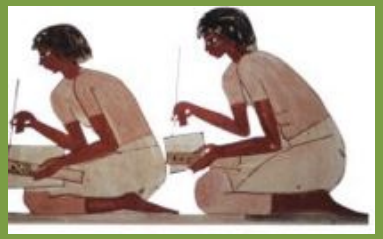
UC Berkeley School of Information



The First Information Technology: Writing Systems

Geoff Nunberg

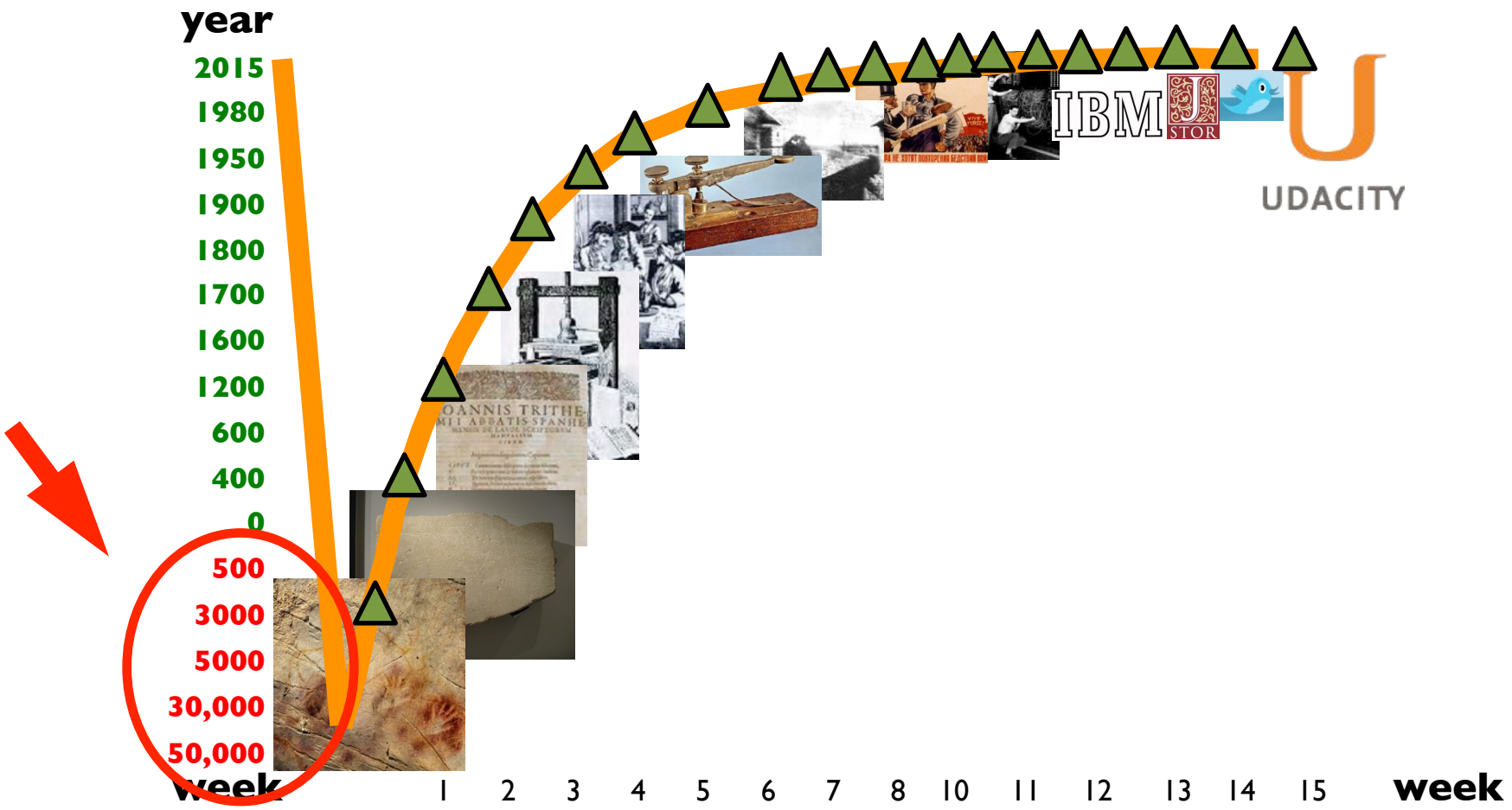
School of Information, UC Berkeley

IS 103

History of Information

Jan. 31, 2013

The journey begins…



Itinerary, 1/31

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

What kind of "information" has a history?

- 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

… 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 us compression methods, in terabytes circa 2002.

Storage Medium	Type of Content	Terabytes/Yr Upper Estimate	Terabytes/Yr Lower Estimate	1999 Report Upper Estimate	1999 Re Lowe Estima
Magnetic	Videotape	1,340,000	1,340,000	1,420,000	1,420
	Audiotape	128,800	128,800	182,000	182
	Digital tape	250,000	250,000	250,000	250
	MiniDV	1,265,000	1,265,000	N/A	
	Floppy disc	80	80	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
						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%

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

Quantifying "information"

