

CSCI 1377

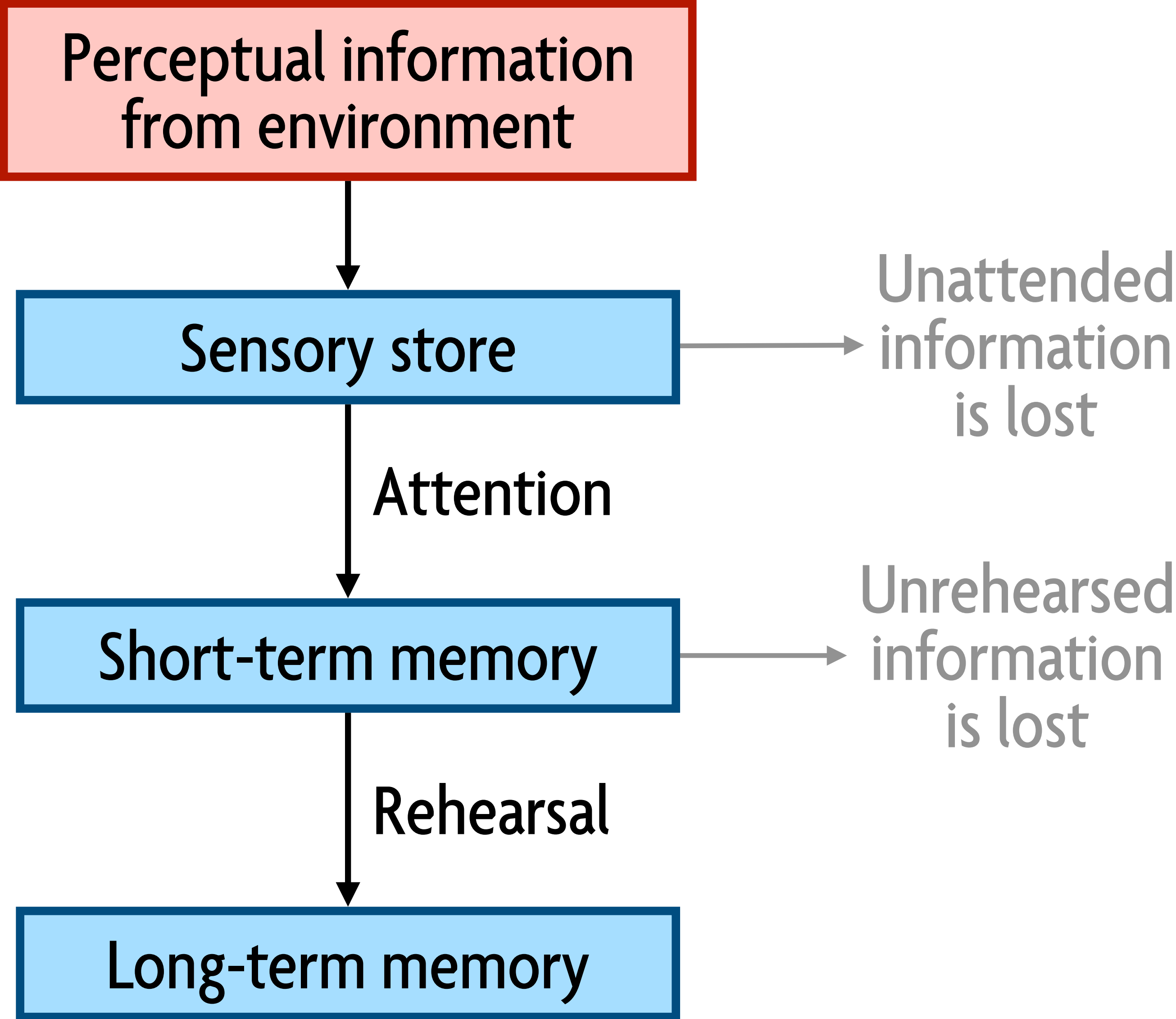
Tools for Thought

Mnemonics I: Science and Tradition of Memory

“Now let us turn to the treasure-house of inventions,
the custodian of all the parts of rhetoric, memory.”

— *Ad Herennium*,
circa 85 BCE

A basic model of memory



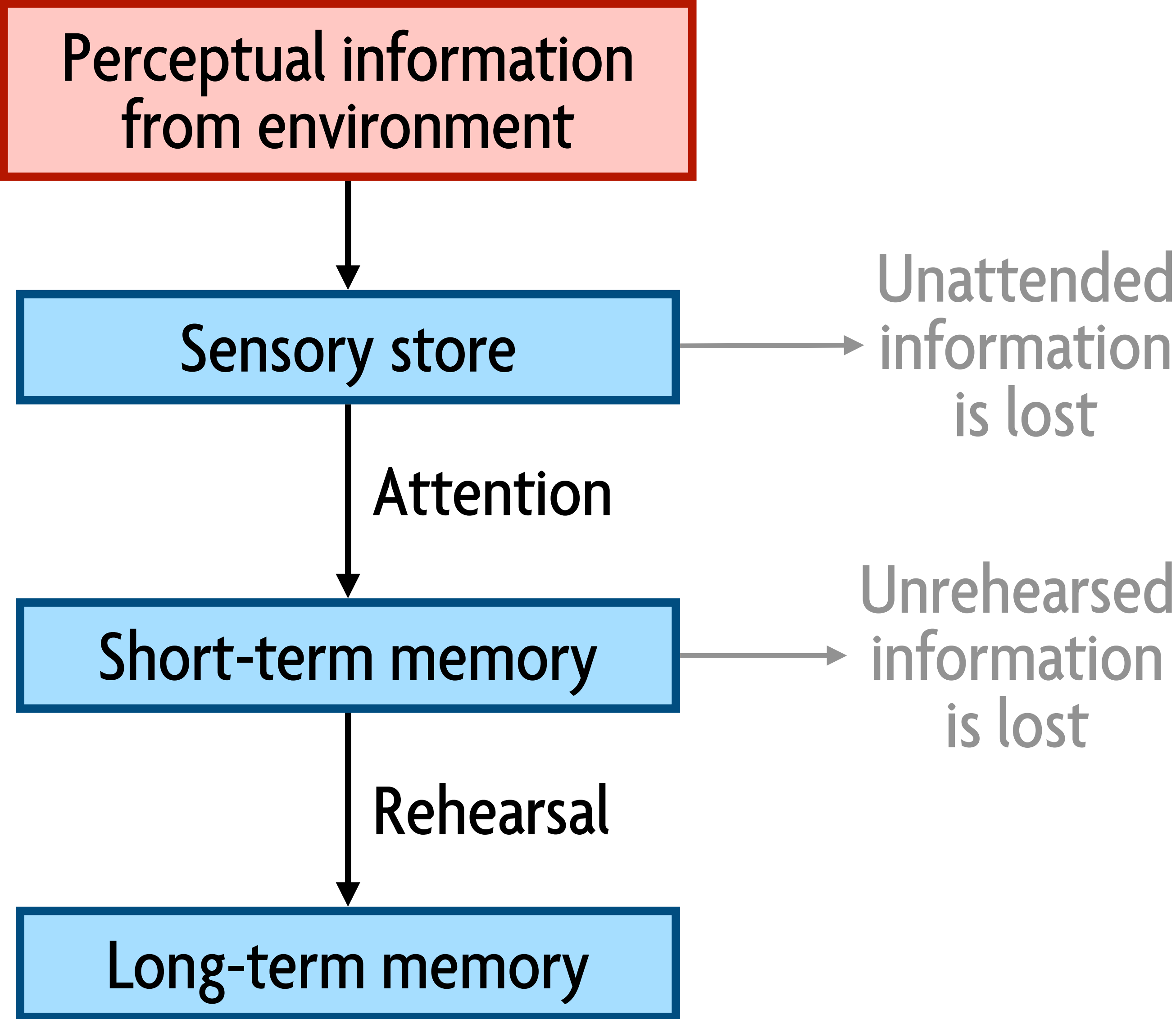
Would a perfect memory eliminate abstraction?



via Goodreads

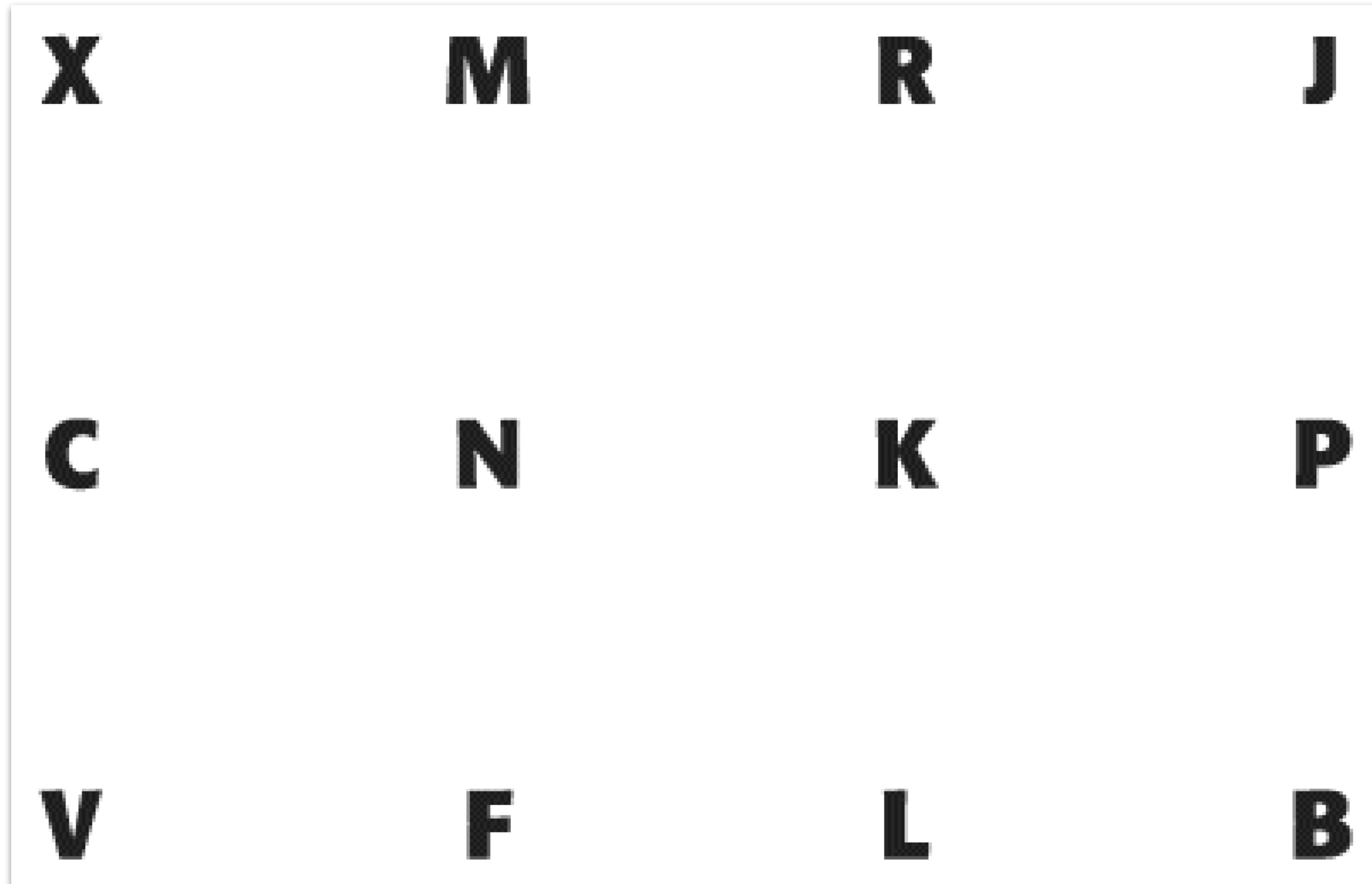
“He was, let us not forget, almost incapable of ideas of a general, Platonic sort. Not only was it difficult for him to comprehend that the generic symbol dog embraces so many unlike individuals of diverse size and form; it bothered him that the dog at three fourteen (seen from the side) should have the same name as the dog at three fifteen (seen from the front). [...] He was the solitary and lucid spectator of a multiform, instantaneous and almost intolerably precise world.”

