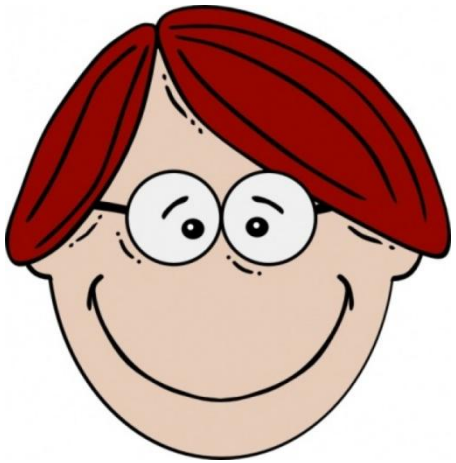
Fundamentos de Neurociencia Cognitiva

Modalities - Comprehension

Language Modalities

READING

HEARING



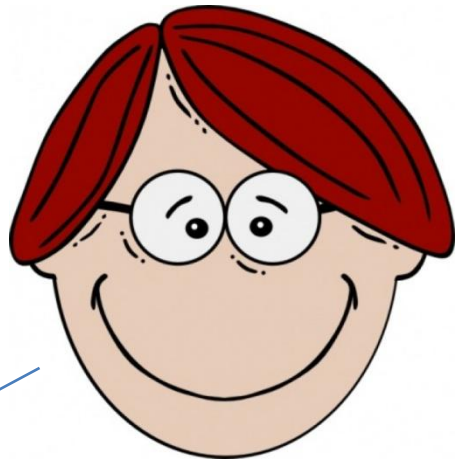
SIGNING

WRITING

SPEAKING

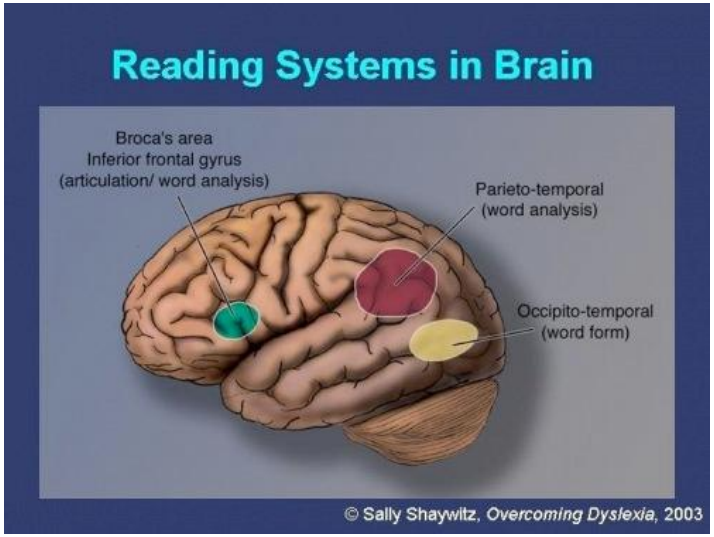
Language modalities

- **Comprehension**
  - Visual (reading)
  - Auditory
- **Production**
  - Speaking
  - Writing
  - Sign language



Language modalities

- How to study these language skills?
  - Psychologically (Cognitive)
  - Brain bases



Reading

- Recent development ~ 6000 yrs ago

- Cognitive/neural bases overlap with others

Reading

- Overlap with object recognition

火

FIRE

Reading

- Classic work on reading: Edward Huey (1908)

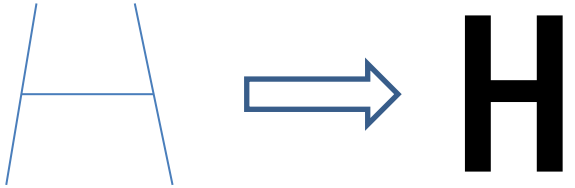
" . . .to completely analyze what we do when we read ... would be to describe very many of the most intricate workings of the human mind . . . ."

Reading

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

Reading

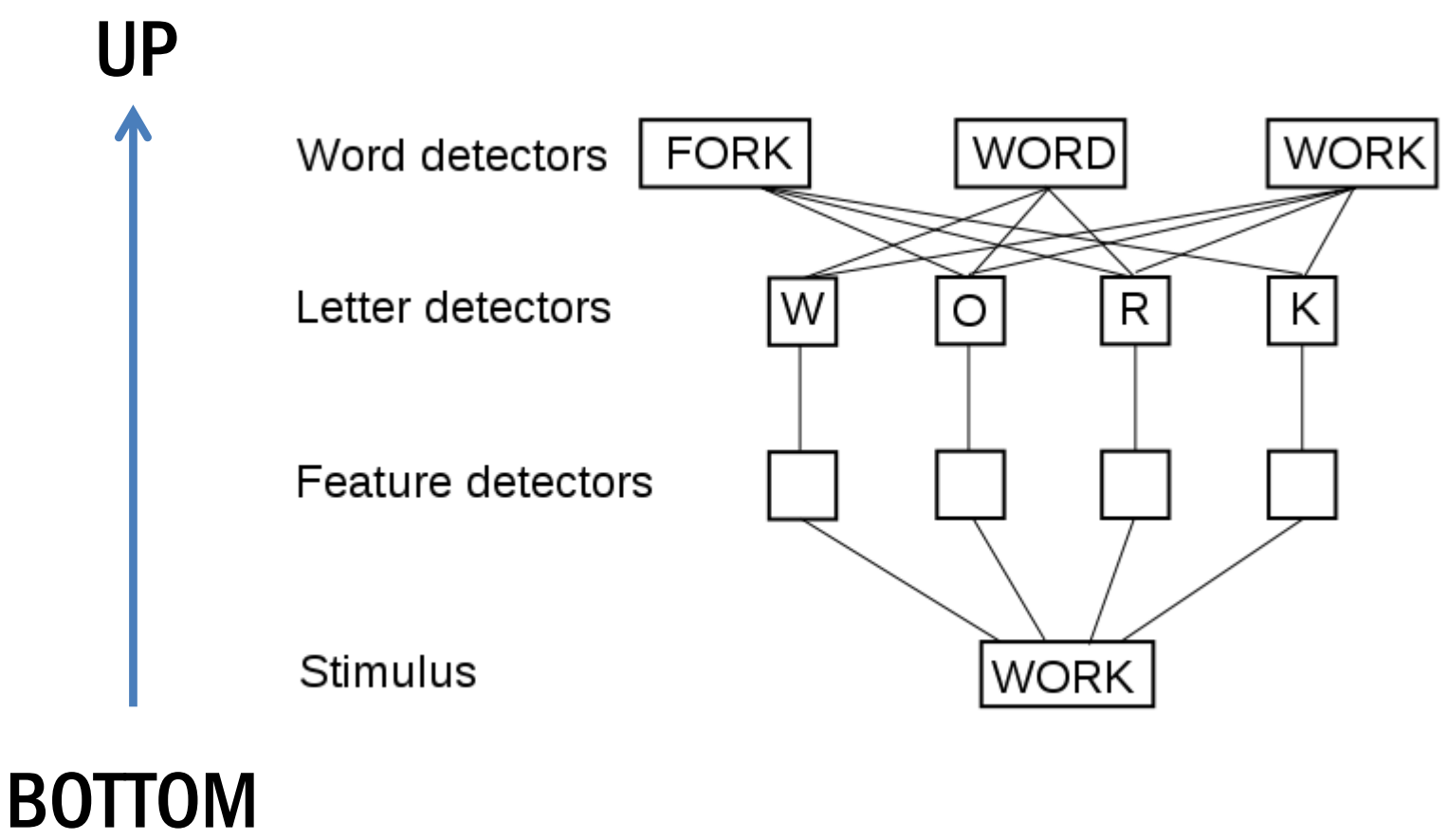
- Early models
  - Bottom up

LETTERS 

WORDS H + A + T ⇨ HAT

SENTENCES PUT ON THE HAT

Reading


UP
Word detectors
FORK
WORD
WORK
Letter detectors
W
O
R
K
Feature detectors
Stimulus
WORK
BOTTOM

