

The First Information Technology: Writing Systems

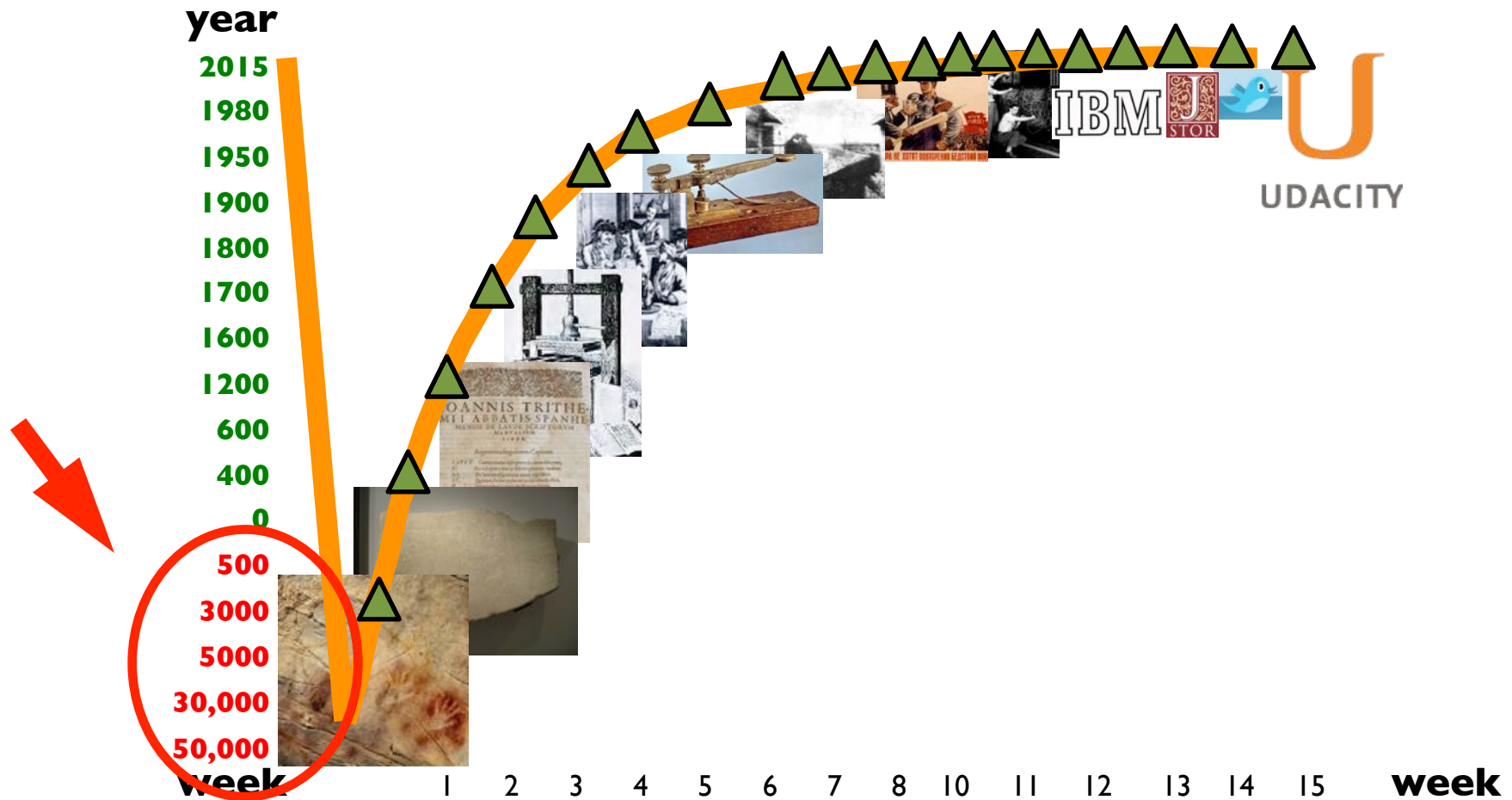


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School of Information, UC Berkeley

IS 103
History of Information
Jan. 31, 2013



The journey begins...





Itinerary, 1/30

The Dawn of Information

The Emergence of Representation

The Variety of Signs

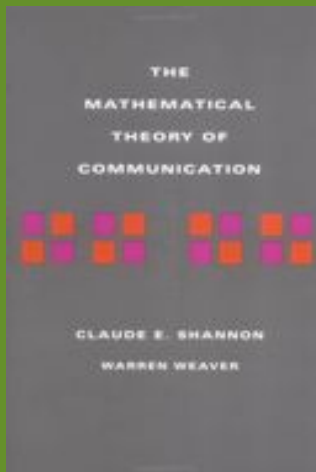
Origins and Development of Writing Systems

Types of Writing Systems

Independent Inventions of Writing Systems



Dawn of the age of “information”



1949

Rarely does it happen in mathematics that a new discipline achieves the character of a mature developed scientific theory in the first investigation devoted to it... So it was with information theory after the work of Shannon.

A. I. Khintchin, 1956



What kind of "information" has a history?

The Beginnings of Information

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... it's always there when we look for it, available wherever we bother to direct our attention. We can glean it from the pages of a book or the morning newspaper and from the glowing phosphors of a video screen. Scientists find it stored in our genes and in the lush complexity of the rain forest. The Vatican Library has a bunch of it, and so does Madonna's latest CD. And it's always in the air where people come together, whether to work, play, or just gab.

What is it that can be so pervasive and yet so mysterious? Information, of course.

John Verity in *Business Week*, special number on the "Information Revolution," 1994



What kind of "information" has a history?

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The Scope of "Information"

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Information (that has a history) always involves the creation, storage, transmission, or manipulation of *representations* of states of affairs.



What we mean when we talk about "information"

Table 1.6: Worldwide production of magnetic original content, if stored digitally using compression methods, in terabytes circa 2002.

Storage Medium	Type of Content	Terabytes/Yr Upper Estimate	Terabytes/Yr Lower Estimate	1999 Report Upper Estimate	1999 Report Lower Estimate
Magnetic	Videotape	1,340,000	1,340,000	1,420,000	1,420,000
	Audiotape	128,800	128,800	182,000	182,000
	Digital tape	250,000	250,000	250,000	250,000
	MiniDV	1,265,000	1,265,000	N/A	N/A
	Floppy disc	80	80	70	70
	Zip	350	350		
	Audio MD	17,000	17,000		
	Flash	12,000	12,000		
	Hard Disk	1,986,000	403,000		
	TOTAL	4,999,230	3,416,230		

Source: How much information 2003

Table 1.3: Worldwide production of printed original content, if stored digitally in terabytes circa 2002. Upper estimate is scanned; lower estimate is compressed.

Storage Medium	Type of Content	Terabytes/Yr Upper Estimate	Terabytes/Yr Lower Estimate	1999 Upper Estimate	1999 Lower Estimate	% Change Upper Estimates
Paper	Books	39	8	39	8	0
	Newspapers	138.4	27.7	124	25	12%
	Office Documents	1,397.5	279.5	975	195	43%
	Mass market periodicals	52	10	52	10	0
	Journals	6	1.3	9	2	-33%
	Newsletters	0.9	0.2	0.8	0.2	0
Subtotal		1,634	327	1,200	240	36%

Table 1.2: Worldwide production of original information, if stored digitally, in terabytes circa 2002. Upper estimates assume information is digitally scanned, lower estimates assume digital content has been compressed.

Storage Medium	2002 Terabytes Upper Estimate	2002 Terabytes Lower Estimate	1999-2000 Upper Estimate	1999-2000 Lower Estimate	% Change Upper Estimates
Paper	1,634	327	1,200	240	36%
Film	420,254	76,69	431,690	58,209	-3%
Magnetic	5187130	3,416,230	2,779,760	2,073,760	87%
Optical	103	51	81	29	28%
TOTAL:	5,609,121	3,416,281	3,212,731	2,132,238	74.5%

Source: How much information 2003

Peter Lyman and Hal Varian, *How Much Information?* 2003



Quantifying "information"