The Beginnings of Information

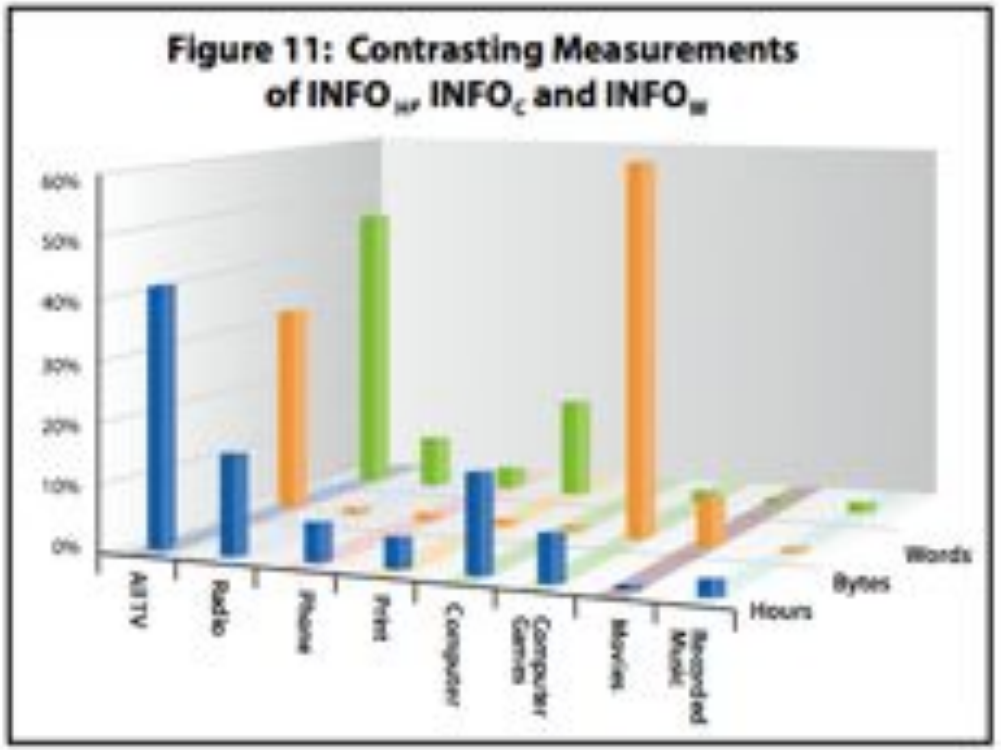
The Emergence of Representation

The Variety of Signs

The Origins and Development of Writing Systems

Types of Writing Systems

Independent Inventions of Writing Systems



How Much Information? 2009 Report on American Consumers

The Beginnings of Material Representation

The Beginnings of Information

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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 concernante l'origine du langage" [All papers dealing with the origin of language]

No direct evidence about origins of language

- No existing "primitive" languages

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 First "Information System": Language

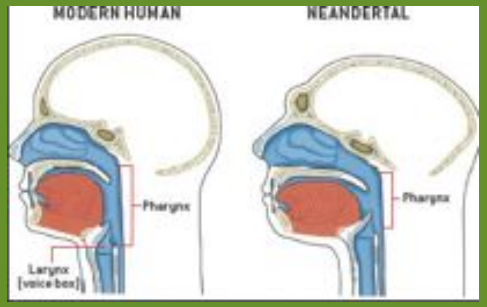
Early theories: "bow-wow," "uh-oh," "pooh-pooh," etc.

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

No direct evidence about origins of language; No existing "primitive" languages. Inference from social behavior, etc.

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

Henri Breuil

Robot & Jacques Marsal

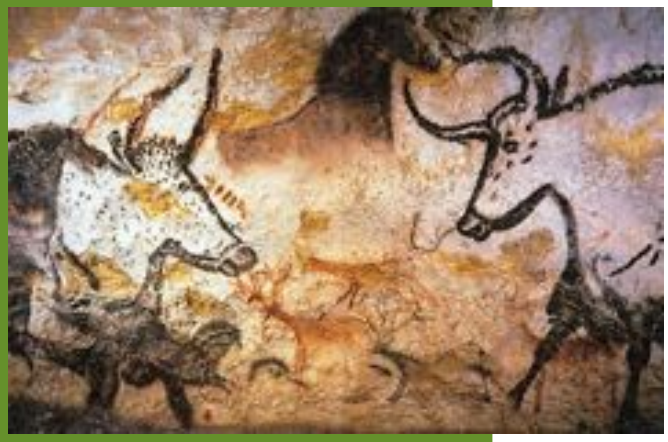
Cave paintings, Lascaux, France: ca 15-13,000 BC (others perhaps to 30,000 BC)

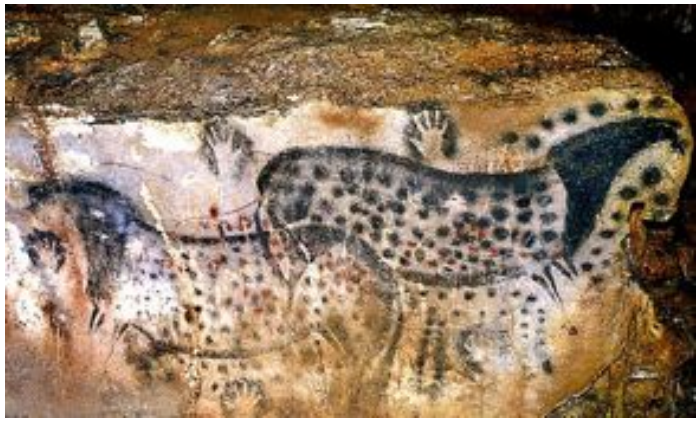
"Man's first affirmation of himself"
Maurice Blanchot

"Venus of Tan-Tan," Morocco, possibly 250k years old, but may be a naturally occurring object.