Reading

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

Reading

XXX XXXXX XXXX XXXXX XXX XXXX

XXXX XXXXX XXX XXX XXXXX XXXX

XXXXX XXXX XXXX XXX XXXXX XXXX

Reading

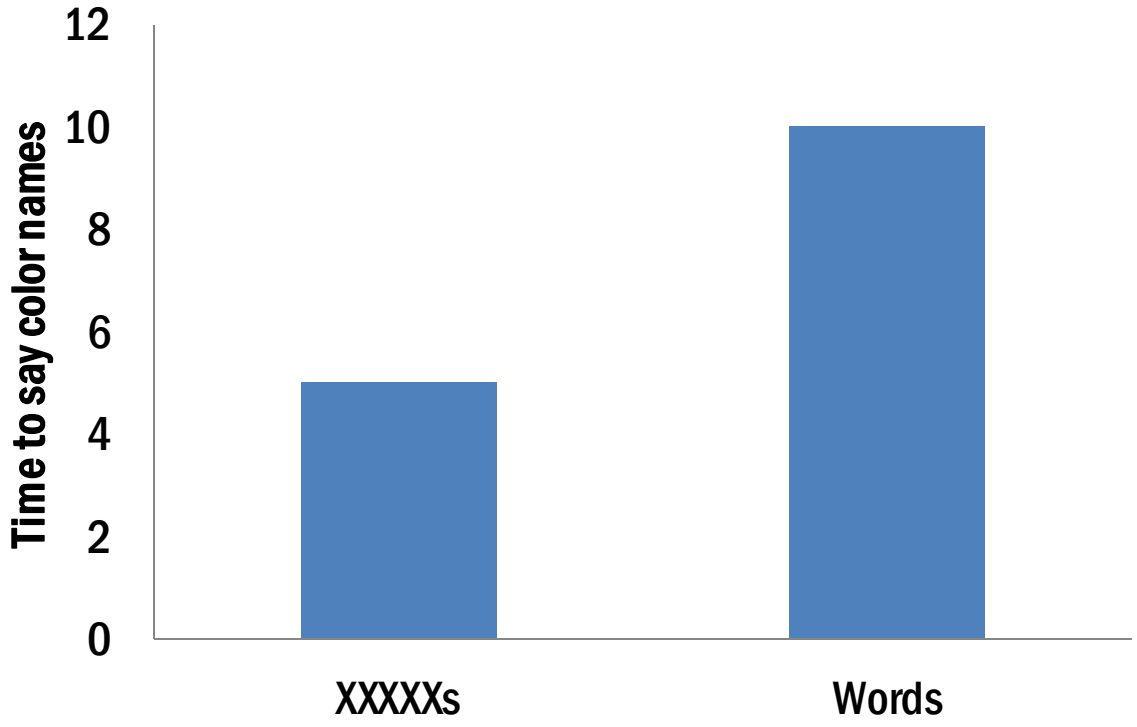
- Now try the same thing

Reading

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

Reading

- Stroop effect (Stroop, 1935)



Reading

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

Reading

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

Reading

*

Reading

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

Reading

- Get ready for list 2

Reading

*

Reading

pool
rugs
mark
send
list
more
pick
stab
neck
your
dice
font

Reading

- Get ready for list 3

Reading

*

Reading

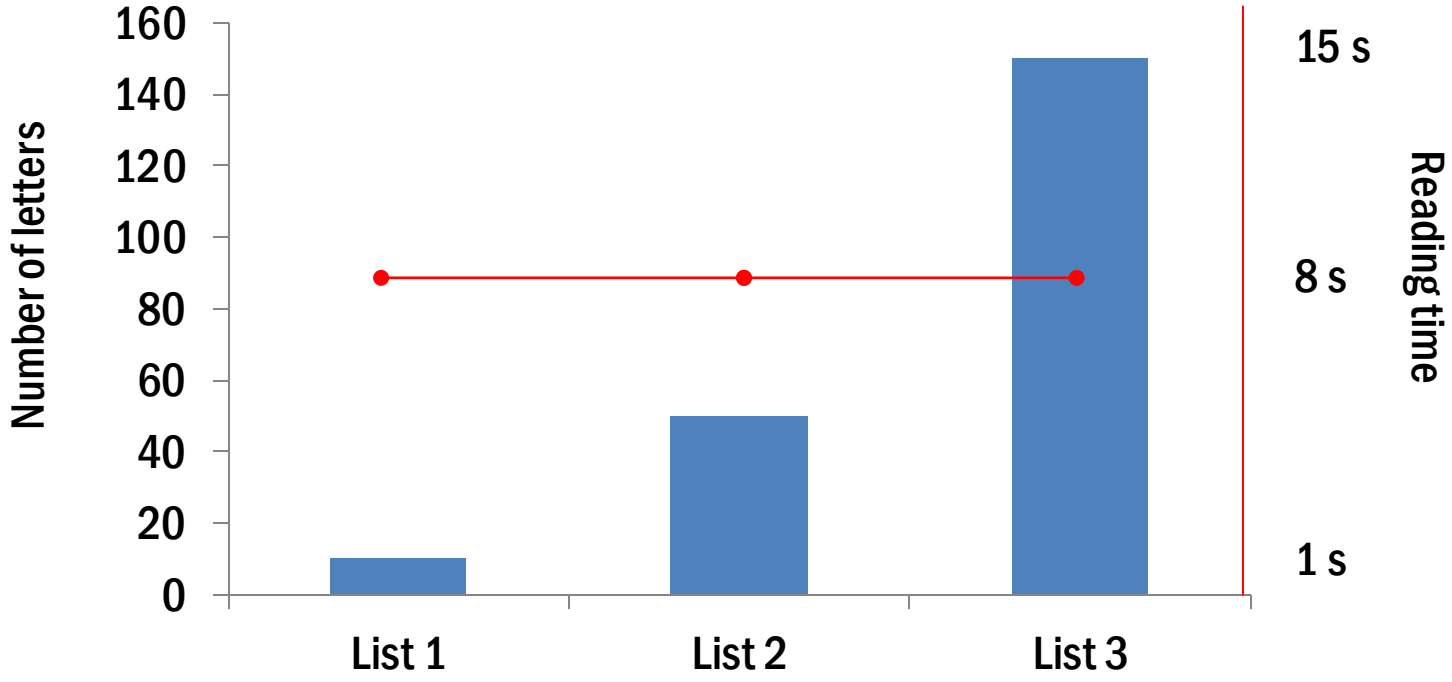
analysis
habitual
occupied
inherent
probable
summoned
devotion
remarked
overcome
resolute
elements
conclude