The Beginnings of Information

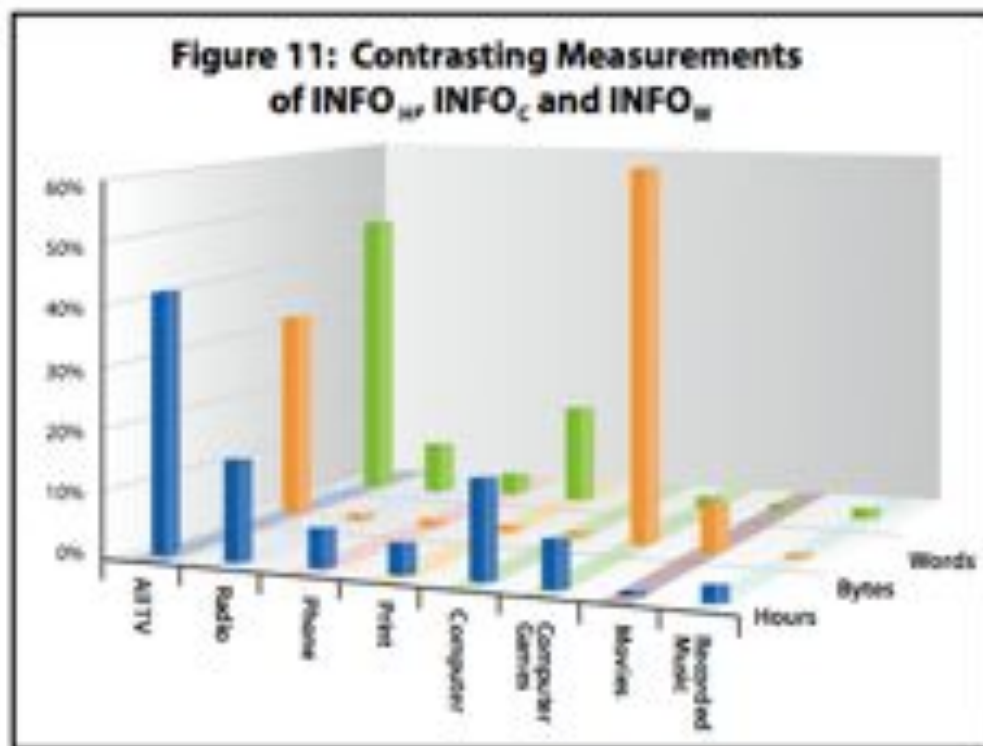
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How Much Information? 2009 Report on American Consumers



Quantifying "information"

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An information explosion?



The Emergence of Representation



The First "Information System": Language



Psamtik I,
654-610 BCE



James V of
Scotland

The Egyptians...believed themselves to be the most ancient of mankind....This king...contrived the following method of discovery: He took two children of the common sort, and gave them over to a herdsman to bring up at his folds, strictly charging him to let no one utter a word in their presence, but to keep them in a sequestered cottage, and from time to time introduce goats to their apartment, see that they got their fill of milk.... His object herein was to know... what word they would first articulate. ... The herdsman obeyed his orders for two years, and on one day opening the door of their room, the children both ran up to him with outstretched arms, and distinctly said "Becos." ...He informed his lord, [who then] learnt that "becos" was the Phrygian name for bread. In consideration of this circumstance the Egyptians yielded their claims, and admitted the greater antiquity of the Phrygians.

Herodotus, *Histories*, 2.2



The First "Information System": Language



Psamtik I



James V of
Scotland

Early theories: "bow-wow," "uh-oh," "pooh-pooh," etc.

1886: Linguistic Society of Paris forbids "toute communication concernant l'origine du langage" [All papers dealing with the origin of language]

No direct evidence about origins of language

No existing "primitive" languages



The First "Information System": Language



FOXP2 gene



Was development of language gradual or sudden? Does language presuppose neural modification?

“language” might have emerged w. *Homo erectus* (1.5 m years) or with mod. *Homo sapiens* (ca 100-150k years) But surely by 60k BP

“The momentum we see in cultural revolution after [the dispersion] was no longer genetically based... Darwinian evolution in the genetic sense continued, and underlies the rather superficial differences that are observed between different racial groups today... but the newly emerging behavioral differences between the groups were not genetically determined. They were learned, and they depended on the transmission of culture.” Colin Renfrew

Evidence from mod. genetics, archaeology, comparative anatomy, etc.



The Beginnings of Representational Artifacts

"... whereas notations of whatever sort were apparently means of recording the passage of time in terms of culturally significant events."





The Beginnings of Representational Artifacts



Henri Breuil



Robot & Jacques Marsal



Cave paintings, Lascaux, France: ca 15-13,000 BC (others perhaps to 30,000 BC)

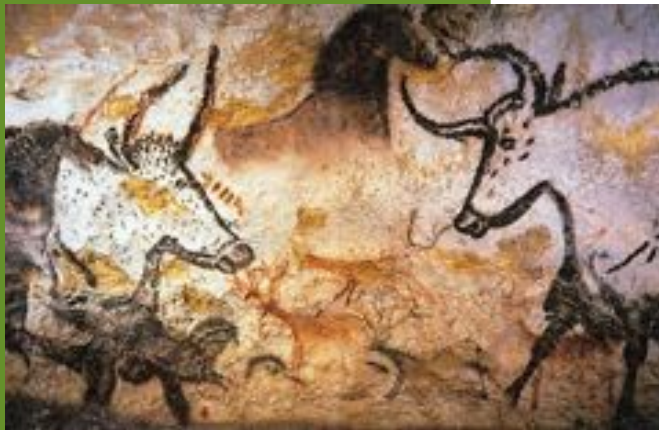
"Man's first affirmation of himself"
Maurice Blanchot



The Beginnings of Representational Artifacts



"Images and symbols... were markers of periodic and continuous cultural processes, of rites, and of repetitive myths and stories..." Alexander Marshack



Spotted Horses, Pech Merle





The Varieties of Signs

The Beginnings of
Information

The Emergence of
Representation

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Charles S. Peirce

The Varieties of Signs

3 Types of signs (after Charles Peirce): *icon*, *index*, *symbol*

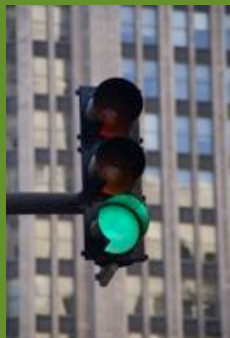
Icon: relation of resemblance (more-or-less) to signified. E.g,



Index: stands in causal/spatial relation to the signified (blaze on tree to act of marking, thermometer to temperature)



Symbol: arbitrary relation between sign and signified. E.g., written word *cat*, spoken word /kæt/.

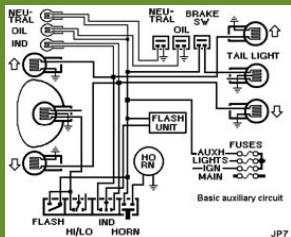




The Varieties of Signs



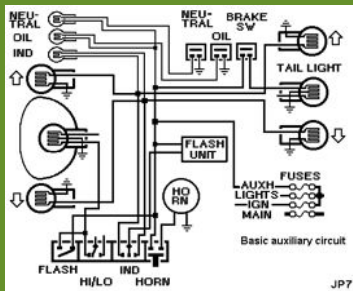
Icon: sign stands in relation of resemblance or similarity to signified (though often only roughly).





The Varieties of Signs

Icon: sign stands in relation of resemblance or similarity to signified (though often only roughly).



The Varieties of Signs: Indexical



Index: stands in causal/spatial relation to the signified (pawprint to bear, blaze on tree to act of marking, thermometer to temperature)

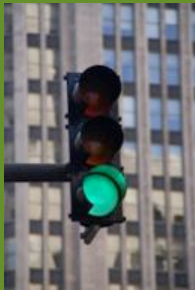




The Varieties of Signs: Symbols

Arbitrary (or effectively arbitrary) relation between
sign and thing signified

C —||—



tree



Early Indexical Signs

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Earliest signs are mnemonics for record-keeping, genealogy, etc. (Tallying systems)

Knotted rope, notched stick or bone, etc.

Become frequent in upper paleolithic



Notched Bone, England, upper paleolithic, 12,000 years old



Notched Bone, Turkey, ca 3000 BC



Notched bone, Congo, ca. 25,000 BC -- may. represent lunar calendar

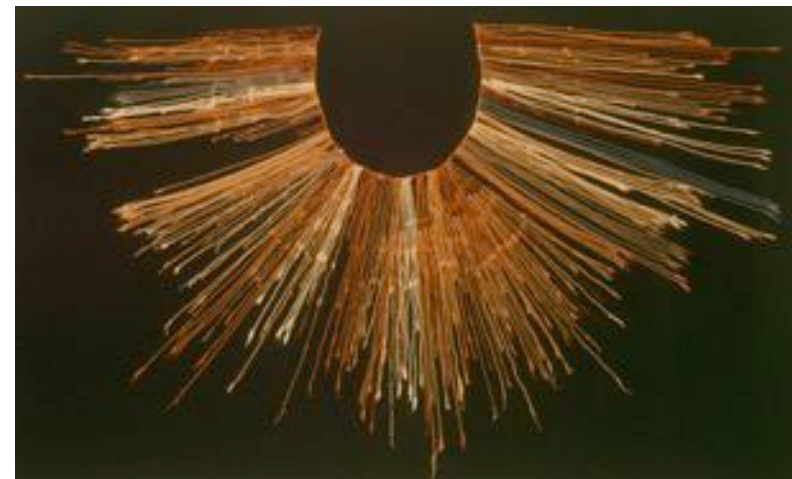
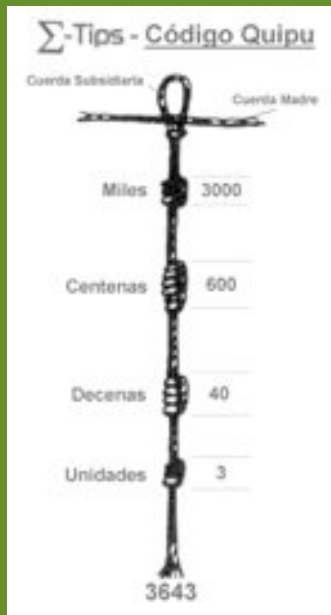