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, Peche Merle

The Varieties of Signs

The Beginnings of Information

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Charles S. Peirce

The Varieties of Signs

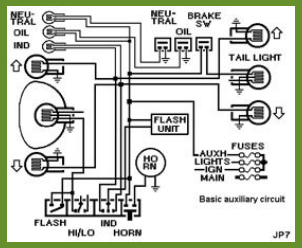
3 Types of signs (after Charles Peirce): *icon, index, symbol*

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: 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

tree

Early Indexical Signs

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

Earliest signs are mnemonics for record-keeping, geneology, 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 *qipu*

Knots of varying colors in llama or alpaca hair

Sequences recorded population, taxes, geneology, astronomy (and possibly names) in base-10 positional system. System maintained by knot-keepers (quipucamayoq).

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

The Beginnings of Information

The Emergence of Representation

The Variety of Signs

The Origins and Development of Writing Systems

Types of Writing Systems

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Early Iconicity

Petroglyphs, Bhimbetka, India, ca 9000 BC

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

Petroglyphs, Scandinavia, Bronze Age

Pictographic (Iconic) Communication Systems

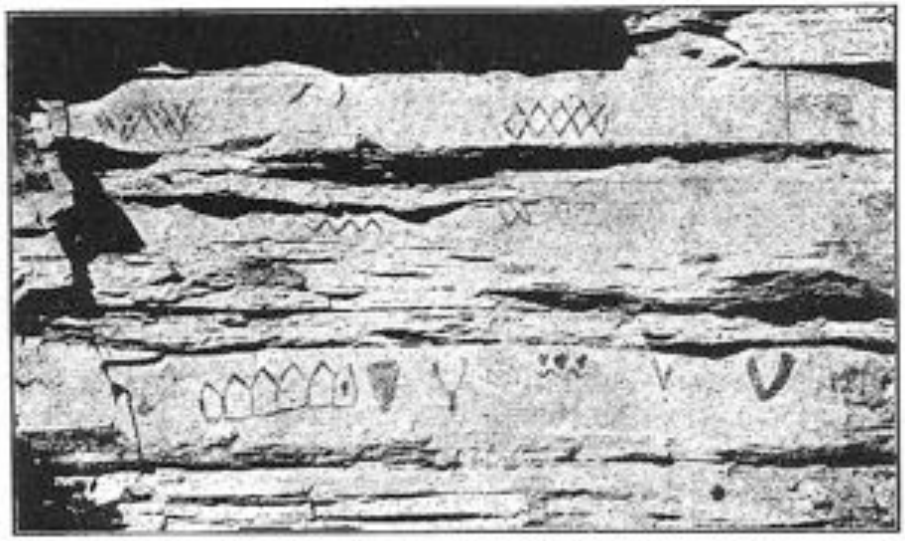


Fig. 4.—Geometrical forms. (From a photograph of rocks).

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

Pictographic (Iconic) Communication Systems

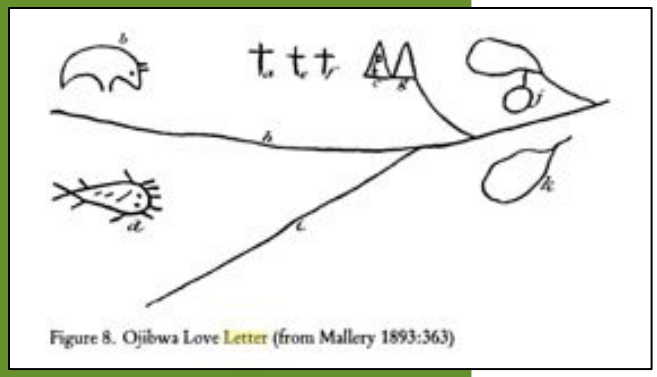
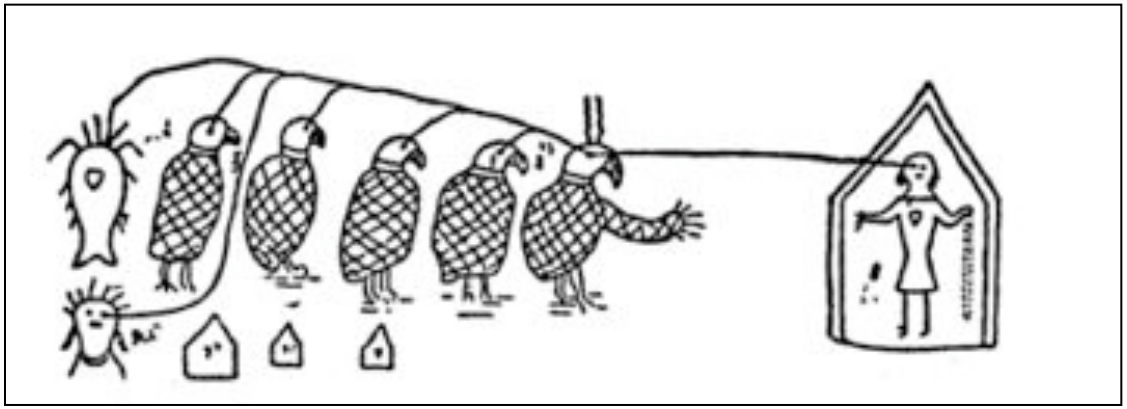


Figure 8. Ojibwa Love Letter (from Mallery 1893:363)



"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."