Reading

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

Reading

- Evidence against "bottom-up" reading

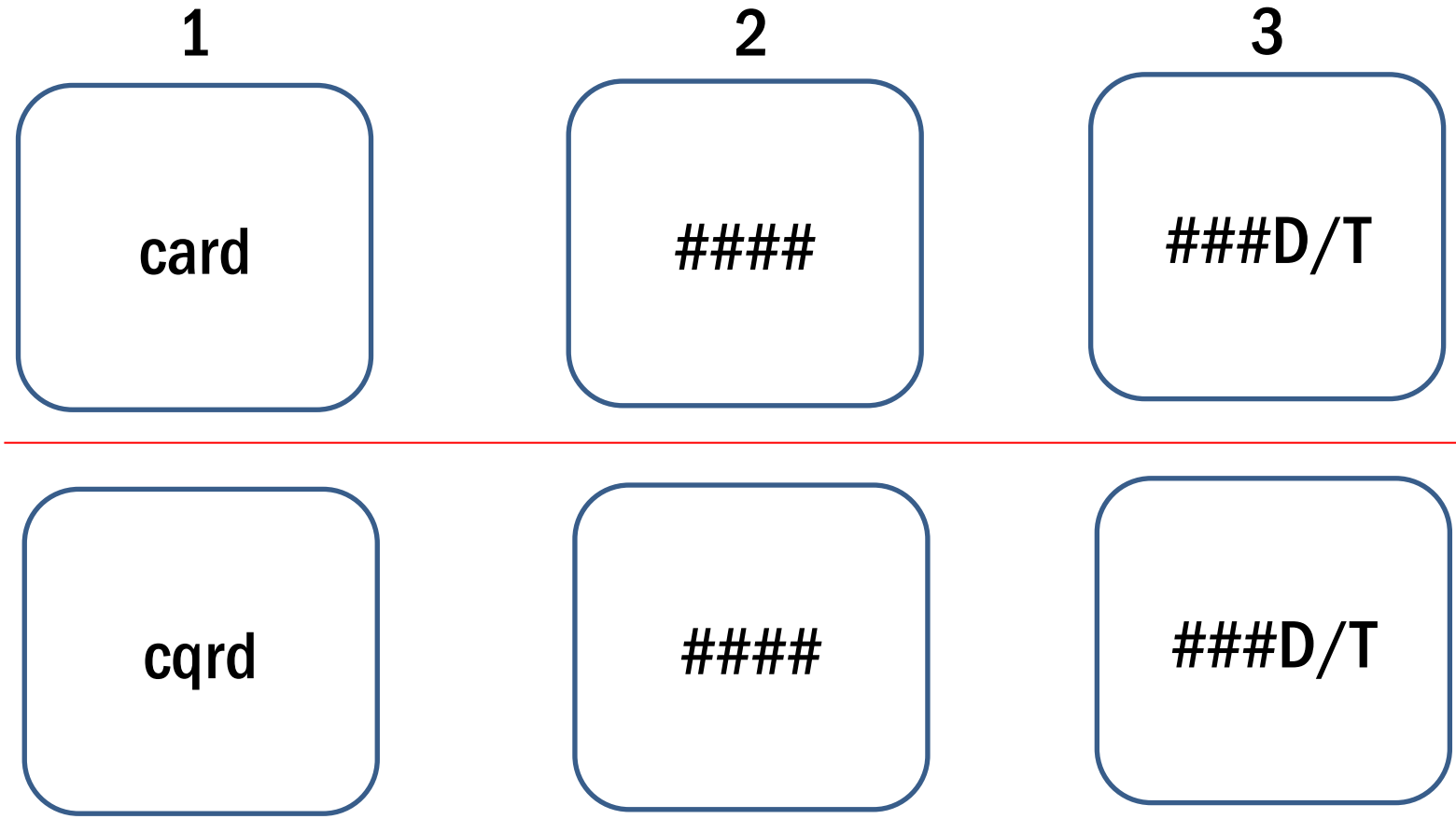


Reading

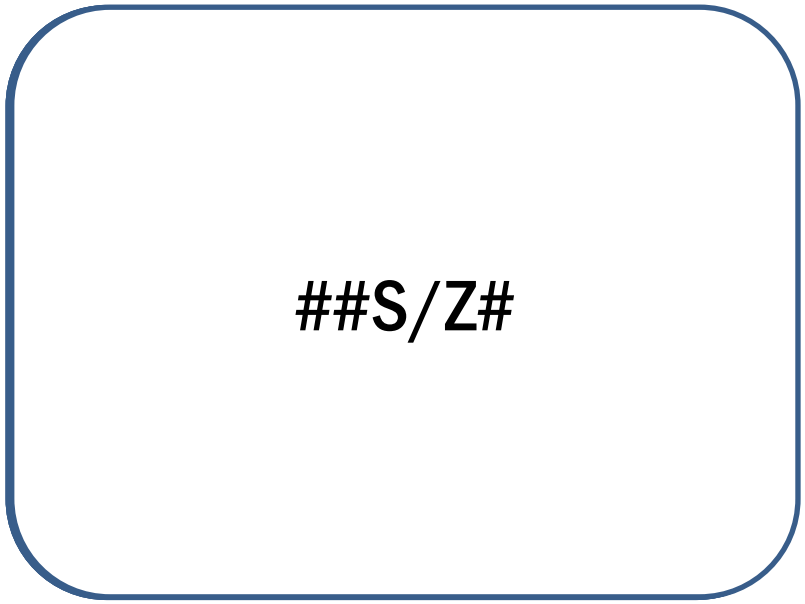
- **Word superiority effect (WSE)**
  - Easier to recognize letters in words than by themselves
- **Reichler-Wheeler paradigm (1969-1970)**

