



# Language acquisition, perception and production

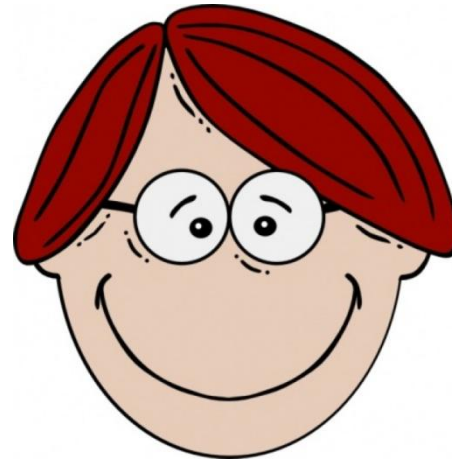
*Lecture 2 – Reading*

# Language Modalities

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**READING**

**HEARING**



**WRITING**

**SIGNING**

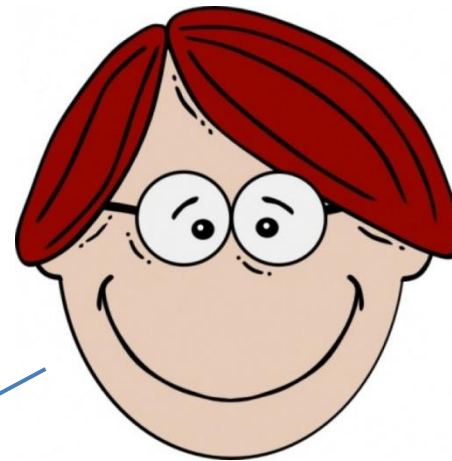
**SPEAKING**

# Language modalities

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- **Comprehension**

- Visual (reading)
- Auditory



- **Production**

- Speaking
- Writing
- Sign language

# Reading

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- Recent development ~ 6000 yrs ago



- Cognitive/neural bases overlap with others

# Types of script

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- Grapheme = unit of written language that corresponds to a phoneme
- Alphabetic languages
  - One grapheme more or less one phoneme
    - Especially in Italian
    - But English (ghoti → fish)
- Consonantal languages
  - Not all sounds are represented
    - Hebrew, Arabic
- Syllabic languages
  - One grapheme corresponds to a syllable
    - Kana (Japanese)
- Logographic languages
  - Each symbol corresponds to a morpheme
    - Chinese, Japanese Kanji



# Reading

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- **Overlap with object recognition**



**FIRE**

# Reading

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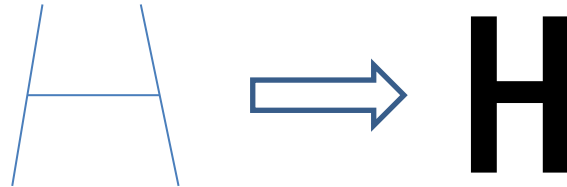
- **Psychological models of reading**
  - **Early models (1970s)**
  - **Later models (1980s)**

# Reading

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- Early models
  - Bottom up

LETTERS



WORDS



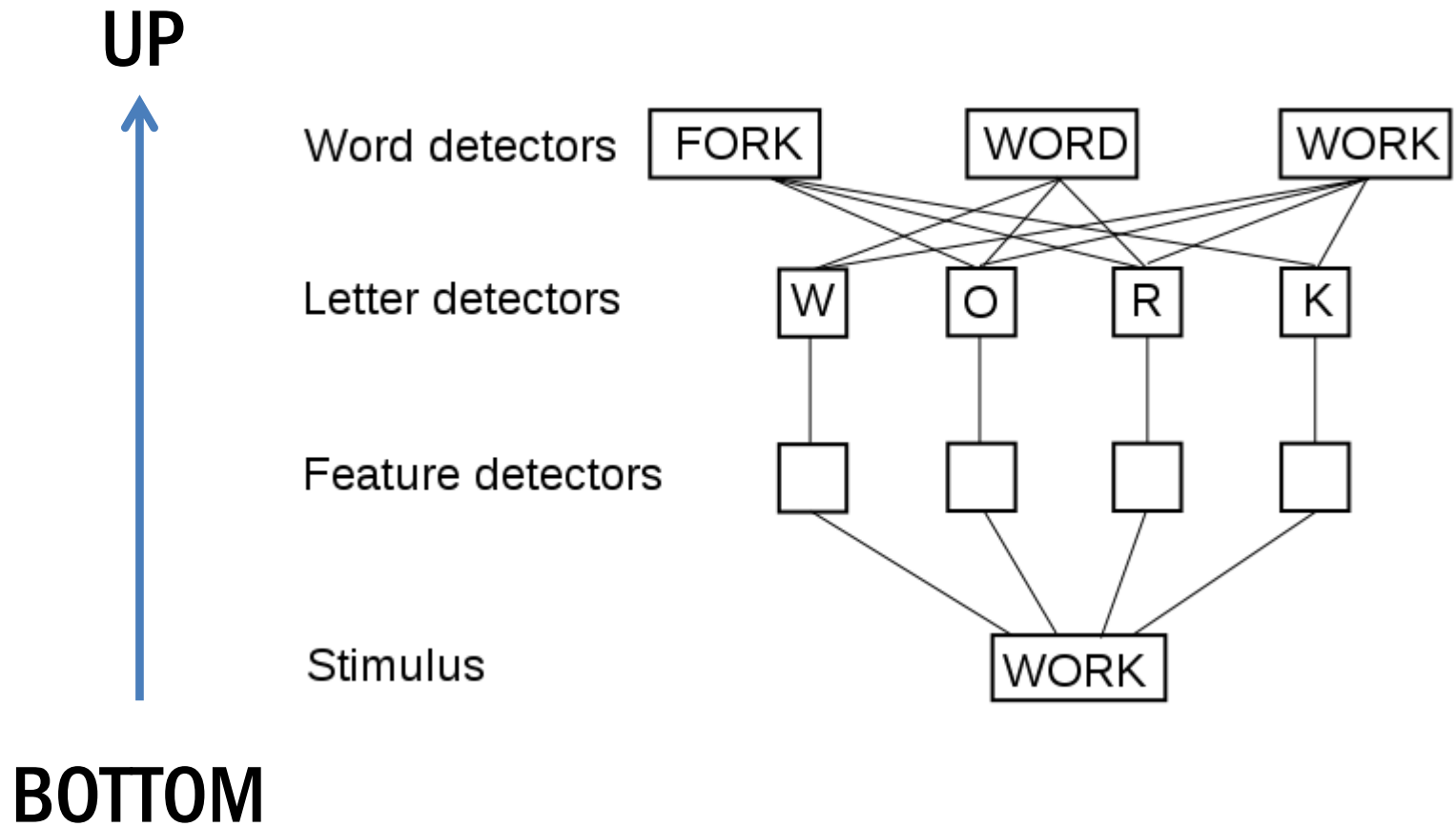
SENTENCES

PUT ON THE HAT



# Reading

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# Reading

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- Evidence for "bottom-up"
- Experiment
- Say names of colors of strings

# Reading

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XXX XXXXX XXXX XXXXX XXX XXXX

XXXX XXXXX XXX XXX XXXXX XXXX

XXXXXX XXXX XXXX XXX XXXXX XXXX

# Reading

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- **Now try the same thing**

