Reading and dyslexia

Lecture 5

1

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Course map

Introduction
- What is language?
- The innateness debate
- What's the evidence (take 1)

What is a rule?
- Do infants use them?
- How to tell?

Rules of morphology: the battle over inflection

The UG hypothesis (in phonology)

Language and beyond (a choice):
Reading and phonology
~~Numeric cognition~~

We've made it!

2

Reading vs. language

Language is easy
- universal
- Acquired early & rapidly
- in every typical child
- Spontaneously—no explicit instruction
- Regenesis (e.g., homesigns, NSL)
- Precursors present at birth

Reading is hard
- Not universal: many illiterate societies
- Acquired late & gradually
- Dyslexia is not negligble(5-10%)
- Usually requires explicit instruction
- Regenesis is limited
- Absent at birth

Why is reading so difficult?

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Our questions today

- Why is (typical reading) reading so hard?
  - What goes wrong in dyslexia?
- What does reading (and dyslexia) tell us about innateness in language?

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Our recycling brain hypothesis

- Human brains form new systems by recycling old ones (innate instincts)

Dehaene, S., & Cohen, L. (2011). The unique role of the visual word form area in reading. *Trends in Cognitive Sciences, 15*, 254-262.

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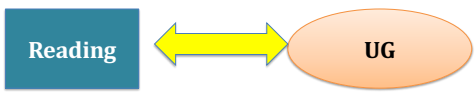
Reading and UG: The implications go *both* ways!



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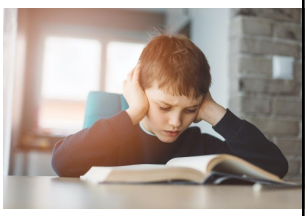
Implications (1): *What the language instinct hypothesis can tell us about reading…*

- Language is a natural biological system (possibly, an instinct)
- Reading is new:
  - Recycles the language system for a new purpose
- Human brains have evolved to support language, not reading
  - *Reading is harder*



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Implications (2): *What reading can tell us about the language instinct*

- If reading recycles a language instinct
  - i.e., shared design to all languages
- We should expect…
  - Common design principles to all reading systems
- *Finding shared design (in reading) suggests a shared design-maker: a language instinct*

8

8

Outline (1): reading

- What is reading, and why it's hard (specifically)
- How reading works: two routes for reading
- Some evidence (English)
  - Regularity effects
  - Homophony effects
- Universal reading principles

9

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Outline (2): dyslexia

- Dyslexia: what it is
- What (often) goes wrong in dyslexia: dyslexia and the speech perception system
- Does dyslexia compromise the phonological grammar?
  - *What UG can do for dyslexia*
  - *What dyslexia can do for UG*

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How reading works?

How do we access the lexicon?

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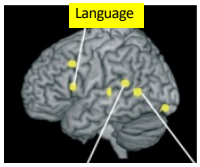
What is reading/writing?

- 1. Writing is a code for language

כלב

dog

狗



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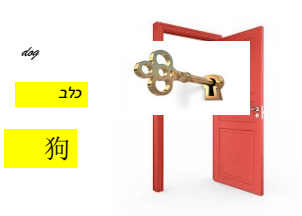
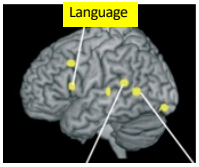
What is reading/writing?

- 1. Writing is a code for language
- 2. Reading=using print to access language





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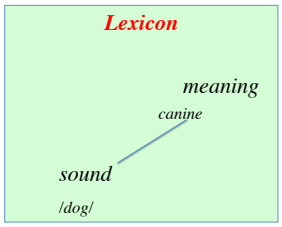
How reading works?

- Store (**spoken**) words: arbitrary sound-meaning pairings



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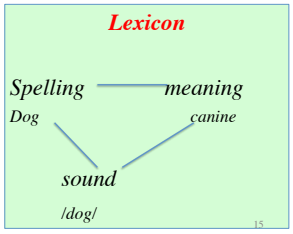
How reading works?

- Store (spoken) words: arbitrary sound-meaning pairings
- Reading:
  - Storing *spelling*-- a new code



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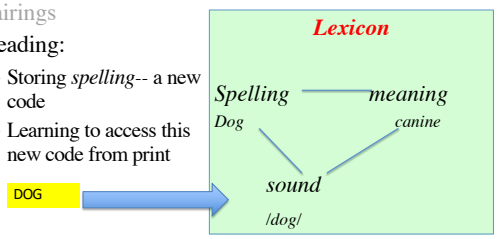
How reading works?

- Store (spoken) words: arbitrary sound-meaning pairings
- Reading:
  - Storing *spelling*-- a new code
  - Learning to access this new code from print



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Why reading is hard?

