

**CSCI 1377**

# **Tools for Thought**

# **Reading I Technology of the Written Word**

“Writing, Phaedrus, has this strange quality, and is very like painting; for the creatures of painting stand like living beings, but if one asks them a question, they preserve a solemn silence.”

— Plato, *Phaedrus* (370 BCE)

# **An abridged technological history of reading and writing**

# Ancient cultures developed physical records as mnemonics

## Notches



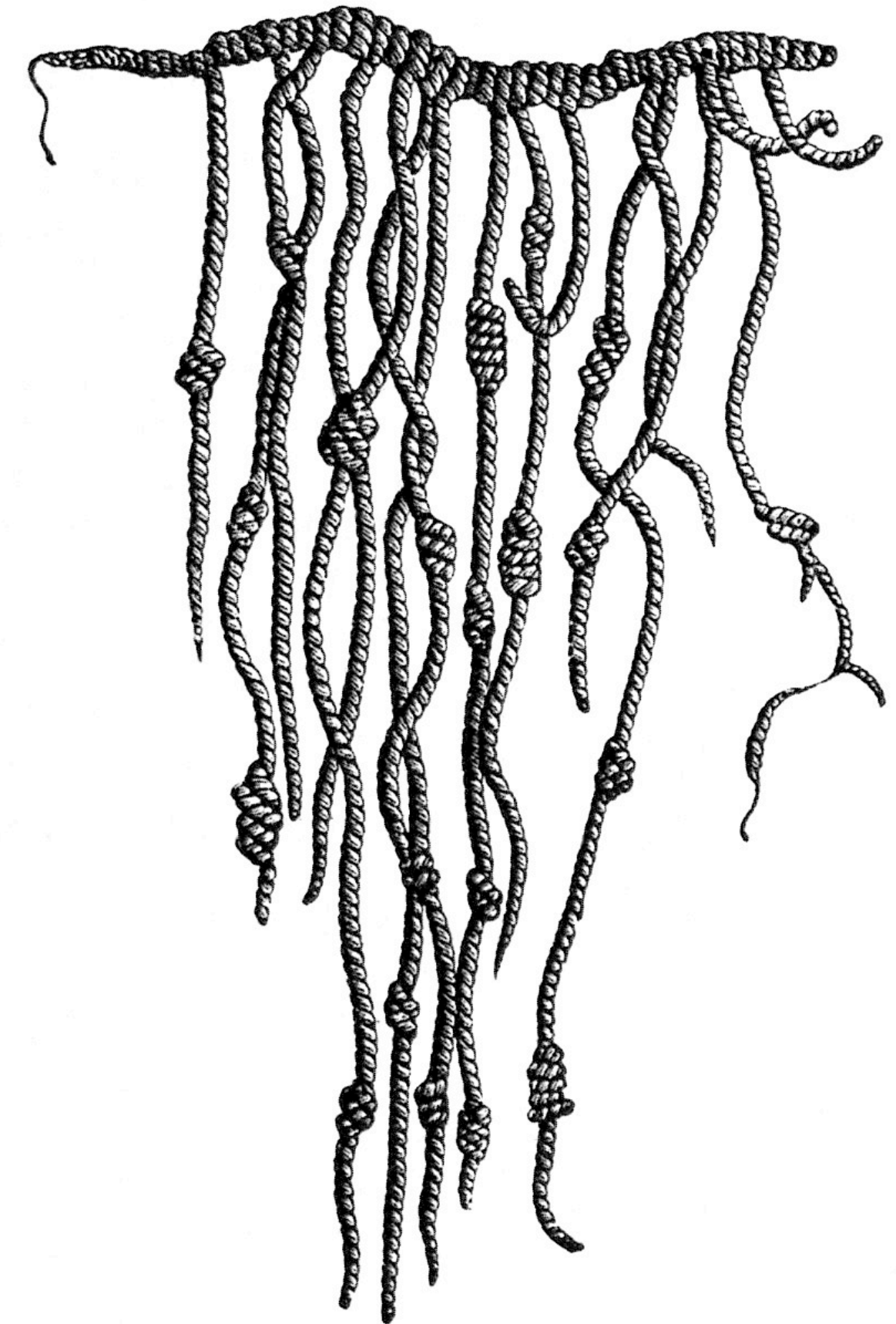
Ishango bone  
(~20k years old)

## Tokens



Middle Eastern clay tokens  
(~8000 BCE)

## Knots



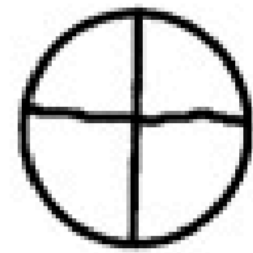
Incan *quipu*  
(~1300 BCE)