A basic model of memory

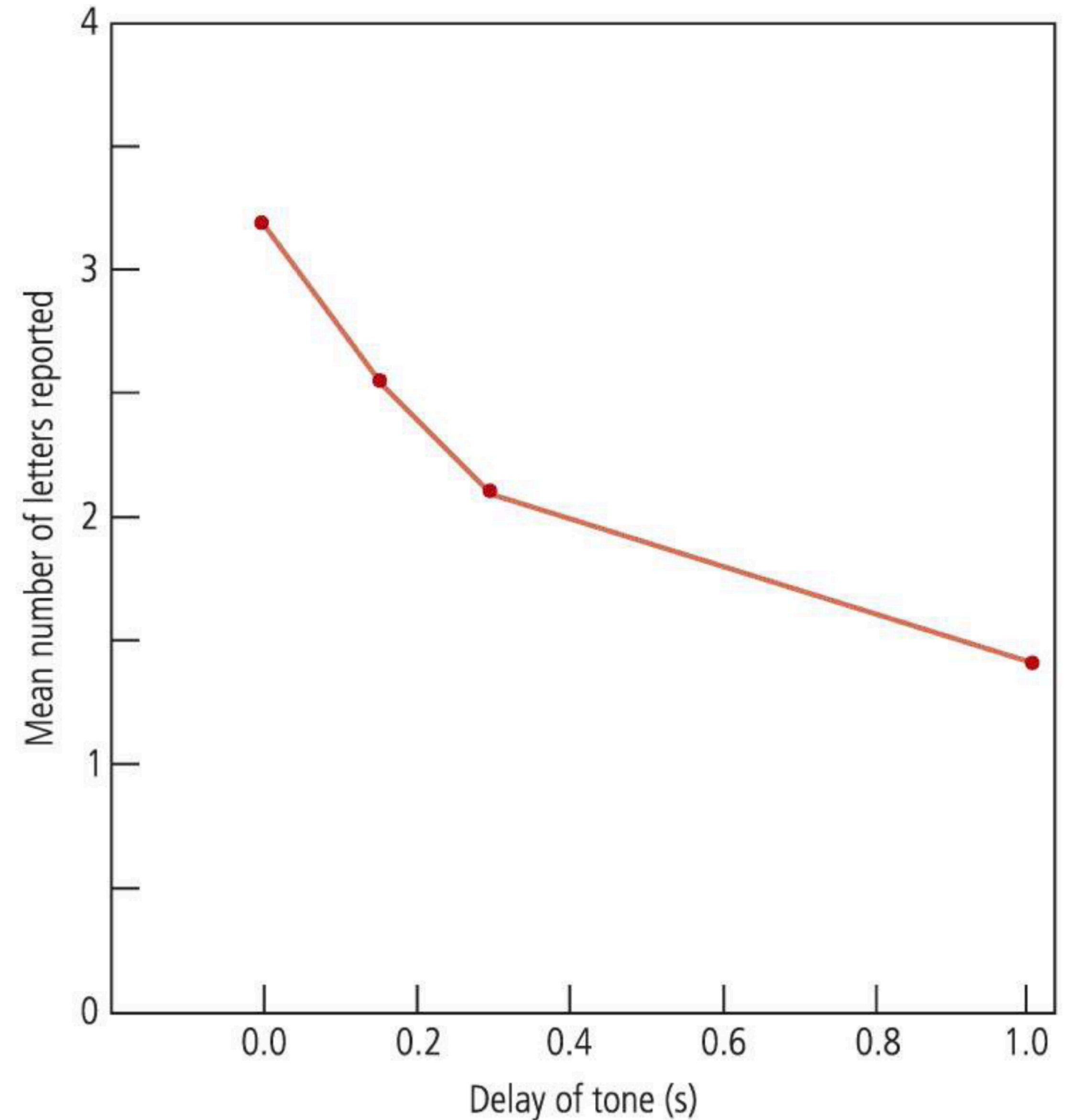


Sensory stores briefly hold perceptions

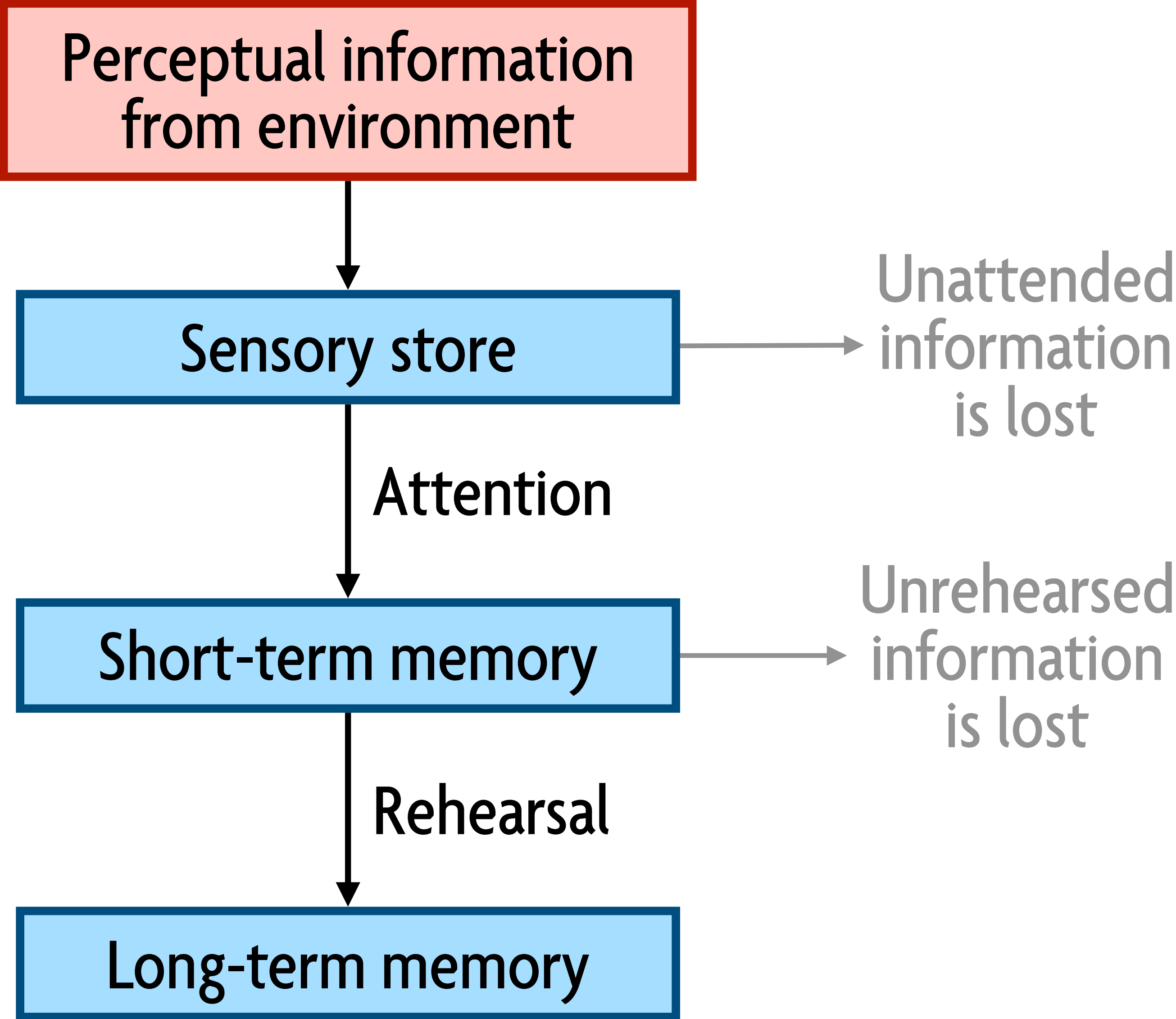
Materials: grids of letters



Procedure: show grid, remove, variable delay, cue attention to row, recall letters



A basic model of memory



Span of immediate recall is limited

3 8 4 1 1 9 7 2 5 2 4 9

Span of immediate recall is limited

3 8 4 1 1 9 7 2 5 2 4 9

Rehearsal must be combined with attention

2s

every 2, 6, or 18s, for 54s

3108 water, water, water, water, ... number?

7243 chair, chair, chair, chair, ... number?

... [repeat 54 times] ...

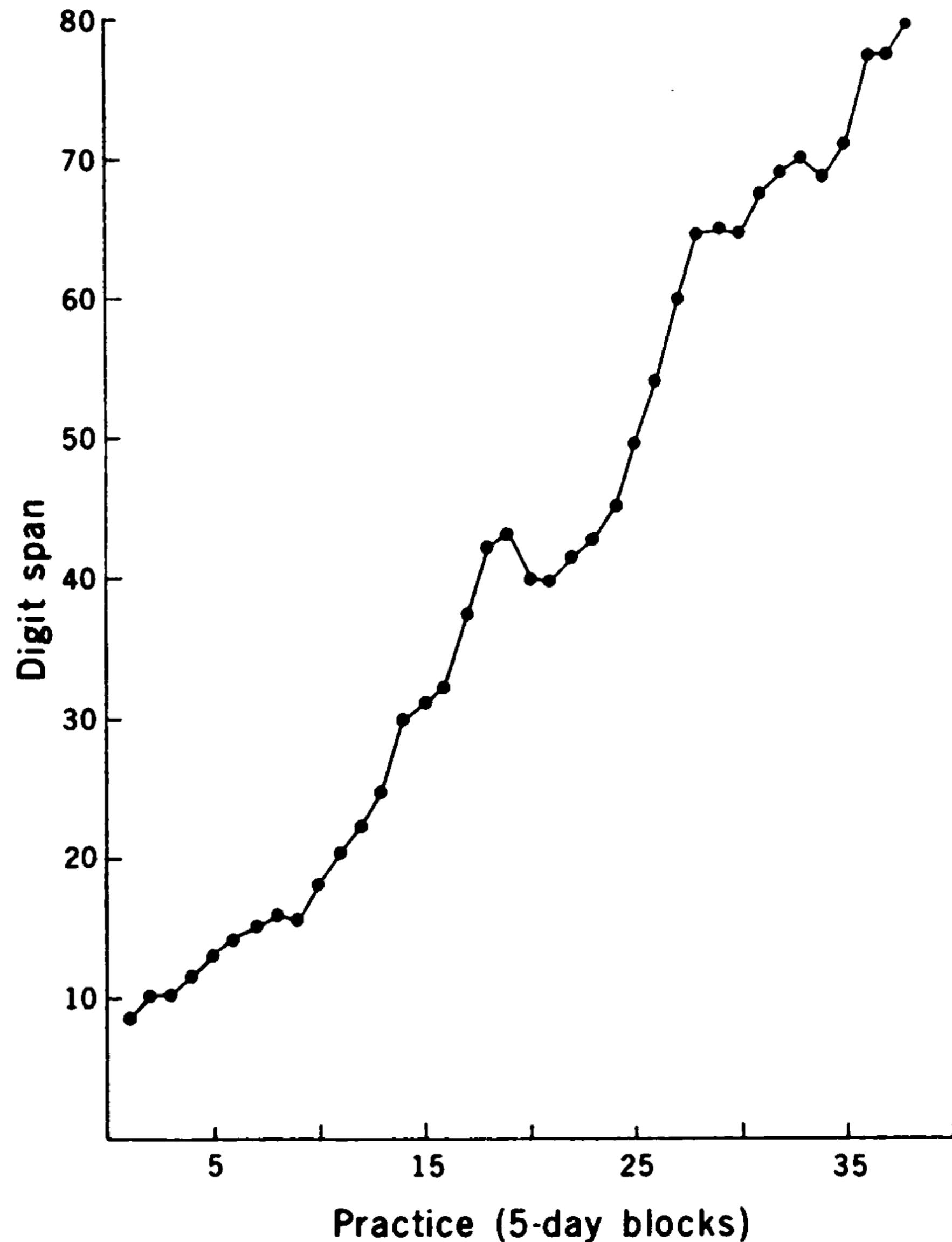
(Unexpectedly) Now recall the words you rehearsed.

~10% recall, regardless of rehearsal interval!