- Reading requires
  - learning a new code for language: letters
  - Bring able to access it efficiently
- *How is the language system accessed?*

17

17

Demo 1

Regularity effects

18

18

Read these words aloud

List 1

- Barge
- Bless
- Brute
- Carve
- Croak
- Dime
- Dire
- Hoard
- Perk
- Peel
- Peach
- Reap
- Silk
- Shelf
- Soar
- starch
- Steer
- Toy
- wipe

List 2

- Blown
- Breast
- Bush
- Cough
- Crow
- Deaf
- Dough
- Hearth
- Pear
- Pint
- Plaid
- Rouse
- Sew
- Shove
- Soot
- Sown
- Steak
- Ton
- wool

19

19

What's going on?

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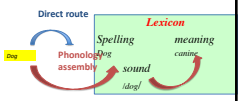
Why two routes?

- Assembled phonology:
  - Necessary for reading novel/unfamiliar words
    - *Blif*
    - *Paradigmatic*
- Direct route:
  - Useful for familiar words
  - Necessary for ***irregular*** words (e.g., *deaf*):
    - words for which sound isn't predictable from spelling
  - Allows one to *address* phonology from the lexicon



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Dual route models: a horse race

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22

Dual route models: a horse race

- The two routes run in parallel;
  - the fastest one "wins" (retrieves the word from the lexicon)
  - Some words yield a mismatch between the two routes → slow reading/errors

23

23

Why is *deaf* hard?

- Deaf is an irregular word
  - phonology is unpredictable from spelling
    - Expect /dif/, get /def/
- *Deaf* generates a mismatch between the two routes:
  - Direct (addressed) route: phonology is /def/
  - Assembled phonology: /dif/
- The resolution of the mismatch takes time, results in errors

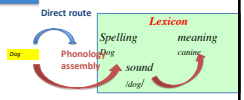
24

24

Regular vs. irregular words
e.g., *leaf* vs. *deaf*

Regular words	Leaf (regular)
assembled	/lif/
addressed	/lif/

Match Easy!



Irregular words	Deaf (irregular)
assembled	/dif/
addressed	/def/

Mismatch Hard!

25

25

Why does it matter?

26

26

How to teach reading?

27

27

The reading wars

28

28

Do readers normally rely on both routes? Two views

"direct route"

- Skilled readers decode words by spelling only
  - Assembled phonology is used rarely
    - By beginning readers ("training wheels")
    - For novel words
  - Most familiar words are decoded by spelling only
  - "Like Chinese"
- **Implications to education: "Phonics" is not really critical for reading**

Phonological view

- All readers rely on phonological decoding
  - As they become skilled, decoding becomes automatic and unconscious
- Phonological decoding is always in use
- **Implications for education: "phonics" is a critical skill**!

29

29

The role of "phonics"

Myth

- "phonics" is just the "training wheels" for reading
- You eventually "outgrow" it

Phonics—just the training wheels…

What the science shows..

- Phonics is critical for *all readers*
- Reading runs on phonological decoding: it's the **wheels**….

30

Phonological decoding is critical

Even for skilled readers…

31

31

Support

- Regularity/predictability effects
- Homophony effects
  - Semantic categorization (phonological interference)
  - Happen "subliminally" (masking)

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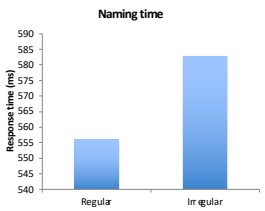
32

Regularity effects

Irregular words: phonology is unpredictable from spelling

	Low freq
Regular	mode
irregular	deaf



Regularity effect: the cost irregular words relative to matched regular controls

Naming irregular words is slower

•Expect:/dif/ (leaf, beat, heat, neat)
•Get: /dɛf/

Seidenberg, M. (1985). The time co… …ems. *Cognition, 10, 645-657.*

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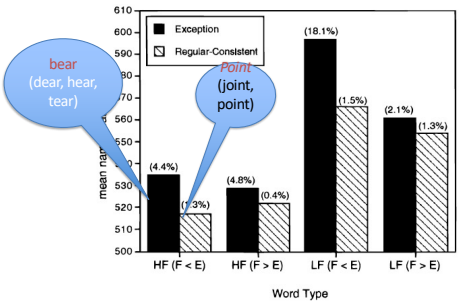
Frequent words are likewise affected by unpredictability



Jared, D. (2002). "Spelling-sound consistency and regularity effects in word naming." Journal of Memory and Language 46(4): 723-750.

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34

Conclusions: regularity effects

- Words are accessed by phonology assembly
- Note (important!):
  - *regularity* here is very different from *regular* in language
    - In reading—no generalizations across the board
    - No need for algebraic rule!
- Limitation:
  - task requires saying the word aloud
  - Is phonology assembly *automatic*
    - Even contrary to task demands?