# “Complete” writing developed from symbols



By Marie-Lan Nguyen, Public Domain,  
via Wikimedia Commons

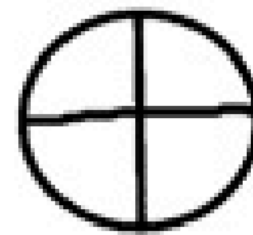
*clay token*



*(8000–3000 BC)*



*pictogram incised in clay*



*(Archaic Uruk, c. 3000 BC)*



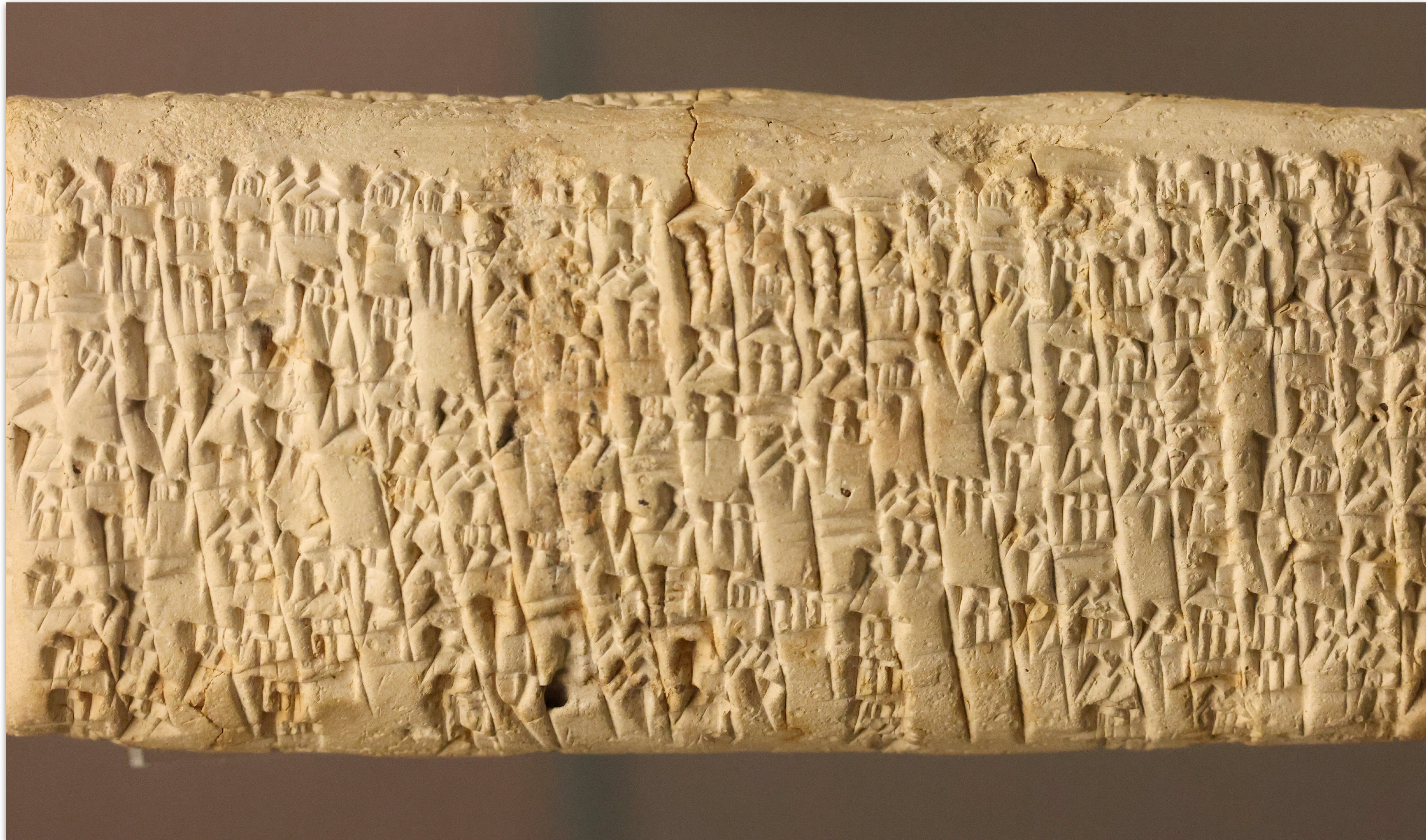
*cuneiform sign*



*(Lagesh, c. 2400 BC)*

- Complete writing must have as its purpose communication
- Complete writing must consist of artificial graphic marks on a durable surface;
- Complete writing must use marks that relate conventionally to articulate speech in such a way that communication is achieved.

# Complaint tablet to Ea-nāsir, c. 1750 BCE



# Symbols increasingly abstracted away from depictions

	<i>Fish</i>	<i>Bird</i>	<i>Ax</i>	<i>Arrow</i>	<i>Bottle</i>
M E S O P O T A M I A					
E G Y P T					
C H I N A					

**Pictogram:** symbol which visually resembles a physical object

“Fish” is a symbol which looks like a fish

**Ideogram:** symbol which denotes an idea or concept

“Fish” is a symbol which is not clearly a fish

# Symbols increasingly denoted linguistic elements

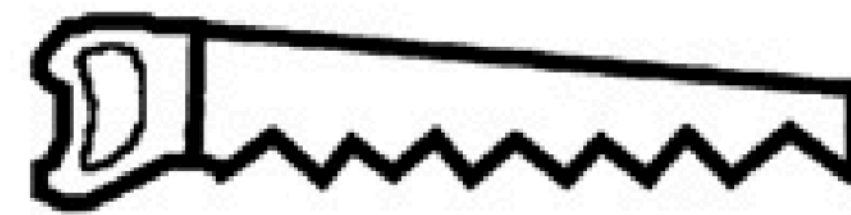
## Rebus principle

[logoconsonantal]

Repurpose symbol  
as phonetic marker



eye



saw



bill

## Morphemes

[logosyllabic]

Symbols represent  
concepts like “plural”

人们

rén -men

# Eventually, some scripts became fully phonetic

**Phonograms:** symbols which represent spoken language

**Syllabaries:** symbols represent syllables

こんにちは世界

ko - n - ni - chi - wa - se - kai

**Alphabets:** symbols represent consonants and vowels

“Hello world”

hɛ'ləʊ wɜ:ld

“Γεια σου κόσμε”

'ɣa su 'kozme

“The most remarkable fact about the alphabet no doubt is that it was invented only once.”

— Walter Ong

# Korean alphabet (hangul) was *commissioned*



King Sejong

“The sounds of our country's language are different from those of [China] and are not confluent with the sounds of characters. Therefore, among the ignorant people, there have been many who, having something they want to put into words, have in the end been unable to express their feelings. I have been distressed because of this, and have newly designed twenty-eight letters, which I wish to have everyone practice at their ease and make convenient for their daily use.”