# Reading

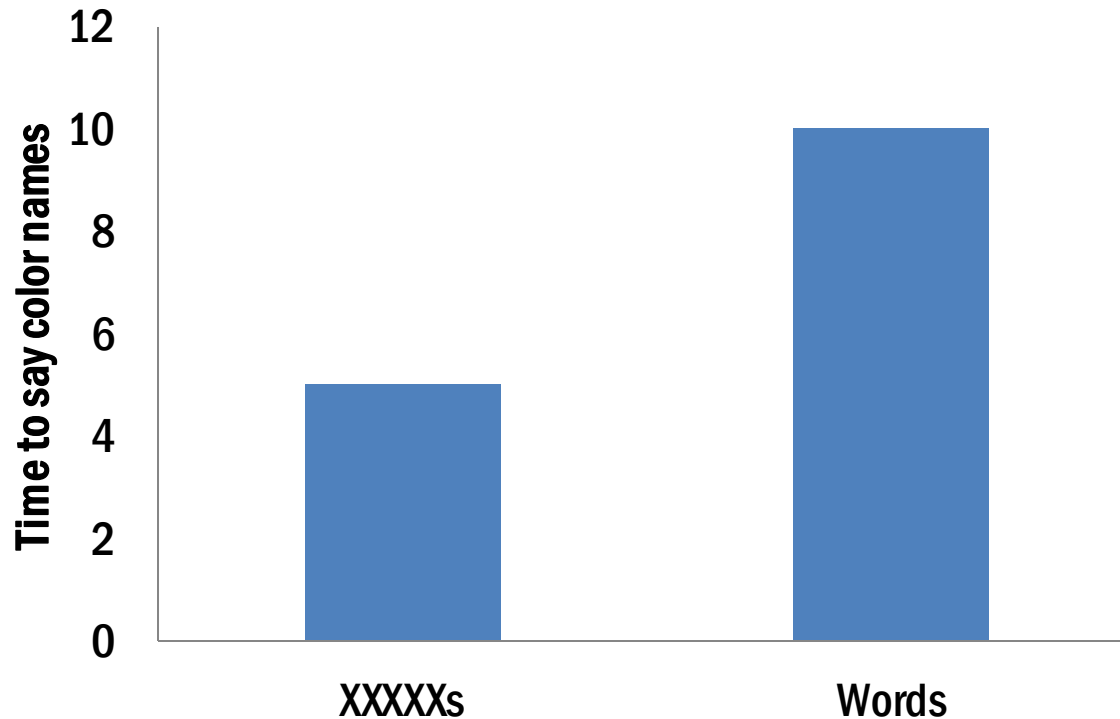
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ROJO VERDE AZUL VERDE ROJO  
AZUL AZUL VERDE ROJO ROJO  
VERDE AZUL VERDE AZUL AZUL  
ROJO VERDE AZUL

# Reading

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- Stroop effect (Stroop, 1935)



# Reading

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- **Much slower with Words**
- **Reading is *automatic***
- **You cannot help but read the words! (bottom-up)**

# Reading

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- **Is this view of reading correct?**
- **Experiment**
- **Read three lists**



# Reading

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# Reading

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y  
w  
u  
s  
q  
o  
m  
k  
i  
g  
e  
c

# Reading

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- **Get ready for list 2**

# Reading

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# Reading

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pool

rugs

mark

send

list

more

pick

stab

neck

your

dice

font

# Reading

---

- **Get ready for list 3**

# Reading

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# Reading

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analysis

habitual

occupied

inherent

probable

summoned

devotion

remarked

overcome

resolute

elements

conclude



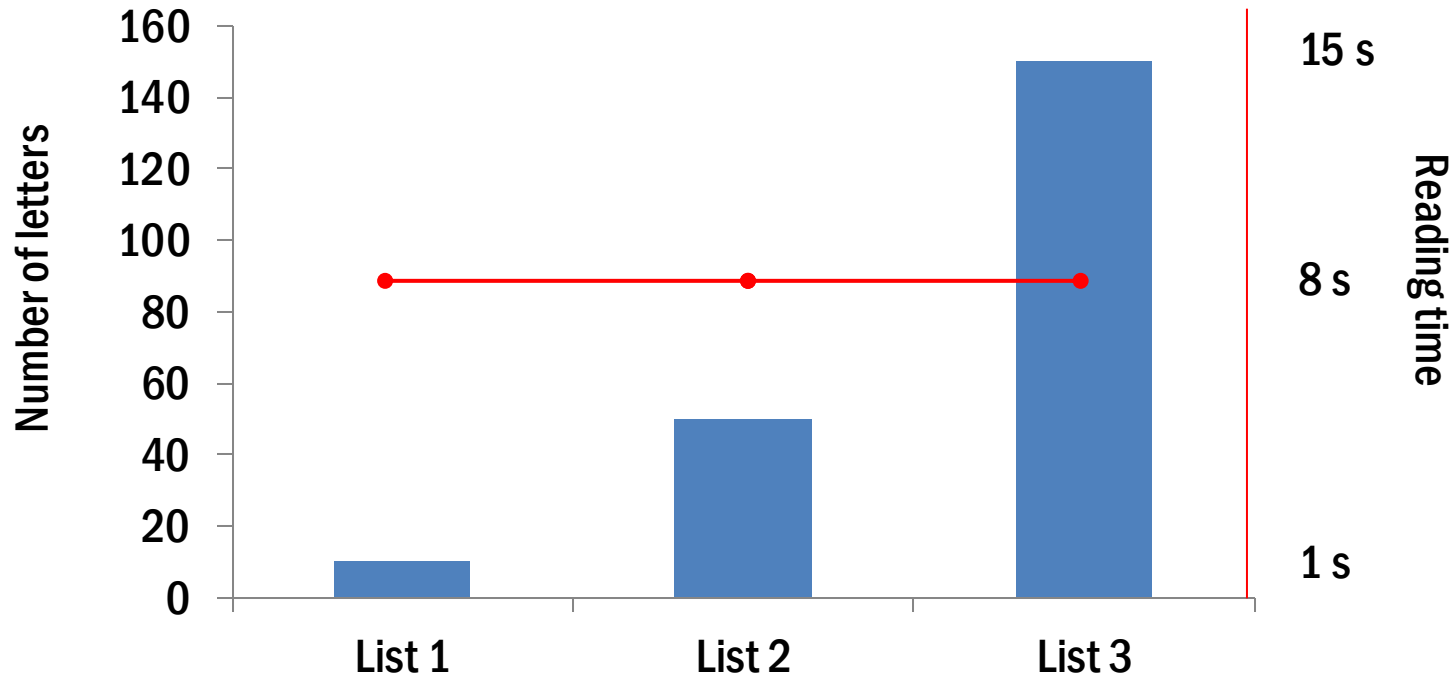
# Reading

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- **Normal readers would be able to read all words in the time on all lists**

# Reading

- Evidence against "bottom-up" reading



# Reading

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- **Word superiority effect (WSE)**
  - Easier to recognize letters in words than by themselves
- **Reichler-Wheeler paradigm (1969-1970)**