Span depends on the size of “chunks”

2 0 2 6 0 1 2 7 1 3 7 7

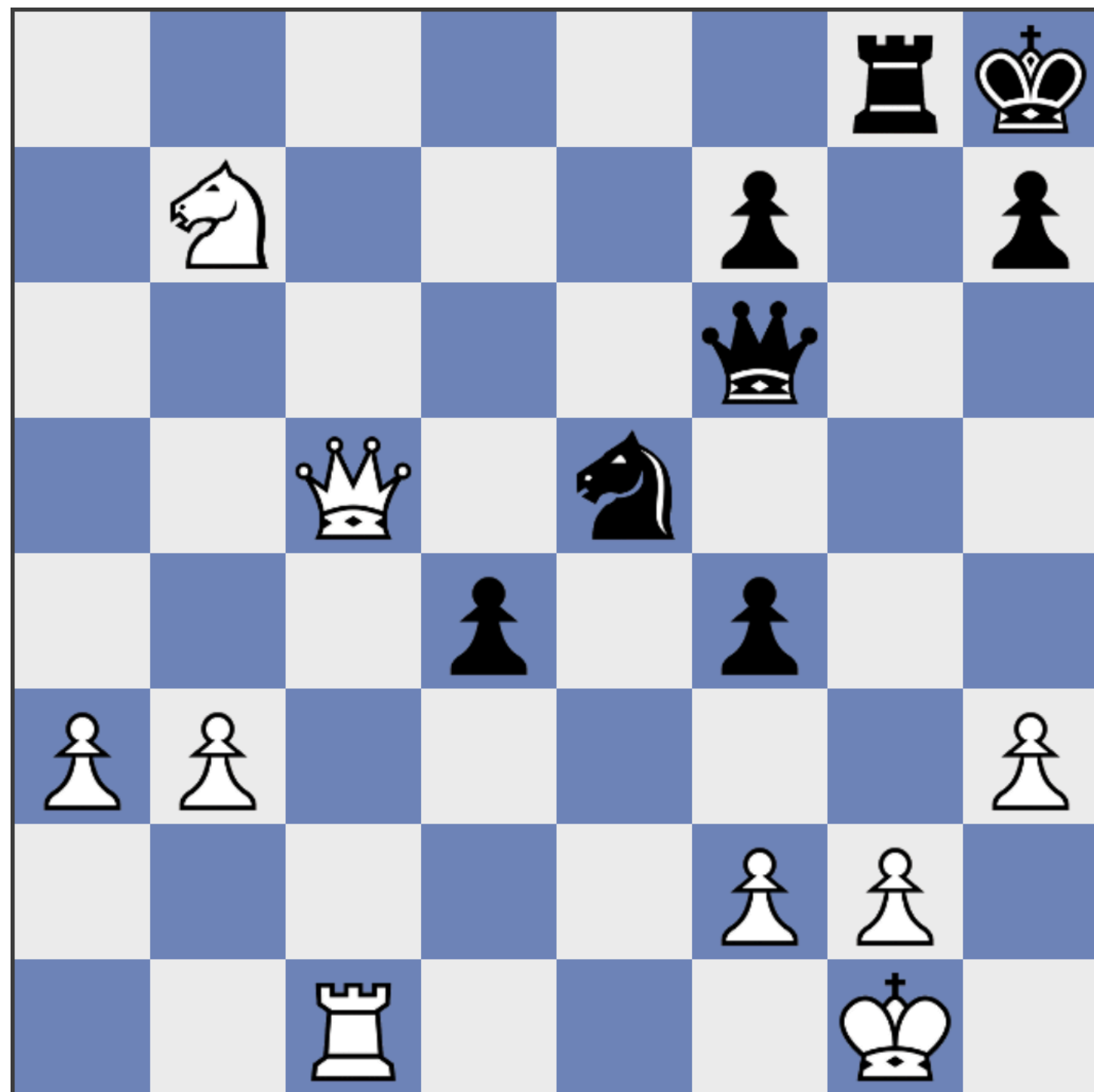
Chunking is learned and domain-specific



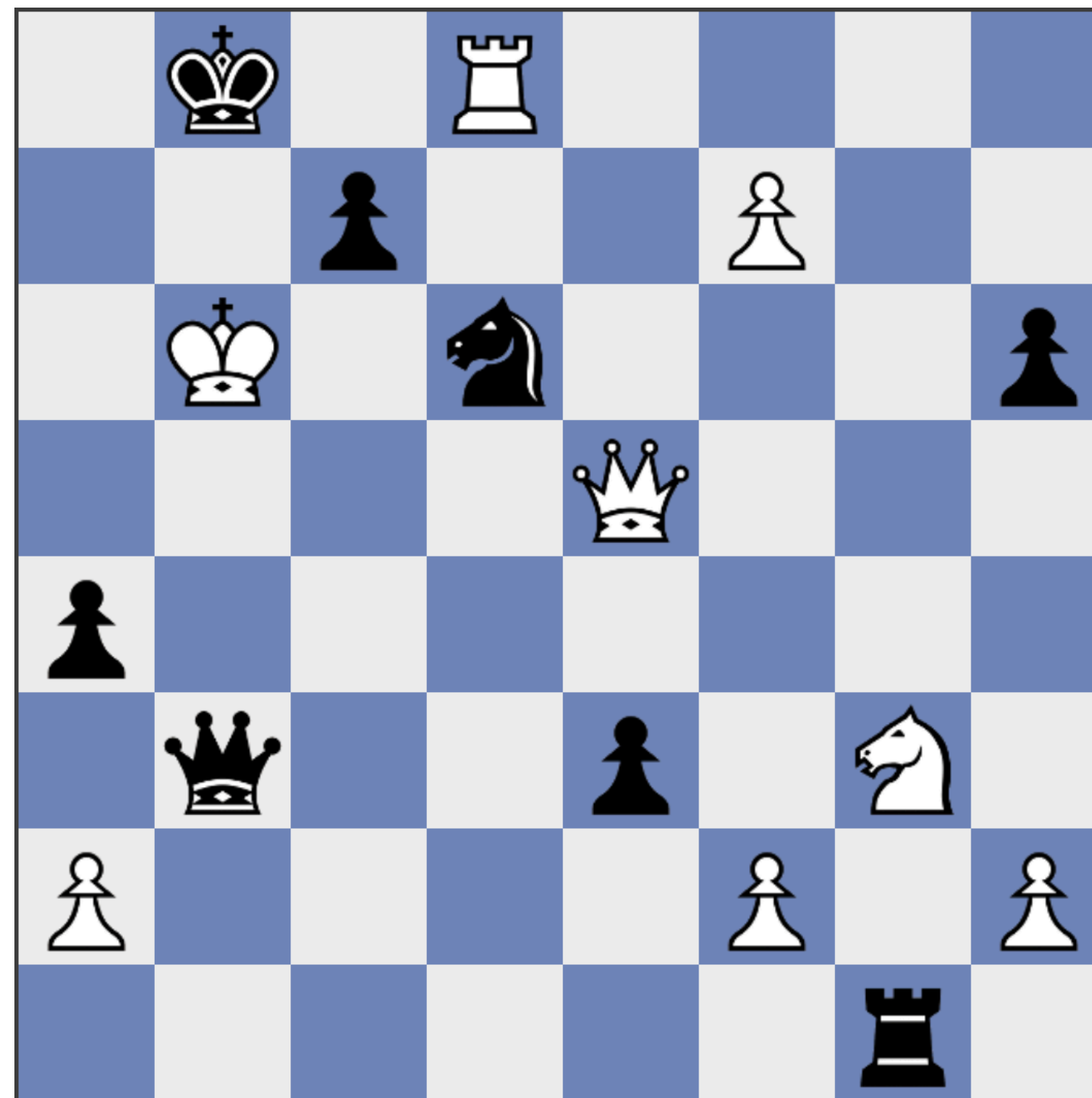
“What S.F. did was to categorize 3- and 4-digit groups as running times for various races. For example, 3492 was recoded as “3 minutes and 49 point 2 seconds, near world-record mile time”. During the first 4 months, S.F. gradually constructed an elaborate set of mnemonic associations based initially on running times and then supplemented with ages (893 was “89 point 3, very old man”) and dates (1944 was “near the end of World War II”) for those sequences that could not be categorized as times.”

Chess masters chunk realistic positions

Materials: chess boards configurations



Deep Blue vs. Garry Kasparov, 1996
Game 2, after move 29. Nxb7 Ne5



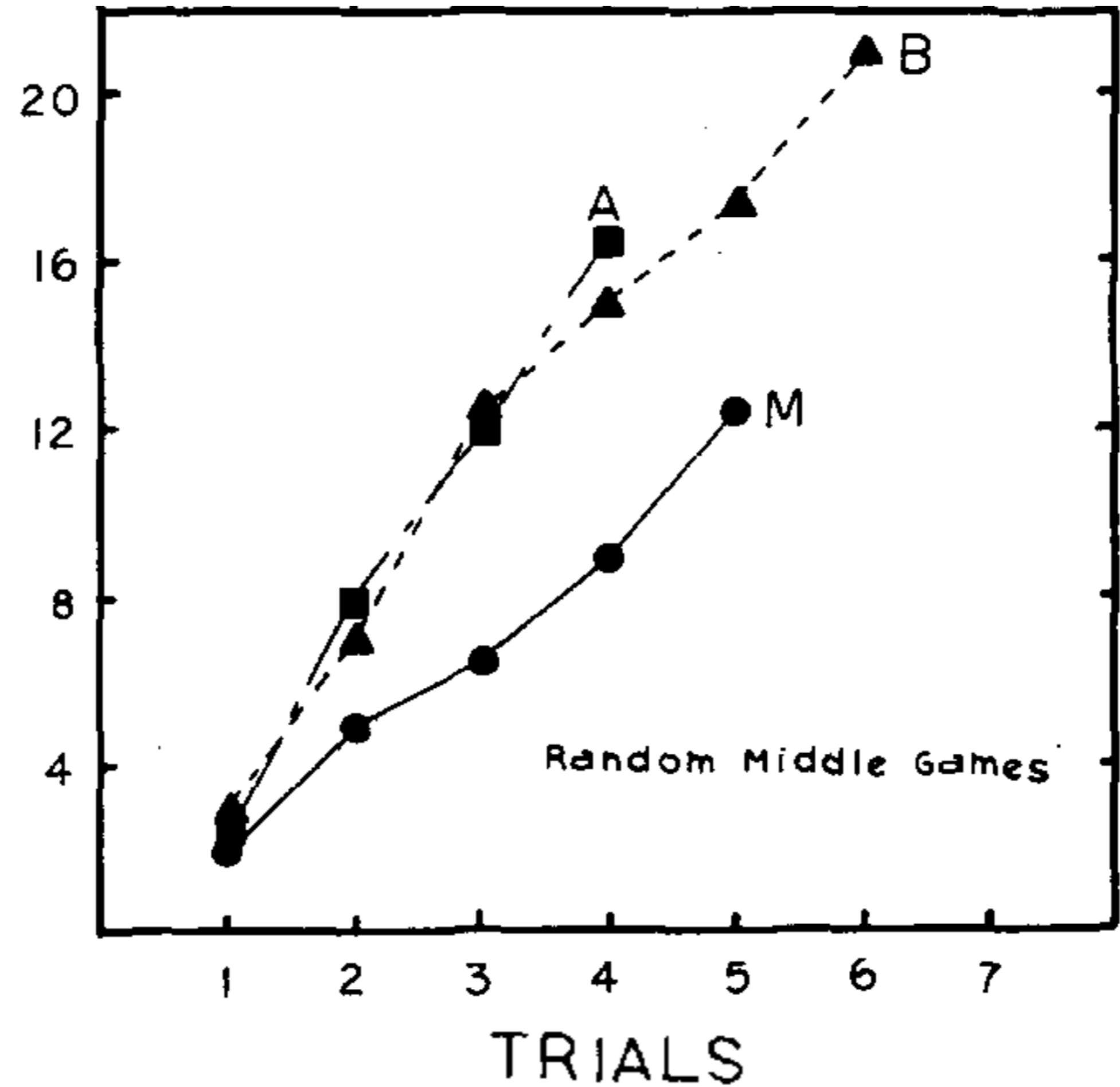
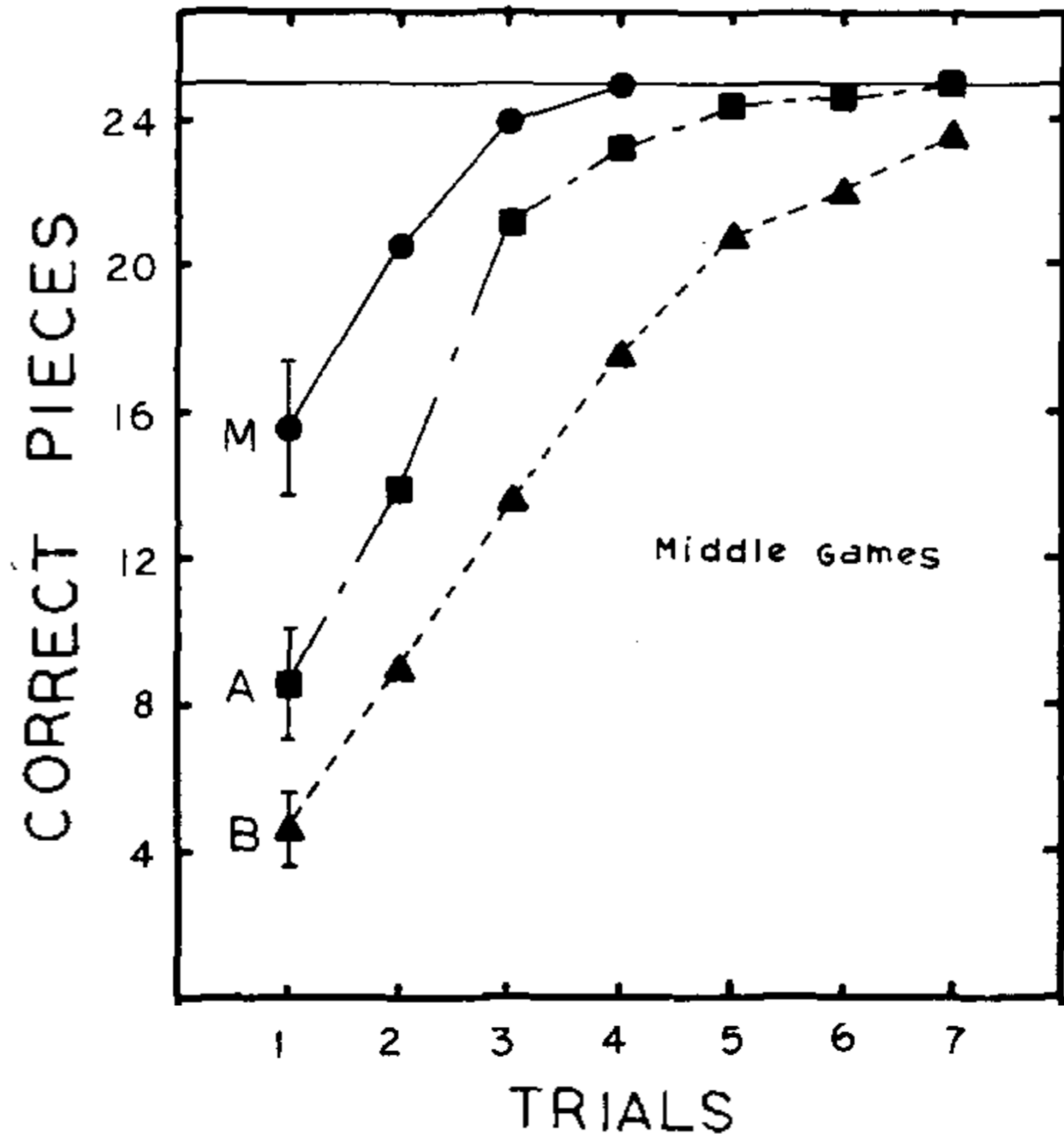
Same board, shuffled

