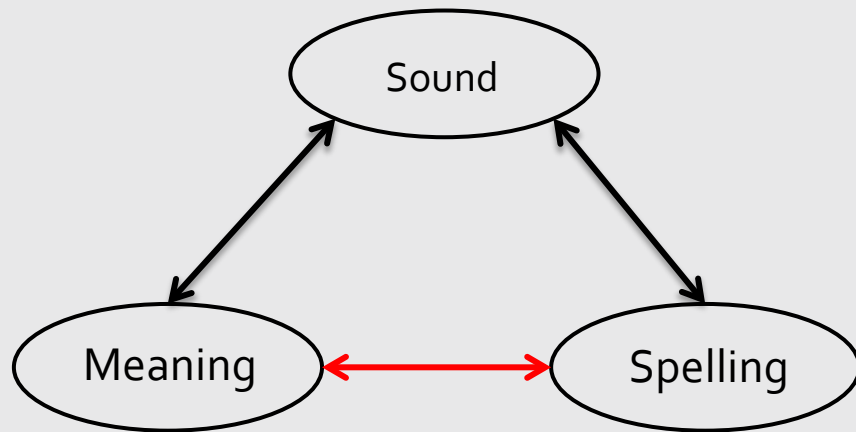
- Mega-study approach
- Item variation strongly determined by regularities in the writing system
- Spelling-sound knowledge mirrors the writing system
- Considerable uncertainty; not viable means of driving skilled reading



# Learning spelling-meaning mapping

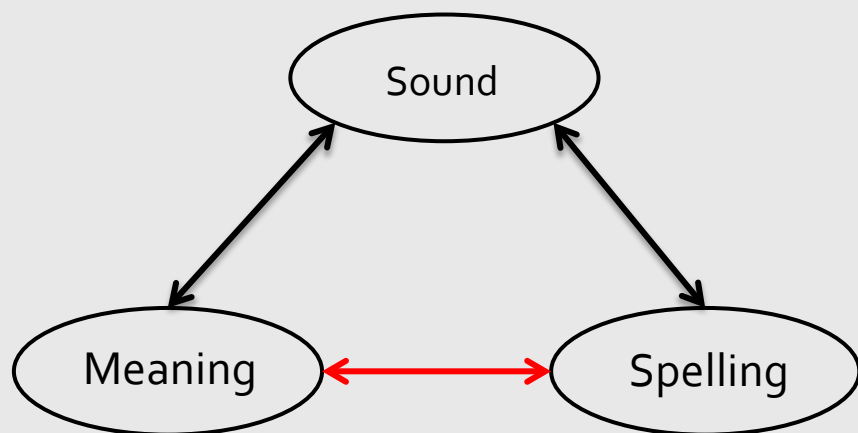


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- Development of expertise, laying down of long-term experience
- Based on *massive* text experience over years of reading acquisition
- *What is it that readers are learning through this text experience?*