# Reading

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- Reicher-Wheeler paradigm

1

card

2

####

3

###D/T

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cqrd

####

###D/T

# Reading

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**##S/Z#**

# Reading

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###D/P

# Reading

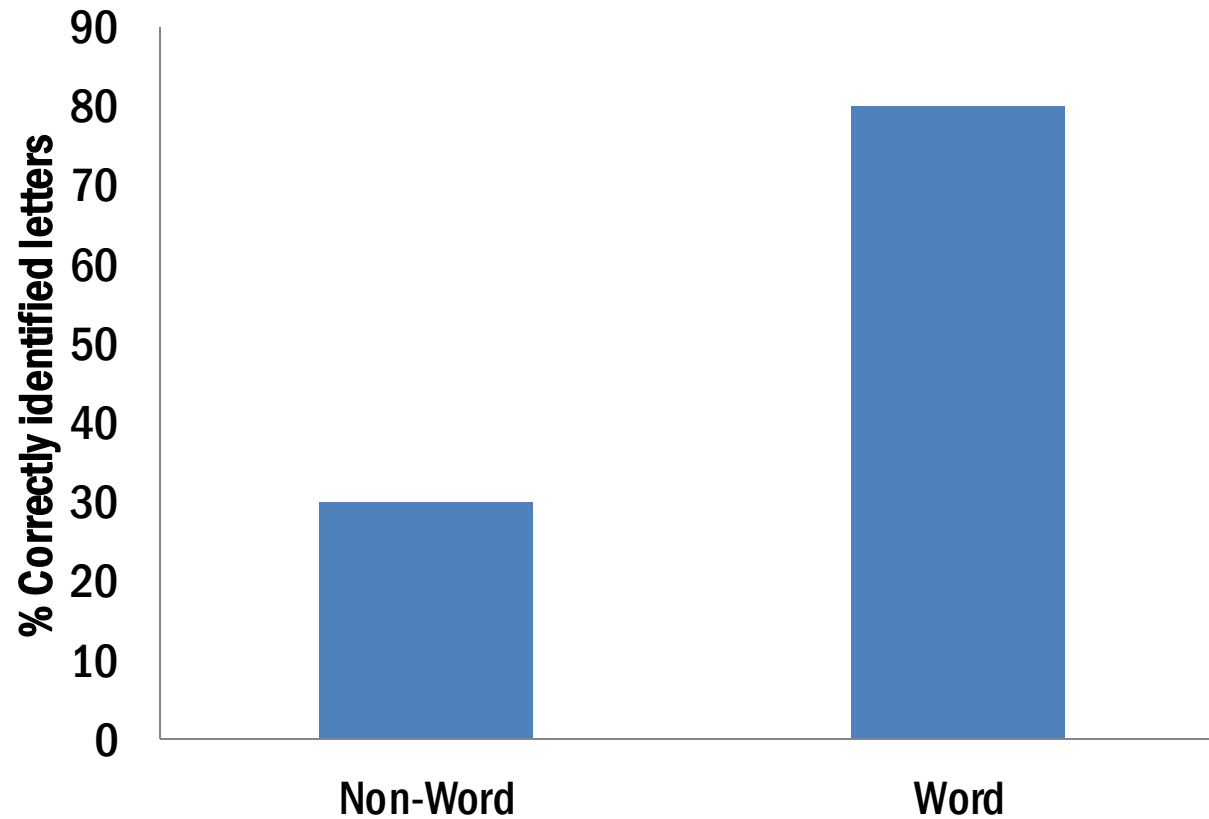
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###A/0

# Reading

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- **Word Superiority Effect**





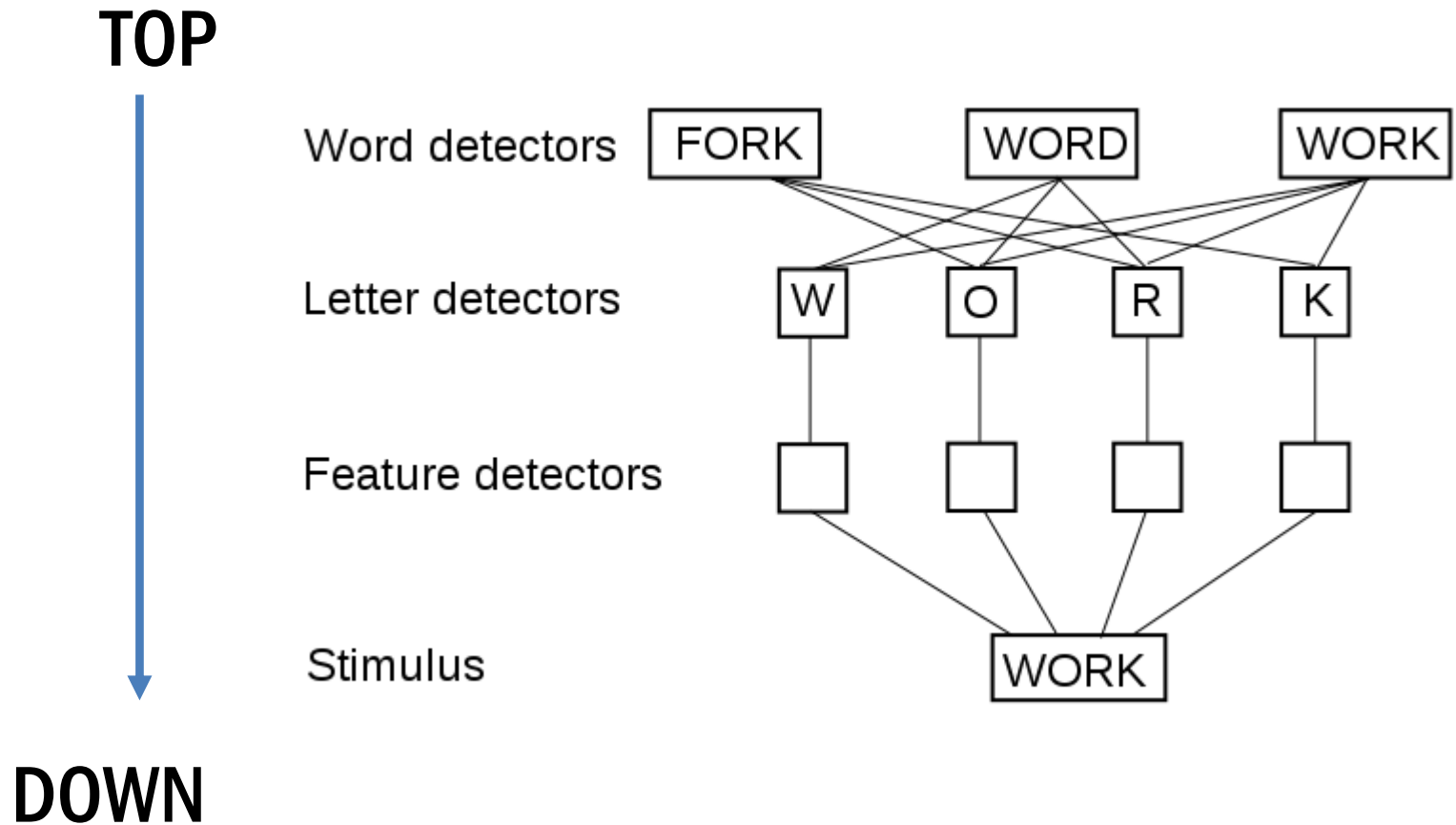
# Reading

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- **Against "bottom up" reading models**
- **Knowledge about words influences letter recognition**
- **"top-down" models**

# Reading

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# Reading

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- **Top down influences**
- **Goodman (1969) – miscue analysis.**
- **Look at errors (miscues) of good and bad readers**
- **Good readers make errors that make sense in context, bad readers do not**

# Reading

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- "after work, he drove home, parked the car and entered the **house**"
- Good readers misread house for **home**. Makes sense in context.
- Poor readers misread house for "horse", "how", or even nonword like "hoose"

# Reading

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- **Further evidence for top-down**
  - **Semantic priming effects**
  - **Prior knowledge effects**