Elaborated Indexical System: The Inca *quipu*



Knots of varying colors in
llama or alpaca hair

Limits: can record only
quantity and category;
requires extensive convention
for interpretation





Early Iconicity

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Petroglyphs, Bhimbetka,
India, ca 9000 BC



Rock carving, Hong Kong
(Kau Sai), 3000 BC



Petroglyphs, Scandinavia, Bronze Age



Pictographic (Iconic) Communication Systems

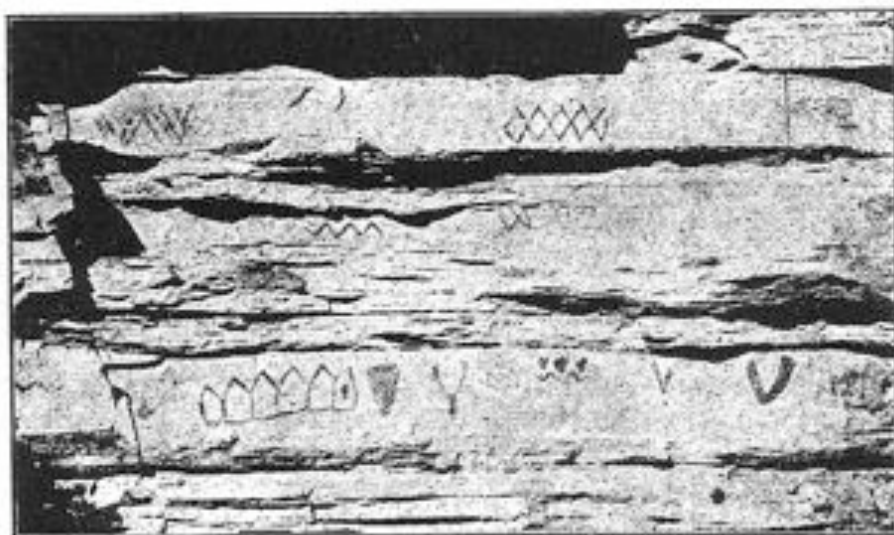
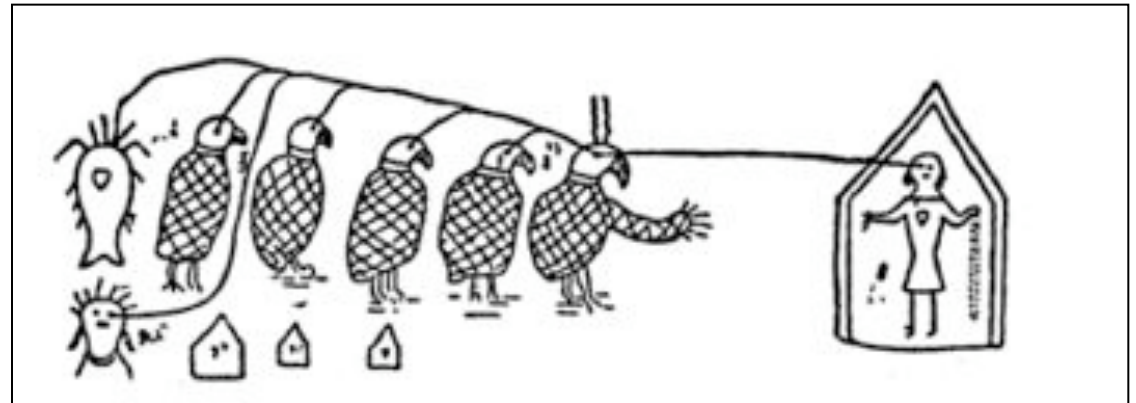
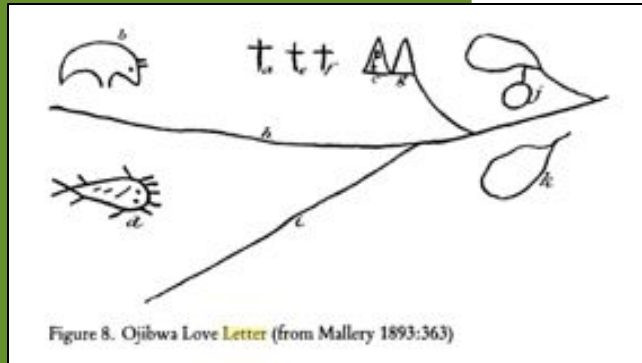


Fig. 4.—Geometrical forms. (From a photograph of rocks).





Pictographic (Iconic) Communication Systems



"Letter of credence" presented by Chippewa delegation to Washington, 1849

"The chief salutes the president, and his warriors belonging to the eagle and catfish totems are in harmony with him and are willing to accept the white man's ways."



Abstraction in pictographic systems

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Extending pictographic systems to deal with abstract or relational notions. E.g., "brother," "go," etc.

A step toward the development of "true" writing:

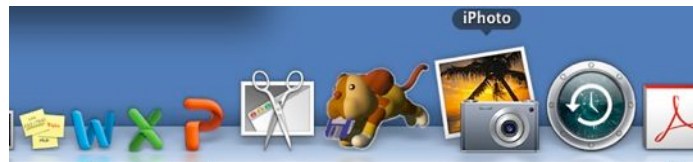
Form signs for abstract entities by extending or combining signs for concrete things (ca. 3300 BC)

foot = "go, come, walk, etc."

person + mountain = "foreigner"

eye + water = "weep," "sad," etc.

Cf modern use of "metonymic" icons





Pictographic Systems

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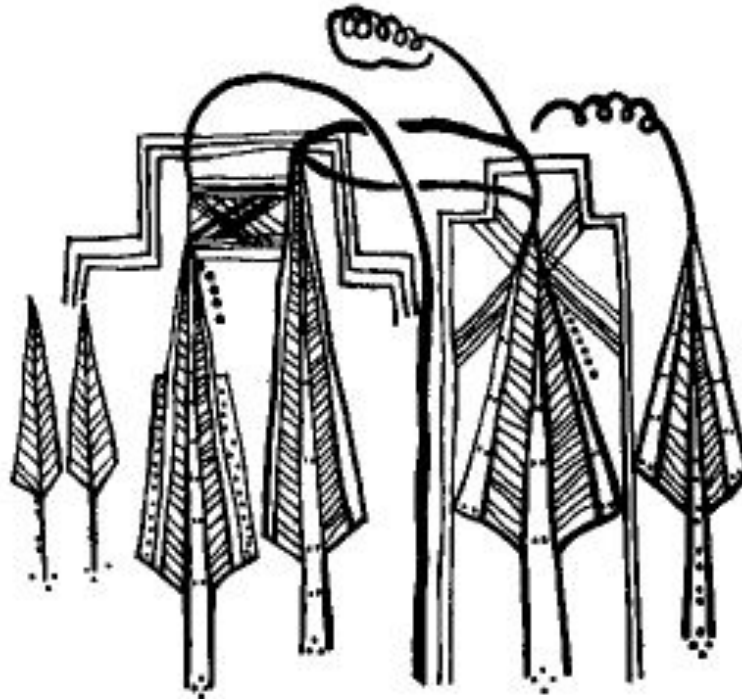
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Yukaghir (Siberia) “love letter,” late 19th c.