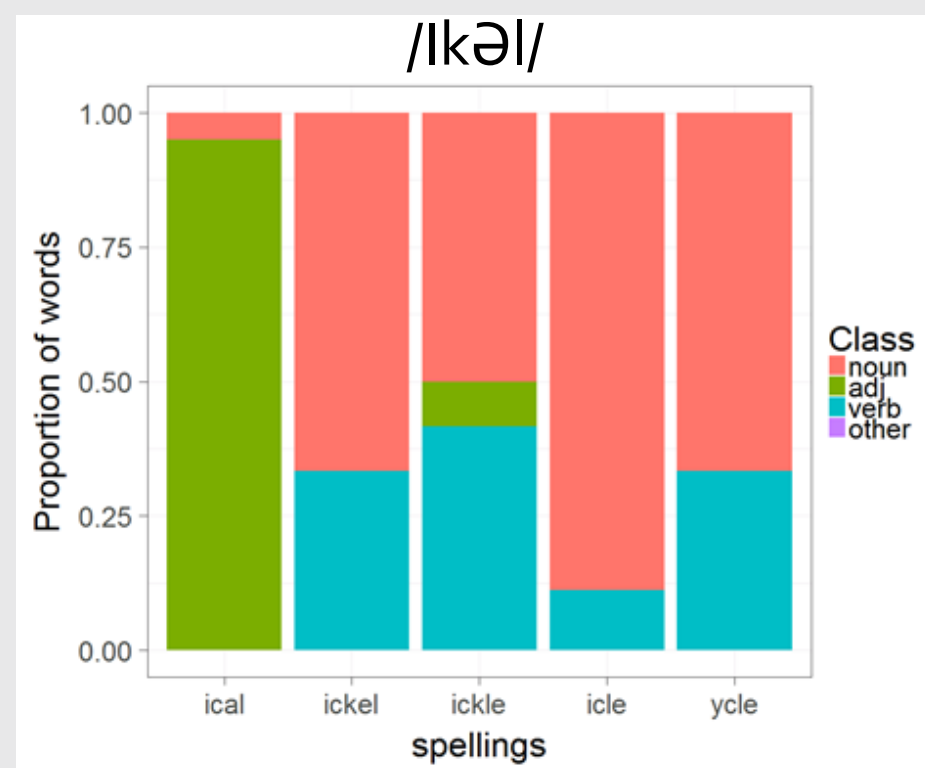
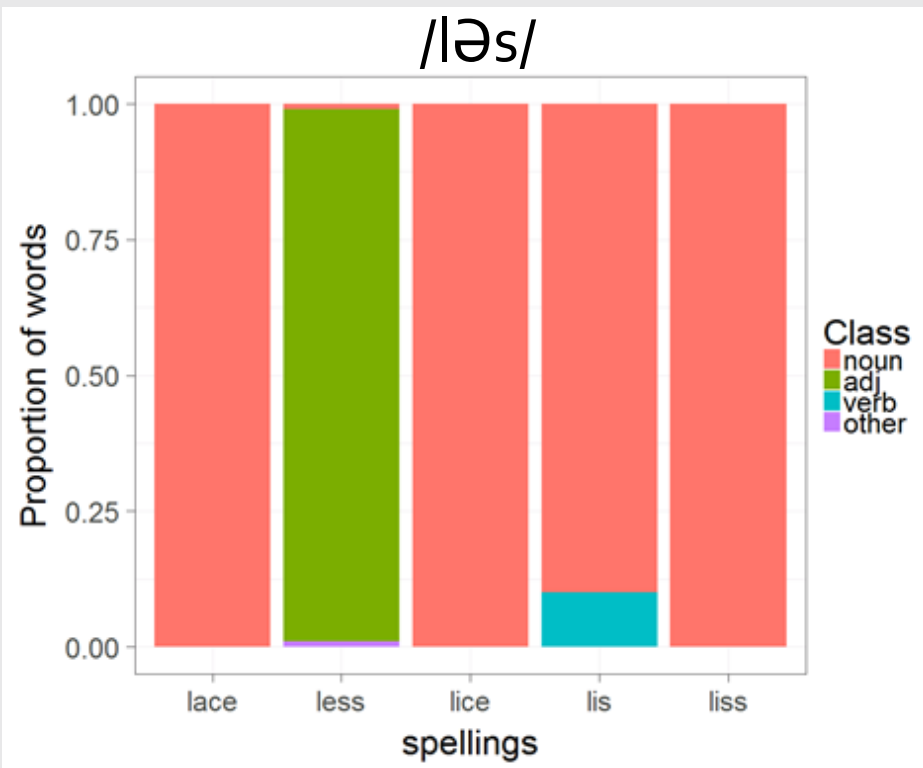
# Learning spelling-meaning mapping



Initial experiences with short words with a single morpheme; but most words are complex

- Morphemes are “islands of regularity” in spelling-meaning mapping
  - Stems (e.g. unclean, cleaner, cleanly)
  - Affixes (e.g. teacherer, builderer, cleanerer)
- Trade-off between spelling-sound and spelling-meaning regularity (e.g. busted, snored, kicked vs bustid, snord, kict).