Procedure:

- see board 5s
- remove board
- try to reconstruct
- repeat until correct

Chess masters chunk realistic positions

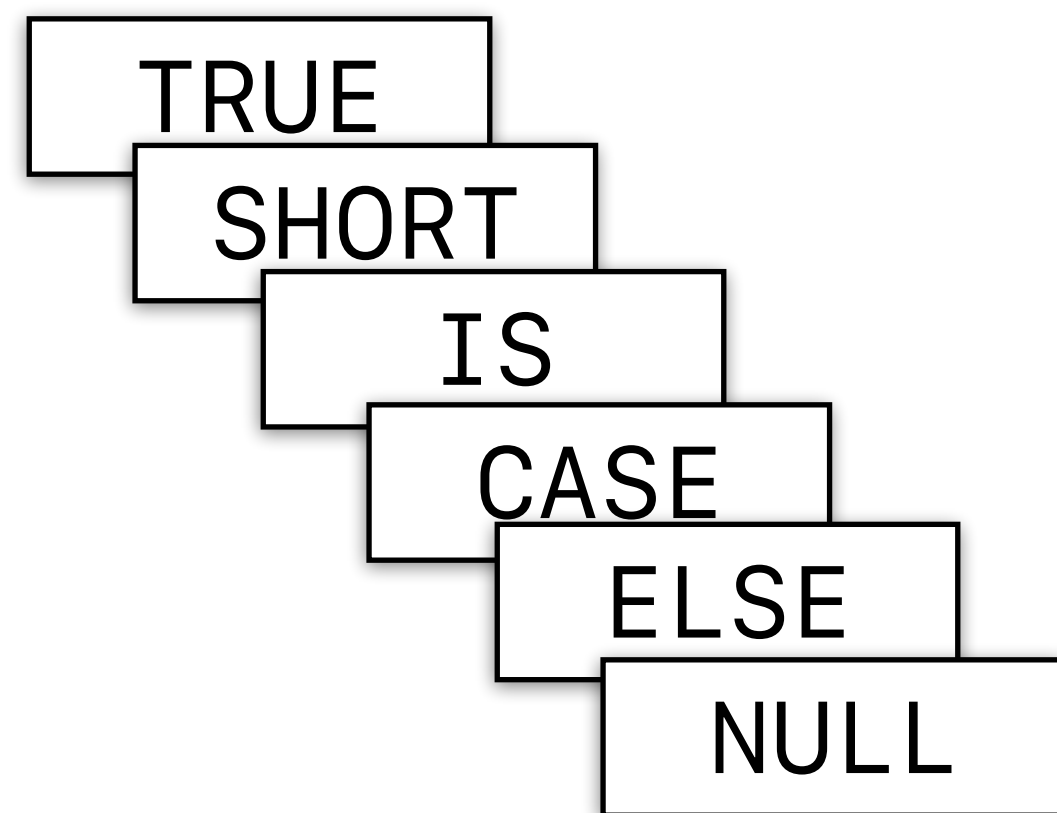
M = "master," A = "class A,"
B = "beginner"



Expert programmers chunk semantically related language keywords

Materials:

ALGOL W keywords



... [21 cards] ...

Procedure:

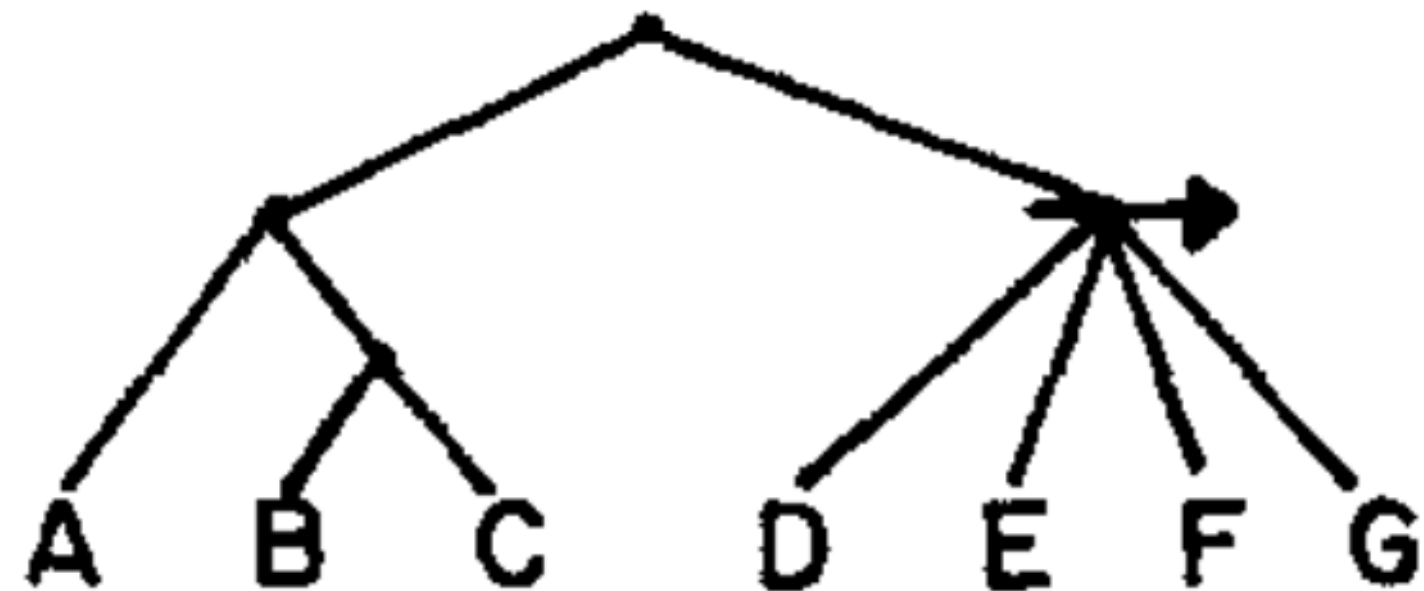
1. Memorize keywords until perfect recall twice.
2. For 25 times: recall all 21 keywords