"Pictographic" Systems

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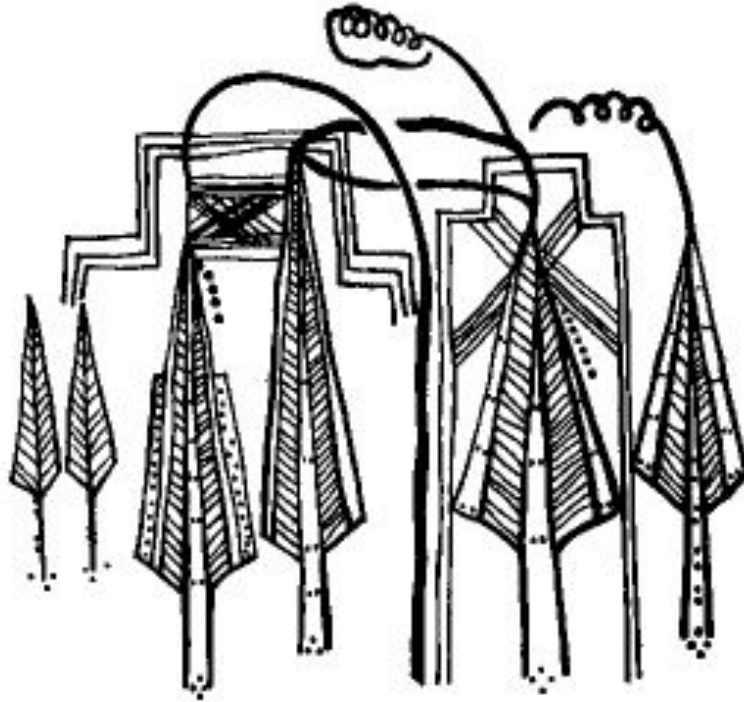
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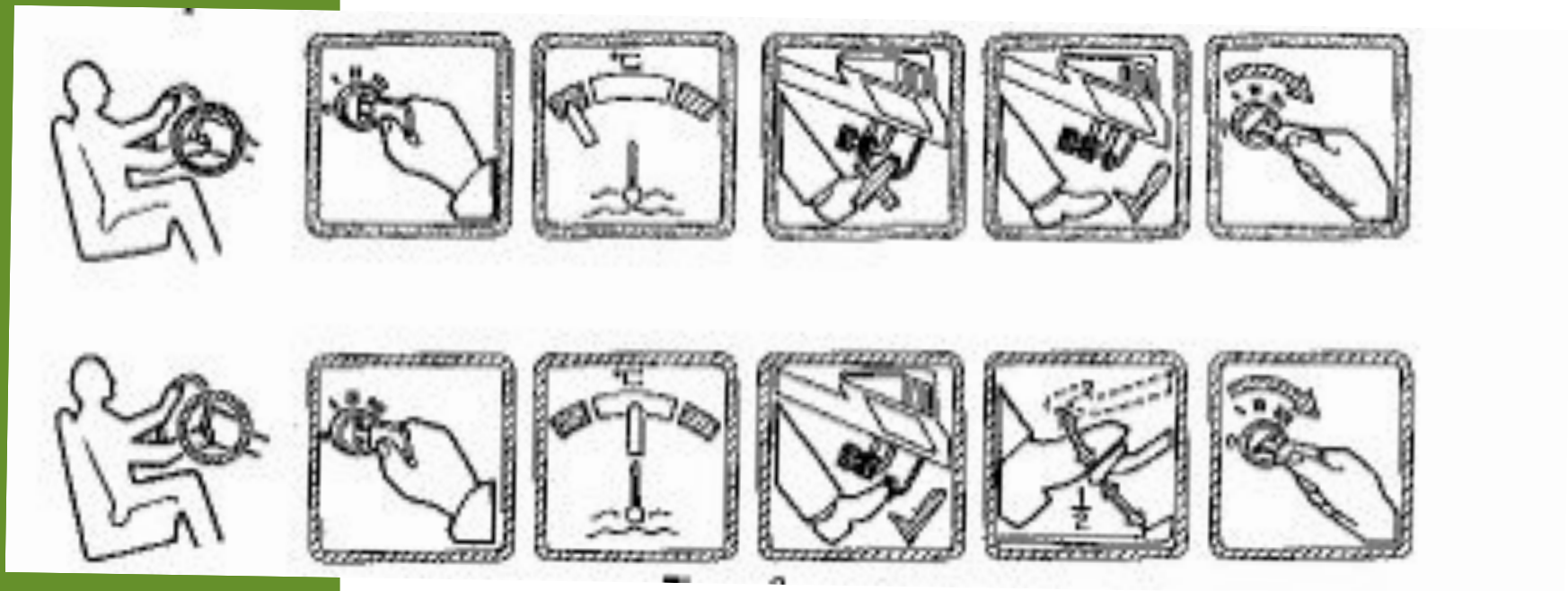
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"I know you're fighting with that Russian girl you broke up with me over. I'm unhappy in my house as I think of you, but you should know there's another guy hitting on me, so get your act together before I get married and have children."

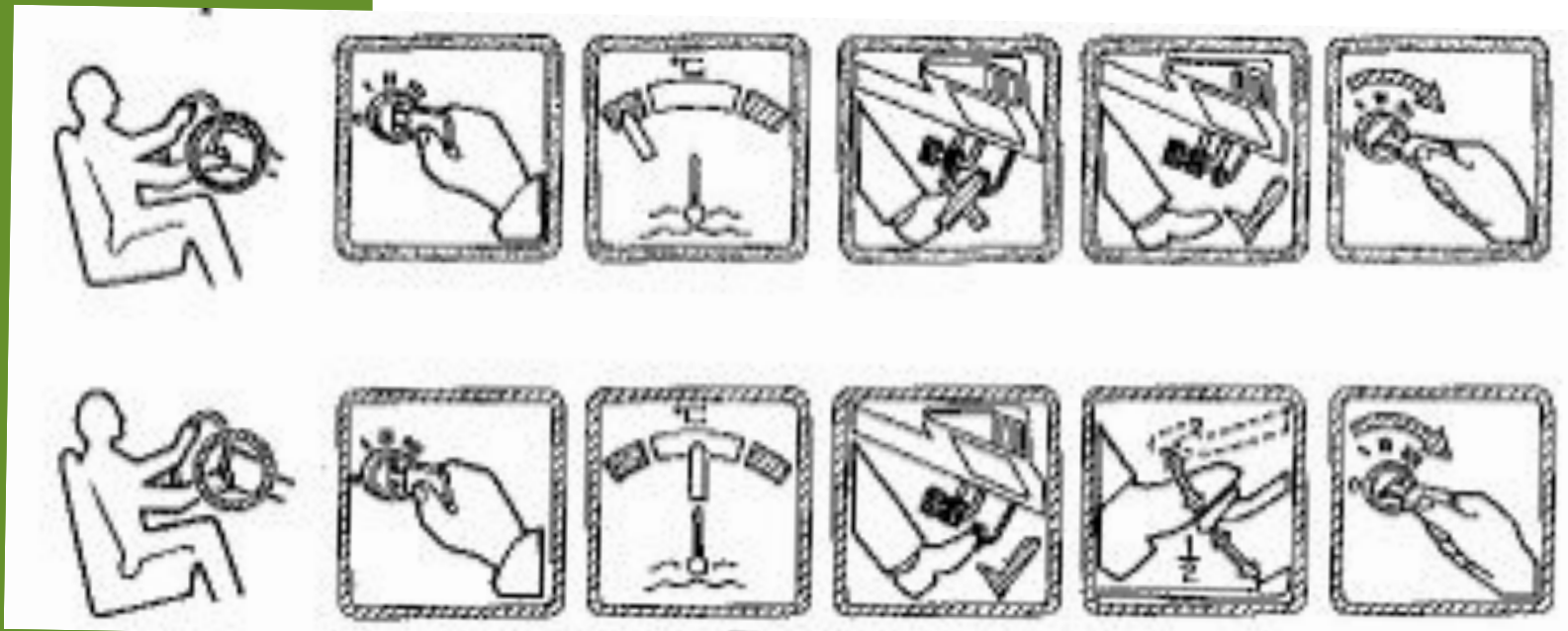


Ideographic (Semasiographic) Systems: the importance of context





Ideographic (Semasiographic) Systems: the importance of context



"Turn the key. If the car is cold, don't step on the gas pedal; if it's warm, depress the gas pedal halfway as you turn the key."



The limits of ideographic/ semasiographic systems

Semasiographic/ideographic system: symbols stand directly for ideas, not for words of a language.

Cf mathematical notation:

$$10^9 = 1,000,000,000$$

"Ten to the ninth equals a billion."/ "Zehn hoch neun gleicht eine Milliarde," "Dieci alla nona potenza equivale ad un miliardo,"etc.

$$\forall x (Fx \rightarrow Gx)$$

"For all x, if F of x then G of x" ("pout tout x si x est F alors x est G") "Everything that is F is G," "If something is an X it's a G,"/ "being F always entails being G," etc.

But language-independent systems appear inadequate to express the full range of thoughts & information



Wilkins' universal language

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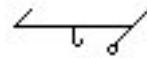
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
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Explaining the symbol



The generic character  doth signify the genus of space. the acute angle on the left side doth denote the first difference, which is Time. The other affix signifies the ninth species under the differences, which is Everness. The Loop at the end of this affix denotes the word is to be used adverbially; so that the sense of it must be the same which we express by the phrase, For Ever and Ever.