Reading

- Reicher-Wheeler paradigm



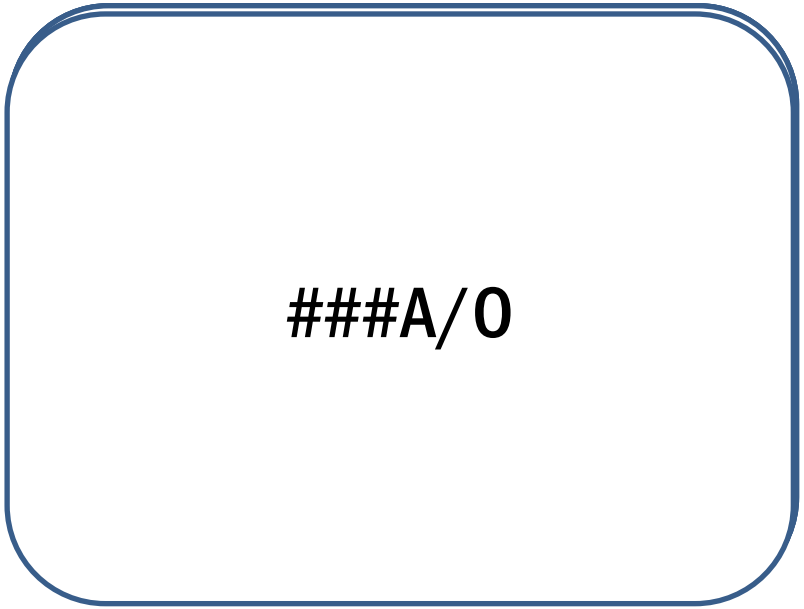
Reading



Reading

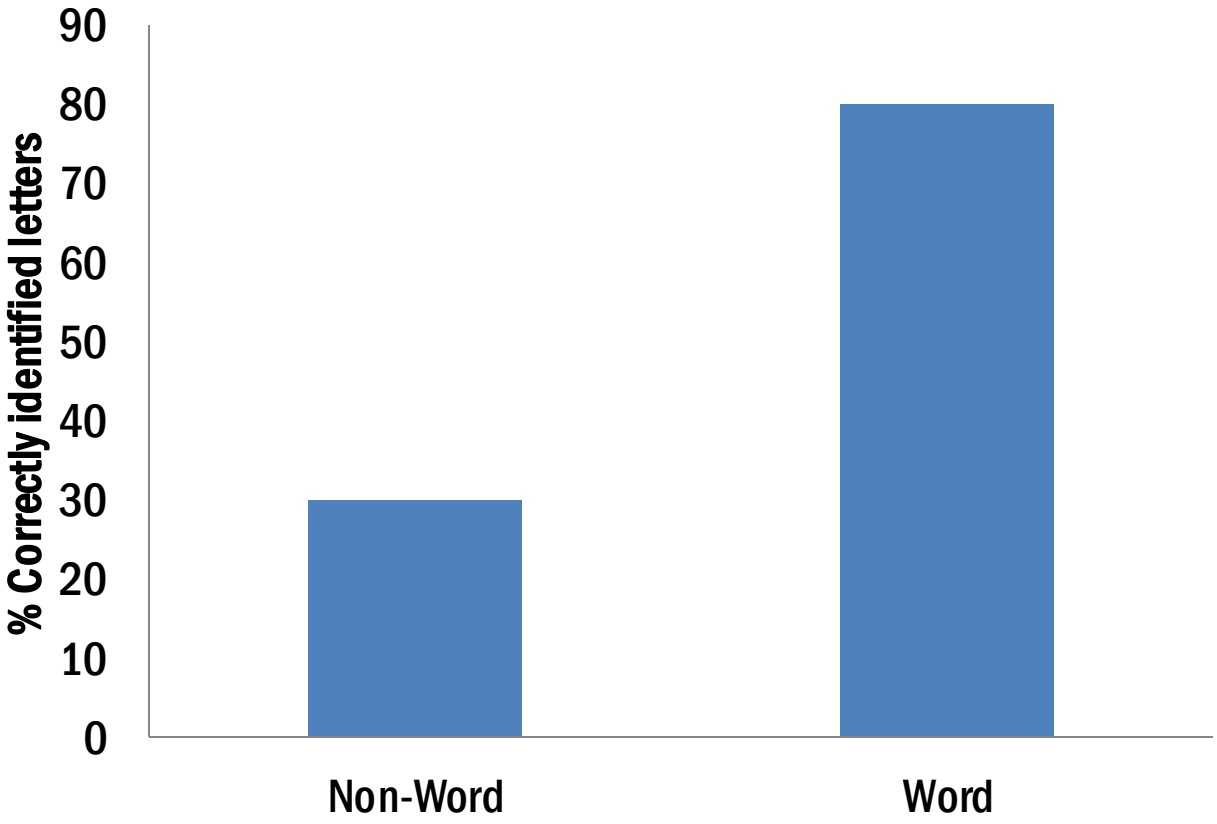
###D/P

Reading



Reading

- Word Superiority Effect

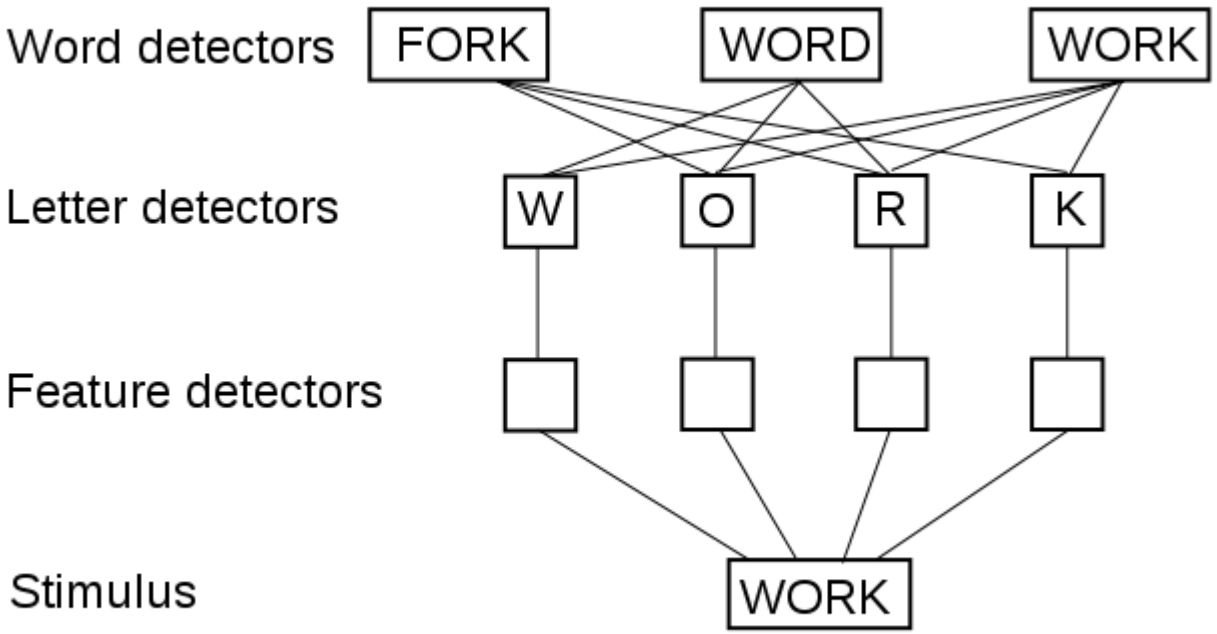


Reading

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

Reading

TOP



DOWN

Reading

- 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

- "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"

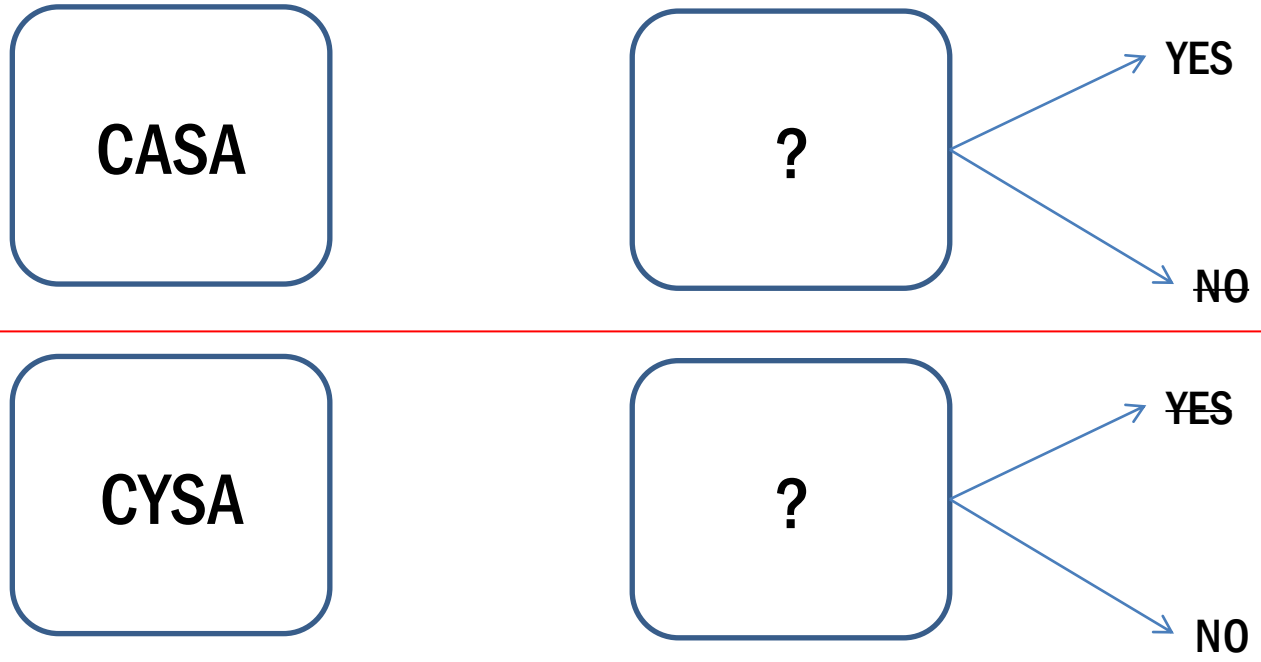
Reading

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

Reading

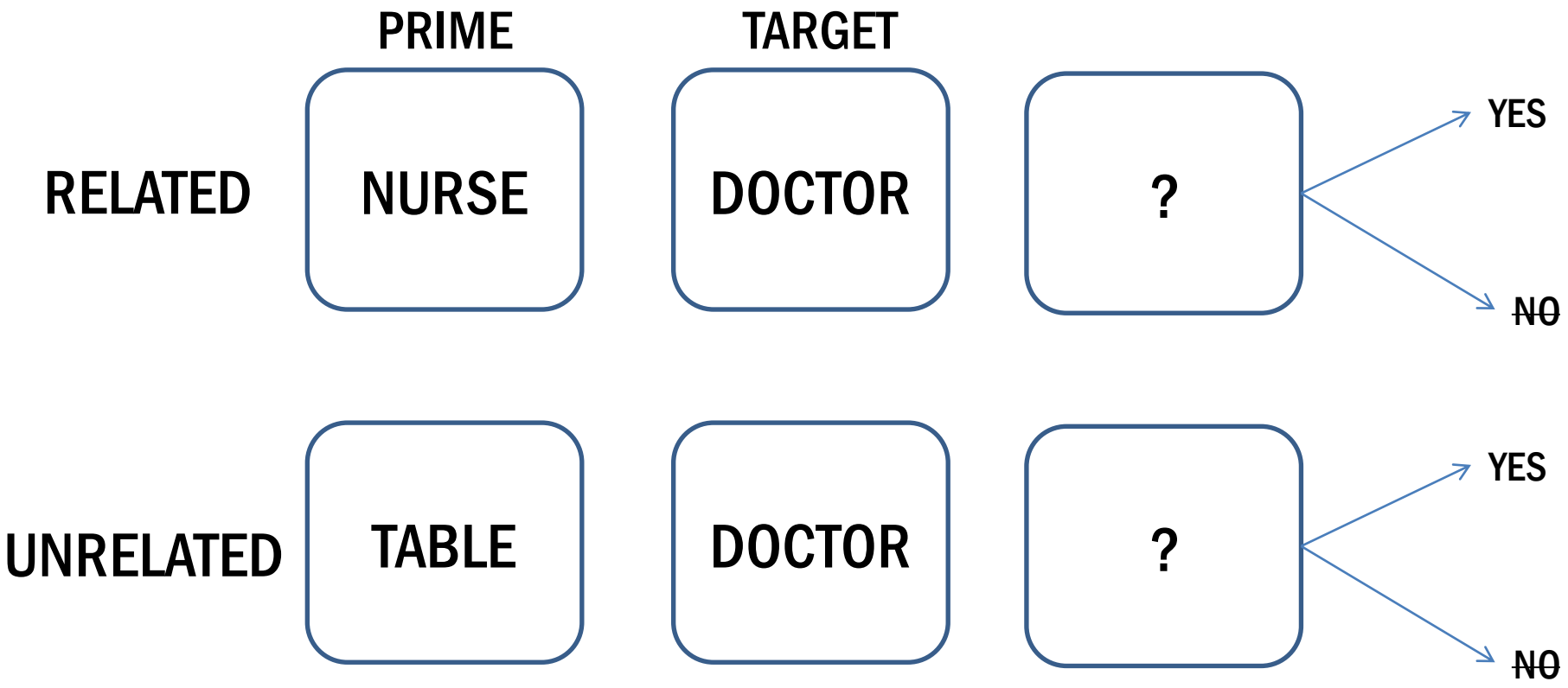
- Semantic priming

- Lexical decision task (Meyer & Schvaneveldt, 1971)