Expert programmers chunk semantically related language keywords

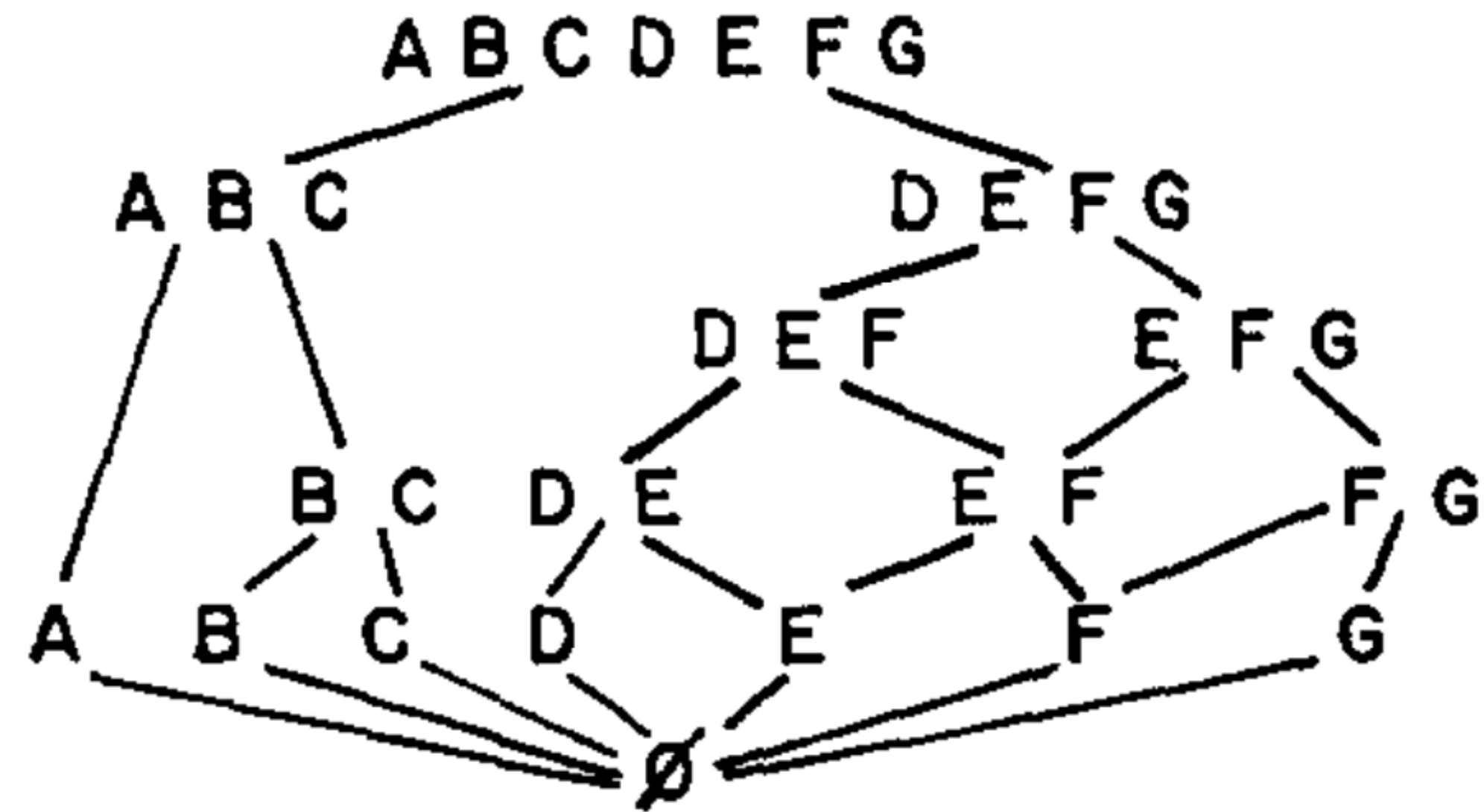
1. Recall strings

A B C D E F G
D E F G C B A
D E F G B C A
B C A D E F G

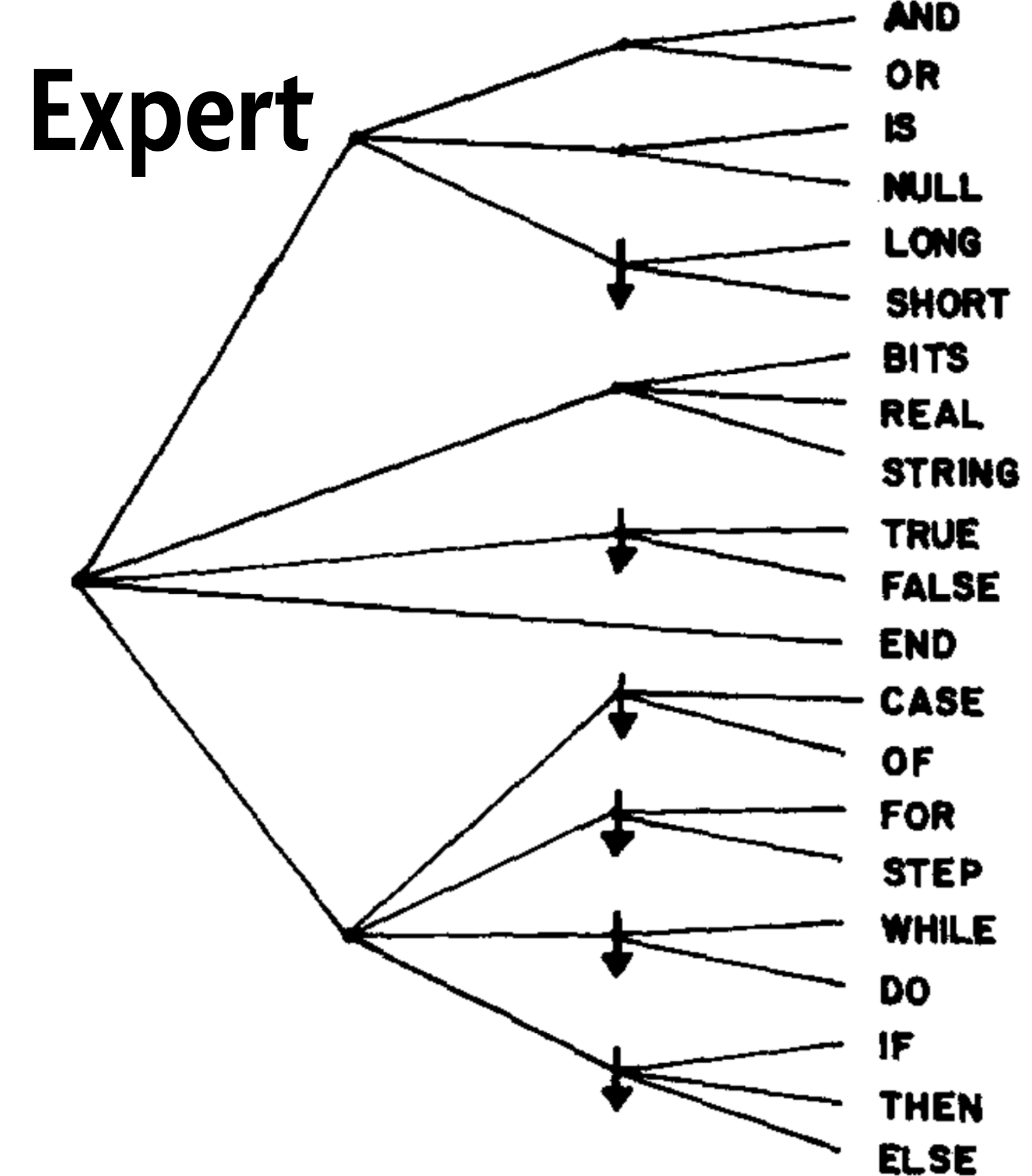
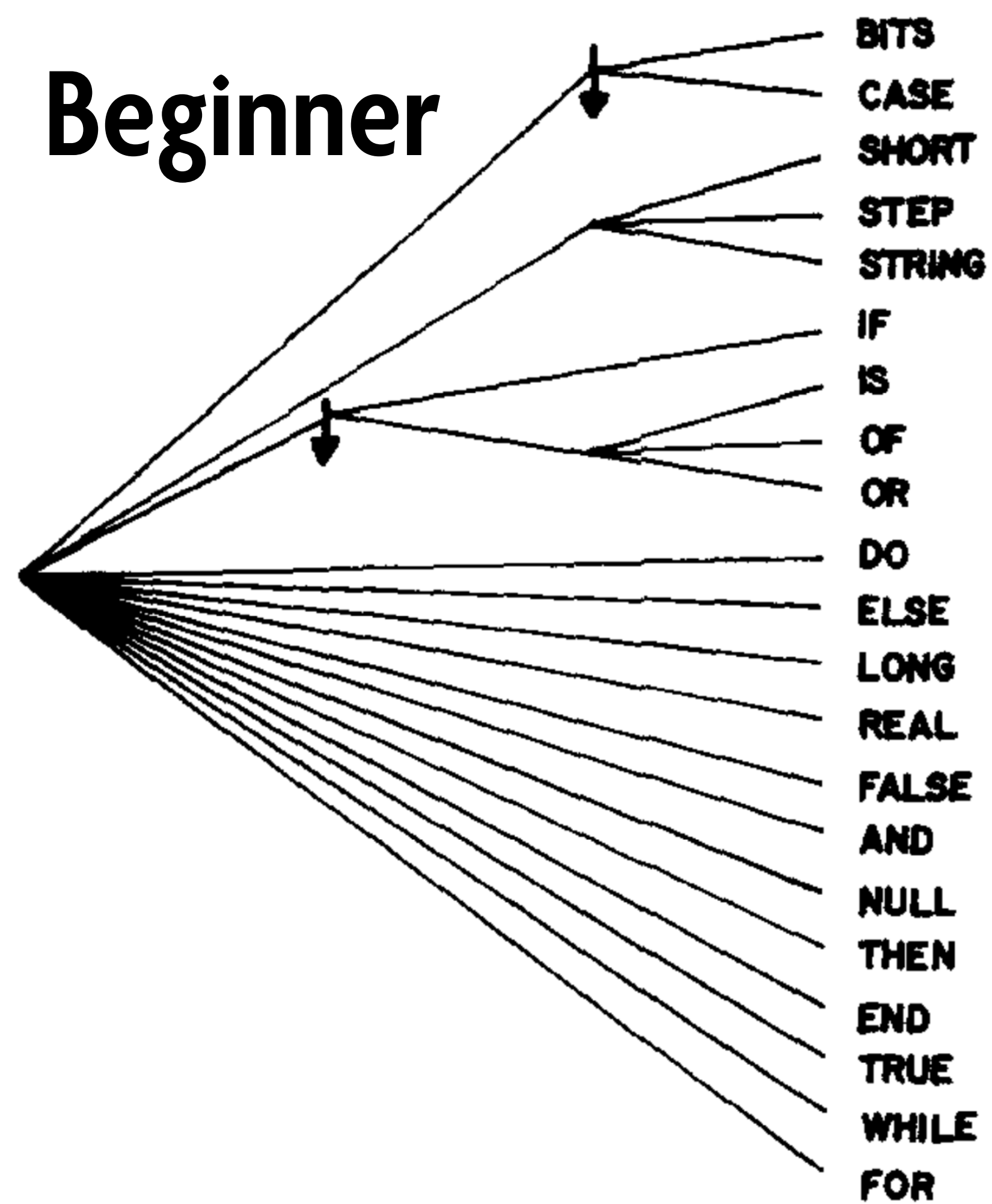
3. Ordered tree



2. Lattice of chunks



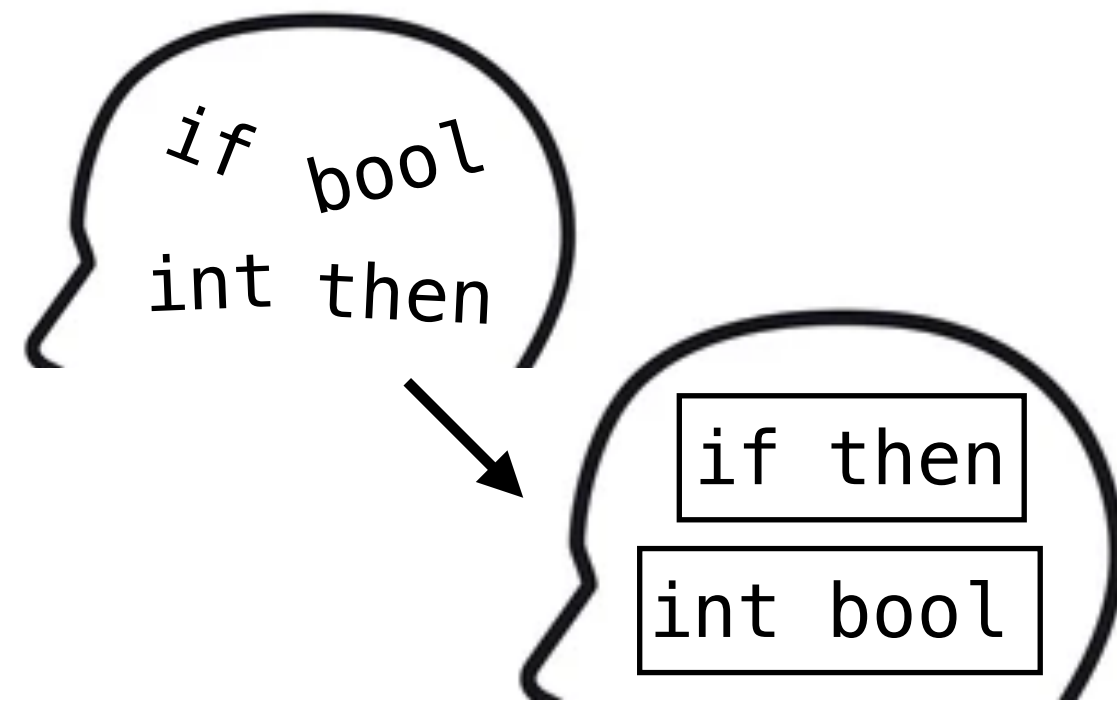
Expert programmers chunk semantically related language keywords



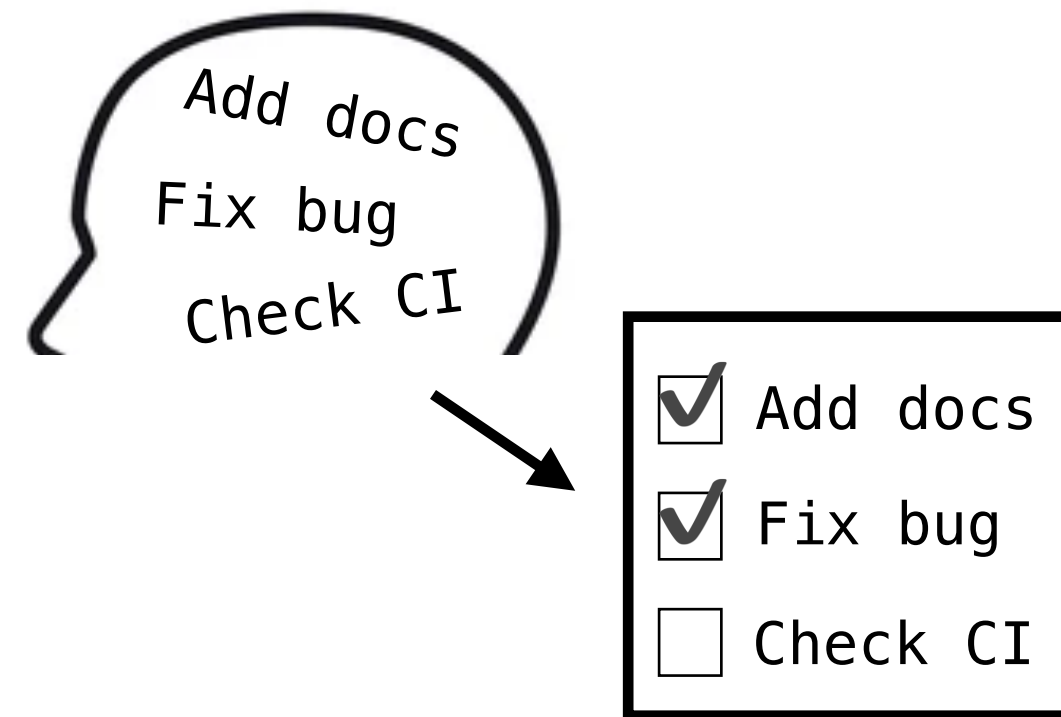
Key observations about working memory

- Working memory is **fragile**: limited capacity (4-10 chunks), easily interfered (competing stimuli), decays quickly (order of seconds)
- **Attention** and **rehearsal** are key to retaining information in working memory & beyond
- A hallmark of skill is efficient use of working memory by compacting related information into **chunks**