John Wilkins "An Essay Towards a Real Character and a Philosophical Language" 1668



The origins of true writing



The origins of true writing

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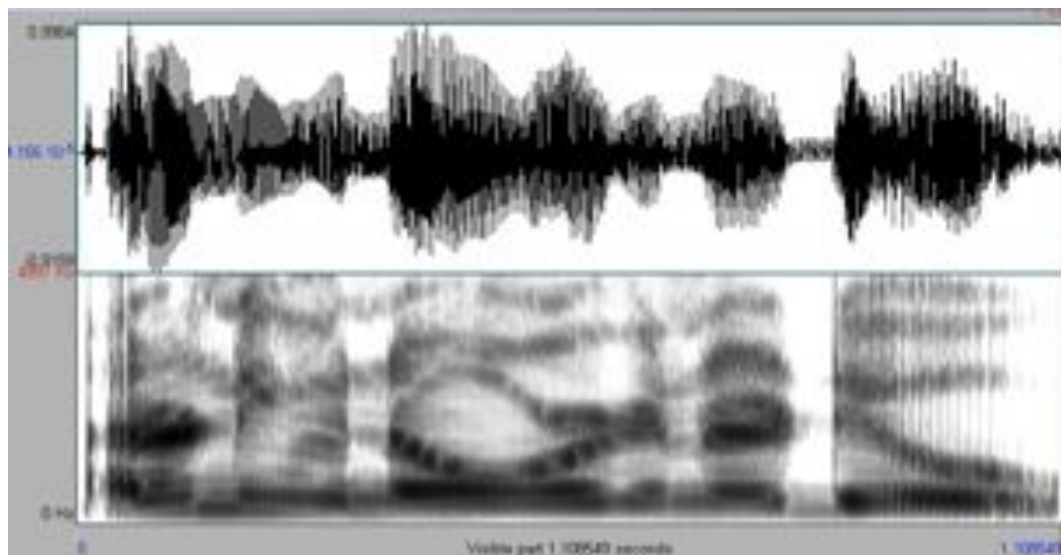
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Writing – what a concept!



a:rənəwə?wɪrgɔ̃nədʊ^w



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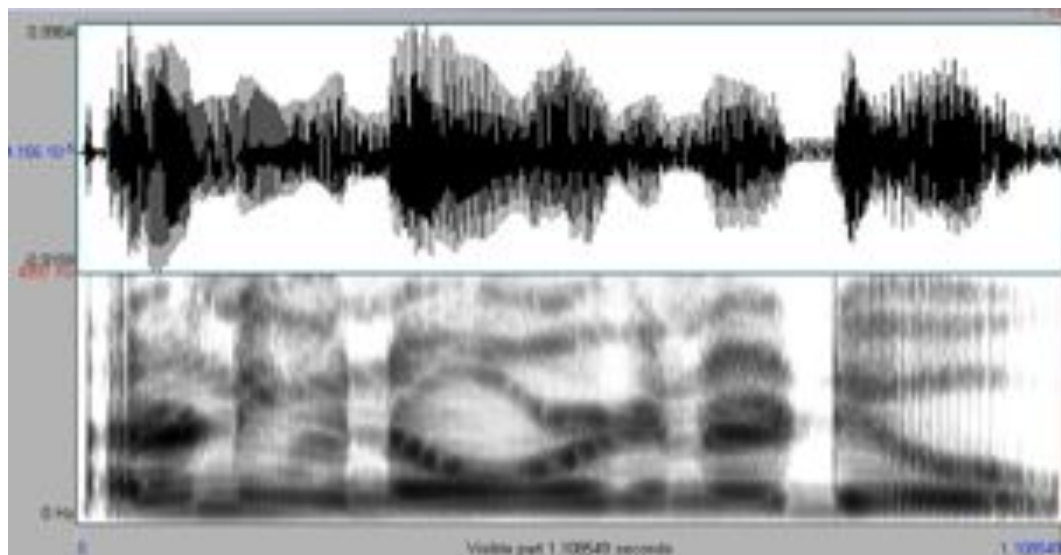
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Writing – what a concept!



a:rənəwə?wɪrgɔ̃nədʊ^w

I don't know what we're going to do



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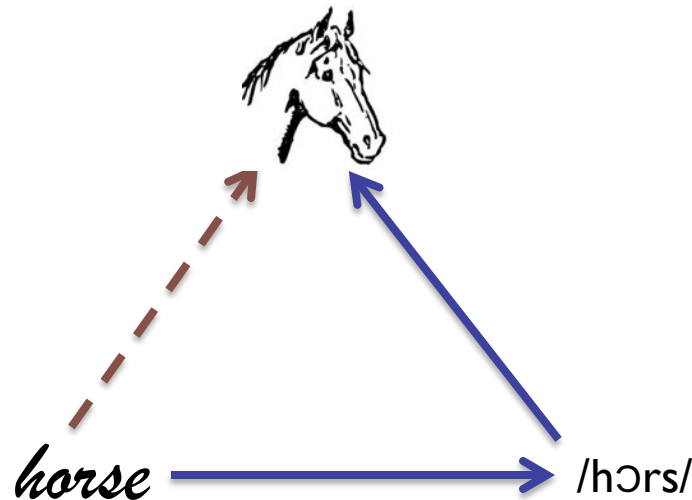
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True Writing: symbols represent elements of language rather than directly representing things in the world.



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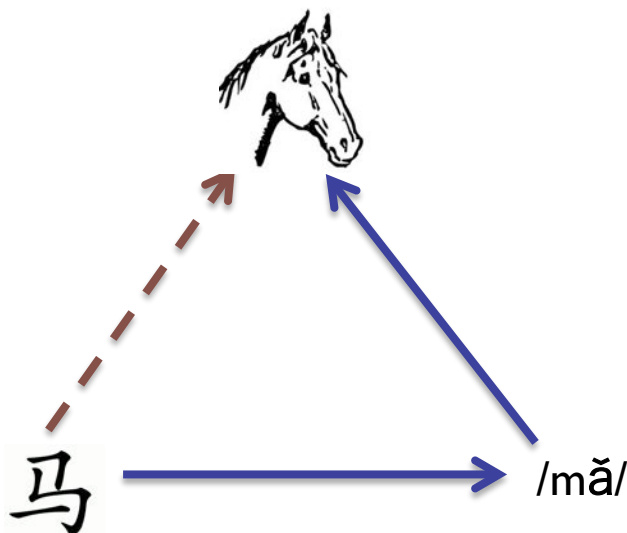
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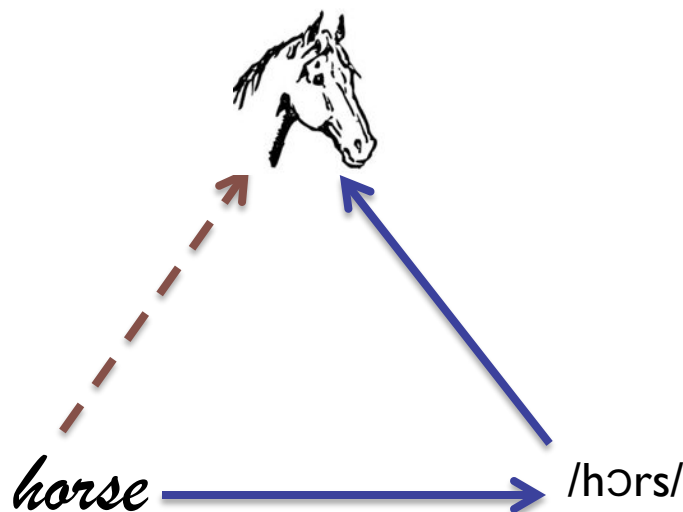
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Glottographic writing: rather than referring directly to reference/ideas, signs are associated with elements of the language (words, morphemes, syllables, phonemes).

Cf "5" vs *five*, *cinque*, *fünf*, *wũ*, etc.

"\$" vs "dollars," etc.



Origins of Writing in Sumer

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Origins of Writing in Sumer

8-5000 BC -- earliest use of clay tokens.

4,000 BC -- earliest clay bullae

3500-3300 BC -- earliest clay tablets from Uruk.



Bullae and tokens



Early cunieform



Tokens as origins of Sumerian writing?



Figure 7 Pictographic tablet from Urak, Iraq, late fourth millennium B.C. The account in the upper central case, for example, shows the sign for sheep and five wedges standing for the abstract numeral 5. Courtesy Vorderasiatisches Museum, Staatliche Museen zu Berlin, East Germany.

Evolution from Token to Cuneiform Writing					
Token	Pictograph	Neo-Sumerian/ Old Babylonian	Neo-Assyrian	Neo-Babylonian	English
					Sheep
					Cattle
					Dog
					Metal
					Oil
					Garment
					Bracelet
					Perfume



The Origins of "complete" writing

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Glottographic system: signs denote words/signs of the language

But how to signify "abstract" words? *Creation, after, but, believe, faithful, if, etc.*

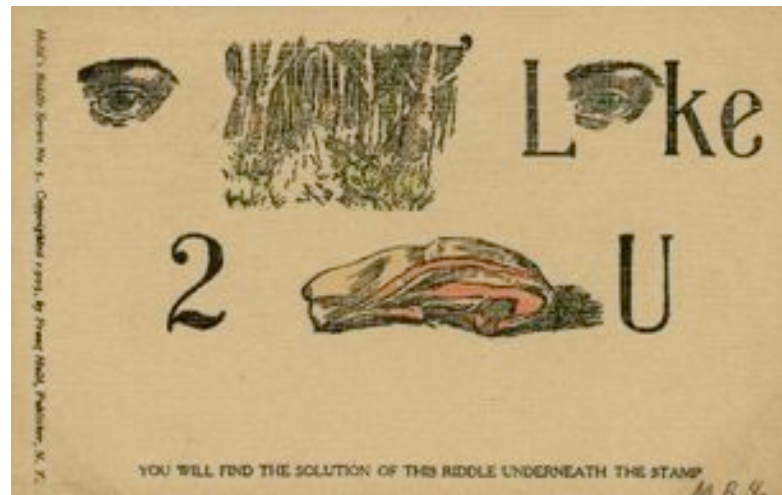
Metaphoric extension (cf extended meanings of head, hand, foot, etc.)