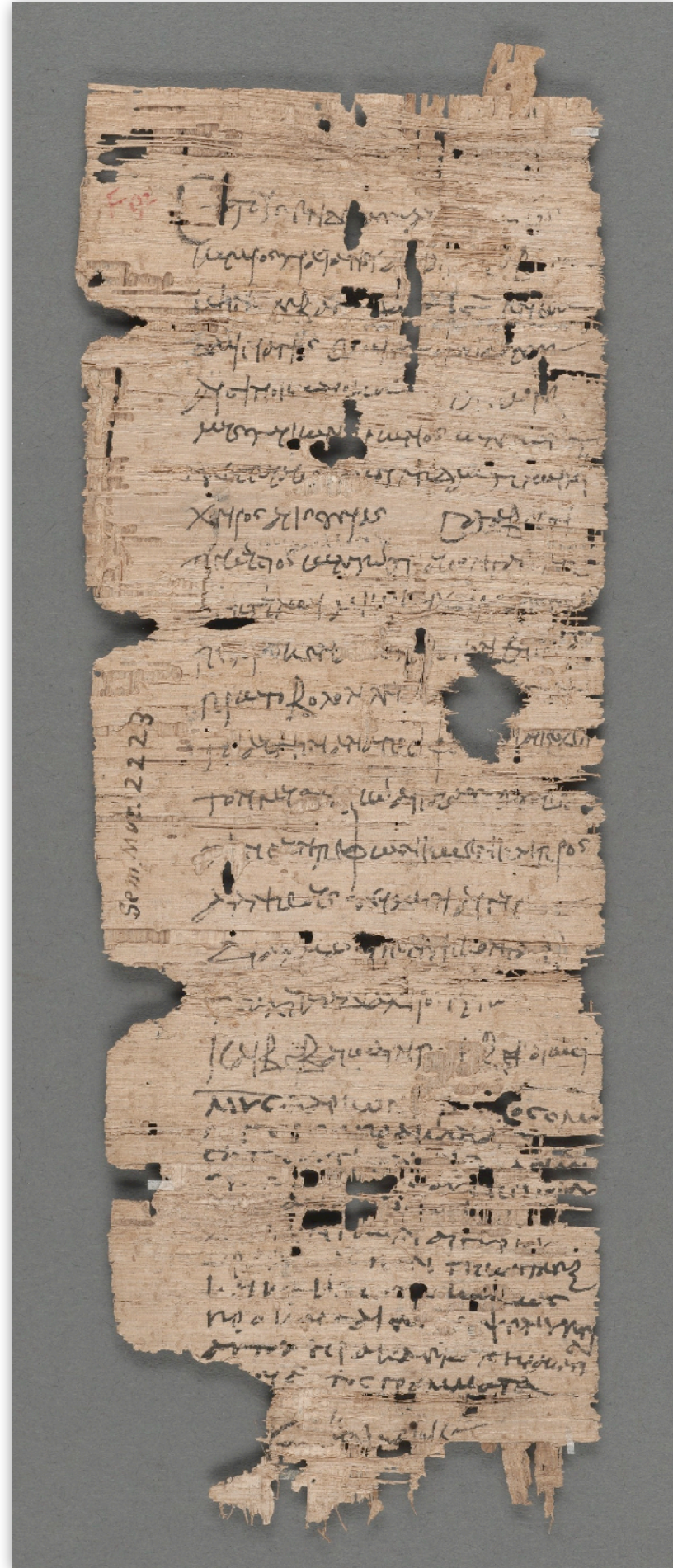
— *Hunminjeongeum* (1446)

# Korean alphabet (hangul) was *commissionsed*

+	ㄱ g	ㄴ n	ㄷ d	ㄹ r	ㅁ m	ㅂ b	ㅅ s	ㅇ o
ㅏ a	가 ga	나 na	다 da	라 ra	마 ma	바 ba	사 sa	아 a
ㅑ ya	가 gya	냐 nya	다 dya	랴 rya	먀 mya	뵤 bya	샤 sya	야 ya
ㅓ eo	거 geo	너 neo	더 deo	러 reo	머 meo	버 beo	서 seo	어 eo
ㅕ yeo	겨 gyeo	녀 nyeo	더 dyeo	려 ryeo	며 myeo	뵤 byeo	셔 syeo	여 yeo
ㅗ o	고 go	노 no	도 do	로 ro	모 mo	보 bo	소 so	오 o
ㅛ yo	고 gyo	뇨 nyo	도 dyo	료 ryo	묘 myo	뵤 byo	쇼 sya	요 yo
ㅜ u	구 gu	누 nu	두 du	루 ru	무 mu	부 bu	수 su	우 u

# Sheets supplanted tablets

Bill of sale (126 CE)  
on papyrus



By Mystharion, son of Heron - Houghton Library, Harvard University, Public Domain