Pictographic Systems

The Beginnings of Information

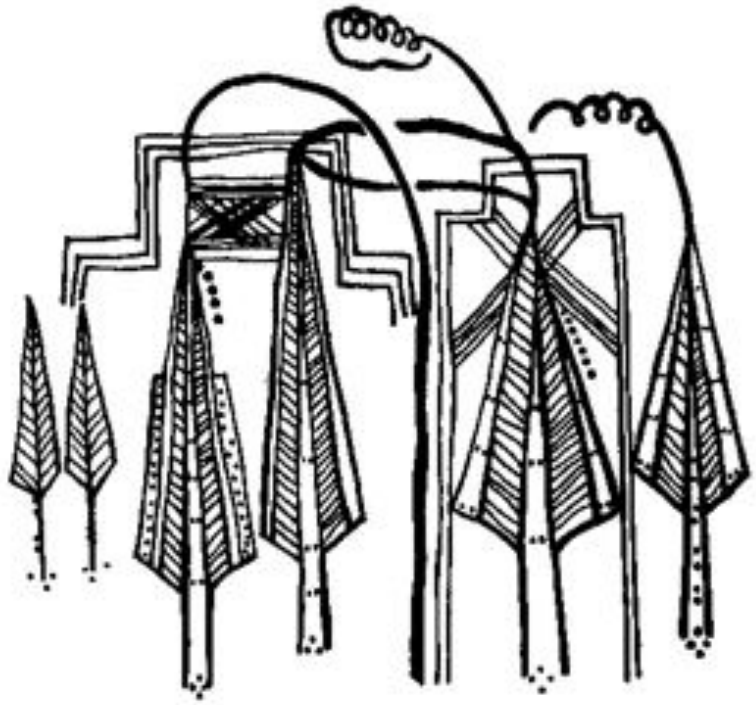
The Emergence of Representation

The Variety of Signs

The Origins and Development of Writing Systems

Types of Writing Systems

Independent Inventions of Writing Systems



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

"Pictographic" Systems

The Beginnings of Information

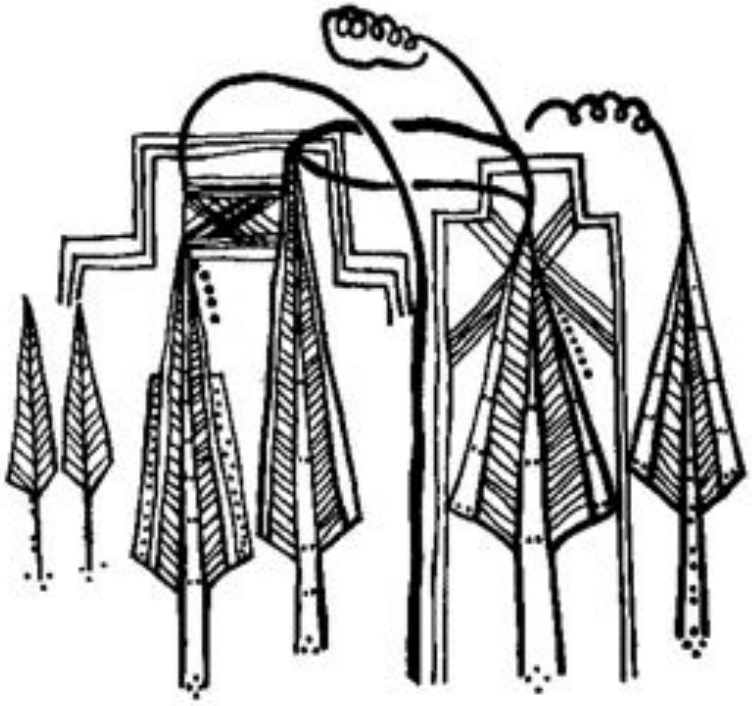
The Emergence of Representation

The Variety of Signs

The Origins and Development of Writing Systems

Types of Writing Systems

Independent Inventions of Writing Systems



"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."

Abstraction in pictographic 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

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

A step toward the development of "true" writing:

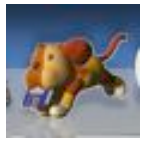
Form signs for abstract entities by extending or combining signs for concrete things (ca. 3300 BC)

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

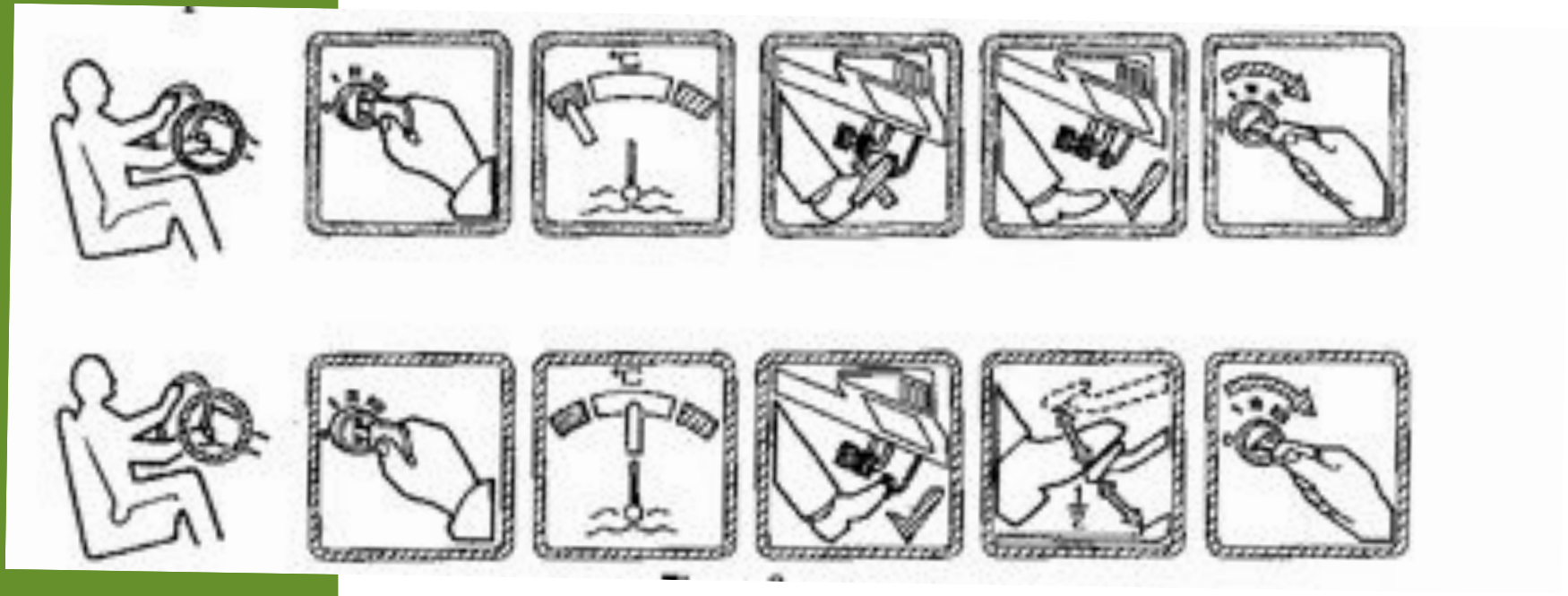
person + mountain = "foreigner"