The Rebus Principle



Rebus: Icons of things that stand in for their (phonetic) names





The Rebus Principle



Eye



saw



ewe

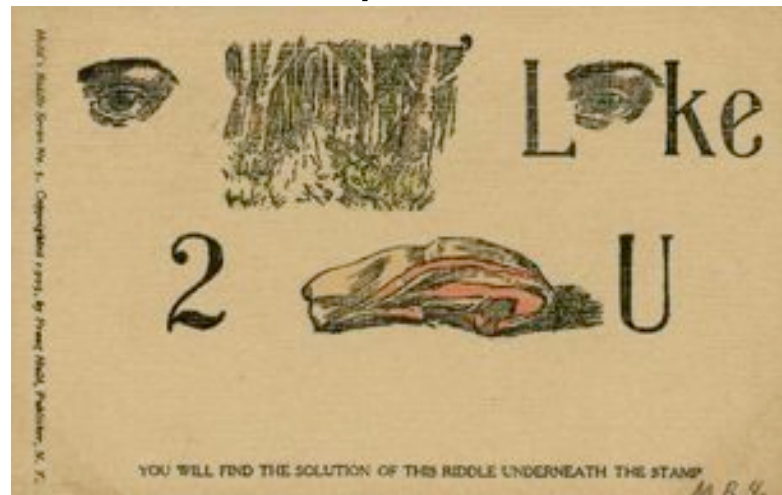


duck



deer

"I saw you duck, dear."





Rebus principle leads to logography

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Rebus principle allows signs to be reutilized to signal abstract words, functional elements, etc.



“water” /a/ → “in” /a/

T “oracle” /me/ → plural suffix /-me/



Logography to Syllabic System

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Logographs ultimately perceived as having purely phonetic value.

Cf English logographs – @, &, £, ¢

imagine the word *h@b&*

Where does this happen in everyday life?

.



Logography to Syllabic System

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Logographs ultimately perceived as having purely phonetic value.

Cf English logographs -- imagine the word *h@b&*

Where does this happen in modern life?

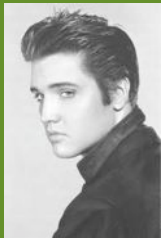
Texting: CU@*\$, 2G2B4GO10, ne14Xs?