Goatskin parchment



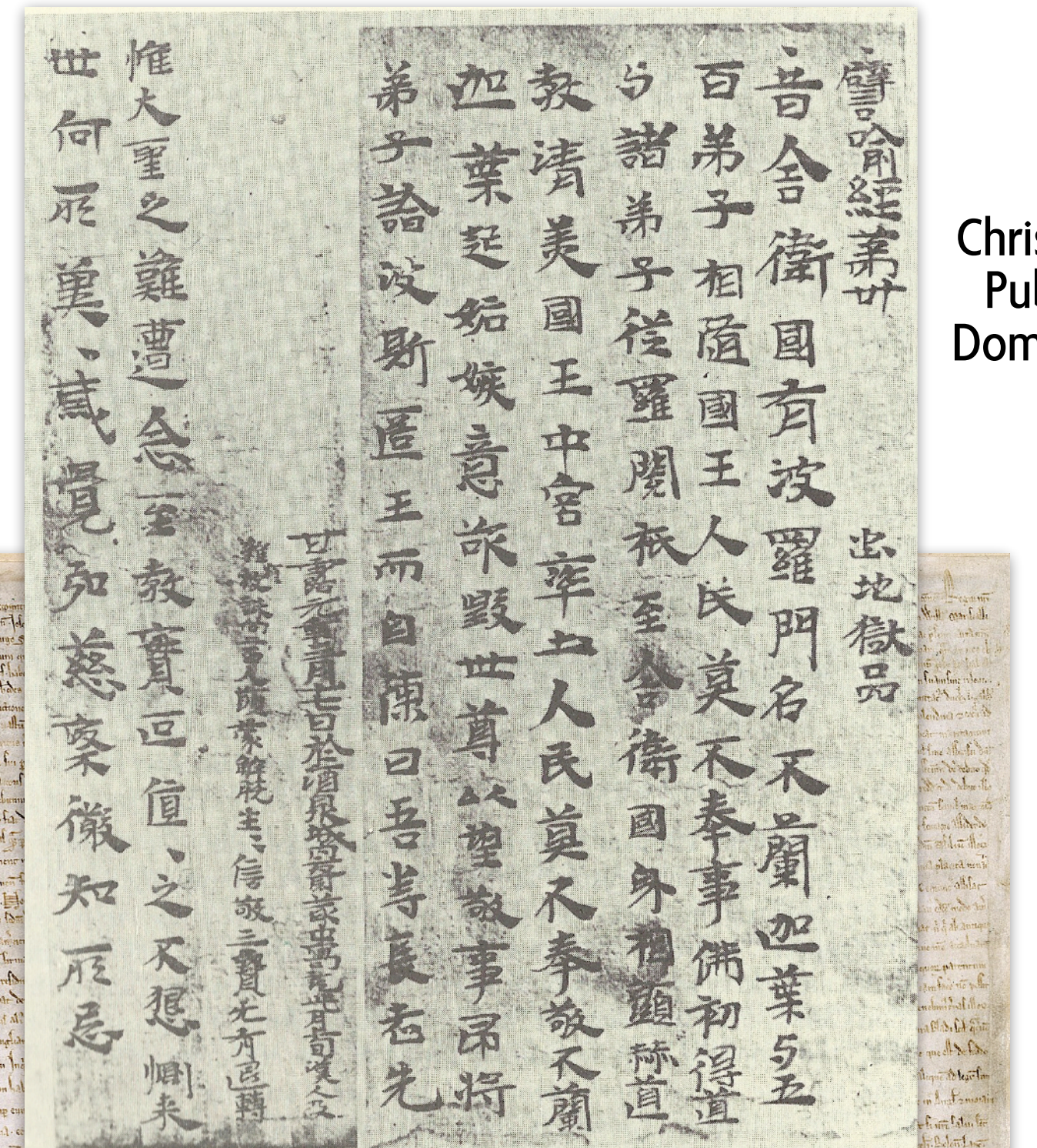
By Michal Mañas, CC BY 2.5

Magna Carta (1215 CE) on vellum



All images via Wikimedia Commons

Pi Yu Jing (c. 256 CE)  
on paper

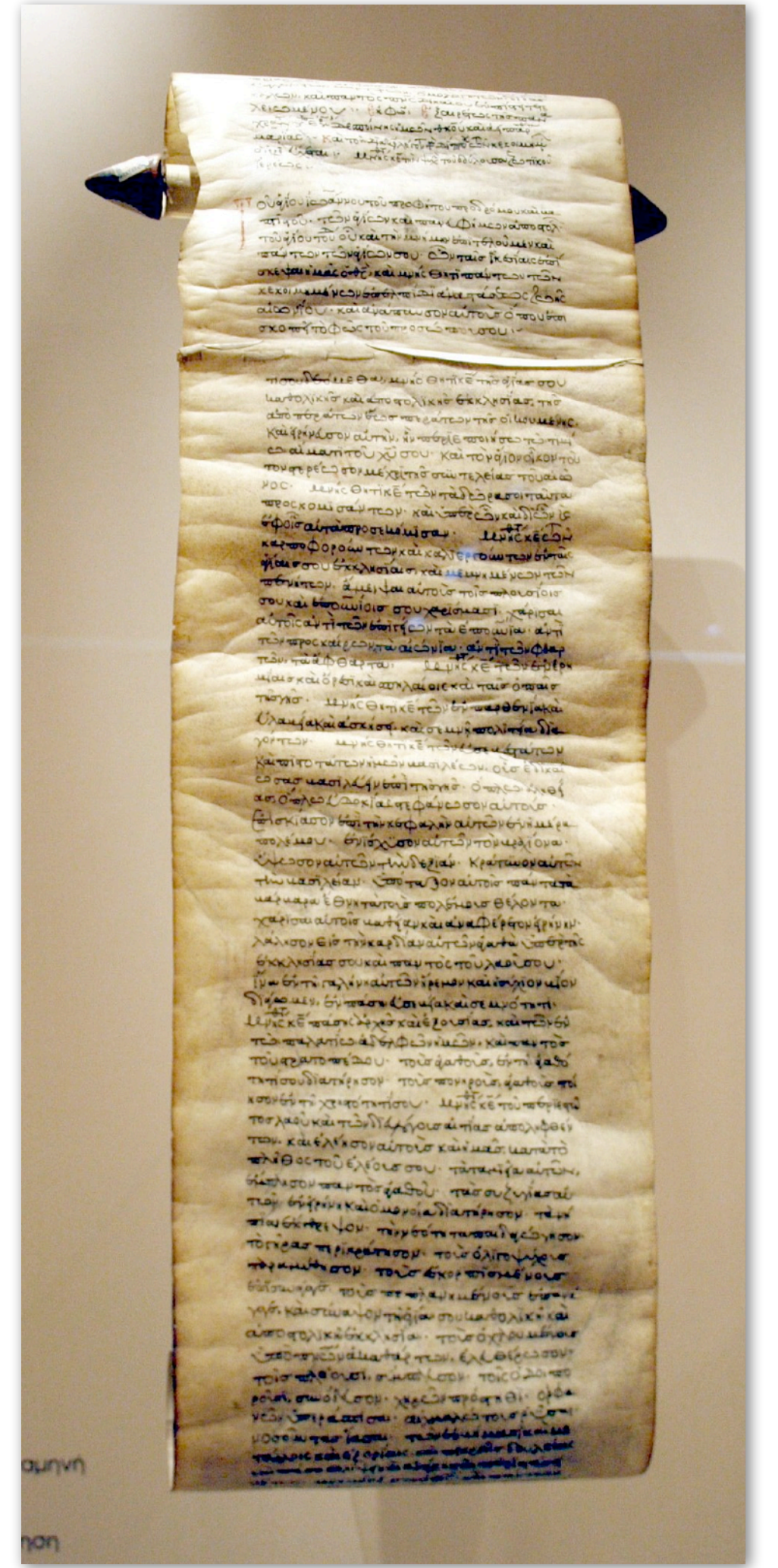


Chris55,  
Public Domain

# Long texts were made into scrolls

## Isaiah Scroll (c. 150 BCE)

G.dallorto, Attribution, via Wikimedia Commons



Photographs by Ardon Bar Hama, Public domain, via Wikimedia Commons

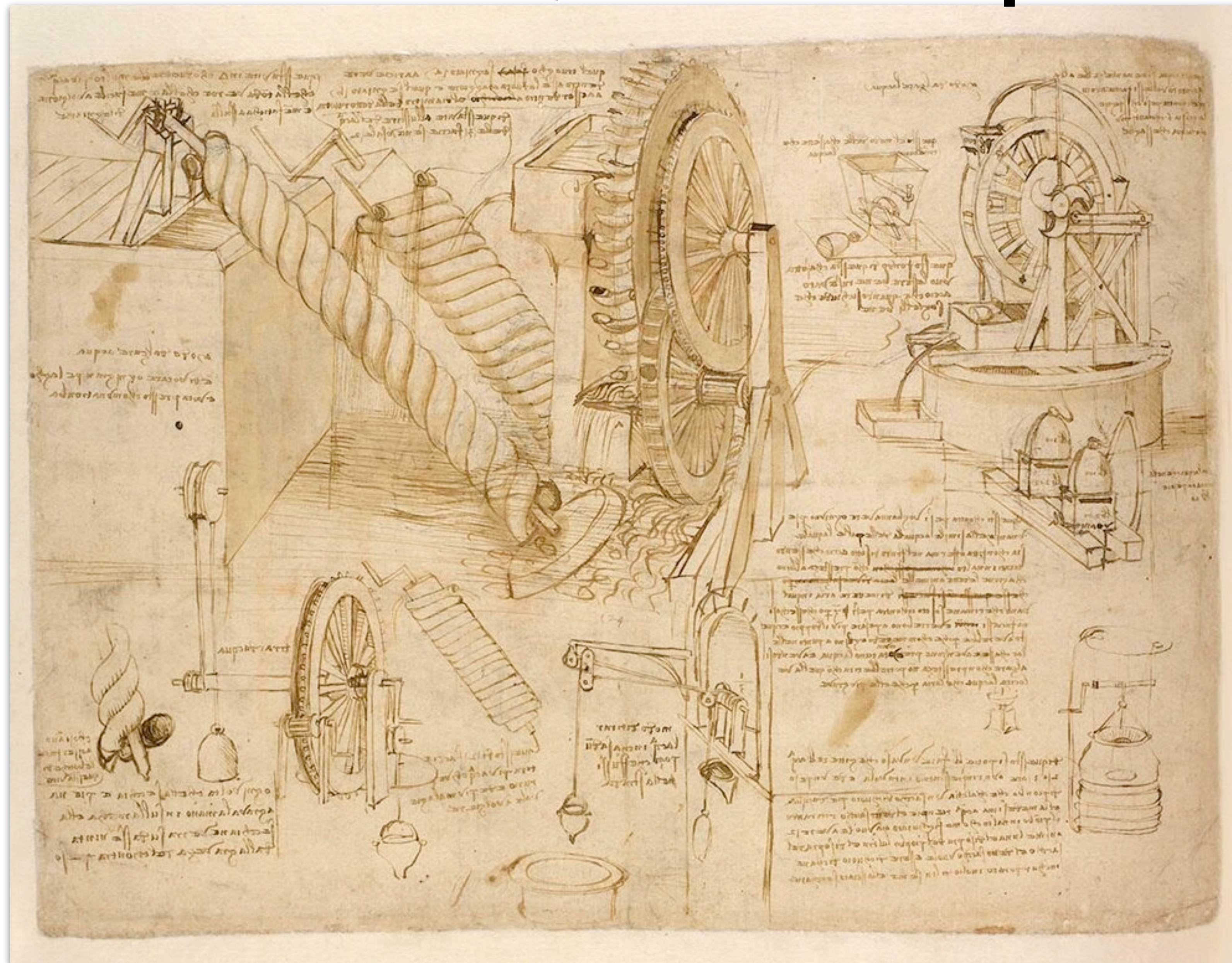