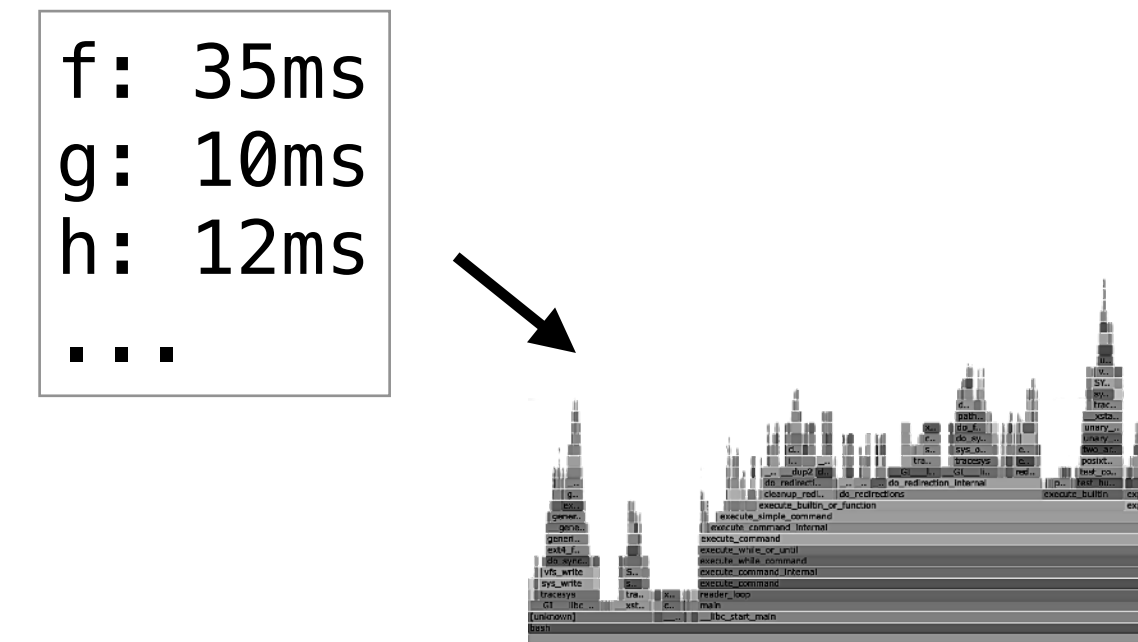
Chunk



Externalize



Visualize



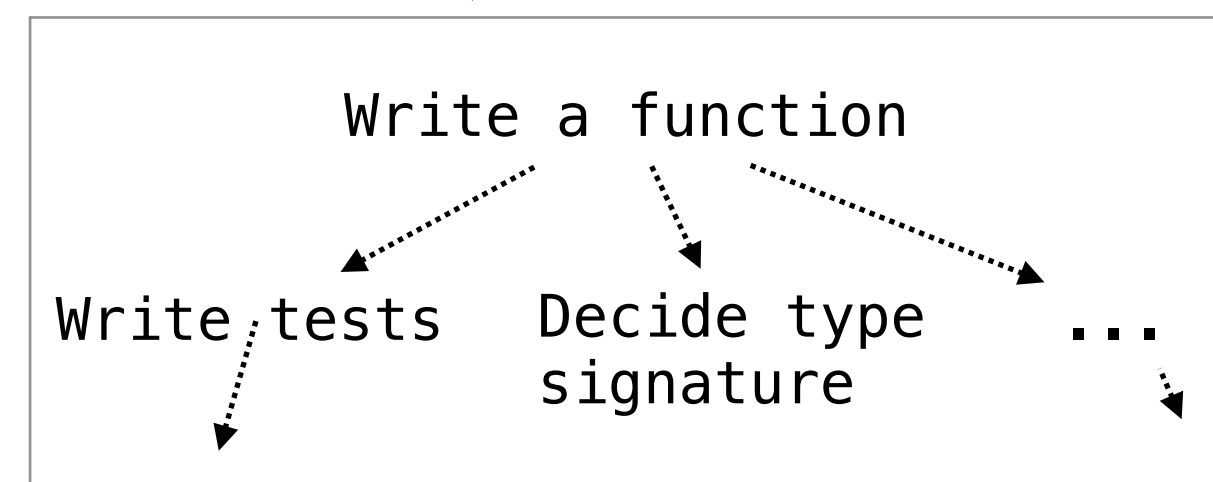
How do we overcome our terrible working memory?

```
f = open('foo.txt', 'r')
for s in f.read().split('\n'):
    print(s)
f.close()
```

```
with open('foo.txt', 'r') as f:
    for s in f.readlines():
        print(s)
```

Schematize

Write the whole function



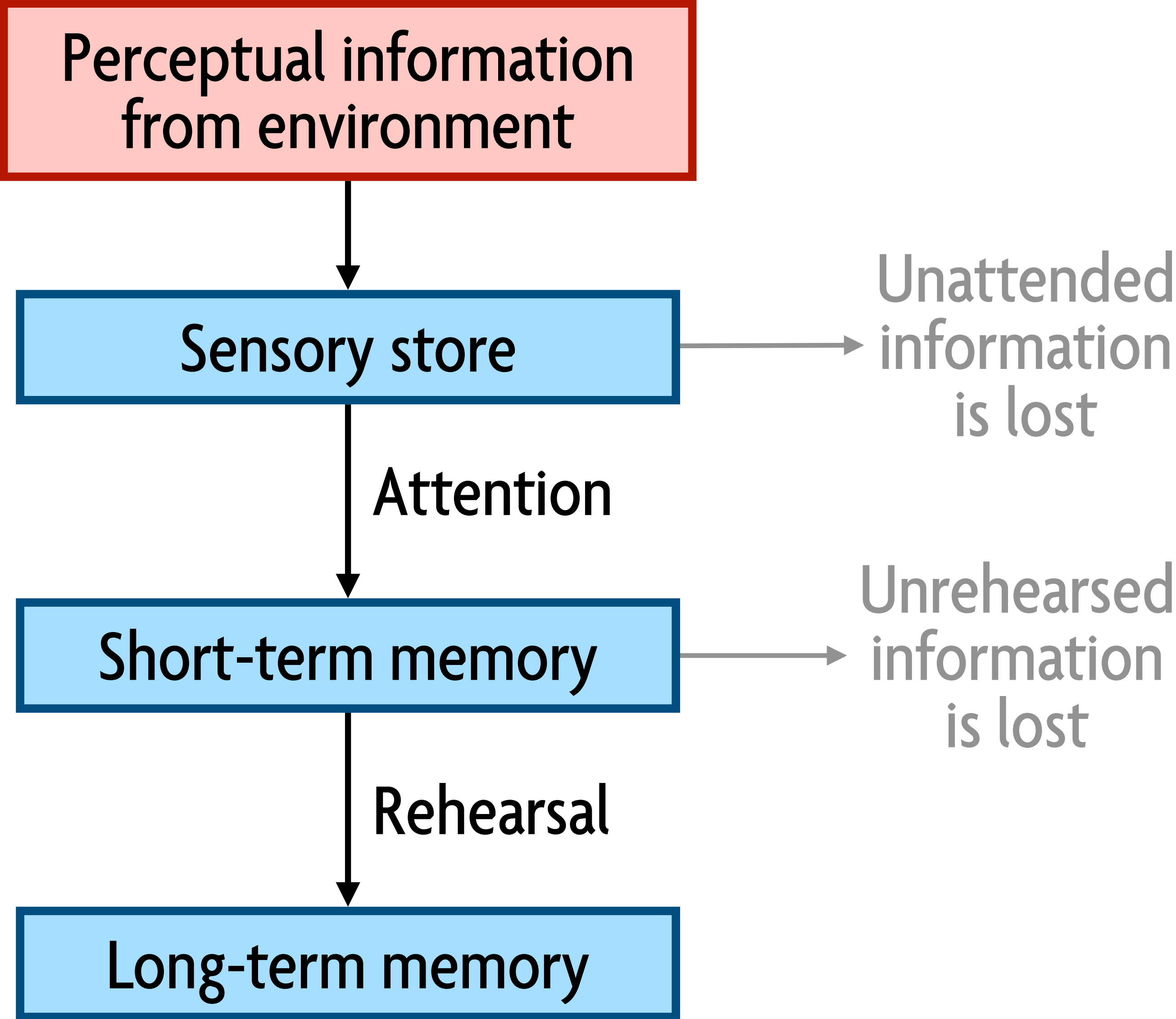
Decompose

Did I use that pointer correctly?

```
error[E0597]: `x` does not live long enough
--> test.rs:4:5
2 |     let z = {
3 |         - borrow later stored here
4 |         let x = 1;
5 |         &x
6 |         ^^ borrowed value does not live long enough
7 |     };
8 |     - `x` dropped here while still borrowed
```

Automate

A basic model of memory



Long-term memories form upon repeated exposure

Materials

The <PROFESSION> <VERB> the <PROFESSION>

“The doctor hated the lawyer”

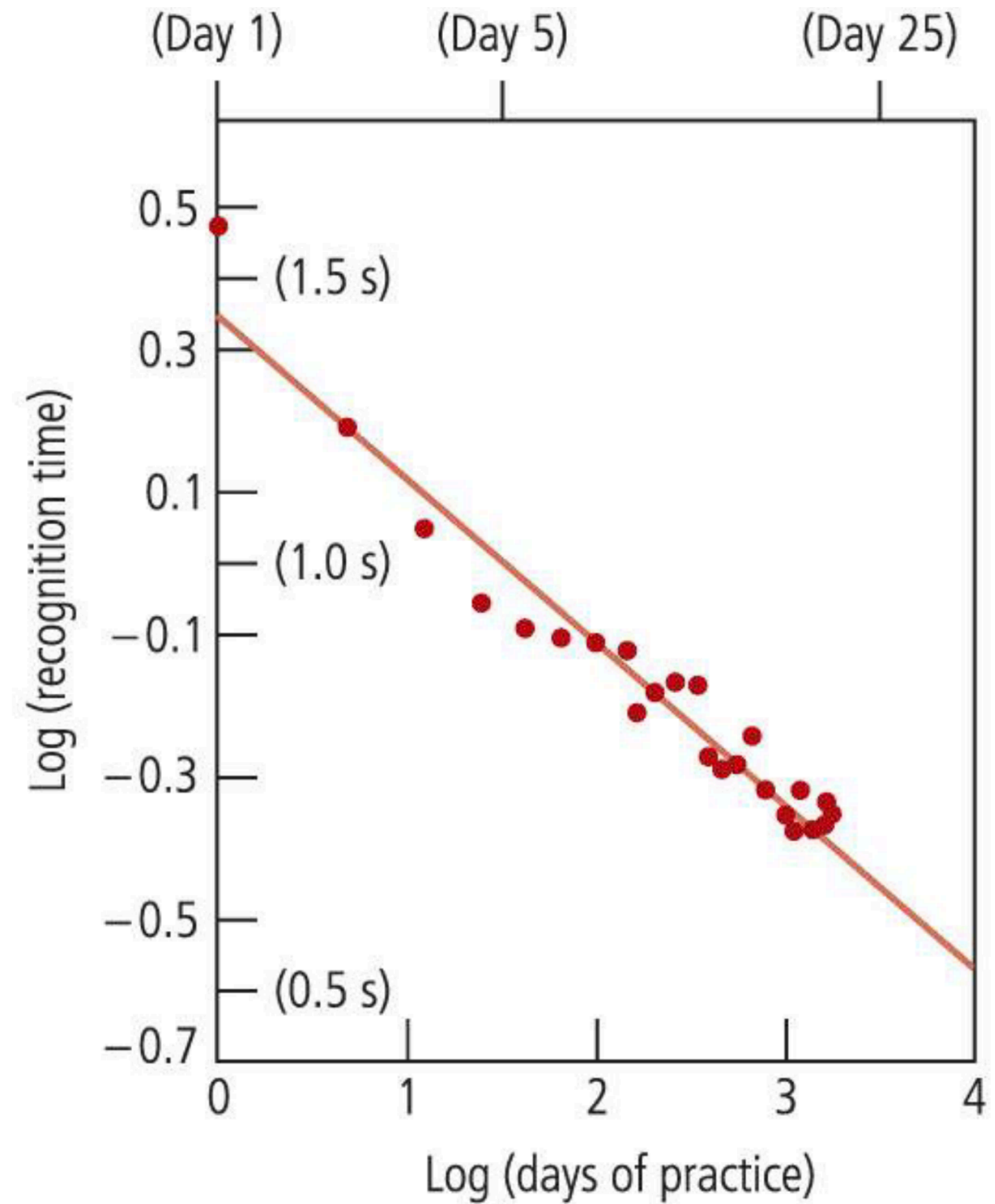
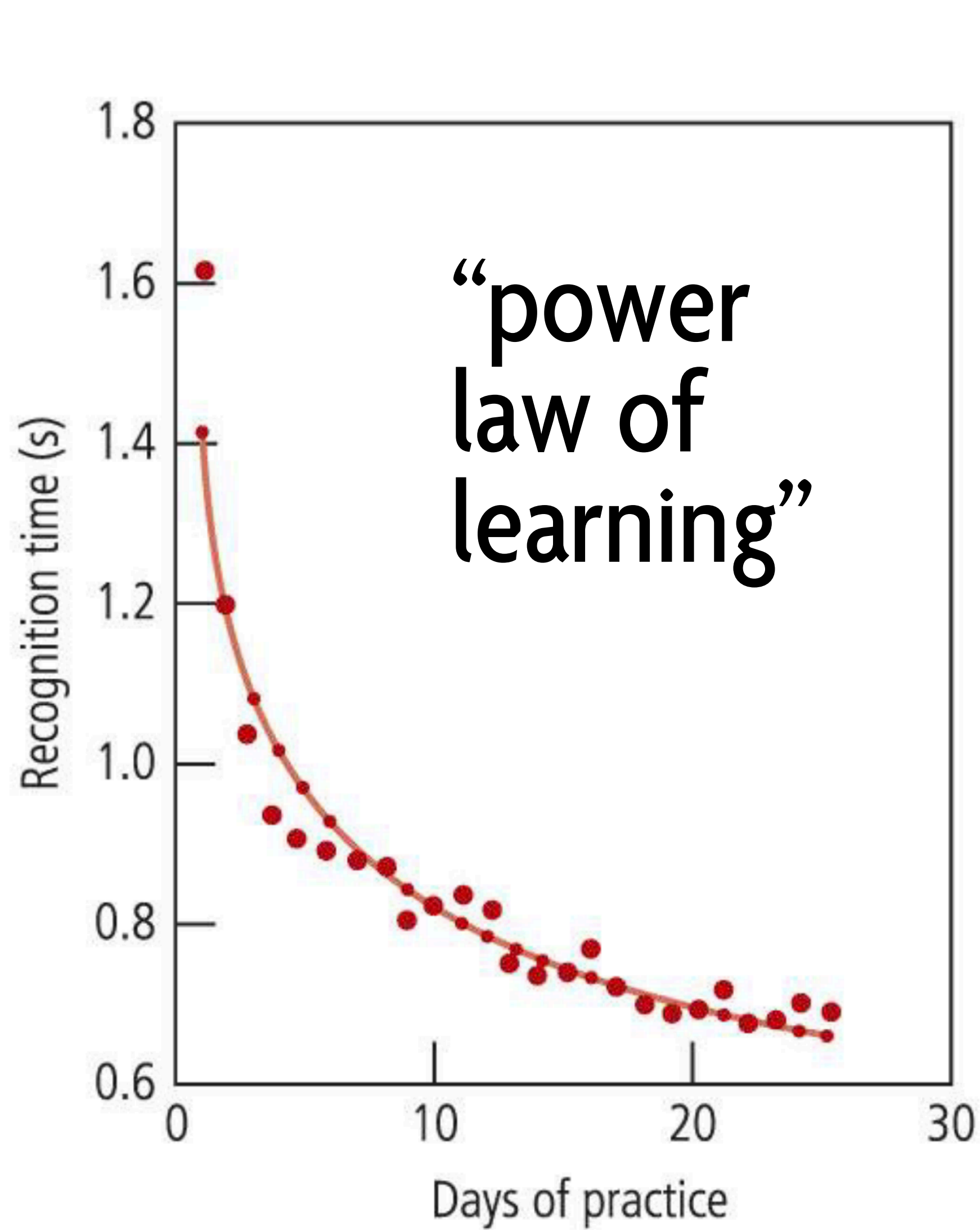
“The nurse hired the doctor”

... [16 sentences] ...