# Reading

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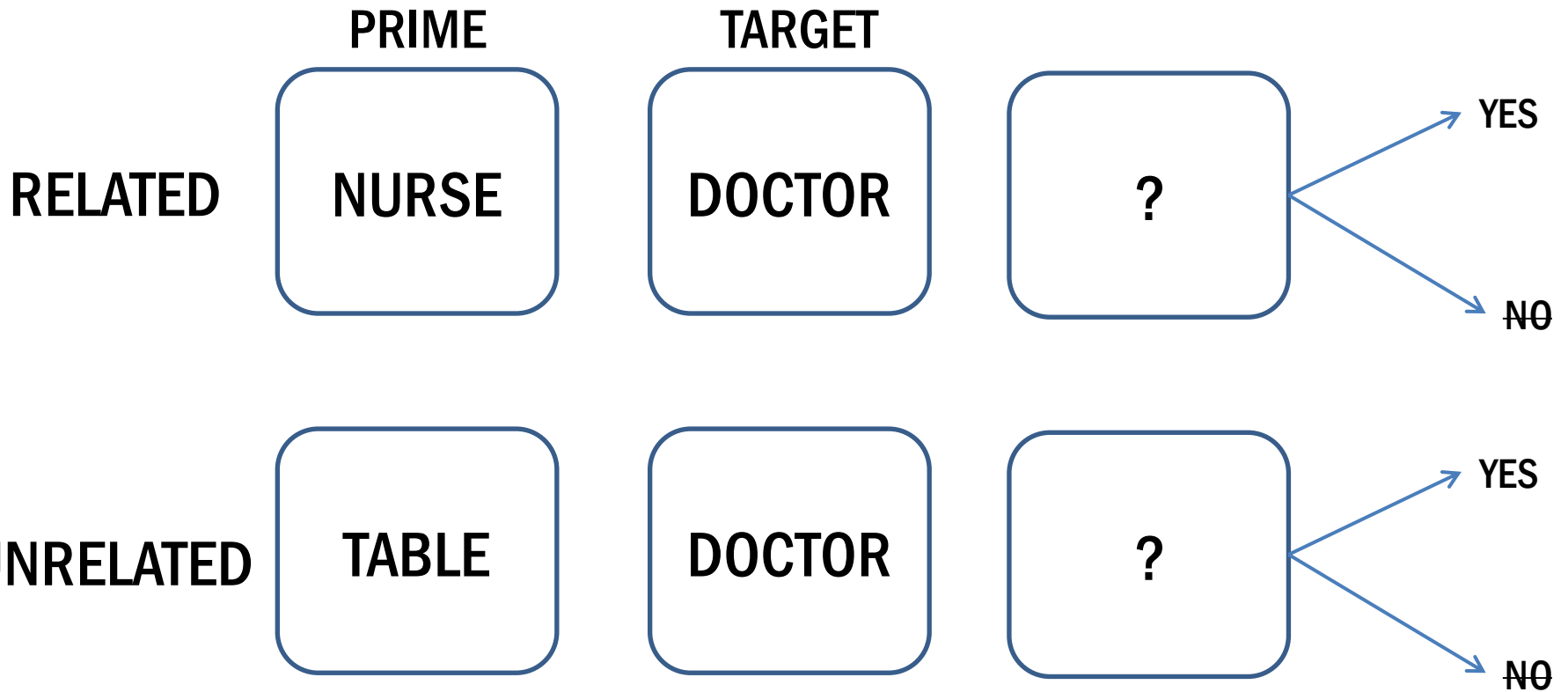
- Semantic priming
- Lexical decision task (Meyer & Schvaneveldt, 1971)



# Reading

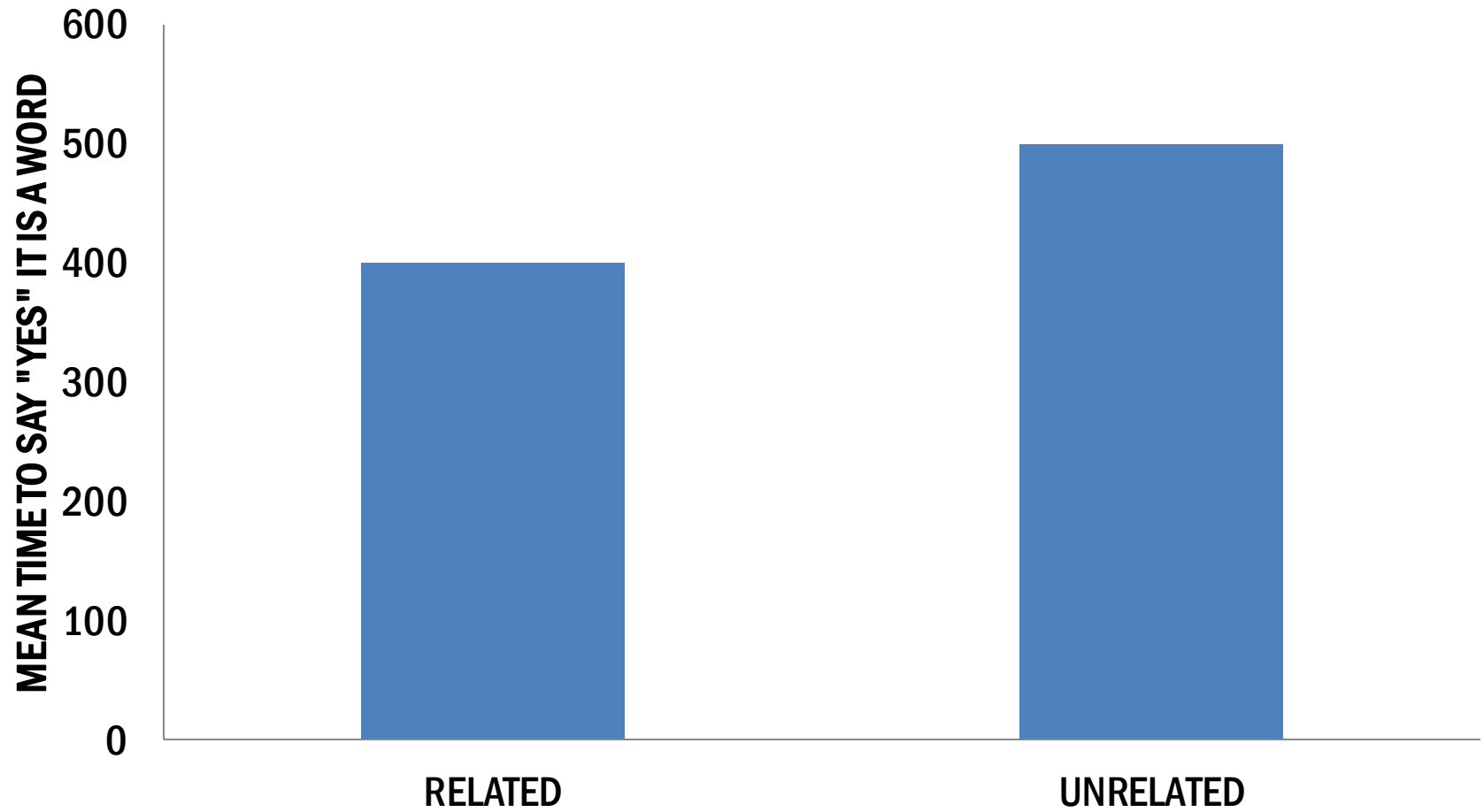
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- Semantic priming



# READING

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# Reading

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- **Prior knowledge effect (Anderson et al., 1977)**
- **Two groups**
  - Female students of music
  - Male weight-lifters

# Reading

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"Every Saturday night, four good friends get together. When Jerry, Mike and Pat arrived, Karen was sitting in her living room writing some notes. She quickly gathered her cards and stood up to meet her friends at the door. They followed her into the living room, but as usual, they couldn't agree on what to play. Jerry eventually took a stand and set things up. Finally, they began to play. Karen's recorder filled the room with soft and pleasant music. Early in the evening, Mike noticed Pat's hand and the many diamonds..."