35

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Homophony effects

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Chuck Perfetti

Guy Van Orden

37

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Demo 2

Semantic categorization

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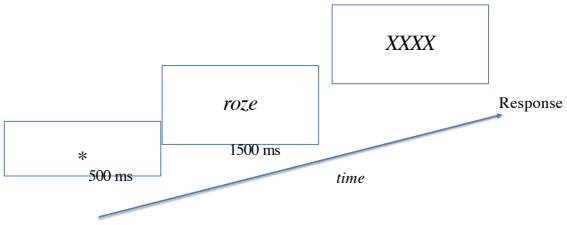
Semantic categorization task

Flower?



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39

Logic of semantic categorization (1)

- Task requires that you access meaning, not sound
- Questions: is phonology activated ***automatically*** (even when it's detrimental)
  - Note: *roze=nonword*; its phonology must be assembled
  - If you attend to its phonology, it can only come from assembled phonology
  - Shows that people rely on assembled phonology automatically!
- **But wait!**
- *Do you wear it?*

	spelling	phonology
Pseudohomophone (nonword)	roze	/roz/

40

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Logic of semantic categorization (2)

The need for spelling control

- *roze* resembles *rose* on two dimensions:
  - *Phonology*
  - *Spelling*
  - Either one can explain the PH effect!
- To rule out access by spelling, compare PH to spelling controls
  - If words are accessed by spelling, then *roze=rofe*
  - If words are accessed by phonology assembly, then *roze >rofe (more similar to rose)*

	spelling	phonology
PH	*roze*	/roz/
Spelling control	*rofe*	/rof/

41

41

Logic of semantic categorization (2)

- How to design a good spelling control?

	target				Letter similarity with target	
	r	o	s	e	Shared	non-shared
PH	r	o	z	e	3	1
Spelling control	*r*	*o*	*f*	*e*	3	1

42

42

Semantic categorization results

- Pseudohomophone effect:
  - *roze* elicits more erroneous "yes" responses than *rofe*
  - Items that sound like words are treated like ones!
  - These effects must be due to assembled (not addressed) phonology
    - Nonwords' phonology cannot be retrieved
- Conclusion: skilled readers use ***assembled*** phonology automatically

Van Orden, G. C., Johnston, J. C., & Hale, B. L. (1988). Word identification in reading proceeds from spelling to sound to meaning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14, 371-386.*

43

43

To examine the role of phonology assembly in reading *cat*, you should compare…

A. *Kat mouse*...
B. Cat and mouse
C. Kat and *zat*
D. kat and cat

44

Demo 3

masking

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Press the space bar...

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XXXX

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make

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PERG

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XXXX

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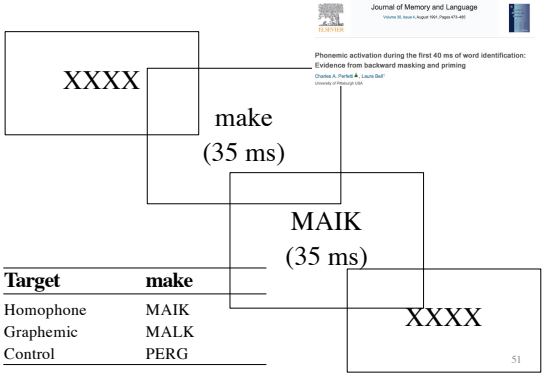
Homophony effects



Target	make
Homophone	MAIK
Graphemic	MALK
Control	PERG

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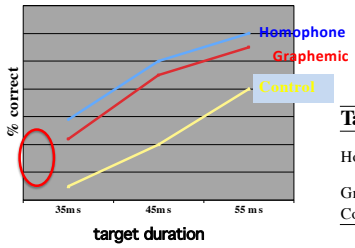
Homophony effects

Homophony effect: the cost incurred by homophones relative to spelling controls

Perfetti & Bell (1988)



Target	make
Homophone	MAIK
Graphemic	MALK
Control	PERG

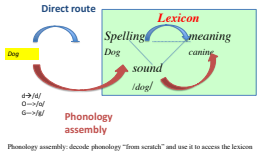
52

52

Rationale

- If people rely on phonology assembly, then
  - *Roze* (PH) should be occasionally confused with *rose* (Word)
- If people mostly rely on phonology assembly, then
  - response time for *rose=roze*
  - such confusions will occur very quickly

Two routes to meaning



Phonology assembly: decode phonology "from scratch" and use it to access the lexicon

53

53

Not just English…

Readers decode it!