Procedure

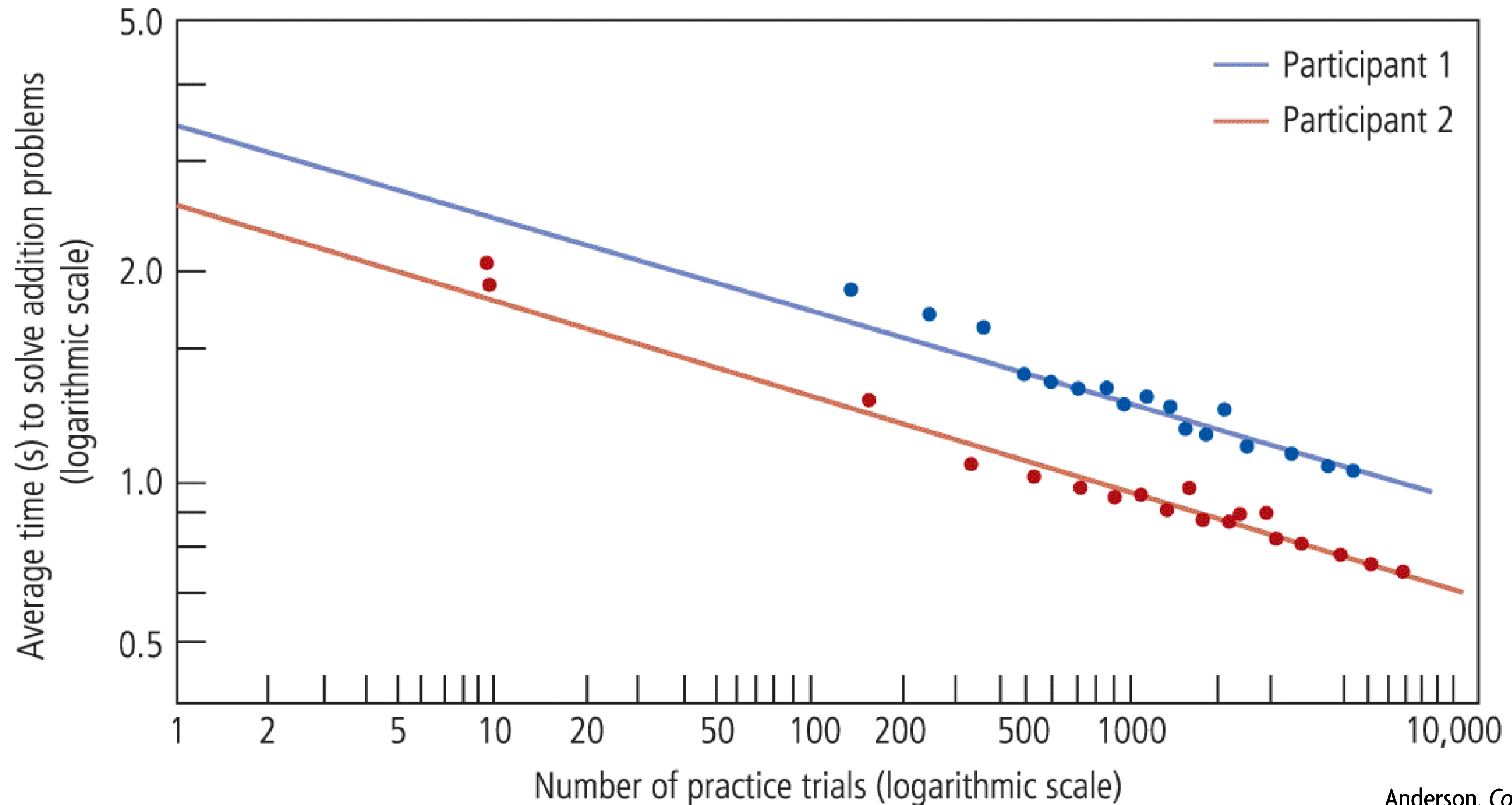
- (1) study the sentences,
- (2) Cloze test until 100% correct,
- (3) measure reaction time of yes/no recognition

Long-term memories form upon repeated exposure

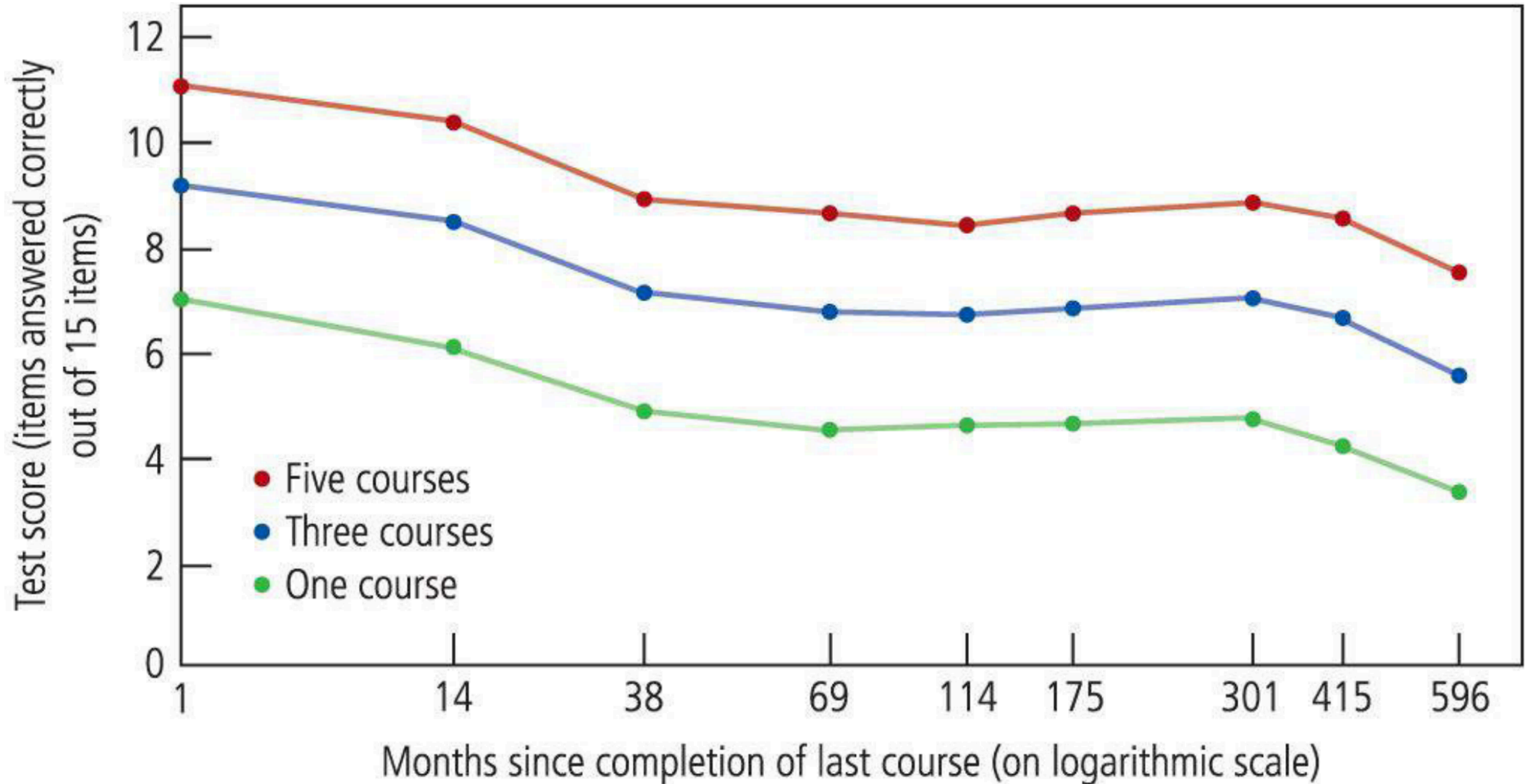


Power law of learning extends quite far

“the effects of practicing addition problems for 10,000 trials by two participants”



Memory decays diminishingly over time



Massing improves short-term retention, spacing improves long-term retention

Materials:

104 Japanese-English
word pairs, e.g.

door — tobira

bird — tori

fish — sakana

rain — ame

...

Procedure:

Study: door — tobira

Study: bird — tori

[... 2, 14, 98 trials later...]

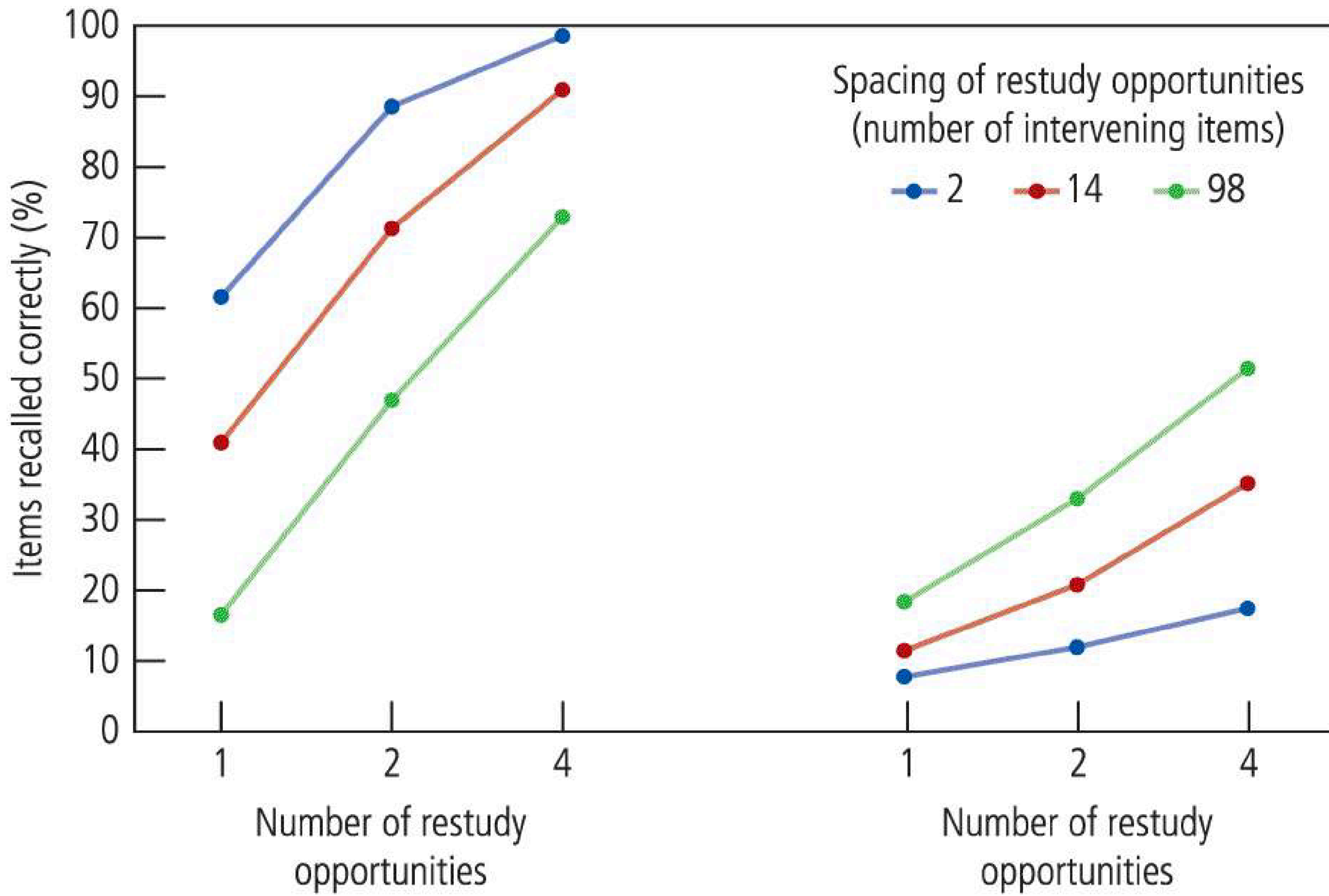
Test: tobira — ?