# Then the codex supplanted the scroll



*Codex Gigas*  
(c. 1222 CE)

Kungl. biblioteket, Attribution,  
via Wikimedia Commons

# Codex Atlanticus, drawn with sepia ink



Leonardo da Vinci, Public domain, via Wikimedia Commons

# Scribes copied manuscripts for dissemination



**Assyrian scribes**

from Hugo Rydén et al. 1982, via Wikimedia Commons



**15th c. Burgundian scribe**

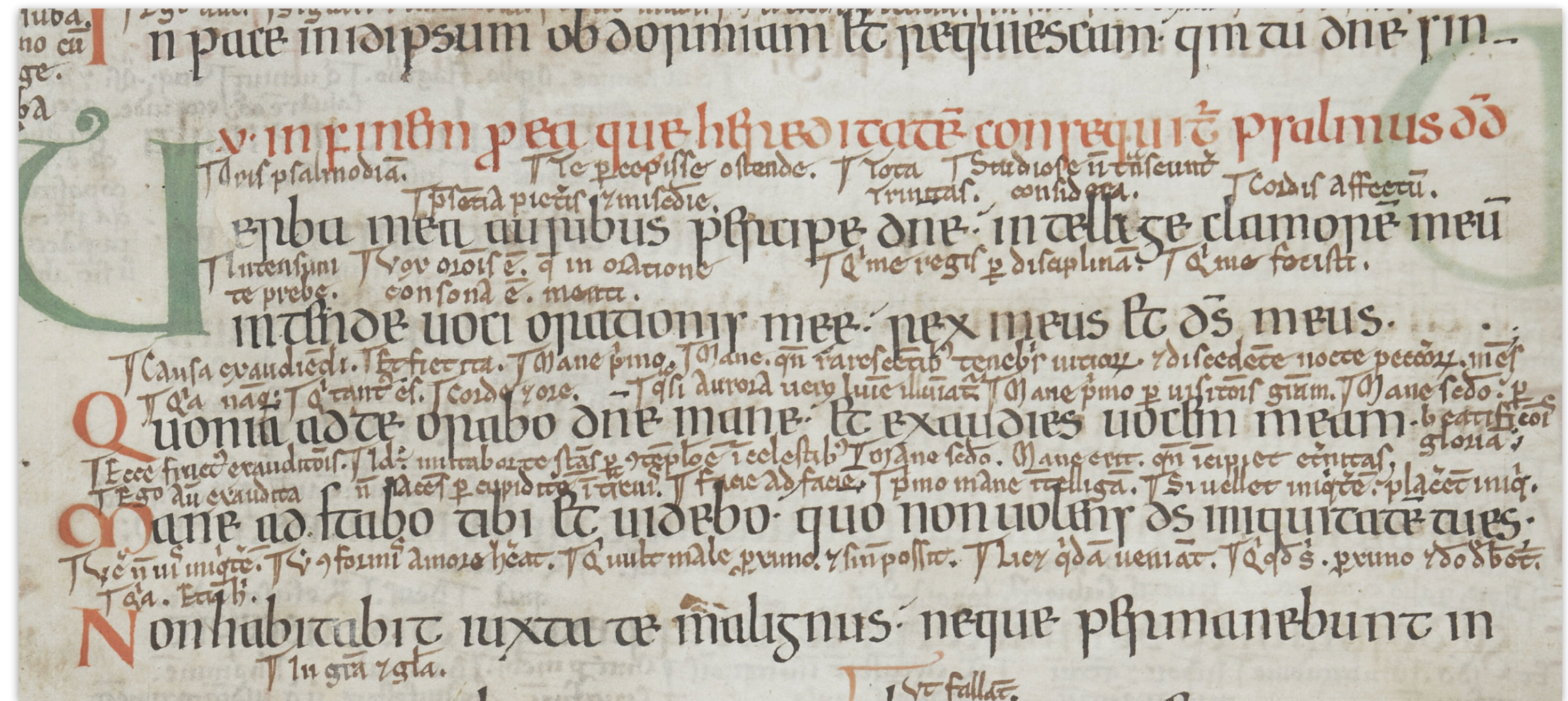
Jean Le Tavernier, Public domain, via Wikimedia Commons