Phonological Processes in Reading Chinese Characters

Charles A. Perfetti and Sulan Zhang
University of Pittsburgh

Native Chinese speakers participated in character identification tasks that differ in the extent to which they involve prelexical vs. postlexical phonological processes. A backward visual masking procedure previously found to show prelexical phonemic effects in English failed to produce such effects in reading Chinese characters. Two priming experiments, by contrast, found evidence for semantic and phonological priming in the identification of masked characters (Experiment 3) and in speed of character naming (Experiment 4). The results confirm the assumption that character identification is not mediated by phonemic processes but also demonstrate that the identification of a printed character immediately causes the activation of its pronunciation. The results support a general orthography-independent principle of reading: Printed word forms routinely and automatically arouse phonological representations as part of their identification.

54

54

Not just English…

Judge: same meaning?

	MASKS/PRIMES			
	TARGET	HOMOPHONIC	GRAPHIC	SEMANTIC	CONTROL
EXPERIMENT 1 and 2	视	事	现	看	清
EXPERIMENT 3 and 4	视	事	现	看	清
PIN YIN/SPELLING	/shi/	/shi/	/xian/	/kan/	/qing/
TRANSLATION	watch	matter	now	see	clear

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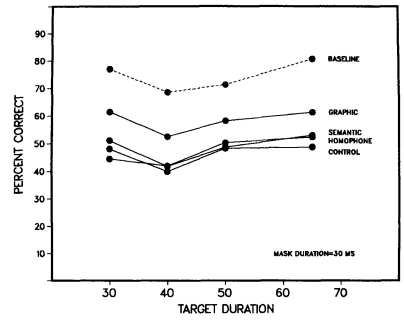
Not just English…



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conclusion

- Readers extract phonology from print
  - Even when doing so is contrary to task demands: an *automatic process*
  - Even in Chinese

57

57

Universal phonological principle

- Readers universally rely on phonology in reading
- Its source (assembled/addressed) varies depending on the orthography

- Chuck Perfetti

58

58

Summary

- Skilled readers assemble phonological codes from print
- Evidence:
  - Unpredictable phonology impairs word naming
  - Homophony matters
    - Interferes with semantic categorization
    - helps recognition (masking)
- Even in silent reading
- Across orthographies: even in Chinese
- Phonological processing is universal; its precise source varies

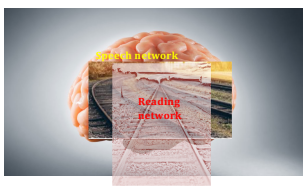
60

60

Why does reading run on phonology?

- The language brain network naturally "runs" on phonological codes
- Reading brain networks "recycles" the speech network
- To get on the "language" highway, writing has to be converted onto phonological inputs

Language "runs" on speech



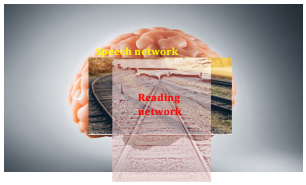
Dehaene, S. (2009). *Reading and the brain: The science and evolution of a human invention*. New-York: Viking.

61

Implications to dyslexia

- If the "speech/phonology" highway is "broke"
- If reading runs on the speech/phonology highway
- Reading acquisition will suffer…

Language "runs" on speech



Dehaene, S. (2009). *Reading and the brain: The science and evolution of a human invention*. New-York: Viking.

62

Dyslexia

63

63

What is dyslexia?

- Defined by exclusion
  - Developmental dyslexia is characterized by an ***unexpected*** difficulty in reading in children and adults who otherwise possess the intelligence, motivation, and schooling considered necessary for accurate and fluent reading
- Could originate from numerous causes
  - Individual differences between children

Shaywitz, S. (1998). "Dyslexia." The New England journal of medicine **338(5): 307-312.**

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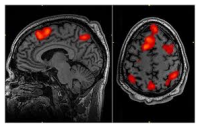
Dyslexia: science vs. myth

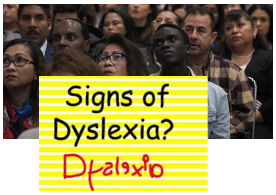
Reading science



- Dyslexia primarily compromises the perception of ***speech sounds*** and their decoding from print (phonics)

Laypeople understanding

- It's a visual problem



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Dyslexia facts: the most common problems are speech-related…

- Phonology assembly
  - Test: reading novel words: *(e.g., blin)*
- Phonemic awareness:
  - how many sounds in *blog?*
  - What is *blog* without first sound?
- Atypical speech perception!
  - Found already in infancy
  - Adults also show atypical phonetic proessing(e.g., *b* or *p?*)

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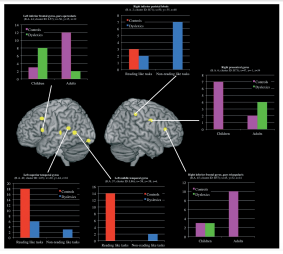
Dyslexia compromises the speech and language brain network