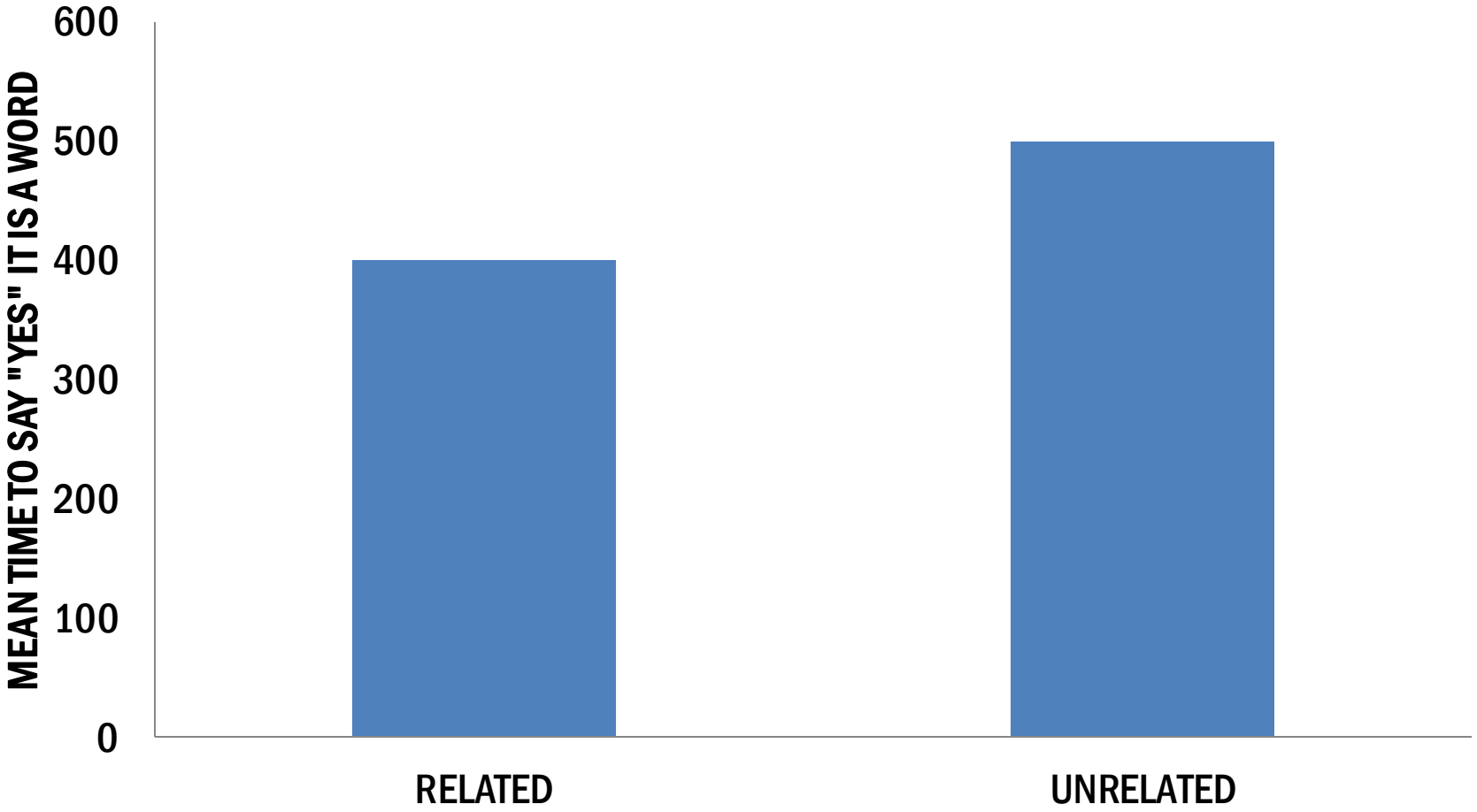


Reading

- Semantic priming



READING


MEAN TIME TO SAY "YES" IT IS A WORD
600
500
400
300
200
100
0
RELATED
UNRELATED

Reading

- Prior knowledge effect (Anderson et al., 1977)

- Two groups
  - Female students of music
  - Male weight-lifters

Reading

"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

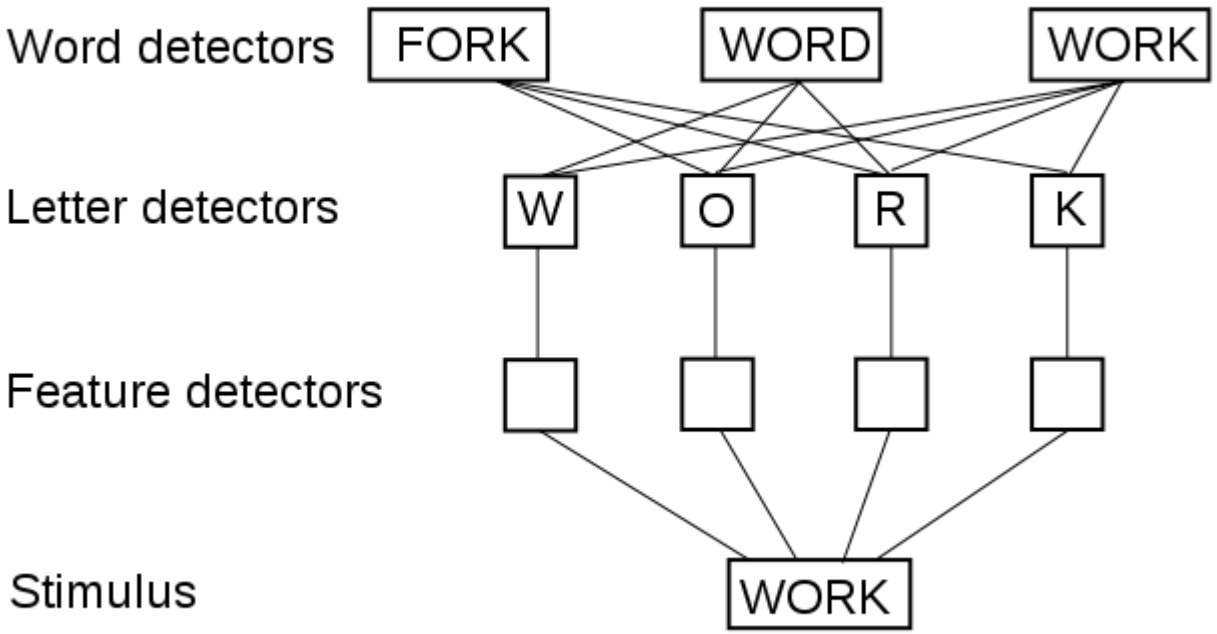
- What is this text about?