# Manuscripts were creatively laid out and embellished



## Drop capitals

National Library of Wales, CC0, via Wikimedia Commons



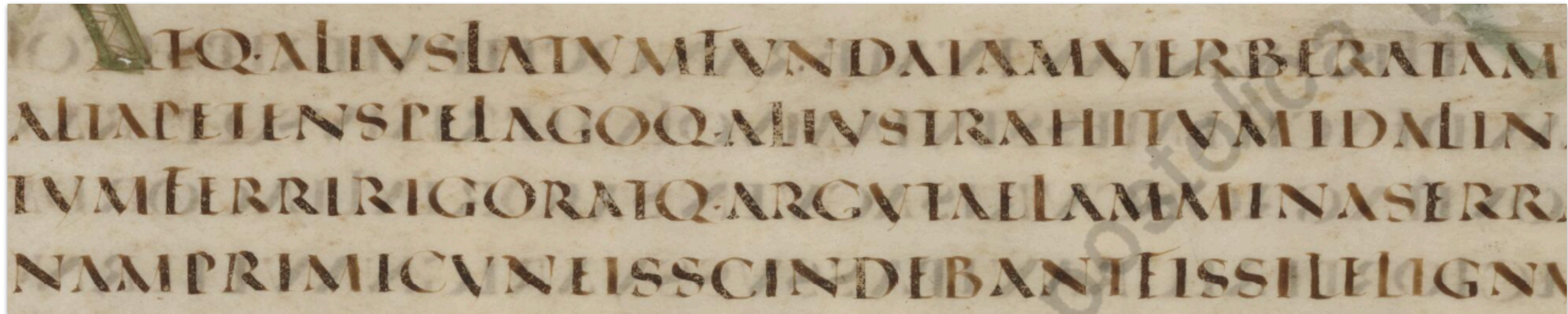
## Interlinear gloss

via The British Library

More on this  
next week...



# Silent reading pushed *scriptio continua* towards modern text



Vergilius Augusteus, circa 15 AD

This program first binds `x` to a value of `5`. Then it creates a new variable `x` by repeating `let x =`, taking the original value and adding `1` so the value of `x` is then `6`. Then, within an inner scope created with the curly brackets, the third `let` statement also shadows `x` and creates a new

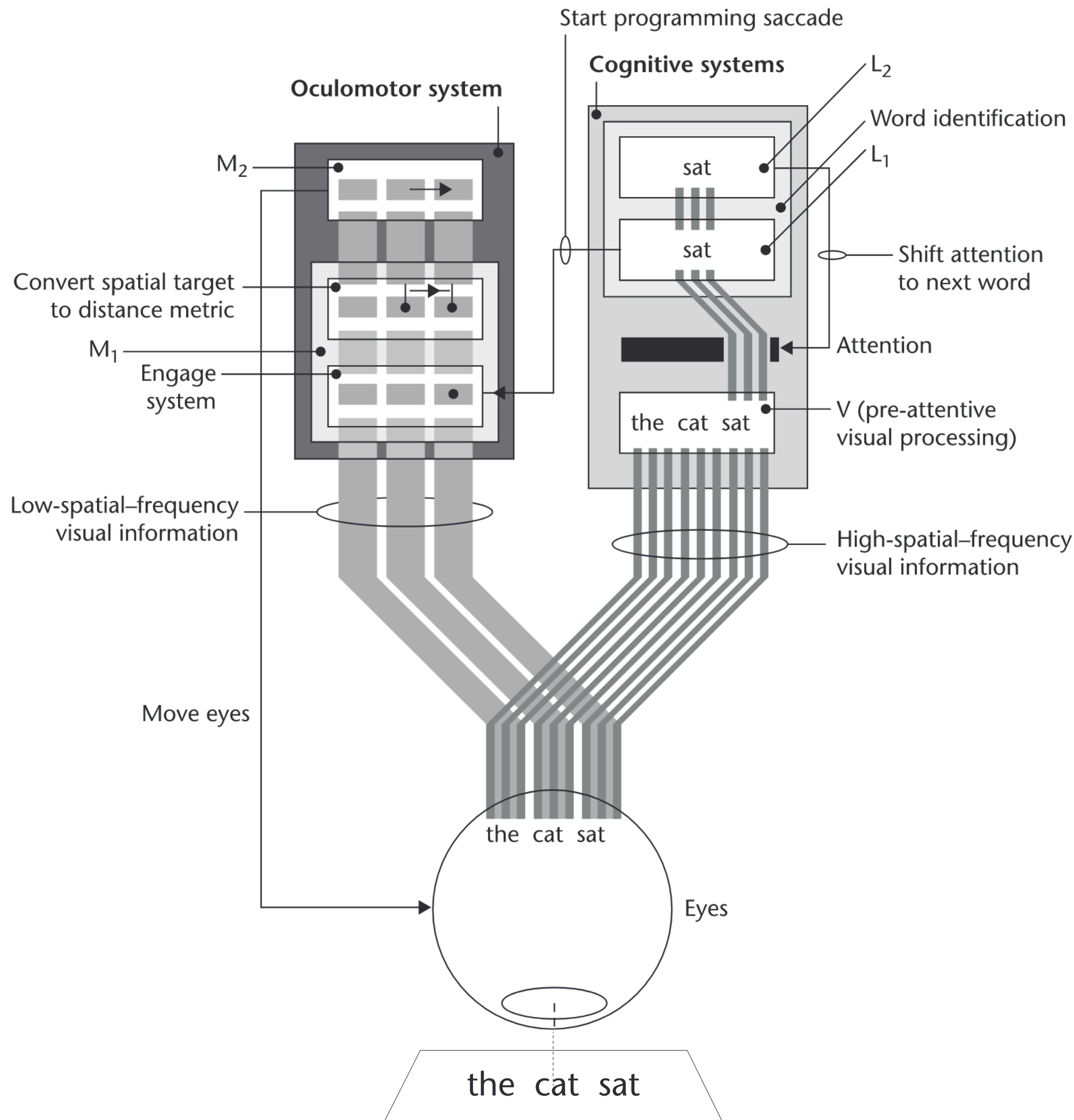
# Key ideas in the technological history of literacy

- Scripts evolved from pictorial representations to conceptual, then linguistic or phonetic representations
  - Consider the modern evolution of the emoji. How do you use 🗨️, 🤔, 💀, 💩, etc.?
  - No “natural endpoint” of language, as logographic and phonographic langs co-exist
- Texts evolved from tablets to scrolls to codices
  - Pages evolved from clay to papyrus to parchment to paper
  - Paper is much more fragile than clay tablets and parchment, but effectively more durable due to printing!
- Pages evolved from continuous script for oral reading to separated script for silent reading