- Broca's area
- Superior temporal gyrus (often linked to speech processing)

Paulesu, E., Danelli, L., & Berlingeri, M. (2014). Reading the dyslexic brain: multiple dysfunctional routes revealed by a new meta-analysis of PET and fMRI activation studies. *Frontiers in Human Neuroscience, 8*. doi:10.3389/fnhum.2014.00830

67

Why are dyslexic brains different? Two possibilities…

- Brain differences→ reading difficulties
- Reading difficulties →brain differences

68

68

The roots of dyslexia predate reading

- Evident in infants
- Genetic risk factors
- The rodent model

69

69

Subtle auditory impairments seen *at birth*

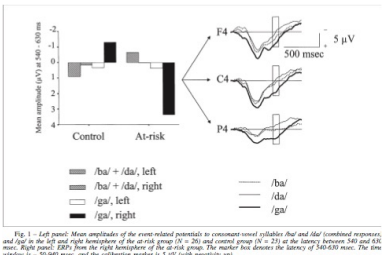


Fig. 1 – Left panel: Mean amplitudes of the event-related potentials to consonant-vowel syllables /ba/ and /da/ (combined responses, and /ga/ in the left and right hemisphere of the at-risk group ($N = 26$) and control group ($N = 23$) at the latency between 540 and 630 msec. Right panel: ERPs from the right hemisphere of the at-risk group. The marker box denotes the latency of 540-630 msec. The time window is – 50-940 msec, and the calibration marker is 5 μV (with negativity up).

- 2 month old infants at risk for dyslexia
  - At risk
  - control
- Study: brain activity to syllables
- at risk infants: abnormal brain response to *ga* (right hemisphere)

Guttorm, T. K., Leppänen, P. H. T., Poikkeus, A.-M., Eklund, K. M., Lyytinen, P., & Lyytinen, H. (2005). Brain event-related potentials (ERPs) measured at birth predict later language development in children with and without familial risk for dyslexia. *Cortex; A Journal Devoted To The Study Of The Nervous System And Behavior, 41, 291-303.*

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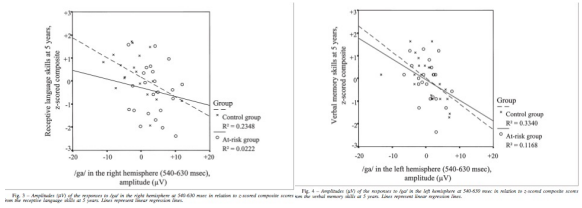
Abnormalities in speech perception at birth predict later language and memory skills (age 5 years)



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71

71

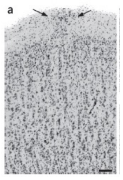
Conclusion: why is decoding impaired?

- ~~A ***consequences*** of reading difficulties?~~
- An underlying difficulty in sound-processing that might be the ***cause*** of dyslexia

72

72

Dyslexia is caused by abnormalities to the developing brain *in utero*



Autopsies

- Individual with dyslexia show cortical malformations
- Cause: disruption of neural migration during embryonic development
- Linked to several candidate genes: DYX1C1, KIAA0319, DCDC2 and ROBO1z

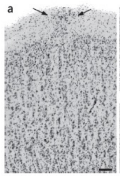
Galaburda AM, LoTurco J, Ramus F, Fitch RH and Rosen GD (2006) From genes to behavior in developmental dyslexia. Nat Neurosci 9: 1213-1217.

73

73

Dyslexia is caused by abnormalities to the developing brain *in utero*

Subtle cortical malformations in dyslexic human brains



A rat model of dyslexia

- Similar malformations can be induced in animals
- Behavioral consequences resemble the human phenotype
  - Difficulties in identification of rapid auditory tones
  - Greater difficulties in males than females

Galaburda AM, LoTurco J, Ramus F, Fitch RH and Rosen GD (2006) From genes to behavior in developmental dyslexia. Nat Neurosci 9: 1213-1217.

74

74

Summary so far...

- Skilled reading entails automatic phonological decoding
- Children with dyslexia exhibit various difficulties related to sound processing
  - *Written language*: decoding sounds from letters
  - *Spoken language*: abnormalities in processing speech sounds
    - Detected close to birth
    - Predict language/memory outcomes (and likely, reading)
- Conclusion: dyslexia is *caused* (in part) by problems related to speech processing
  - The auditory/speech abnormalities of adults with dyslexia are not merely a consequence of reading delay

75

75

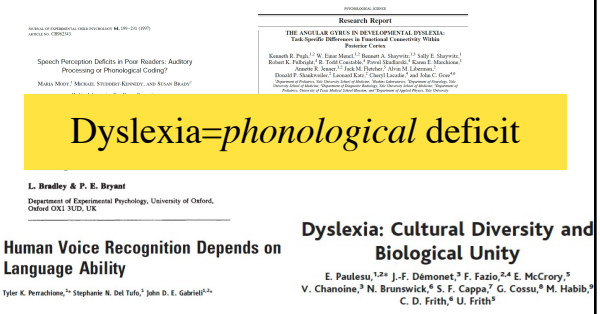
But what *kind* of speech perception problem…

And what can it tell us about phonology and UG

76

76

A common assertion in the literature



Speech Perception Deficits in Poor Readers: Auditory Processing or Phonological Coding?