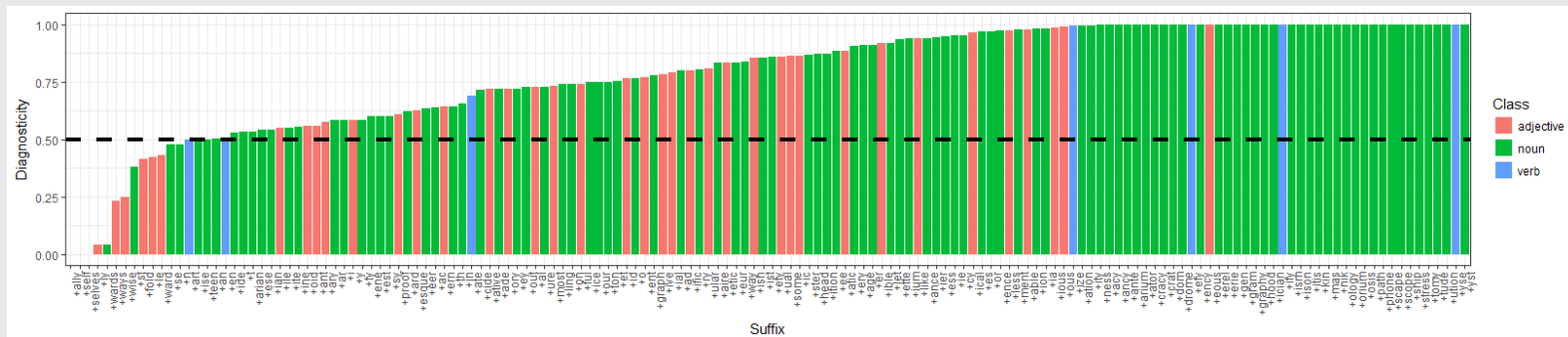
# Islands of regularity



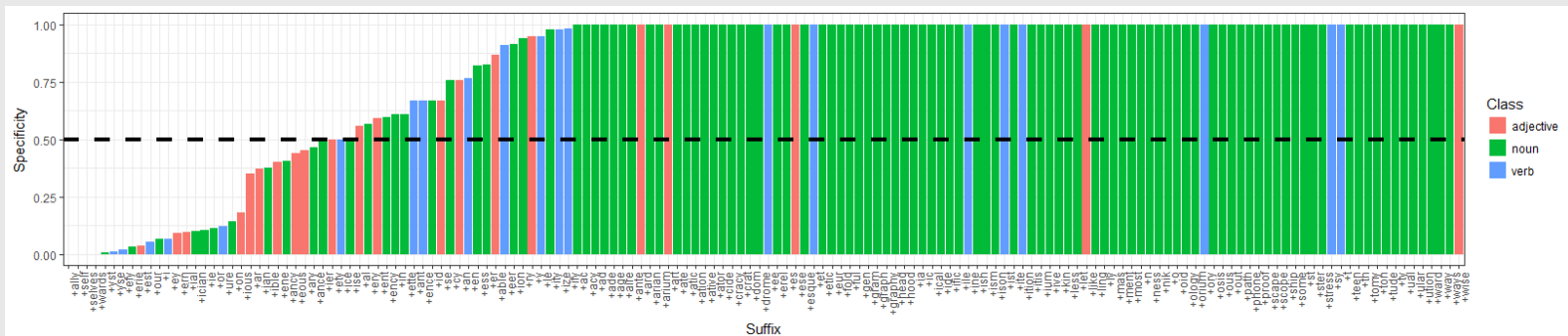
- Letter clusters in English become “reserved” for communicating meaning
- Information not available in spoken language
- English is self-organising; why did it evolve this way?