- Students of music said "music playing"

- Weightlifters said "playing cards"

Reading

TOP



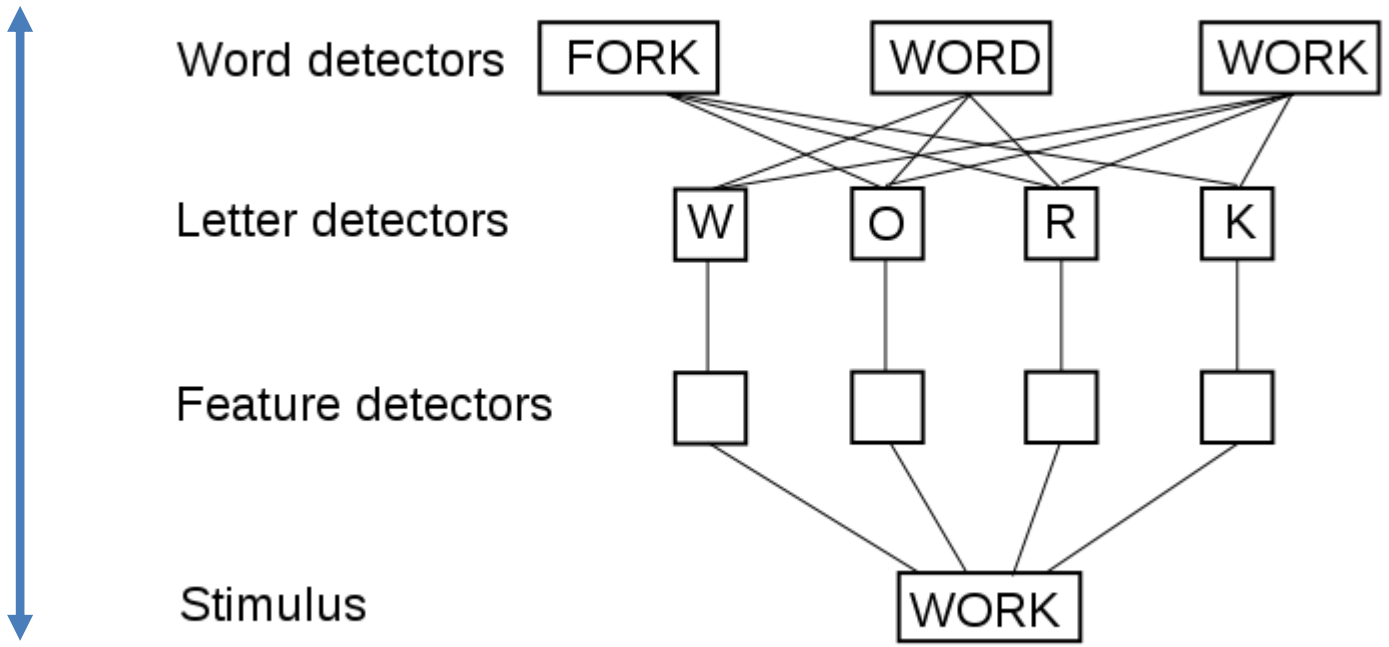
DOWN

Reading

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

Reading

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



Reading

- 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

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

Reading

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

Reading

- 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

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

Reading

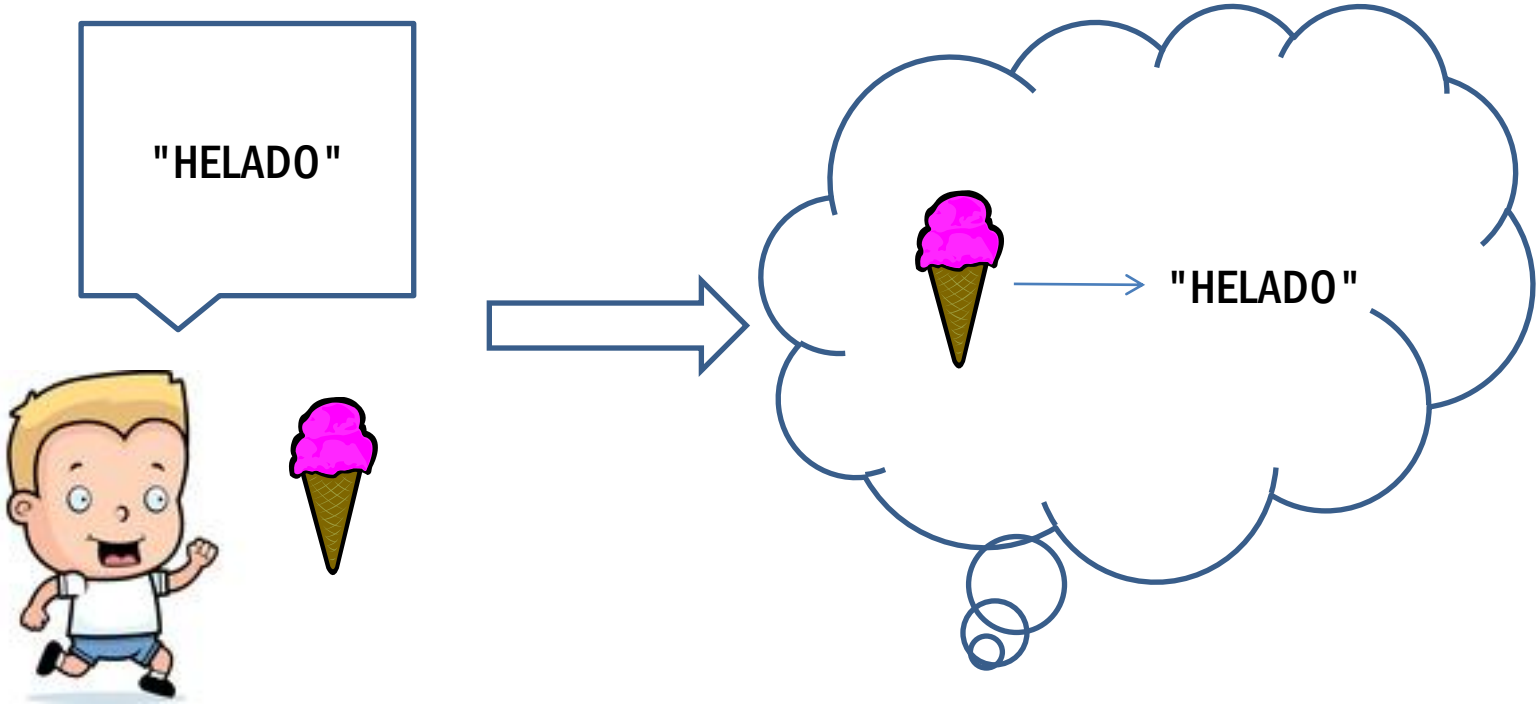
- Dyslexia
  - 5 to 10% of (American) children