Research Report

THE ANGULAR GYRUS IN DEVELOPMENTAL DYSLEXIA: Task-Specific Differences in Functional Connectivity Within Posterior Cortex

Dyslexia=*phonological* deficit

L. Bradley & P. E. Bryant

Department of Experimental Psychology, University of Oxford, Oxford OX1 3UD, UK

Human Voice Recognition Depends on Language Ability

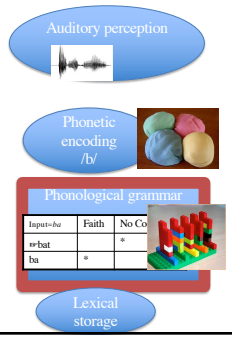
Dyslexia: Cultural Diversity and Biological Unity

E. Paulesu,[1,2,*] J.-F. Démonet,[3] F. Fazio,[2,4] E. McCrory,[5] V. Chanoine,[3] N. Brunswick,[6] S. F. Cappa,[7] G. Cossu,[8] M. Habib,[9] C. D. Frith,[6] U. Frith[5]

77

But is this claim based on any evidence?

- Speech perception has multiple faces
- Phonological grammar is only one of them….
- Existing evidence mostly examines
  - Phonetic categorization
  - Phonological decoding from print
  - *Not the phonological grammar*

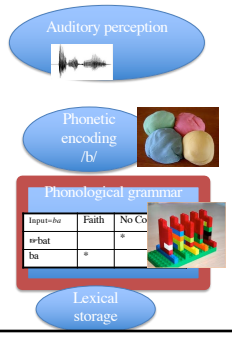


78

So why does the literature claims there is a "phonological deficit"

Two possibilities

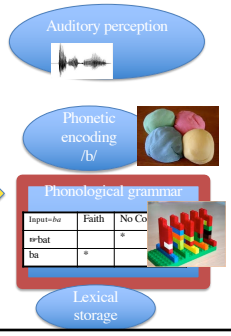
- Option 1: perhaps it is true…
- Option 2: a Whorfian confusion
  - Whorf claimed that language affects thinking
  - Reading research refers to phonological decoding as *phonology*
  - This terminology leads scientists to confuse reading and phonology…



79

Dissociating the phonological grammar from non-grammatical components

- Let's find out!
- How: *dissociate* phonology from phonetics/speech perception



80

Plan

Two tests…

- Let's give dyslexics two tests
  - Phonology
  - Phonetics
- Which one is impaired?
  - *Competing hypotheses!*

	H1:	H2
Phonetics		*Impaired*
Phonology	*Impaired*	*spared*

Two phonological cases

- OCP (Hebrew(
- Sonority (syllable structure—English & Hebrew)

- Why *these cases?*
- Arguably, UG constraints
- Possibly, more resilient

81

Case 1: identity restrictions

OPEN ACCESS Freely available online PLOS ONE

Dyslexia Impairs Speech Recognition but Can Spare Phonological Competence

Iris Berent[1]*, Vered Vaknin-Nusbaum[2], Evan Balaban[3], Albert M. Galaburda[4]

1 Department of Psychology, Northeastern University, Boston, Massachusetts, United States of America, 2 Western Galilee College, Akko & University of Haifa, Haifa, Israel, 3 Department of Psychology, McGill University, Montreal, Canada, 4 Department of Neurology, Division of Cognitive Neurology, Harvard Medical School, Beth Israel Deaconess Medical Center, Boston, Massachusetts, United States of America

82

Stem structure in Hebrew

Algebraic rule in Hebrew

	Example	gloss
ABB✓	*bisus*	base
	Ginun	gardening
*AAB	bibus	
	gigun	

- This rule is **productive** and **tacit**

(e.g., Berent & Shimron, 1997; Berent, Everett, & Shimron, 2001; Berent, Shimron, & Vaknin, 2001; Berent, Marcus, Shimron, & Gafos, 2002; Berent, Bibi, & Tzelgov, 2006; Berent, Vaknin, & Marcus, 2007).

Do dyslexics encode the rule: generalize *AAB to new forms?