# Meaningful information is *highly visible* in English spelling

# Most English suffix spellings are highly diagnostic of grammatical category



Most English suffix spellings provide the *only* means of expressing a sound sequence for a particular grammatical category

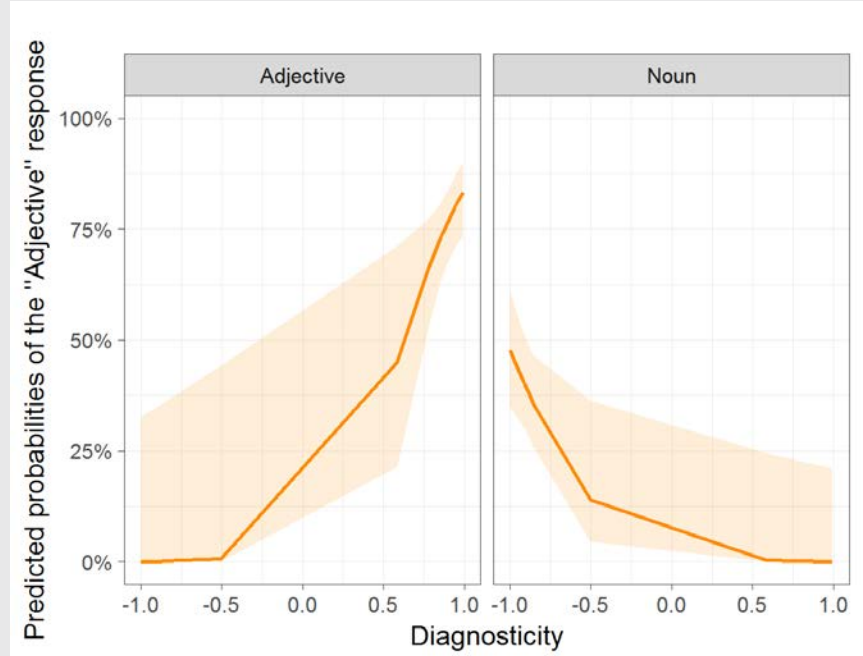
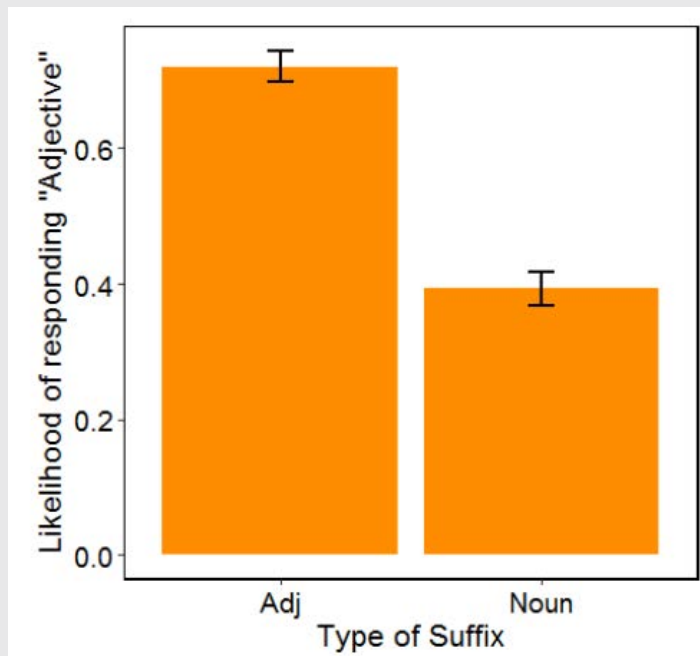


# Skilled readers' sensitivity to this regularity



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Is it an adjective or noun?  
DOMOUS, JIXLET, TERISH, RABNESS ...