# **The psychology of reading**

# Reading consists of saccades and fixations

<https://youtu.be/eBts0Q4eMaY>



<i>Type of processing</i>	<i>Parameter</i>	<i>Interpretation</i>
Word identification	$\alpha_1$	mean maximum $L_1$ time (ms)
	$\alpha_2$	effect of $\log_e$ frequency on $L_1$ time (ms)
	$\alpha_3$	effect of predictability on $L_1$ time (ms)
	$\Delta$	proportional differences between $L_1$ and $L_2$ durations
Higher-level language processing	$A$	mean attention-shift time (ms)
	$I$	mean integration time (ms)
	$P_F$ $P_N$	probability of integration failure probability of regression being directed to prior word
Saccadic programming & execution	$M_1$	mean labile programming time (ms)
	$\xi$	proportion of $M_1$ allocated to “preparatory” sub-stage
	$M_{1,R}$	additional time required for labile regressive programs (ms)
	$M_2$	mean non-labile programming time (ms)
	$\Psi$	optimal saccade length (character spaces)
	$\Omega_1$	effect of launch-site fixation duration of systematic error
	$\Omega_2$	effect of launch-site fixation duration of systematic error
	$\eta_1$	mean maximum random error (character spaces)
	$\eta_2$	effect of saccade length on random error (character spaces)
	$\lambda$	increase in refixation probability (character spaces)
Visual processing	$S$	saccade duration (ms)
	$V$	eye-to-brain transmission time (ms)
General	$\epsilon$	effect of visual acuity
	$\sigma_\gamma$	standard deviation of gamma distributions

# Word recognition can become automatic

- **Quick:** recognition improves with practice following power law of learning
- **Effortless:** can perform other tasks concurrently with little penalty
- **Autonomous:** happens without deliberate thought
  - Try \*not\* reading text put in front of you!
- **Unaware:** not conscious of the process occurring
- **Q:** what are other automatic skills, innate or learned?

# Word recognition follows the power law of practice

Change in oral reading fluency for American students, circa 2005

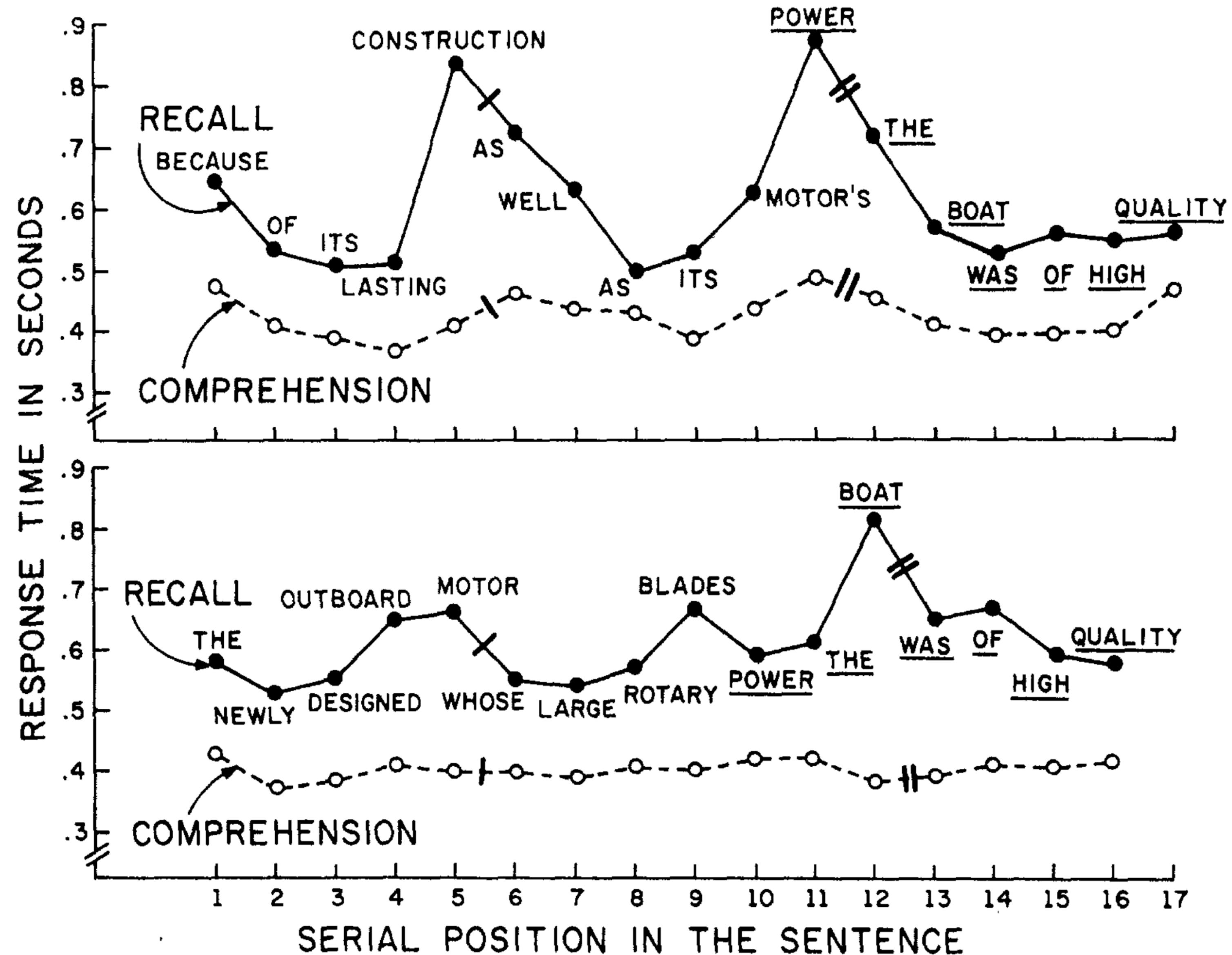


# Comprehension is influenced by prosodic constituents

**Materials:** short English sentences.

## Procedure:

- Give participant a task: comprehension or recall
- Using a computer, read one word at a time
- Measure time per word



# Facts are connected by levels of inference

A dentist pulled the tooth?

## 1. **Direct statement:** plain statement of fact

- Ex: “The dentist pulled the tooth painlessly. The patient liked the method.”