83

Dissociating phonology from phonetics

Algebraic rule in Hebrew

Auditory lexical decision

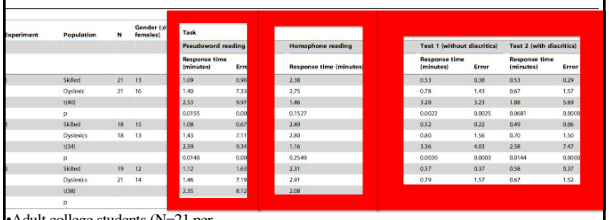
words	ABC	tipul	'treatment'
nonwords	AAB	*titug	Ill-formed
	ABB	gitut	well-formed
	ABC	migus	

Phonetic processing

- Phoneme identification/discrimination
  - E.g., ba/pa
- Speech/nonspeech discrimination

84

Participants

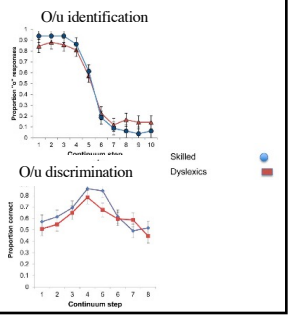


- Adult college students (N=21 per group)
- Native Hebrew speakers
- Documented diagnosis of dyslexia

85

Results

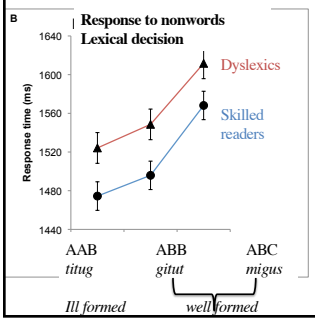
Phonetics/audition impaired



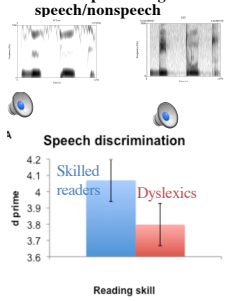
86

Results

Phonological grammar intact



Phonetic processing: speech/nonspeech



87

conclusions

- Phonology and phonetics can dissociate in dyslexia:
  - Phonetic/auditory processing is impaired
  - No evidence for a phonological impairment
- **Limitation**: A single phonological rule…

90

Case 2: sonority restrictions on onset clusters

Berent, I., Zhao, X., Balaban, E., & Galaburda, A. M. (2016). Phonology and phonetics dissociate in dyslexia: Evidence from adult English speakers. *Language, Cognition and Neuroscience, 31*(9), 1178-1192

91

- **Typology**:
- *bl* ≻ *bn* ≻ *bd* ≻ *lb*
- Large rise ≻ small rise ≻ plateau ≻ fall

Greenberg's typology (1978): (Berent, Steriade, Lennertz & Vaknin, 2007):
•Frequency:
•*Bl>bn>bd>lb*

- **Optimality Theory** (Prince & Smolensky, 1993/2004):

UG
bl ≻ *bn* ≻ *bd* ≻ *lb*

Grammatical constraints are universal
- present in ***all*** grammar
•regardless of whether clusters are attested

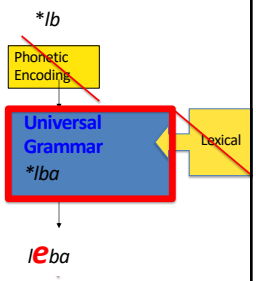
92

Tests

Typical individuals

	Bla	*Sna, spa*	*bna, bda, lba*
English	+	+	-
Spanish	+	-	-
Korean		-	-
Mandarin	-	-	-

Evidence: grammatical repair



•Berent, I., Steriade, D., Lennertz, T., & Vaknin, V. (2007). What we know about what we have never heard: Evidence from perceptual illusions. *Cognition, 104*, 591-630.
•Berent, I., Lennertz, T., Jun, J., Moreno, M. A., & Smolensky, P. (2008). Language universals in human brains. *Proceedings of the National Academy of Sciences, 105*, 5321-5325.
•Berent, I., Lennertz, T., Smolensky, P., & Vaknin-Nusbaum, V. (2009). Listeners' knowledge of phonological universals: Evidence from nasal clusters. *Phonology* 26, 75-108.
•Berent, I., & Lennertz, T. (2010). Universal constraints on the sound structure of language: Phonological or acoustic? *Journal of Experimental Psychology: Human Perception & Performance, 36*, 212-223.
•Berent, I., Balaban, E., Lennertz, T., & Vaknin-Nusbaum, V. (2010). Phonological universals constrain the processing of nonspeech. *Journal of Experimental Psychology: General, 139*, 418-435.
•Berent, I., Lennertz, T., & Rosselli, M. (2011). Universal phonological restrictions and language-specific repairs: Evidence from Spanish. Manuscript submitted for publication.
Berent, I., Harder, K., & Lennertz, T. (in press). Phonological universals in early childhood: Evidence from sonority restrictions. *Language Acquisition*.
•Zhao, X., & Berent, I. (2012). *Are markedness constraints universal? Evidence from Mandarin Chinese speakers. Mental Lexicon, 3*, 275-305.