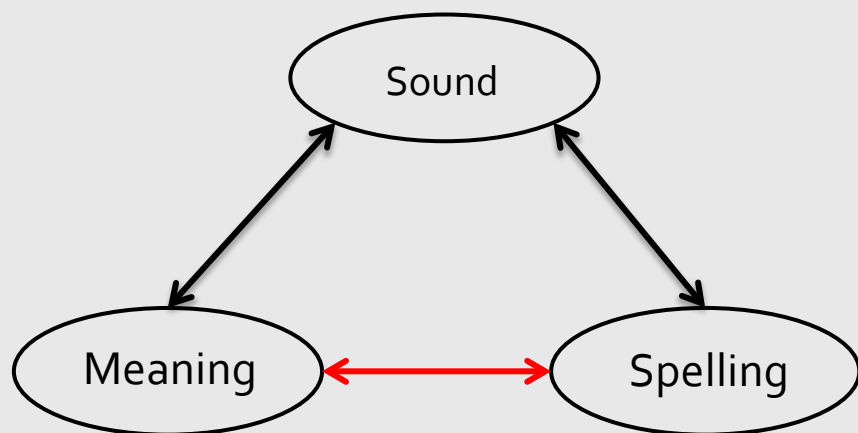


- Explicit knowledge of object / property status, linked to strength of cue
- Knowledge superior for adults with higher vocabulary & spelling
- Similar effects in spelling and in eye-tracking experiments

**Spelling-meaning knowledge mirrors the writing system**



# Learning spelling-meaning mapping



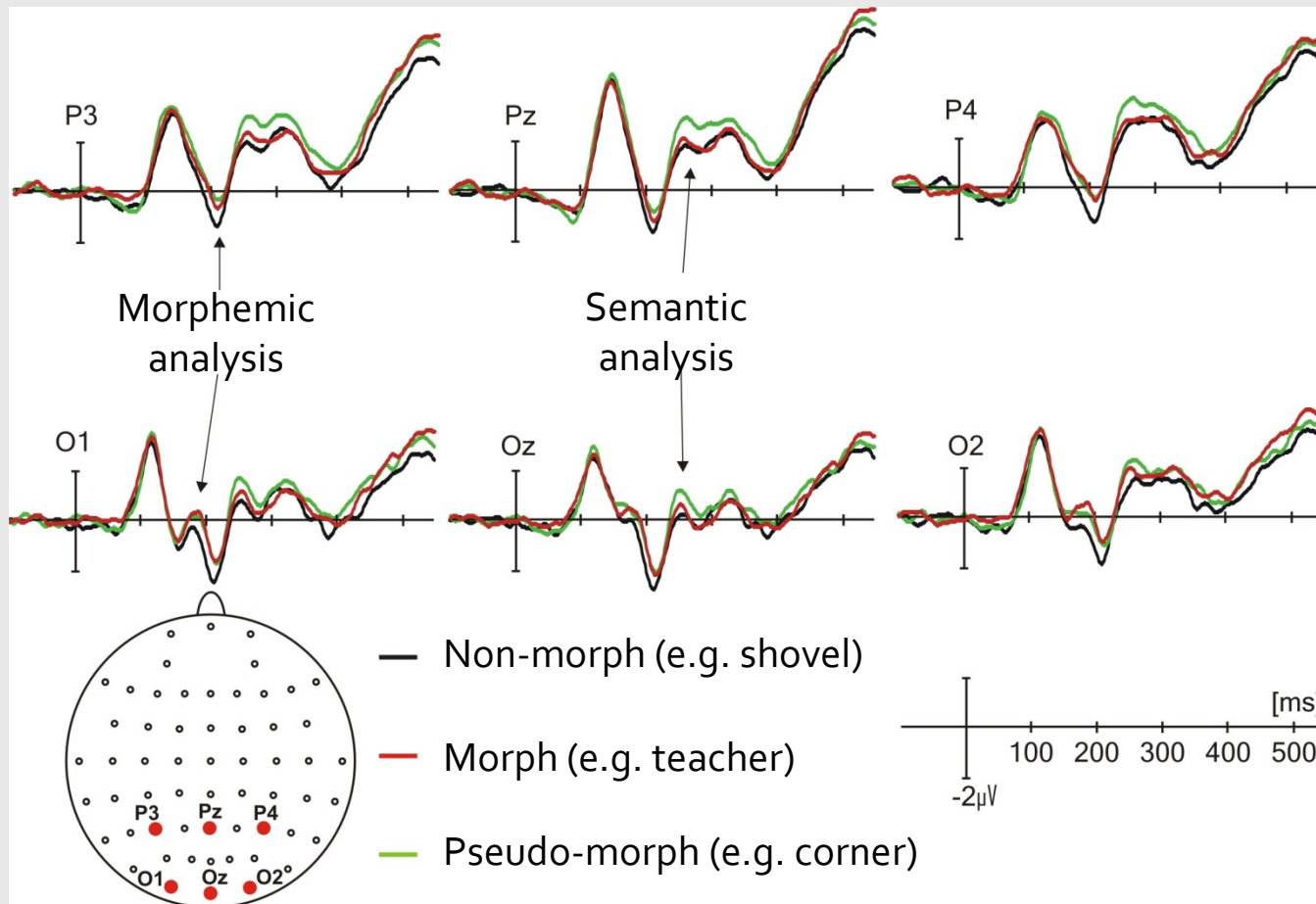
- High visibility of morphology in English yields structured representation.
- Dramatically reduces the learning challenge (~70,000 words -> ~11,000 base words).
- Skilled readers use this information for rapid, superficial analysis of meaning (*Rastle et al., 2000, 2004*).