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

Cf modern use of "metonymic" icons


Ideographic (Semasiographic) Systems: the importance of context



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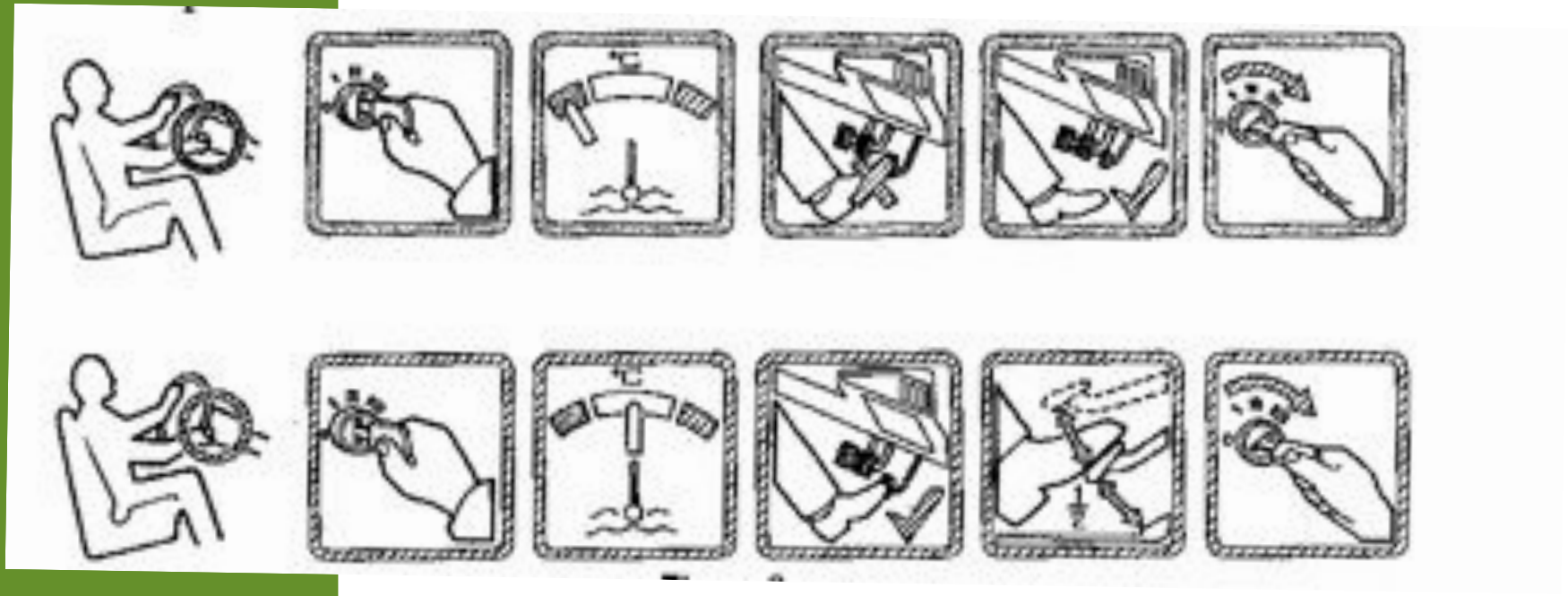


"Turn the key. If the car is cold, don't step on the gas pedal; if it's warm, depress the gas pedal halfway as you turn the key."

The limits of ideographic/ semasiographic systems

Semasiographic 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 (as opposed, e.g., to artificial languages.)