1. Comprehension: fluency problems

2. Production: Child will make errors

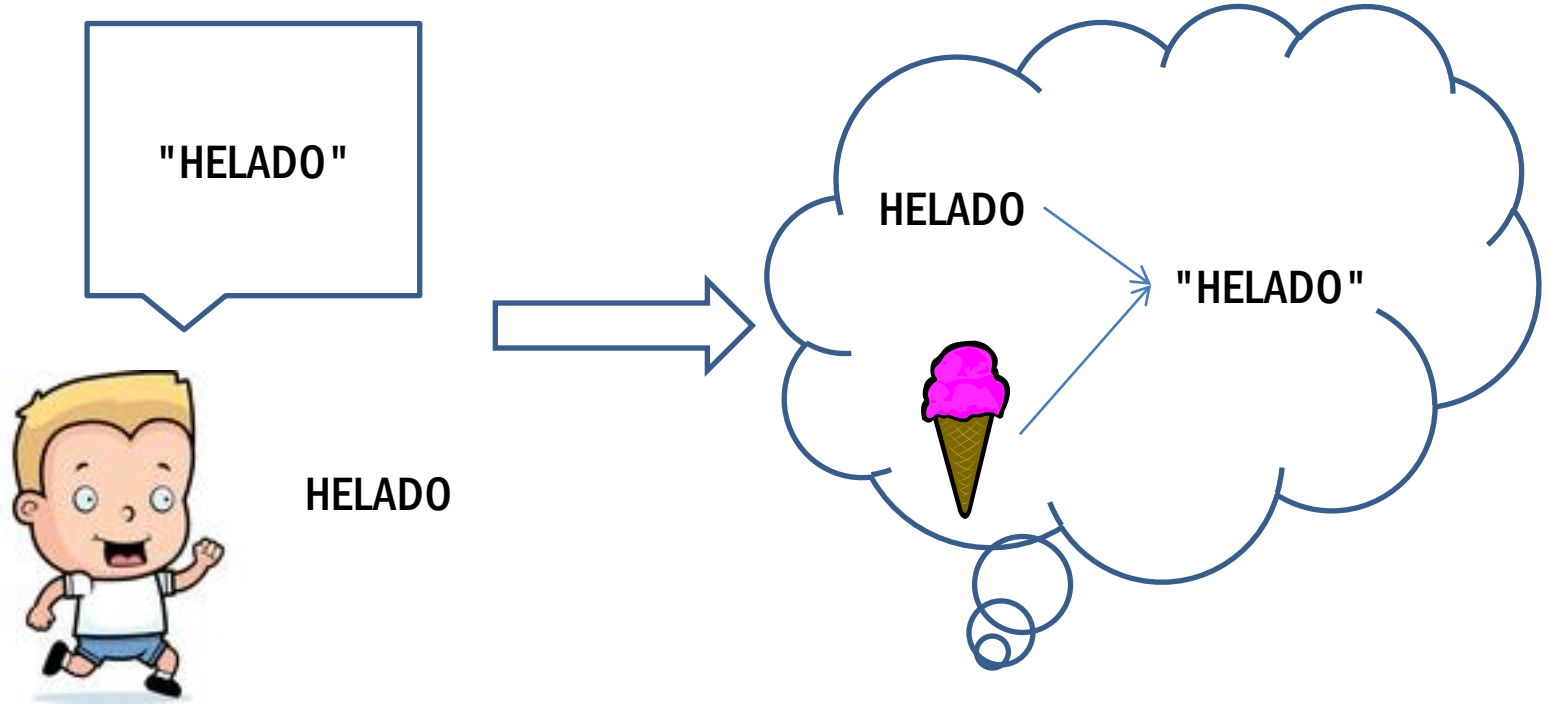
Reading

- Phonological deficit



Reading

- Phonological deficit



Reading

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

Reading

- 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

- **Languages with complex mapping**
  - Opaque orthography (English)
  - Transparent orthography (Spanish, Japanese)

- **ghoti → "fish"**
  - Tough, women, caution

reading

- Learning to read is learning to map letters to sounds

- Dyslexia is problem in learning this mapping
  - Phonological hypothesis

Reading

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

Reading

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

Reading

- 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

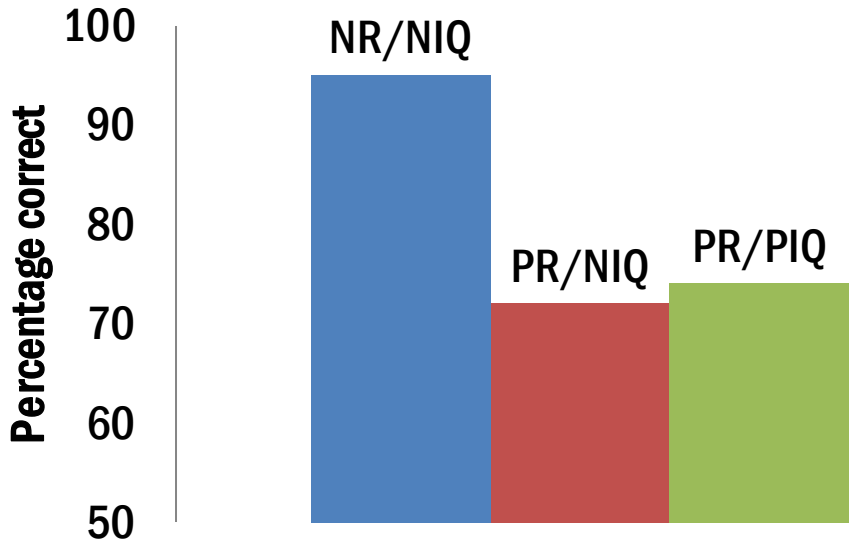
Reading

- 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?