	develop		
	develop	s	
	develop	ing	
	develop	ed	
	develop	er	s
un	develop	ed	
un	develop	able	
	develop	able	
	develop	ment	
	develop	ment	al
	develop	ment	al
	develop	ment	ly
anti	develop	ment	
re	develop		
pre	develop		
pre	develop	ment	

# Rapid morphological processing in reading



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- Rapid morphological analysis ~190 ms; sublexical
- Semantic analysis / integration ~250 ms
- Converging evidence from priming tasks
- Dependent on reader skill and experience

**Rapid, superficial analysis; only possible because of nature of the writing system**

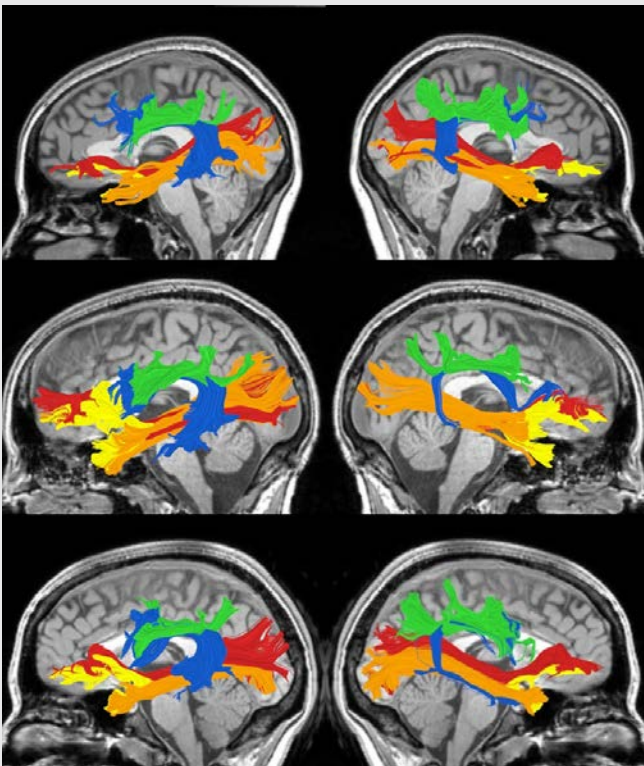
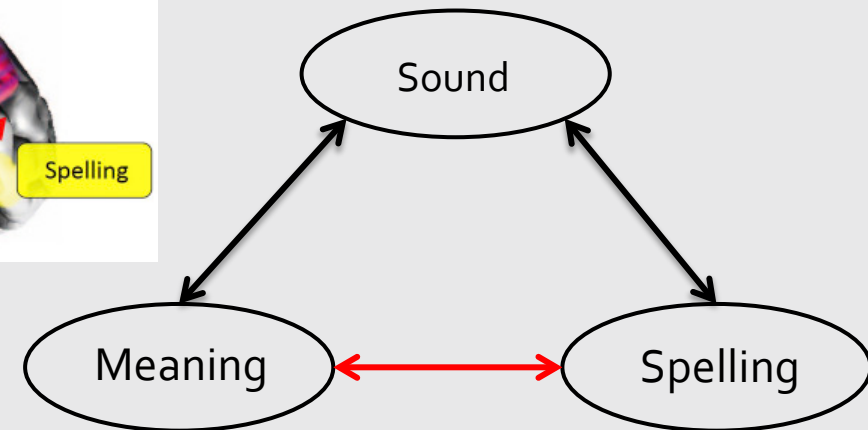
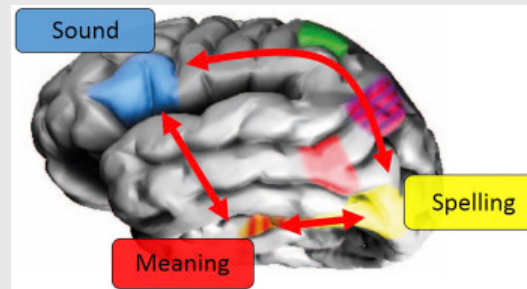
# Morphology and ventral pathway