Wilkins' universal language

The Beginnings of Information

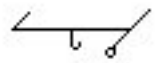
The Emergence of Representation

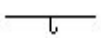
The Variety of Signs

The Origins and Development of Writing Systems

Types of Writing Systems

Independent Inventions of Writing Systems

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 Beginnings of Information

The Emergence of Representation

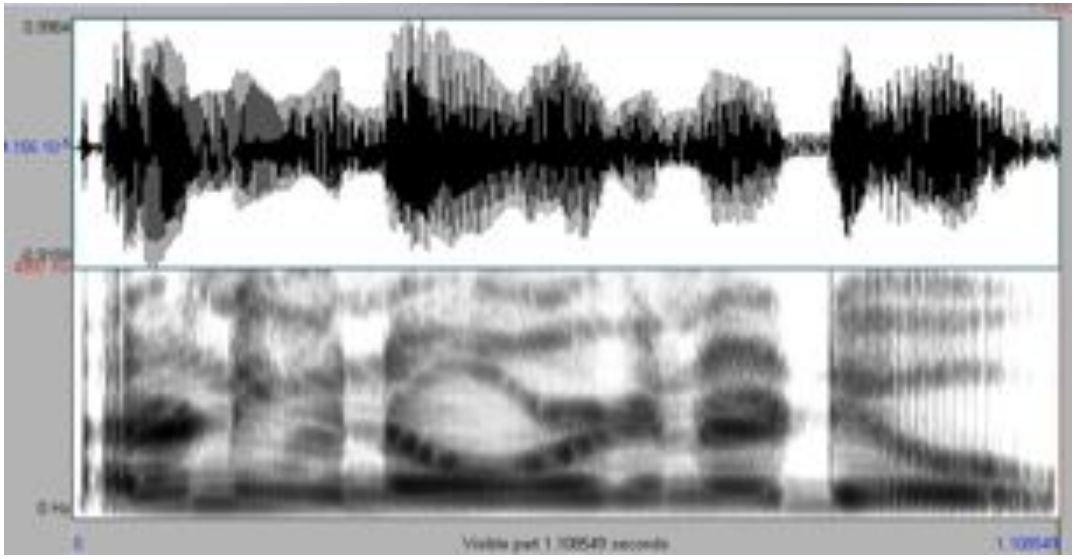
The Variety of Signs

The Origins and Development of Writing Systems

Types of Writing Systems

Independent Inventions of Writing Systems

Writing – what a concept!



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The Beginnings of Information

The Emergence of Representation

The Variety of Signs

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Types of Writing Systems

Independent Inventions of Writing Systems

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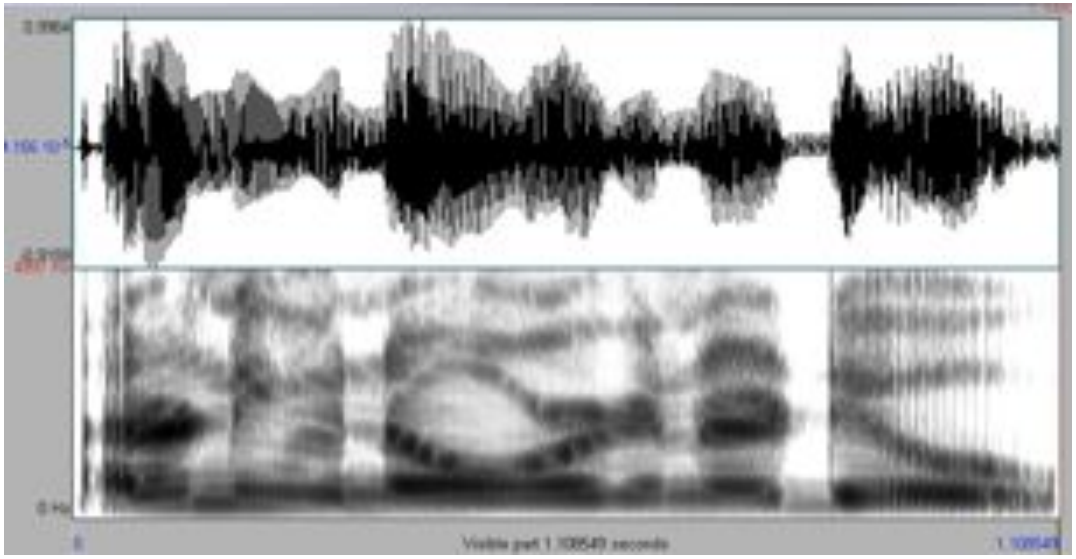

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I don't know what we're going to do

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The Beginnings of Information

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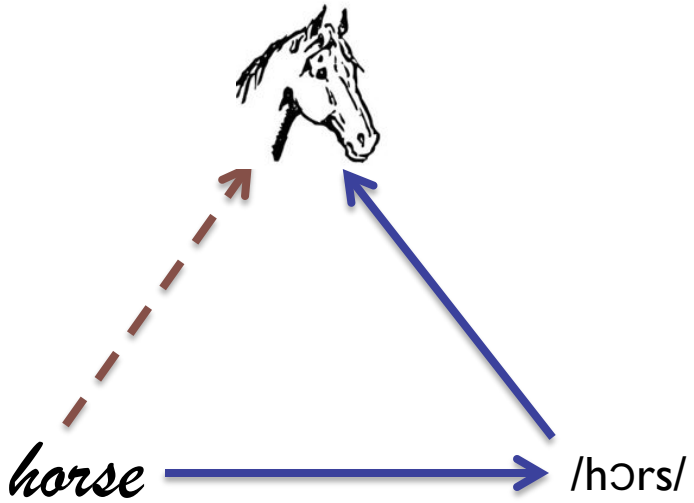

Writing: symbols represent elements of language rather than directly representing things in the world.