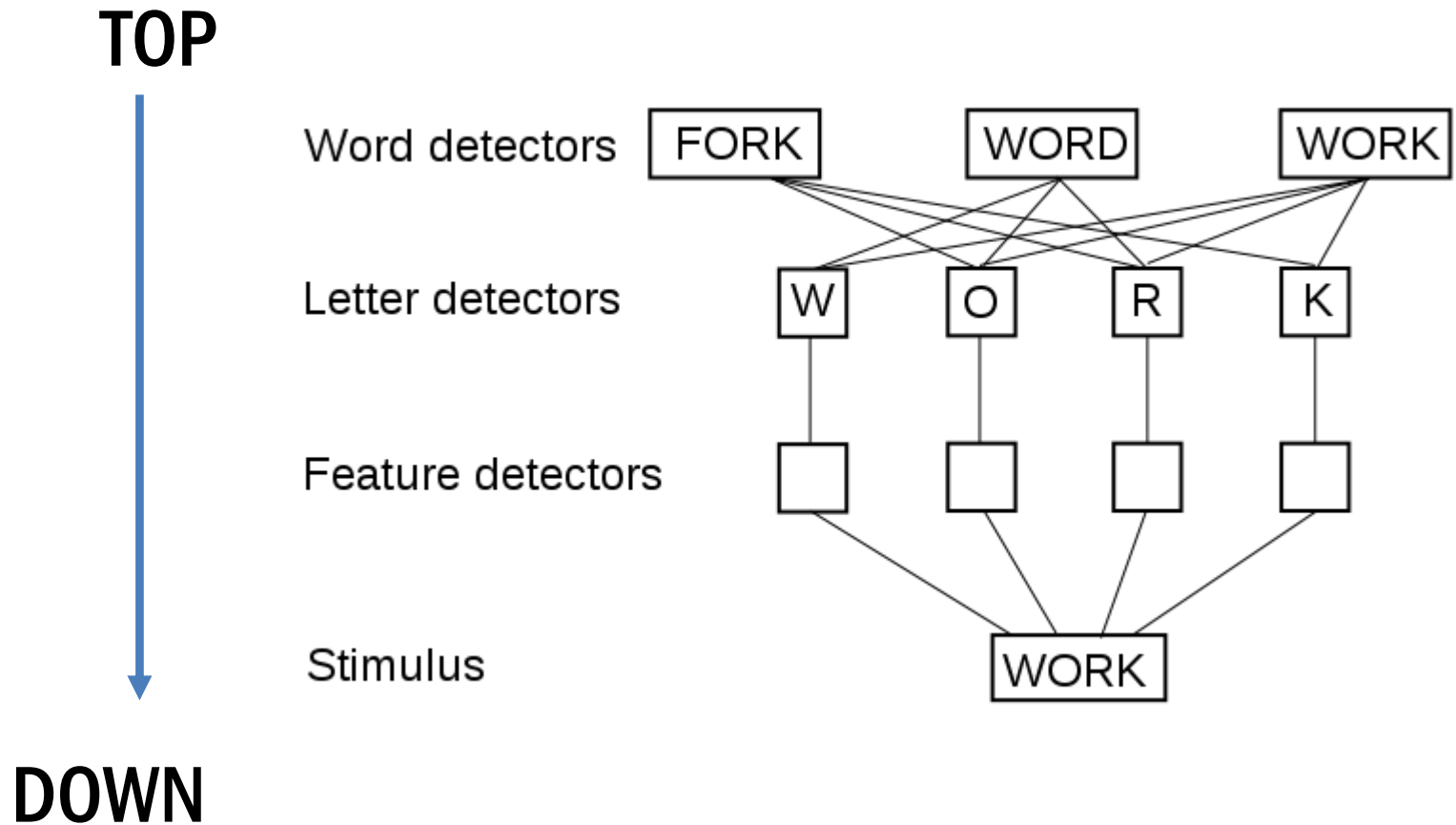
# Reading

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- **What is this text about?**
- **Students of music said "music playing"**
- **Weightlifters said "playing cards"**

# Reading

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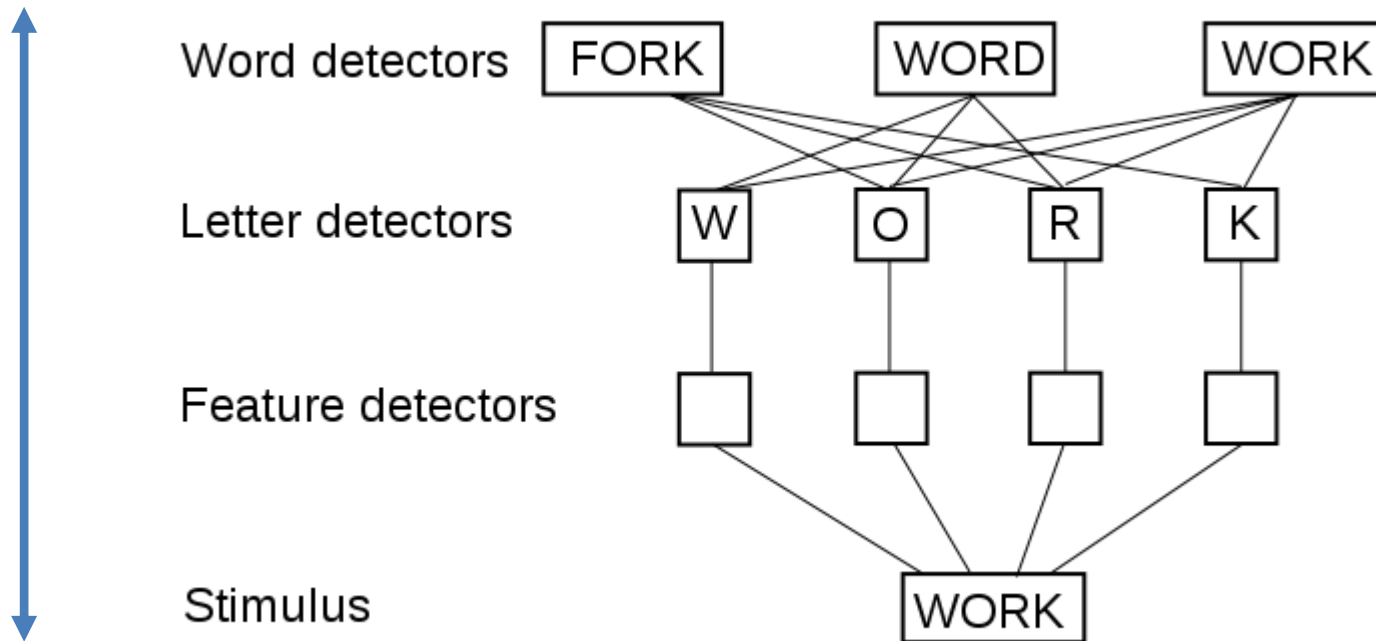
# Reading

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- Lots of evidence for "top-down" reading
- However, can't be whole story.