## 2. **Bridging inference:** inference of fact from text

- Ex: “The tooth was pulled painlessly. The dentist used a new method.”

## 3. **Elaborative inference:** inference of fact from context

- Ex: “The tooth was pulled painlessly. The patient liked the new method.”

Singer 1994: direct and bridging inferences equally fast, elaborative inferences ~1/4s slower

Nicholas decided to take the night off from studying and go to the movies. He needed to look in the newspaper to see what was playing But the paper wasn't anywhere in the front yard. He spotted it on the porch roof. Nicholas climbed on the roof to get the paper. From the roof he cursed the paperboy's aim. Nicholas scanned the movie section of the paper. Several good films were showing.

Nicholas decided to see a new comedy. It was already too late to make the seven o'clock show so he had to go to the late show. That gave him another two hours to study. He knew he should outline his economics chapter. He picked up his favorite pen. The pen ran out of ink. Nicholas took this to be a sign to not study at all this night. Instead, Nicholas got an ice cream cone before he went to the theater. The ticket line at the movie was short. He handed the usher his ticket stub and headed over to the popcorn stand. There he bumped into his ex-girlfriend Andrea and her date. Andrea said a few words. Andrea's tone of voice was distinctly cool. Nicholas felt awkward. He went into the darkened theater. It was easy for Nicholas to find a good seat. The comedy was hilarious. Nicholas was still laughing when he left the theater two hours later.

Nicholas decided to see a new comedy.

Schematic, verbatim

Nicholas easily found a good seat.

Schematic, paraphrase

Nicholas bought a ticket for the show.

Schematic, inference

Nicholas climbed on the roof to get the paper.

Non-schem, verbatim

Andrea spoke a few words.

Non-schem, paraphrase

Nicholas began to write.

Non-schem, inference

Several people were waiting in the lobby.

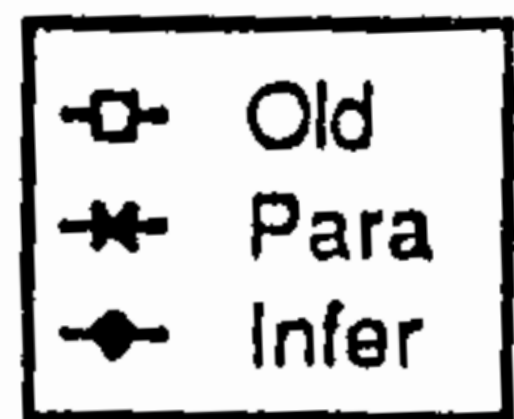
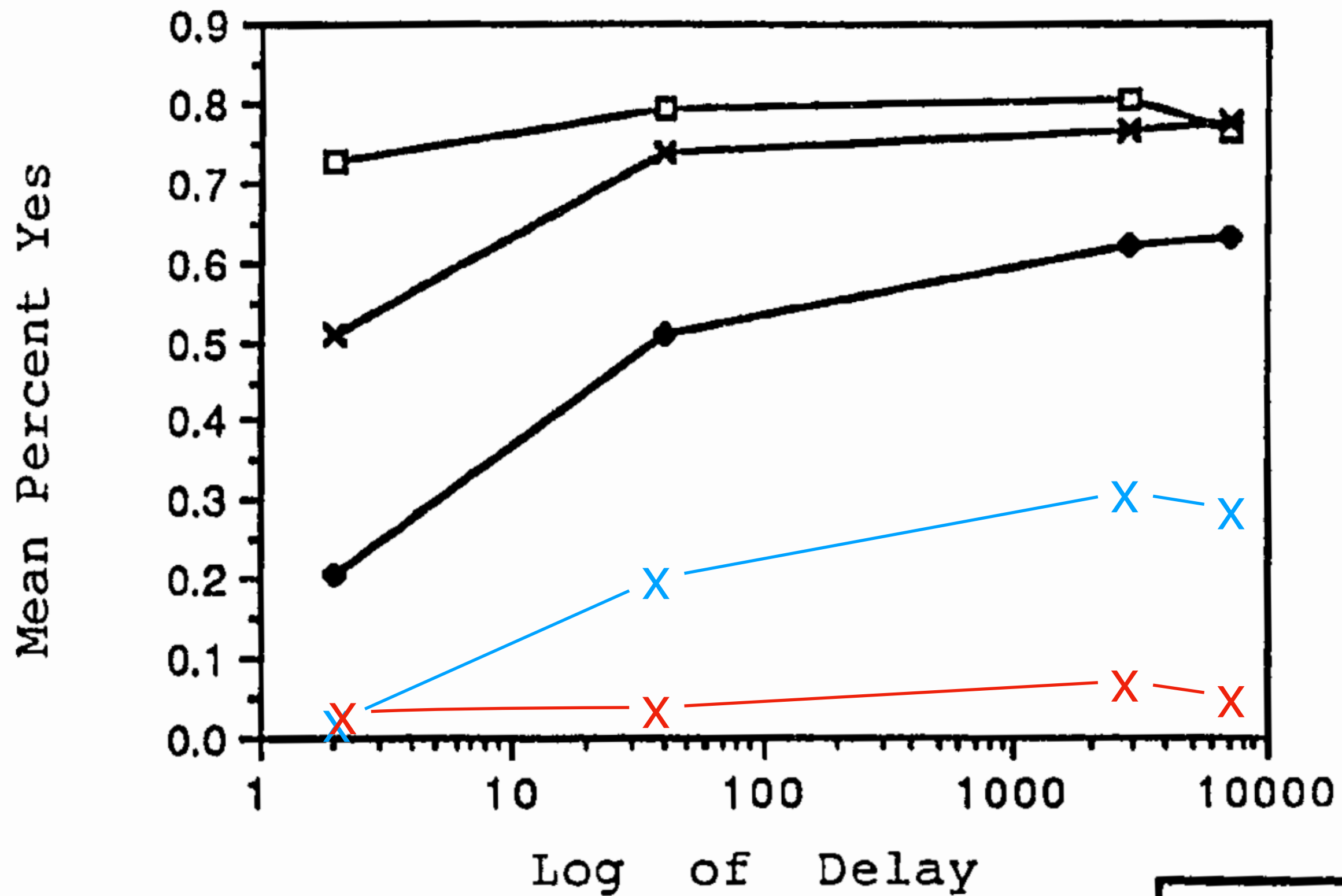
New, context-appropriate

The kite got tangled in the branches.

New, context-inappropriate

# Text recall suggests levels of representation

Schematic Situation Relevant



Non-Schematic Situation Relevant