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The Beginnings of Information

The Emergence of Representation

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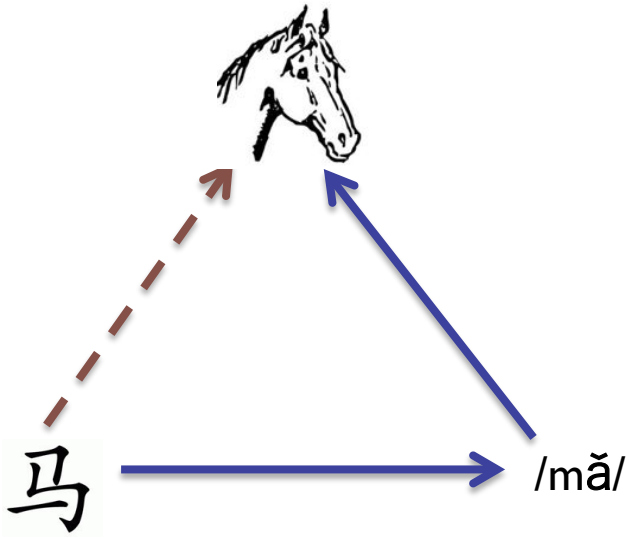

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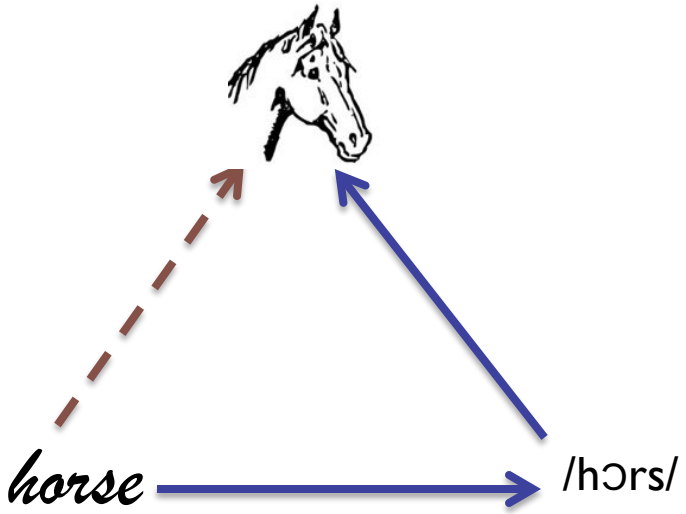

Glottographic writing: rather than referring directly to reference/ideas, signs are associated with elements of the language (words, morphemes, syllables, phonemes).

Cf "5" vs *five*," *cinque*, wŭ, etc.
"$" vs "dollars," etc.

Origins of Writing in Sumer

The Beginnings of Information

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The Variety of Signs

The Origins and Development of Writing Systems

Types of Writing Systems

Independent Inventions of Writing Systems

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 Uruk, 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.

The Origins of "complete" writing

The Beginnings of Information

The Emergence of Representation

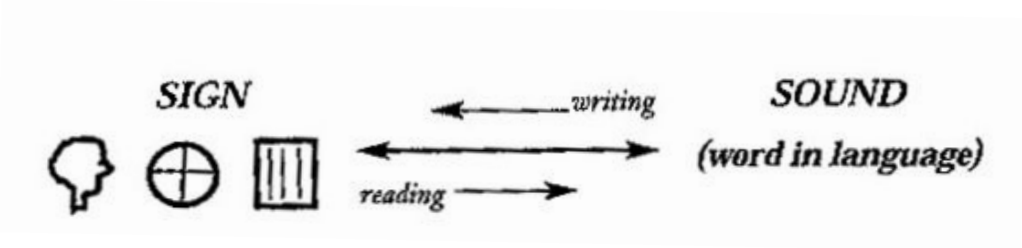
The Variety of Signs

The Origins and Development of Writing Systems

Types of Writing Systems

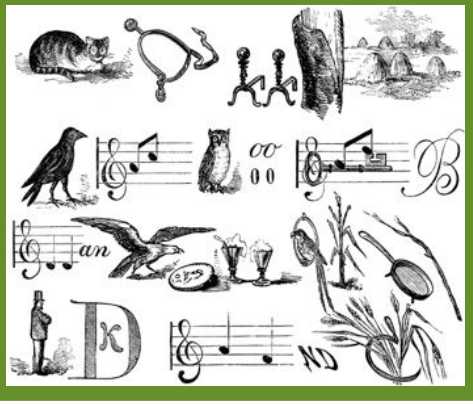
Independent Inventions of Writing Systems

"Complete" 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

The Beginnings of Information

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

"water" /a/ → "in" /a/

"oracle" /me/ → plural suffix /-me/

Accompanied by increasing conventionalization of signs... Creates need for "determinative" signs to indicate how other signs are being used.

Eg. "marsh plant" (/te/) sign also used for name of goddess assoc. w. marshes /eresh/ -- /u/ "plant" used to indicate "marsh plant" use of sign.

Logography to Syllabic System

The Beginnings of Information

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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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The Emergence of Representation

The Variety of Signs

The Origins and Development of Writing Systems

Types of Writing Systems

Independent Inventions of Writing Systems

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@*$, 2G2B4GOT10, ne14?^

Signs come to stand in for syllables

Logographs ultimately perceived as having purely phonetic value.

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Origins of Alphabetic Writing

Alphabetic system derived from application of syllabic system to different phonological structures.