# Reading

- **Interactive models of reading**
  - Bottom up & top-down



# Reading

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- **Interactivity is complicated**
- **How much bottom up and how much top-down?**
- **There must be a balance**
  - Text from the page
  - Context from previous words
  - Knowledge that you have

# Reading

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- **Summary**
  - **Bottom up**
    - Stroop effect
  - **Top down**
    - Word Superiority Effect
    - Semantic priming
    - Prior knowledge effect
  - **Interactive models**



# Reading

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- **What are the brain bases of reading**
  - **Dyslexia**
  - **Visual Word Form Area (like object recognition!)**

# Reading

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- **Dyslexia**

**"Dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. (Lyon, Shaywitz, & Shaywitz, 2003, p. 2)"**

# Reading

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- **Dyslexia**

- specific learning disability
- Neurobiological in origin
- Difficulties reading, spelling
- Deficit phonological component
- No other cognitive problems

# Reading

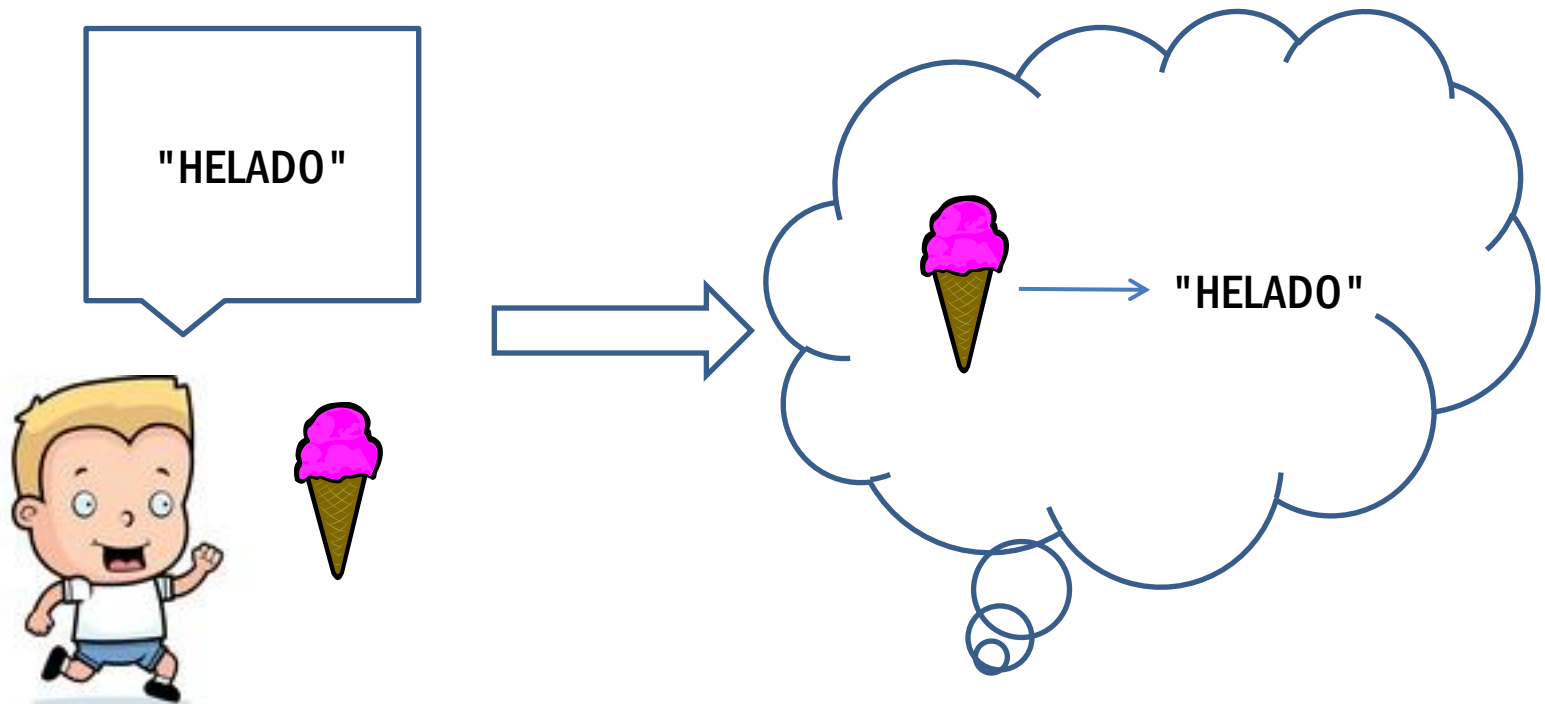
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- **Dyslexia**
    - 5 to 10% of (American) children
1. **Comprehension: fluency problems**
  2. **Production: Child will make errors**

# Reading

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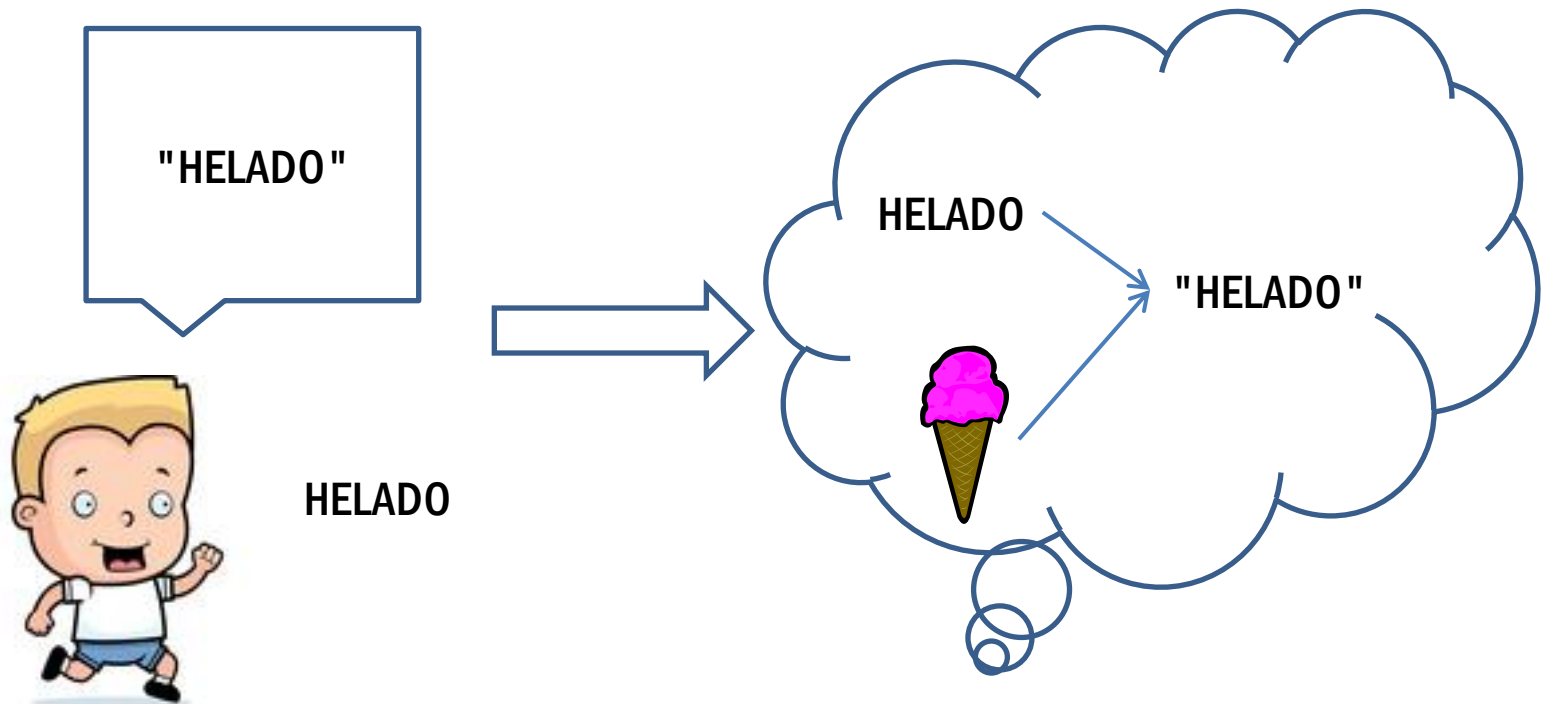
- Phonological deficit