Signs come to stand in for syllables



Development of Written Symbols



Iconic



Development of Written Symbols

Simplification of sign →



Iconic

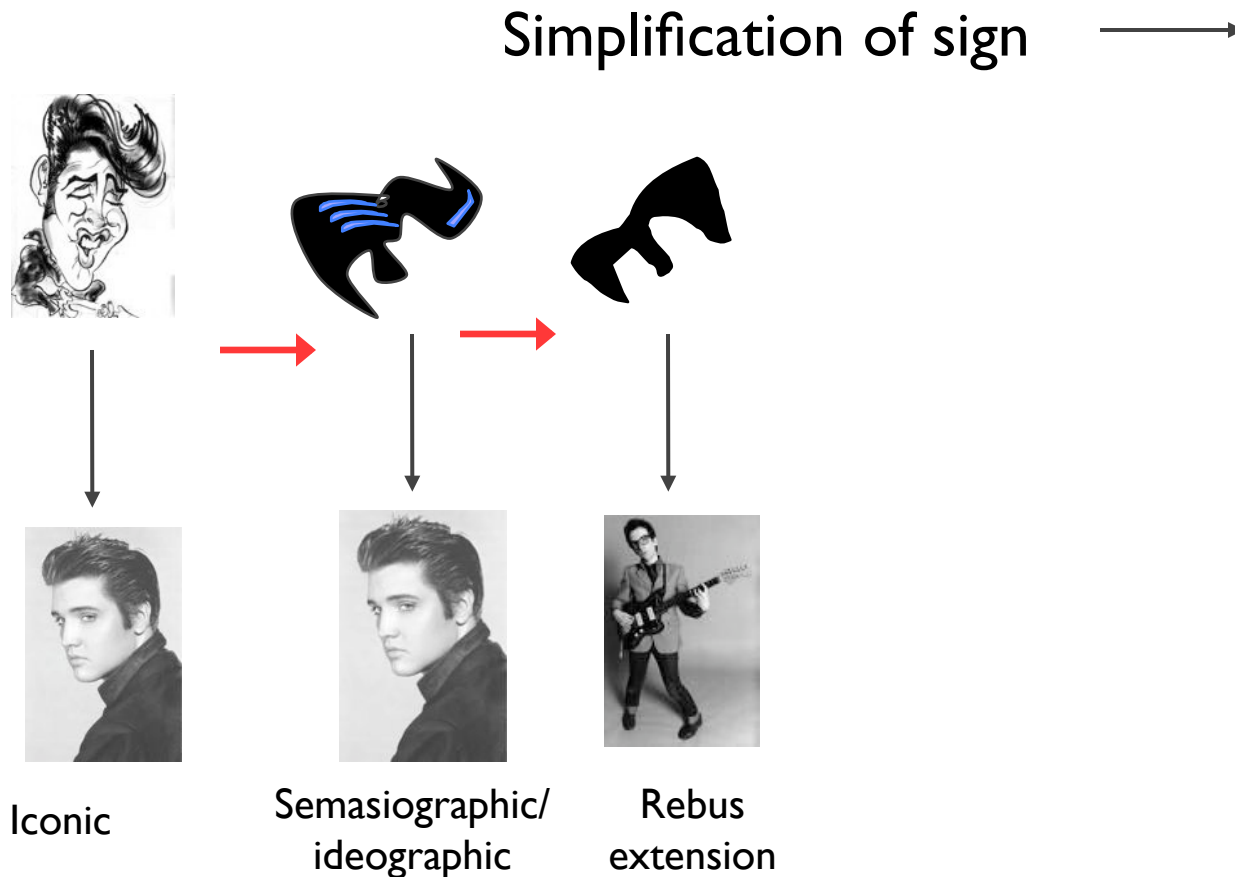


Semasiographic/
ideographic

Proto-writing



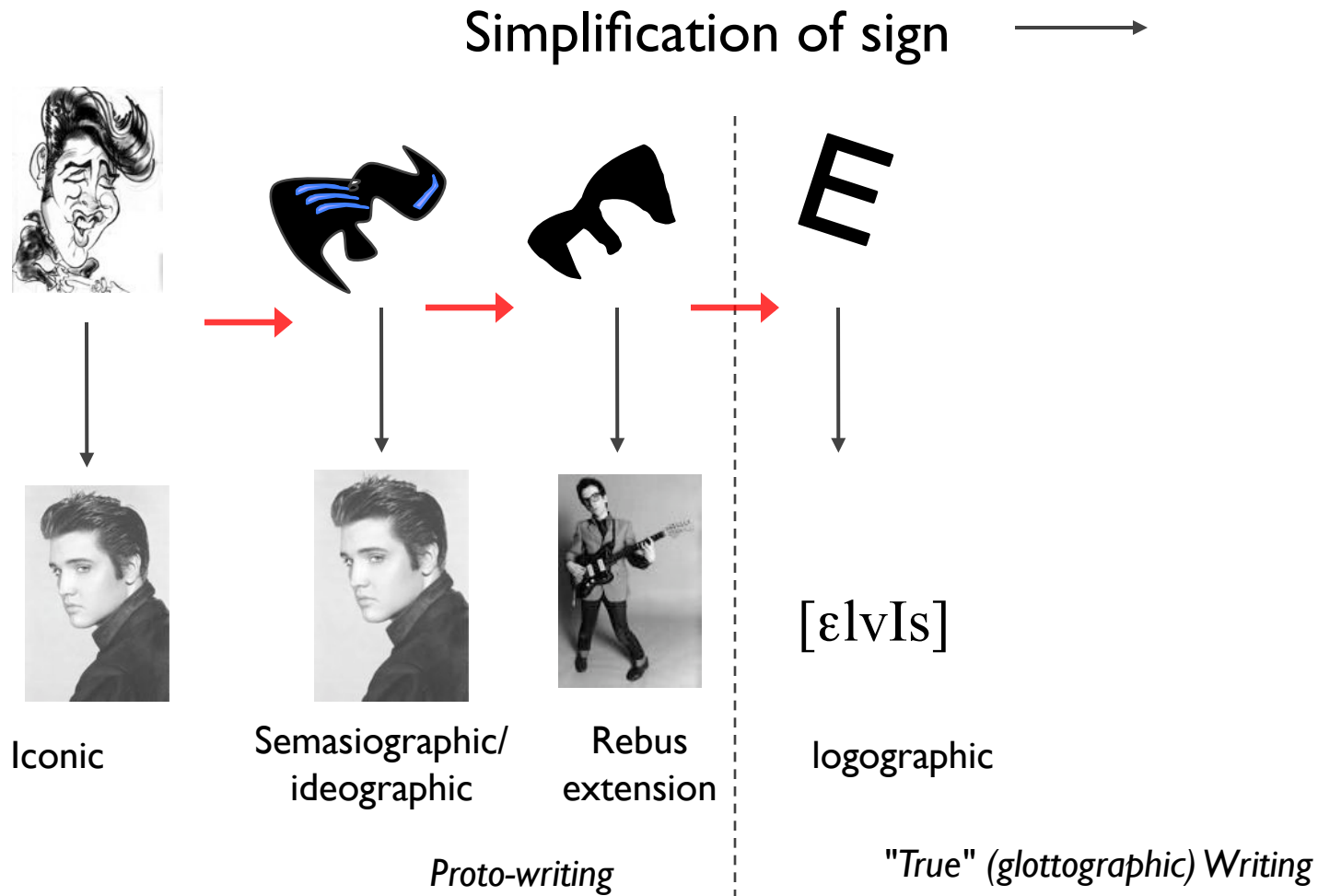
Development of Written Symbols



Proto-writing

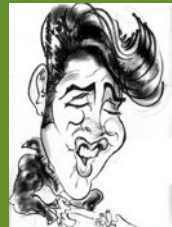


Development of Written Symbols





Development of Written Symbols



Iconic

Simplification of sign



Semasiographic/
ideographic



Rebus
extension



E

[ɛlvɪs]