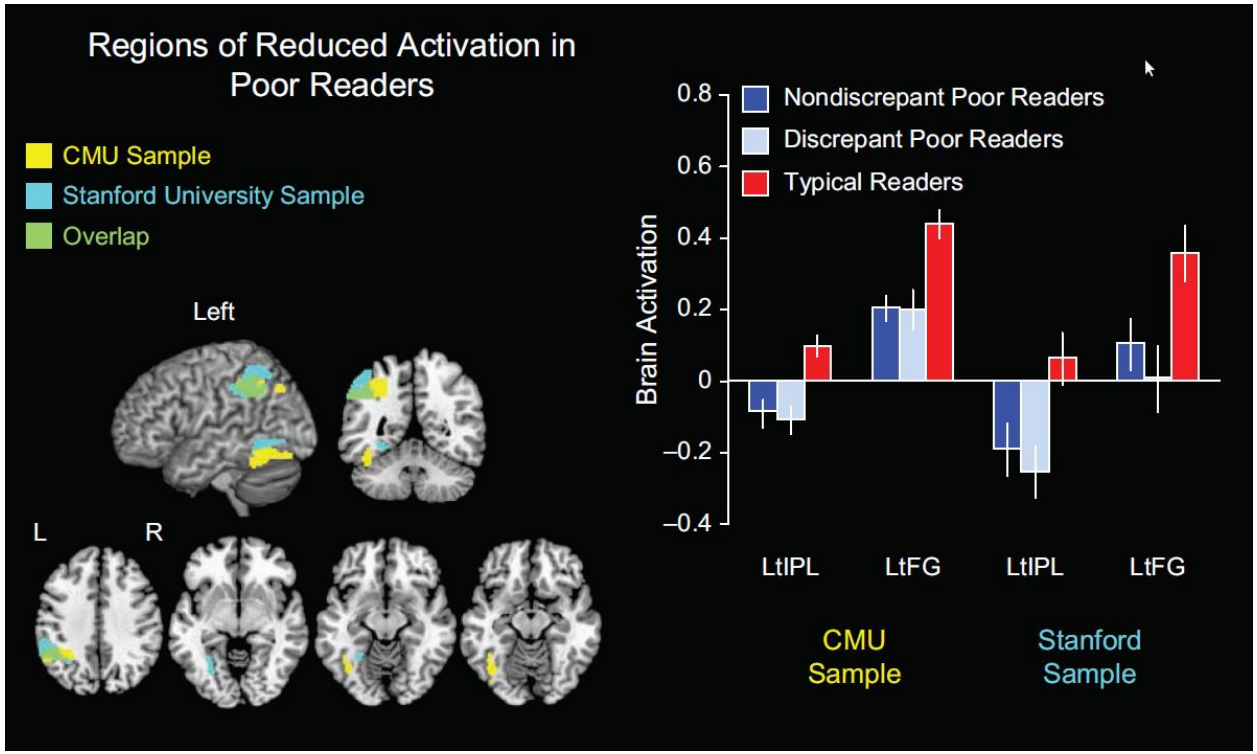
Reading

- Results
  - Behavioral



Reading

- Results
  - fMRI



Reading effects in

1. Left inferior parietal lobule
2. Left fusiform gyrus

reading

- 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

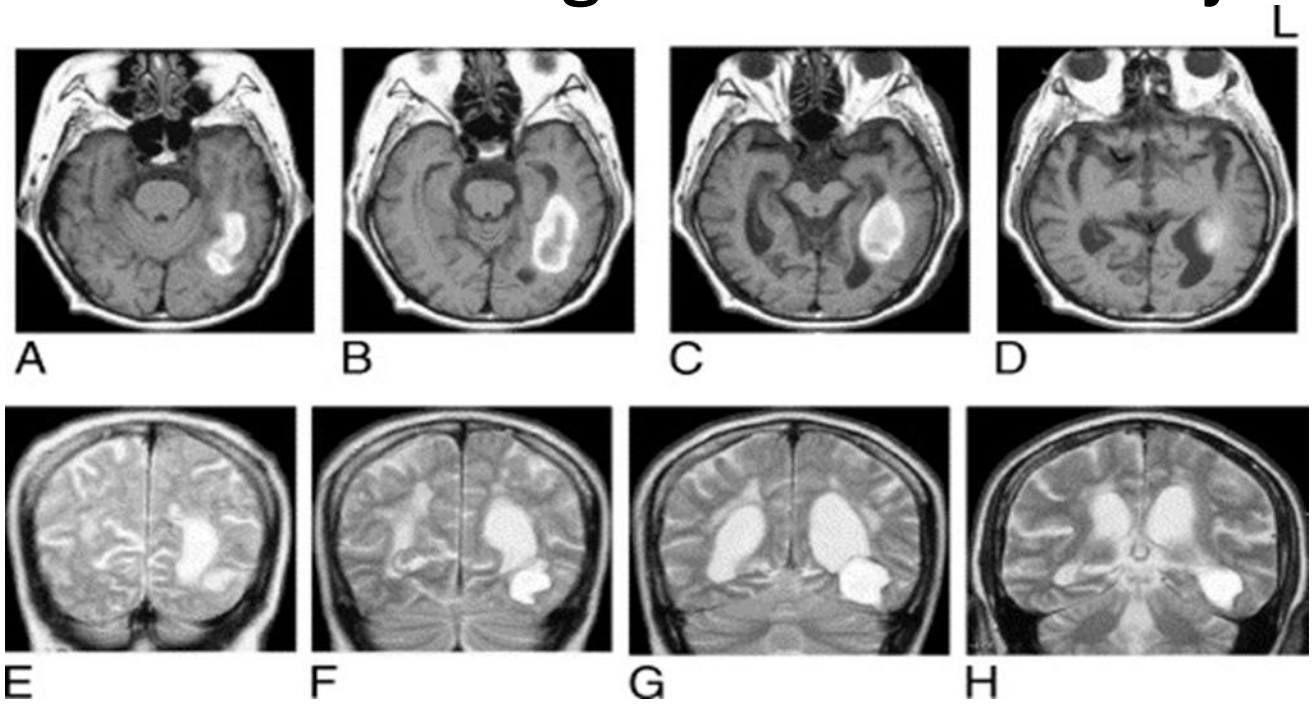
- Neuropsychological evidence
- Pure Alexia
  - inability to read
  - Can write
  - Auditory word comprehension OK

Reading

- Pure alexia video here!

Reading

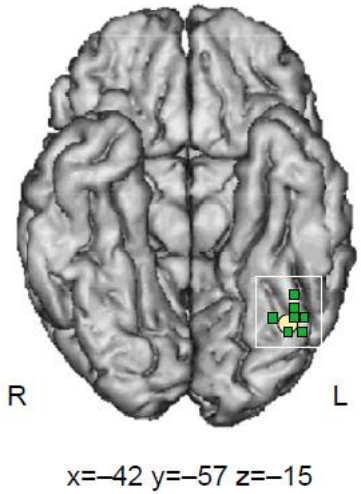
- Pure Alexia = Damage to Left Fusiform Gyrus

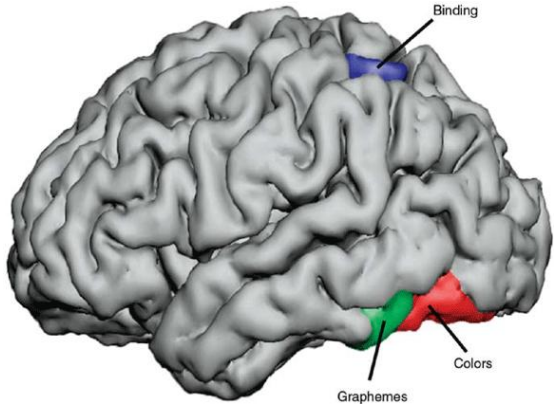


Sakurai et al., 2006 JNS

Reading

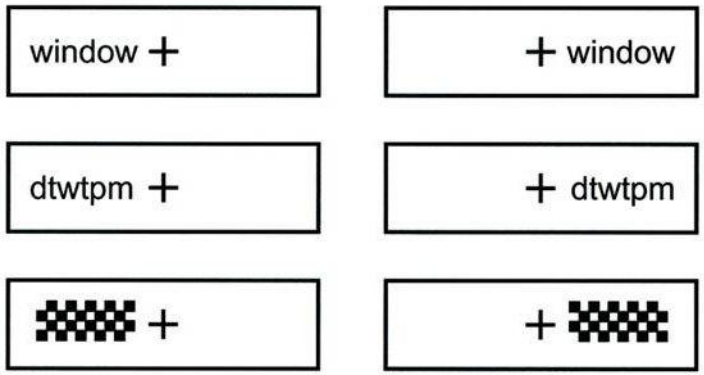
- **Left Fusiform Gyrus (LtFG)**
  - Visual Word Form Area (VWFA)





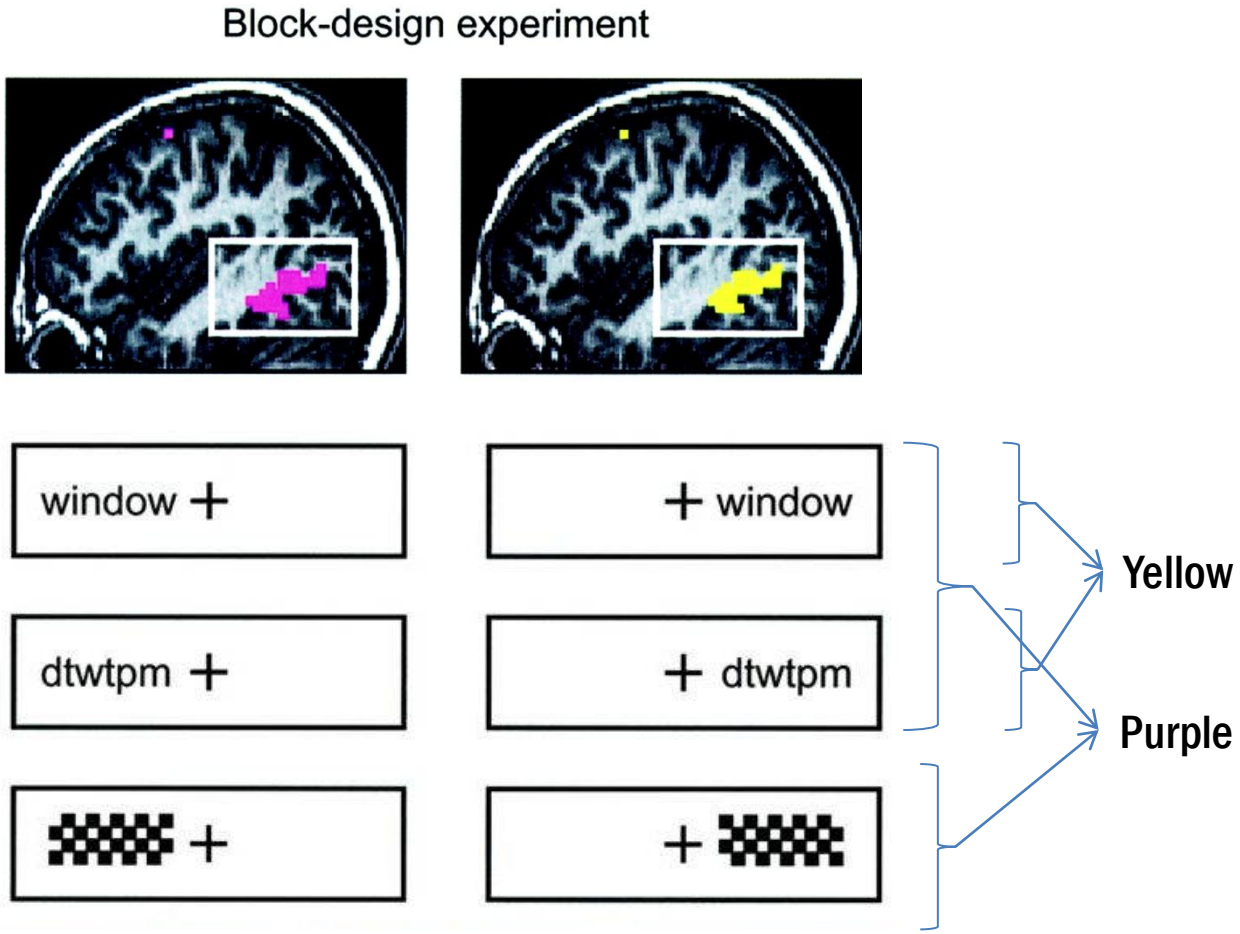
Reading

- VWFA (Cohen et al., 2002 Brain)



  - Task: pay attention to stimuli

Reading


Block-design experiment
window +
+ window
dtwtpm +
+ dtwtpm
+
+
Yellow
Purple

Reading

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

Reading

- 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

- **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