# Reading

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- Phonological deficit



# Reading

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- **Phonological deficit**
  - There are are rules
    - [he] always pronounced "he" {heroe, etc}
    - [la] always pronounced "la" {la, etc}
    - [do] always pronounced "do" {delgado, etc}
- **You have to learn these mappings**

# Reading

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- **It's complicated**
- **Two sounds – one letter:**
  - Spanish: c is "s" or "k"? casa versus cena
- **Many words look alike**
  - casa - caza
- **English very complex**
  - Tough – though - thought



# Reading

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- **Languages with complex mapping**
  - Opaque orthography (English)
  - Transparent orthography (Spanish, Japanese)
  
- **ghoti → "fish"**
  - Tough, women, caution

# reading

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- **Learning to read is learning to map letters to sounds**
- **Dyslexia is problem in learning this mapping**
  - Phonological hypothesis

# Reading

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- Rhyme judgement task
  - Gate vs mate
  - Gate vs dog
  - Gate vs bait (!)
  - Pint vs mint (!)

# Reading

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- **What is relationship between reading skill and IQ?**
  - **Poor readers have low IQ?**

# Reading

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- **Study (Tanaka et al., 2011, Psych. Science)**
- **131 children, age 7 – 17 years old**
  
- **Three groups**
  - 1. Typical reader – typical IQ**
  - 2. Poor reader – typical IQ**
  - 3. Poor reader – low IQ**

# Reading

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- Used rhyme judgment task
- Look at neural activity (fMRI)

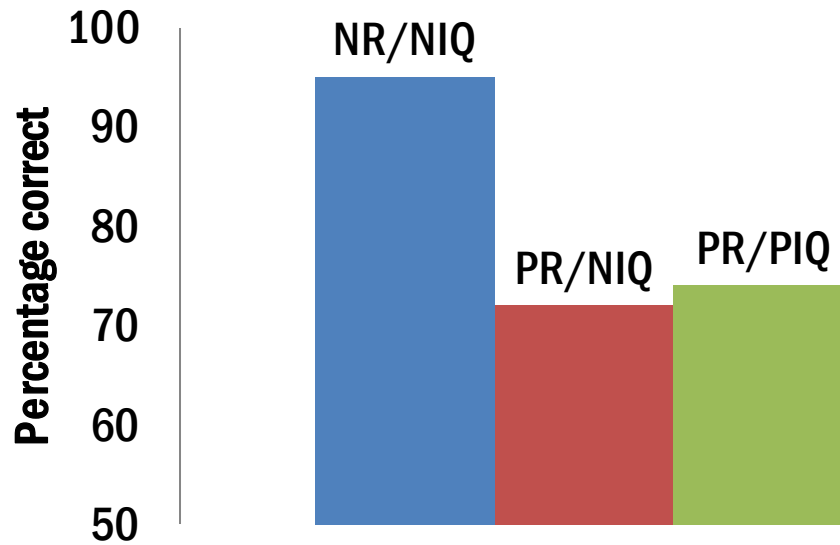


- Do poor readers (with low and normal IQ) differ relative to normal readers with normal IQ?

# Reading

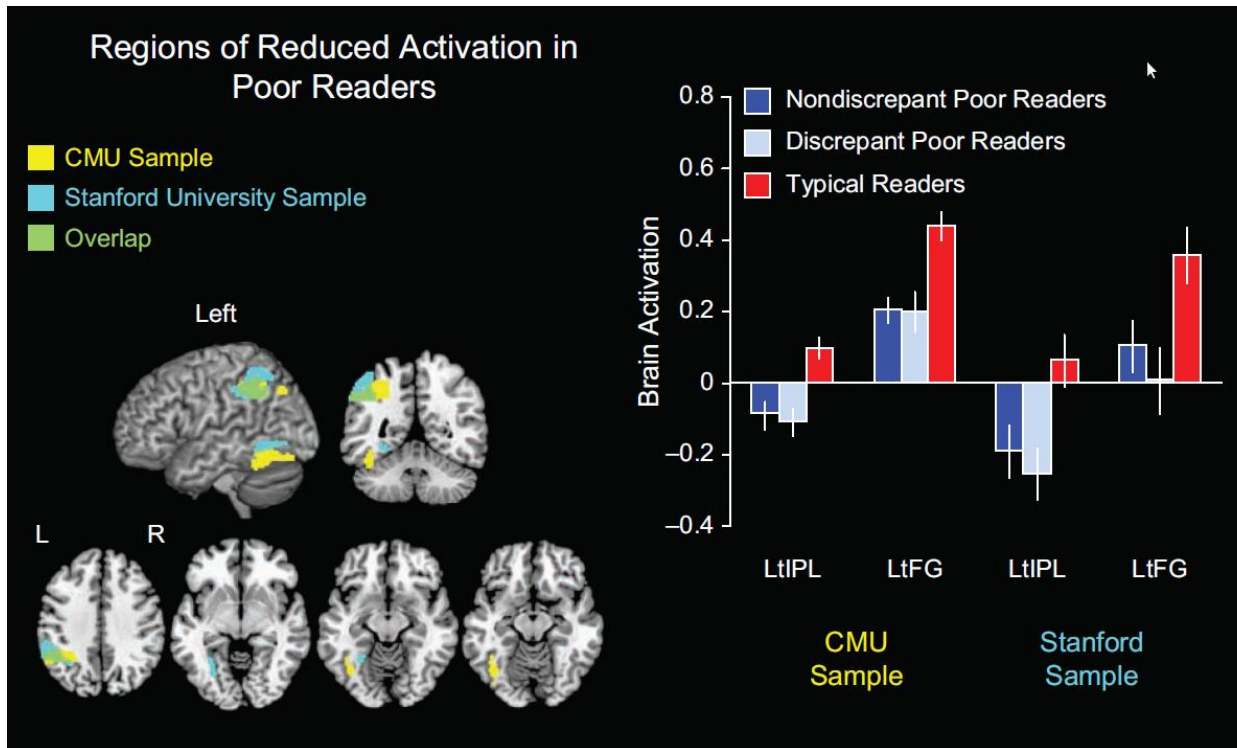
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- Results
  - Behavioral



# Reading

- Results
  - fMRI



Reading effects in

1. Left inferior parietal lobule
2. Left fusiform gyrus



# reading

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- **Discussion**
  - Activation in region depend on reading skill
  - These regions do not differentiate between low and normal IQ
- **Reading skills and IQ are independent**

# Reading

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- **Neuropsychological evidence**
- **Pure Alexia**
  - inability to read
  - Can write
  - Auditory word comprehension OK