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■ IFOF  
■ ILF  
■ UF

■ AF fronto-temporal  
■ AF fronto-parietal



- Behavioural measure of sensitivity to morphemes in skilled adult readers (N=45)
- Significant correlations with diffusion properties in all **ventral** (spelling-meaning) tracts in left hemisphere
- Relationship remains after controlling for phonological processing (nonword repetition and nonword reading aloud)

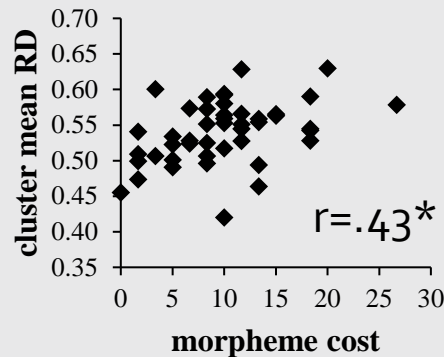
# Morphology and ventral pathway



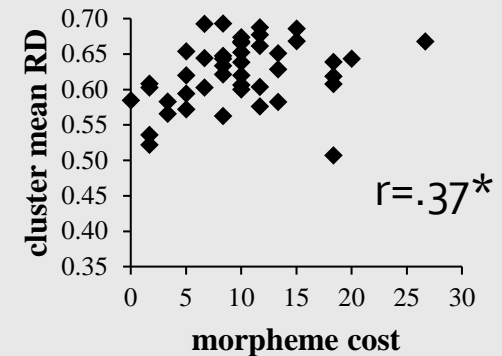
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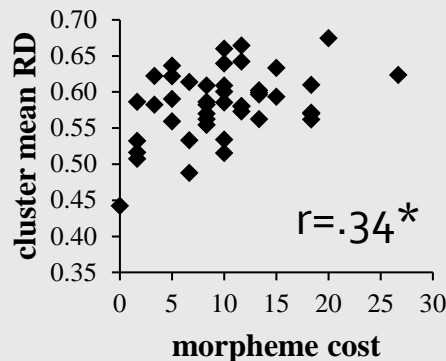
Left IFOF