logographic

E

/ɛl/

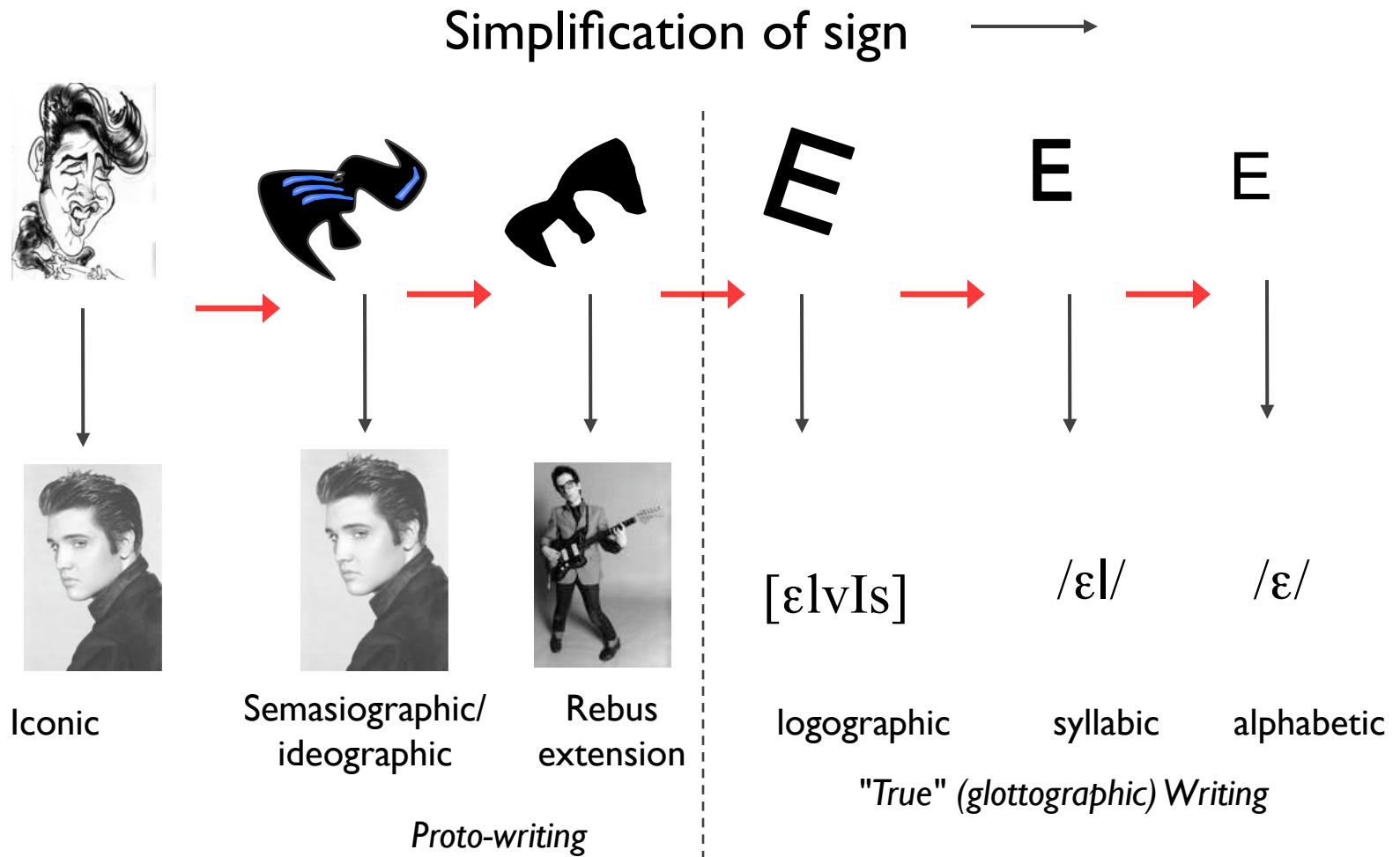
syllabic

"True" (glottographic) Writing

Proto-writing



Development of Written Symbols



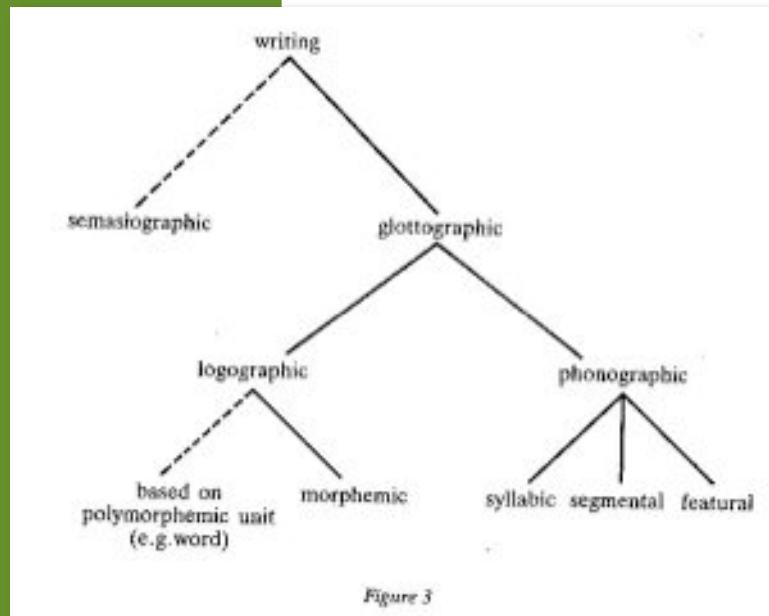


Types of Writing Systems

Logographic: mod. Chinese (logosyllabic), Japanese kanji

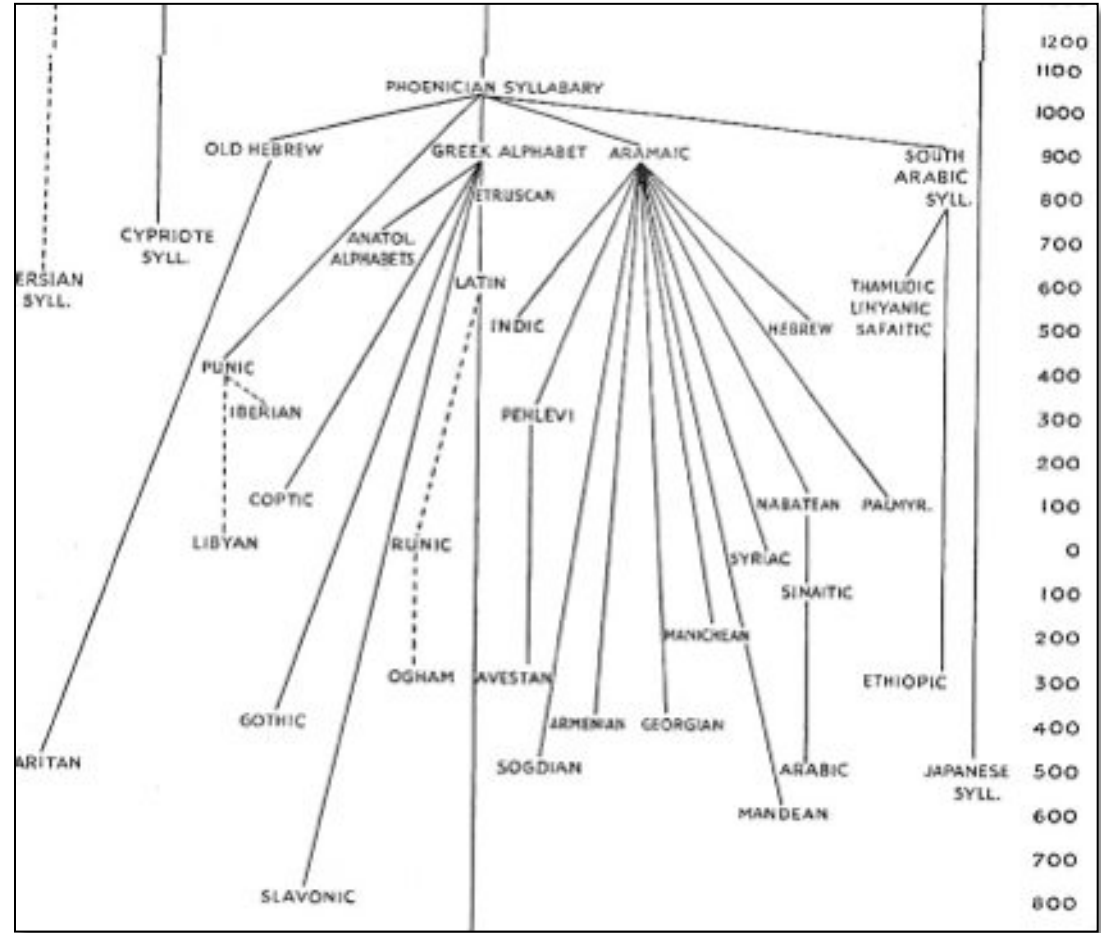
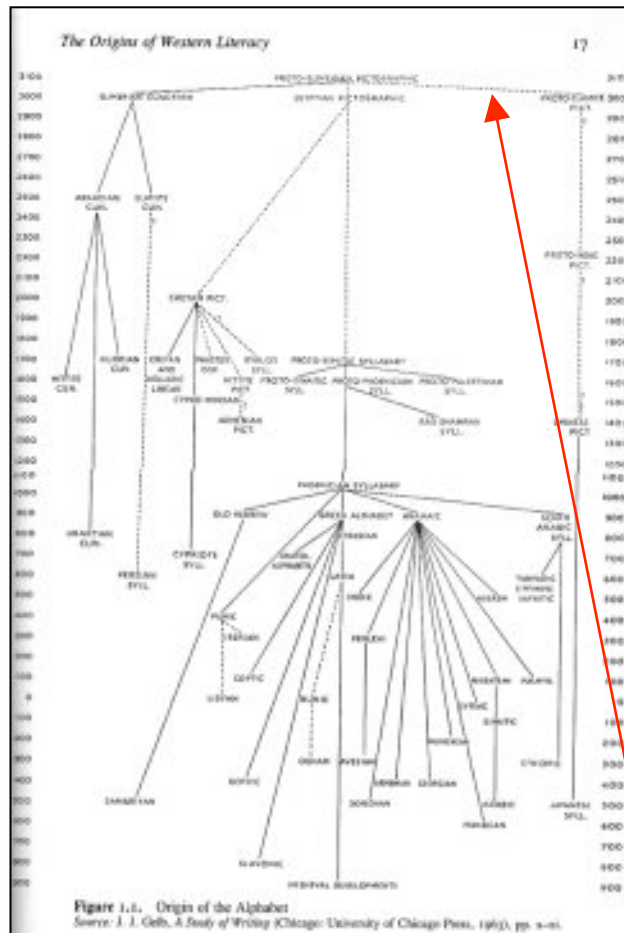
Syllabic: Phoenician, Linear B, Cherokee, Korean Hangul (featural), Japanese (hiragana & katakana), Bengali, Gujarati...

Alphabetic: Roman, Cyrillic, Gk, Hebrew, etc,





Genealogy of Writing Systems



But evidence is slight for derivation of Chinese from proto-Sumerian



Later Developments

boustrophedon

ΦΑΝΟΔΙΚΟ
← ΕΜΙΤΟΡΜΟΚ
→ ΡΑΤΕΟΣΤΟ
← ΗΝΙΟΚΟΝΗ
→ ΣΙΟΚΡΗΤΗΡ
← ΧΟΠΥΙΑΚ:ΔΑ
→ ΡΗΤΗΡΙΟΝ:Κ
← ΑΙΘΗΡΟΝ:ΕΠ
→ ΡΥΤΑΝΗΙΟΝ
← ΕΔΩΚΕΝ:ΣΥΚΕ
→ ΕΥΣΙΝ

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Does direction of writing influence cognition?



Later Developments

Subsequent development of further orthographic elements: word-spacing, punctuation, paragraphing, etc.





Independent Invention of Writing Systems

The Beginnings of Information

The Emergence of Representation

The Variety of Signs

The Origins and Development of Writing Systems

Types of Writing Systems

Independent Inventions of Writing Systems



Independent writing systems: The Cherokee Syllabary

Sequoyah [George Gist] and the "talking leaves": 1819



a	e	i	o	u	v [w]
D a	R e	T i	Ꭰ o	Ꭱ u	Ꭲ v
S ga Ꭳ ka	F go	Y gi	A go	J gu	E gv
Ꭶ ha	P ho	Ꭰ hi	F ho	Ꭶ hu	Ꭷ hv
W la	Ꭱ lo	P li	Ꭲ lo	M lu	Ꭳ lv
Ꭴ ma	Ꭵ me	H mi	Ꭶ mo	Ꭷ mu	
Ꭸ na Ꭹ na Ꭺ na	A ne	h ni	Z no	Ꭺ nu	Ꭴ nv
Ꭼ qua	Ꭽ que	Ꭾ qui	Ꭿ quo	Ꮀ quu	Ꮁ quv
Ꮂ s Ꮃ sa	Ꮄ se	Ꮅ si	Ꮆ so	Ꮇ su	R sv
Ꮉ da W ta	S de Ꮊ te	J di Ꮋ ti	V do	S du	Ꮍ dv
Ꮎ dia Ꮏ tia	L tie	C ti	Ꮏ tio	Ꮎ tu	P thv
G tsa	Ꮎ tse	Ꮏ tsi	K tso	Ꮎ tsu	Ꮏ tsv
G wa	Ꮎ we	Ꮎ wi	Ꮎ wo	Ꮎ wu	Ꮎ wv
Ꮎ ya	B ye	Ꮎ yi	Ꮎ yo	G yu	B yv



Independently invented writing systems: The Cherokee Syllabary



Cherokee Phoenix: First American
Indian newspaper (1828)



Independently invented writing systems:

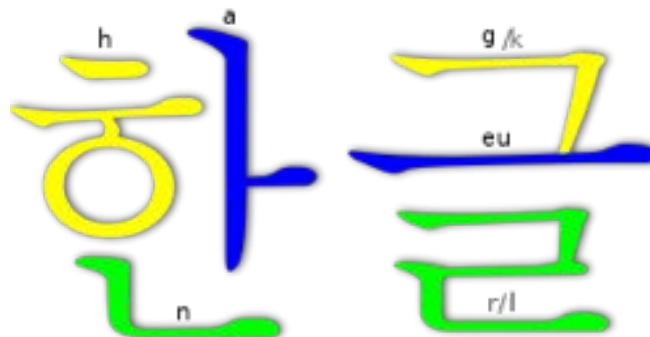
Korean Hangul



Writing system invented in mid-15th c. to replace hanja (Chinese-based writing system). Invention credited to King Sejong ("the Great"), who introduced it to increase mass literacy



Hunmin Jeong-eum Exemplar
(1446): Earliest Hangul text



The word 'hangeul' in hangul



Assignment for 2/4

Havelock writes:

The introduction of the Greek letters into inscription somewhere around 700 B.C. was to alter the character of human culture, placing a gulf between all alphabetic societies and their precursors. The Greeks did not just invent an alphabet, they invented literacy and the literate basis of modern thought [55]....It is no accident that the pre-alphabetic cultures of the world were also in a large sense the pre-scientific cultures, pre-philosophical and pre-literary. [58]

Consider just one aspect or element of this broad claim. Taking into consideration both Havelock and Gough's articles, evaluate the claim from the point of view of either McLuhan or Williams.



Assignment for 2/5

Havelock, Eric, “The Greek Legacy,” in David Crowley, ed. *Communication in History: Technology, Culture, Society*. Allyn & Bacon. Pp. 55-62.

Gough, Kathleen. 1968. *Implications of literacy in traditional China and India*. In Goody, Jack (ed.). *Literacy in Traditional Societies*. Cambridge: Cambridge University Press, 44-56.

Additional Materials

Scribner, Silvia and Michael Cole. 1988. “Unpackaging Literacy.” *Social Science Information*, 17, 1