# Reading

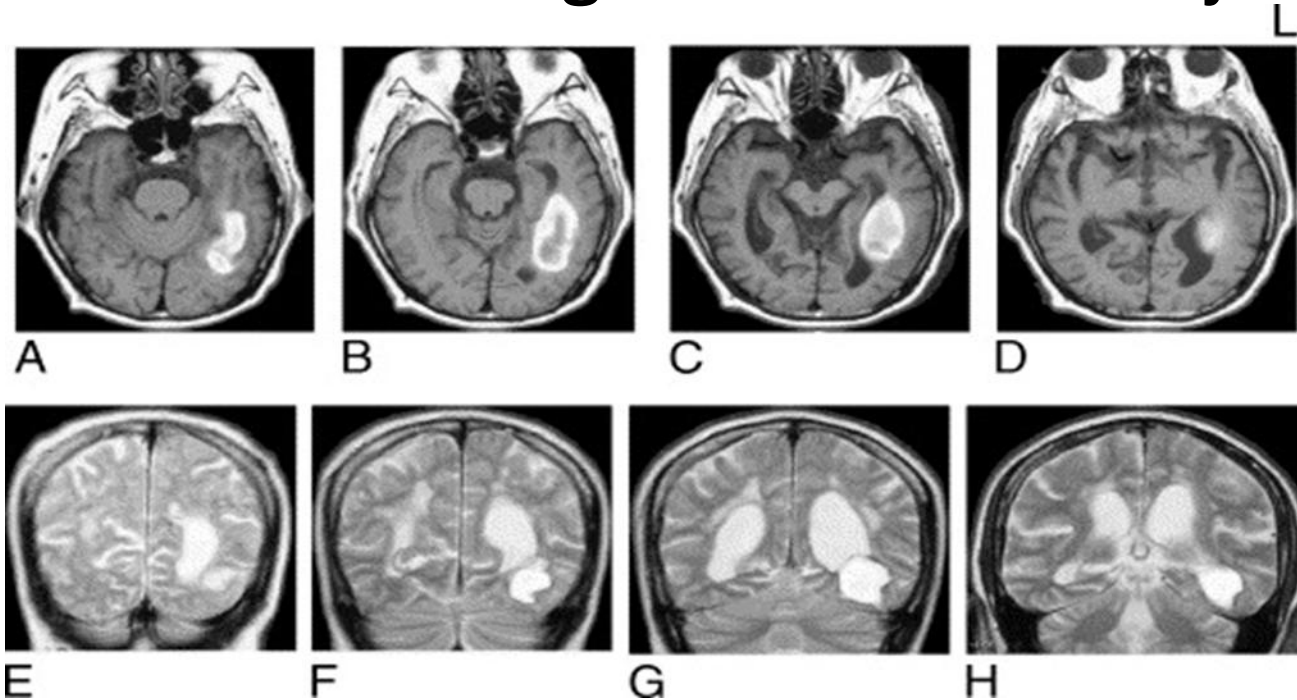
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- **Pure alexia video here!**

# Reading

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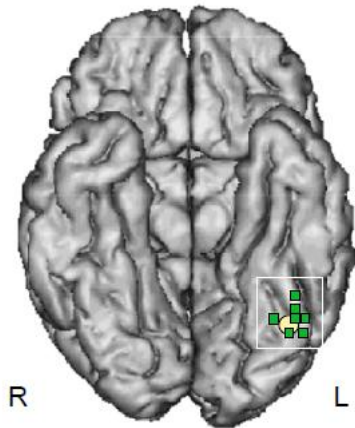
- Pure Alexia = Damage to Left Fusiform Gyrus



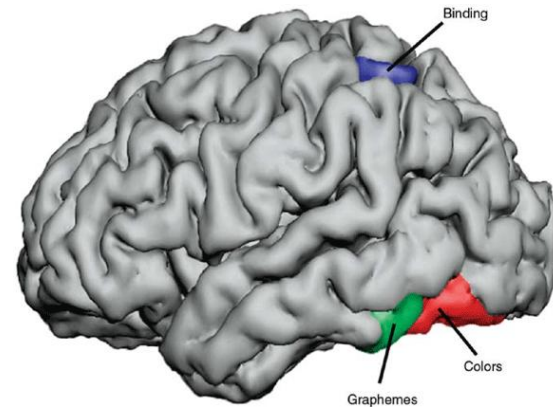
# Reading

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- **Left Fusiform Gyrus (LtFG)**
  - Visual Word Form Area (VWFA)



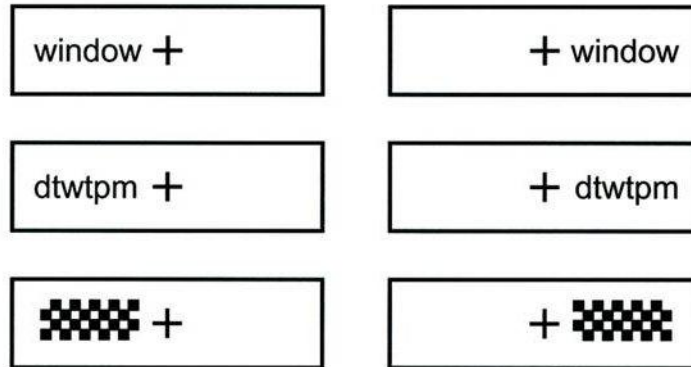
$x=-42$   $y=-57$   $z=-15$



# Reading

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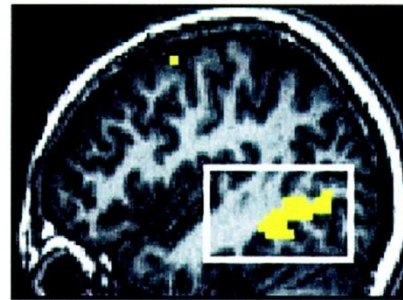
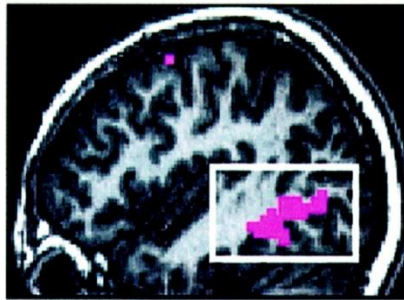
- **VWFA (Cohen et al., 2002 Brain)**



– Task: pay attention to stimuli

# Reading

Block-design experiment

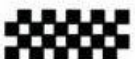



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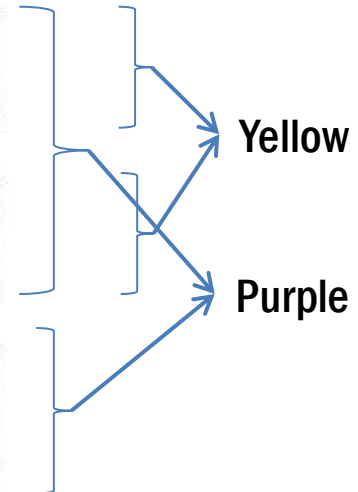
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# Reading

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- **Left Fusiform Gyrus is**
  - Stronger activated by alphabetic than checkerboard
  - Stronger activated by words than by consonant strings
  - Location invariant (same for LVF or RVF)



# Reading

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- **Is Left Fusiform Gyrus EXCLUSIVE to word processing?**
- **Unlikely** (Dehaene & Cohen, 2011, TICS).
  - **Brain region specialized to such a recent human invention?**
- **Region also responds to other stimuli that are word-like, like line-drawings**

# Reading

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- **Summary**

- Reading is recent development
- Involves stimulus driven, bottom-up processes
- And knowledge driven, top-down processes
- Interactive models balance these two mechanisms
  
- Dyslexia involves problem mapping letters to sounds
- Pure alexia involves the left fusiform gyrus (VWFA)
- FMRI has further confirmed role of VWFA in reading