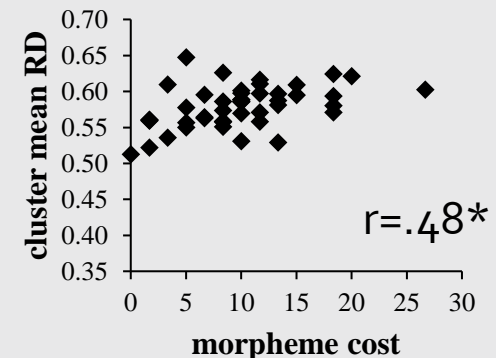
Left ILF



Right IFOF

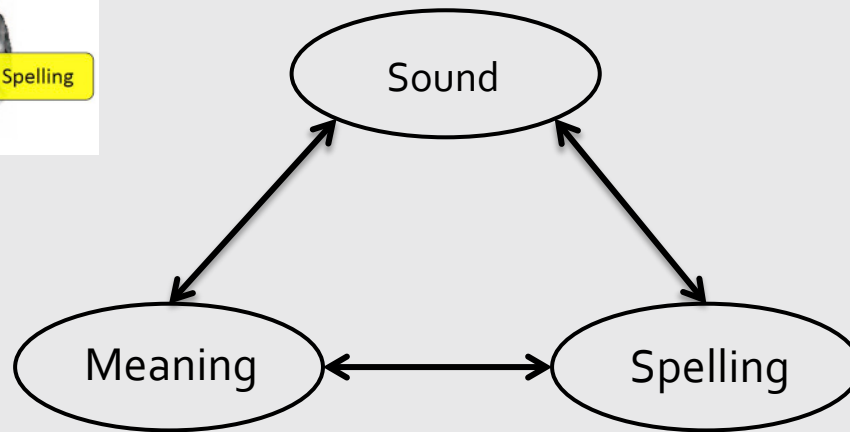
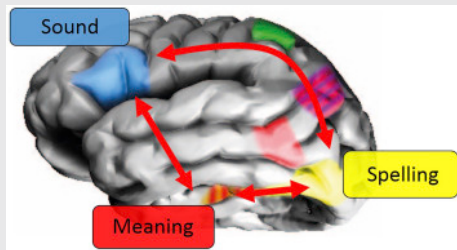


Left UF



Variation in morphological knowledge in adults associated with diffusion properties of ventral white matter pathway; consistent with work using MEG and fMRI

# The reading system is the writing system



- Spelling-sound and spelling-meaning regularities in writing
- Strength of regularities mirrored in reading system
- Sensitivity to regularities a function of reader skill and experience



# Some thoughts about text ...



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## Passage from national reading exam in England (age 10/11)

There were rooms in the old farmhouse which I never saw used and which smelt of the past that held extraordinary fascination for me: little windows where unknown ancestors had sat on autumn evenings; old leather-lined bookcases with books that no one had handled for fifty years; dust that no one had bothered to remove; piles of candle wax in unlikely corners; huge chamber pots and cracked basins, and everywhere a great generosity of space. Outside there was a big lawn hardly walked on, flowerbeds hardly looked at, a vegetable garden which always produced too much, a vast horse chestnut with enough conkers to satisfy the needs of a whole village of boys, a second lawn that nobody ever sat on, and the poignant smells of animals and harvests of a bygone age.

- Richer vocabulary, more complicated syntax than in spoken language
- Reading and writing today are very different than 2000 years ago
- How does literacy shape language knowledge?



- Writing is a form of information that allows us to experience language through the visual modality.
- The reading system is the writing system; information stored in the skilled reading system is a mirror of the writing system.
- Spoken language is represented through writing but written language carries different information to spoken language. I believe this is at the heart of our capacity for rapid, skilled reading.



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Betty Mousikou, Ana Ulicheva, Jo Taylor, David Crepaldi, Jakke Tamminen, Clare Lally, Sam McCormick, Maria Ktori, Nicky Dawson, Adam Jowett, Benedetta Cevoli, Chloe Newbury, Becky Crowley, Oxana Grosseck

Matt Davis, Mark Aronoff, Aureliu Lavric, Michal Ben-Shachar, Maya Yablonski



**The Leverhulme Trust**



Thank you!



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