93

93

A recent test

LANGUAGE, COGNITION AND NEUROSCIENCE, 2016
http://dx.doi.org/10.1080/23273798.2016.1211301

Routledge
Taylor & Francis Group

Phonology and phonetics dissociate in dyslexia: evidence from adult English speakers

Iris Berent[a], Xu Zhao[a], Evan Balaban[b] and Albert Galaburda[c]

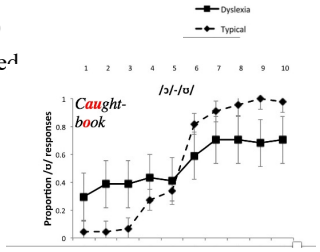
[a]Department of Psychology, Northeastern University, Boston, MA, USA; [b]Department of Psychology, McGill University, Montreal, Quebec, Canada; [c]Department of Neurology, Harvard Medical School and Beth Israel Deaconess Medical Center, Boston, MA, USA

109

109

Findings

- Phonetic categorization: various subtle impairments)
  - In line with published reports



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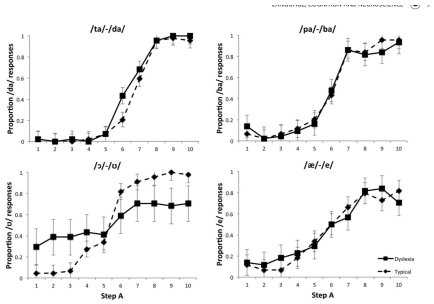
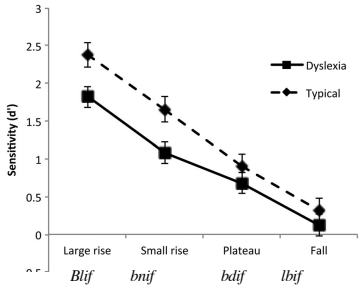


111

111

Test of phonology: sensitivity to the syllable hierarchy



- Dyslexia group: less accurate in judging the *number* of syllables
  - Likely due to the phonetic difficulty
- *Equally* sensitive to their internal structure of the syllable
  - Ill-formed syllables are misidentified
- *Conclusion: The phonological grammar is intact*

112

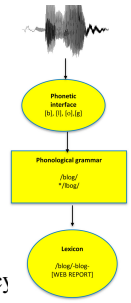
112

Summary: what exactly is impaired in dyslexia?

- Low-level difficulties in speech perception
  - Auditory
  - Phonetic

The phonological grammar appears intact

- Full sensitivity to stem structure
- Full sensitivity to the syllable hierarhcy



113

113

Why is phonology be spared? The core knowledge hypothesis

- Reading (cultural invention) recycles phonology (language): a biological system of core knowledge
- Core knowledge systems are resilient
  - Supported by innate knowledge
  - Can overcome some developmental perturbations
  - Give rise to later-developing systems
- Phonology is a core knowledge system
  - Gives rise to reading (an later skill)
  - Can overcome impairments to audition/phonetic processing

114

114

Implications of the recycling hypothesis

What phonology can do for dyslexia

- Reading researchers conflate phonological decoding, phonology and phonetics
- A clear account of the phonological system can shed light on the problem in dyslexia

115

115

Implications of the recycling hypothesis

What phonology can do for dyslexia

- Reading researchers conflate phonological decoding, phonology and phonetics
- A clear account of the phonological system can shed light on the problem in dyslexia

What dyslexia can do for phonology

- Innate systems of core knowledge are resilient
  - Relatively protected from early perturbations
- Finding that phonology is spared in dyslexia suggests that phonology *is* a system of core knowledge

116

116

So why do we think otherwise?

- Why do we think that…
  - Phonology is all about sensorimotor acuity
    - No rules
    - No innate rules
  - Dyslexia is either
    - "just in your head"
    - A visual problem
- You've guessed it—it's our old friends:
  - Dualism
  - Essentialism
- More on this tomorrow..

- https://www.scientificamerican.com/author/iris-berent/

117

117

General conclusions

- Reading is hard, language comes easy, why?
  - Answer: reading requires phonological decoding
    - We need to get "on the language highway"
- People with dyslexia have congenital problems with speech perception, but not necessarily in phonology (i.e., phonological grammar)
- How do we explain all this?
  - H1: *innateness*
    - phonology is resilient because it is an innate system of core knowledge
  - H2: *recycling*
    - Reading recycles phonology

118

118