— **bird**

Restudy: door — tobira

Test: fish — sakana

[... each pair
tested 1, 2, or
4 times ...]



(a) Results of last test on first day

(b) Results of first test on next day

Next lecture:
spaced repetition systems!

In the meantime:
what makes thoughts memorable?

Recognition task is easier than recall task

Materials:

600 common English words

For each participant:

- Randomly partition into 540 training words and 60 negative test words
- Random sample 60 positive test words from 540
- Pair positive and negative words into test items

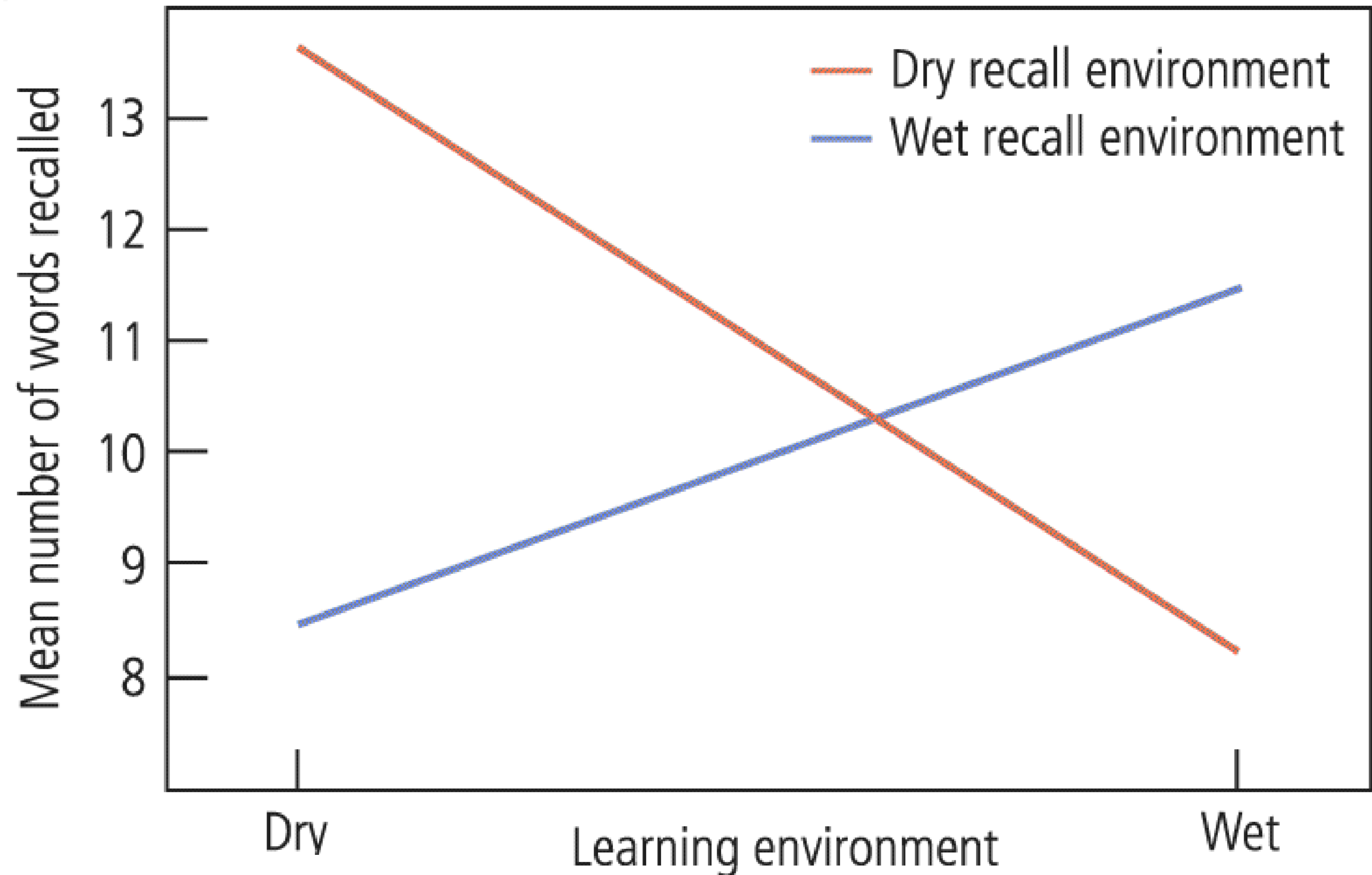
Procedure:

- Read through training deck of 540 words
- For each test item, guess which word is positive

Results: median 90% correct
(88% for sentences, 98% for pictures)

Context can strengthen recall

Procedure: memorize words [underwater, on land] and recall [underwater, on land]



...But not all context strengthens recall

Procedure: randomly assign undergraduates to take psych/CS/anthro exams in lecture room or different room

Results: no measurable effect on grades

Lessons from oral tradition and “artificial memory”

Orality and literacy produce different discursive structures

New American Bible (1970)

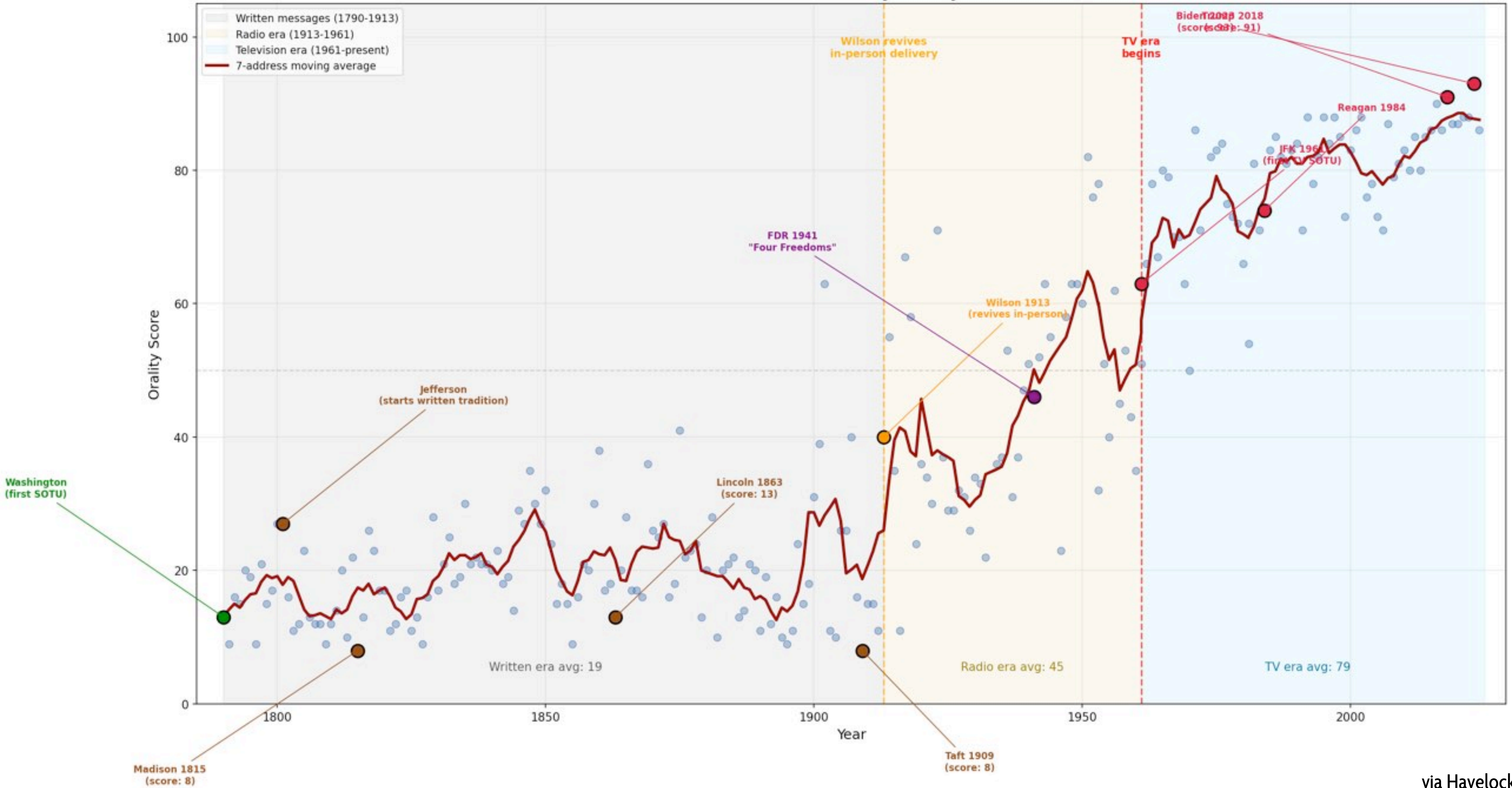
In the beginning,
when God created the heavens and the earth,
the earth was a formless wasteland,
and darkness covered the abyss,
while a mighty wind swept over the waters.
Then God said, 'Let there be light',
and there was light.

Douay Bible (1610)

In the beginning
God created heaven and earth.
And the earth was void and empty,
and darkness was upon the face of the deep;
and the spirit of God moved over the waters.
And God said: Be light made.
And light was made.

The Oral Turn: 234 Years of Presidential Communication

State of the Union Addresses Scored by Orality (0=Literate, 100=Oral)



1. Concrete and Imagistic

Oral traditions prefer concrete, imagistic, and agonistic language

"The angles of a triangle are equal to two right angles."

VS.

"The triangle stood firm in battle, astride and poised on its equal legs, fighting resolutely to protect its two right angles against the attack of the enemy,"

Mind palaces originated $\geq 2,000$ years ago



“For the places are very much like wax tablets or papyrus, the images like the letters, the arrangement and disposition of the images like the script, and the delivery is like the reading.”

“give each fifth *locus* some distinguishing mark”

“form one's memory *loci* in a deserted and solitary place”

“too many intercolumnar spaces are not good”

“The interveals between the *loci* should be of moderate extent, perhaps about thirty feet”

Ad Herennium, orig. circa 85 BCE

2. Poetic and Musical

Poetics limit choice and cue memory

Rhyme

There once was a man from **Peru**
Who dreamed he was eating his **shoe**
He woke with a **fright**
In the middle of the **night**
To find that his dream had come **true**

Alliteration

Ma be rí rofesser
recht flatho,
fothuth iar miad,
mesbada slóg
sabaid cuirmthige,
cuir mescae;
mess tíre,
tomus forrag,
forberta díri
díthle mesraid;

Poetics limit choice and cue memory

Rhythm

Iambic pentameter

˘ — ˘ — ˘ — ˘ —

But soft, what light through yonder window breaks?

Dactylic hexameter

https://youtu.be/7k7u8XeTG0U?si=6RR-9tfI3pug00S_&t=4

Music reinforces language in parallel

Minor third

Perfect fourth

Hey Jude, don't make it bad,

Detailed description: The image shows a musical staff in 4/4 time with a key signature of one flat (B-flat). The melody consists of the following notes: G4 (quarter), F4 (half), E4 (quarter), D4 (quarter), C4 (half). A red bracket labeled 'Minor third' spans the interval between G4 and E4. Another red bracket labeled 'Perfect fourth' spans the interval between D4 and G4. The lyrics 'Hey Jude, don't make it bad,' are written below the staff, with 'Hey' under G4, 'Jude,' under F4, 'don't make it' under E4, and 'bad,' under D4.

3. Repetitive and Cliché

Scripts: patterns of action

Excerpts from the *Iliad*

As for now a black ship let us draw
down to the great salt sea

And therein oarsmen let us advisedly
gather and thereupon a hecatomb

Let us set and upon the deck Chryseis
of fair cheeks

Let us embark. And one man as captain,
a man of counsel, there must be.

The son of Atreus a swift ship to the salt sea
drew down

And therein oarsmen he selected twenty and
thereupon a hecatomb

He embarked for the god and on the deck
Chryseis of the fair cheeks

He set having brought her. And therein a
captain went, even Odysseus of many counsels

Oral tradition is concrete, imagistic, poetic, musical, repetitive, and cliché

- Concrete images are more memorable than abstract statements
- Poetics and music constrain choice, cue recall, and strengthen associations through overlapping signal
- Repetition and cliché strengthen memory, permit reuse of narrative schema
- **Q:** what are the implications for tools for thought?