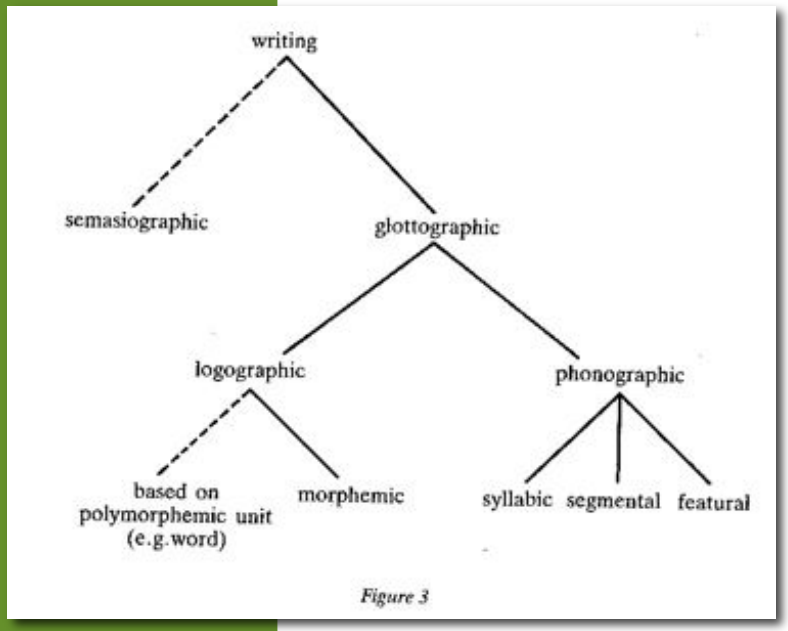

Figure 3

Logographic: mod. Chinese, Japanese (mixed)

Syllabic: Linear B, Cherokee, Korean Hangul (featural)

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

Origins of Alphabetic Writing

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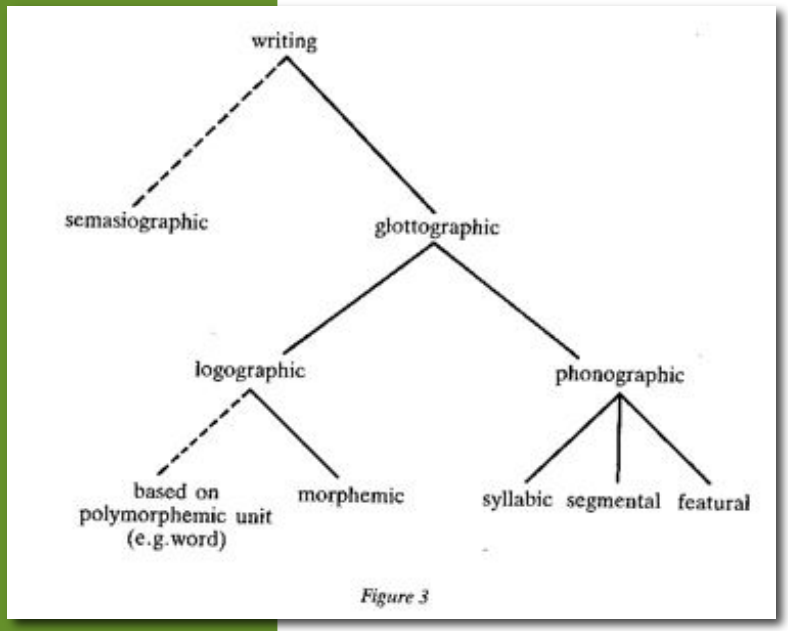


Figure 3

Logographic: mod. Chinese, Japanese (mixed)

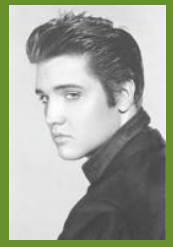
Syllabic: Linear B, Cherokee, Korean Hangul (featural)

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

Problem with completely phonetic alphabetic systems: ambiguity.

Cf French *au, aux, ô, os, haut, hauts, eau, eaux, os*, etc.

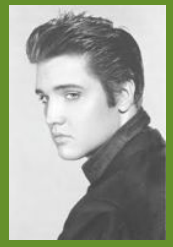
Development of Written Symbols

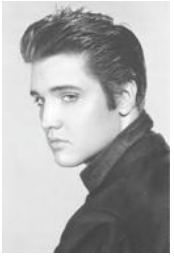


Iconic

Development of Written Symbols

Simplification of sign





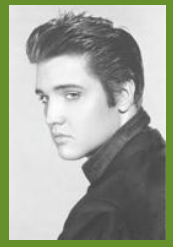
Iconic

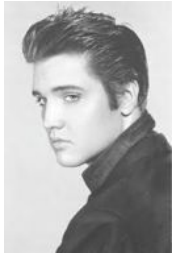
Semasiographic/
ideographic

Proto-writing

Development of Written Symbols

Simplification of sign →





Iconic

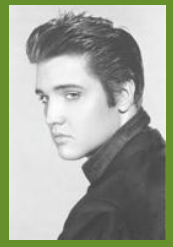
Semasiographic/ ideographic

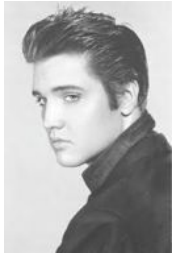
Rebus extension

Proto-writing

Development of Written Symbols

Simplification of sign →





[ɛlvIs]

Iconic

Semasiographic/ ideographic

Rebus extension

logographic

Proto-writing

"True" (glottographic) Writing

Development of Written Symbols

Simplification of sign

E

E

[ɛlvIs]

/ɛl/

Iconic

Semasiographic/ ideographic

Rebus extension

logographic

syllabic

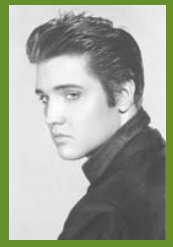
Proto-writing

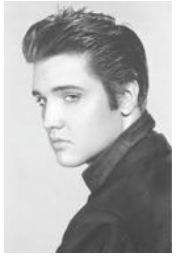
"True" (glottographic) Writing

Development of Written Symbols

Simplification of sign →

E E E





[ɛlvIs] /ɛl/ /ɛ/

Iconic

Semasiographic/ ideographic

Rebus extension

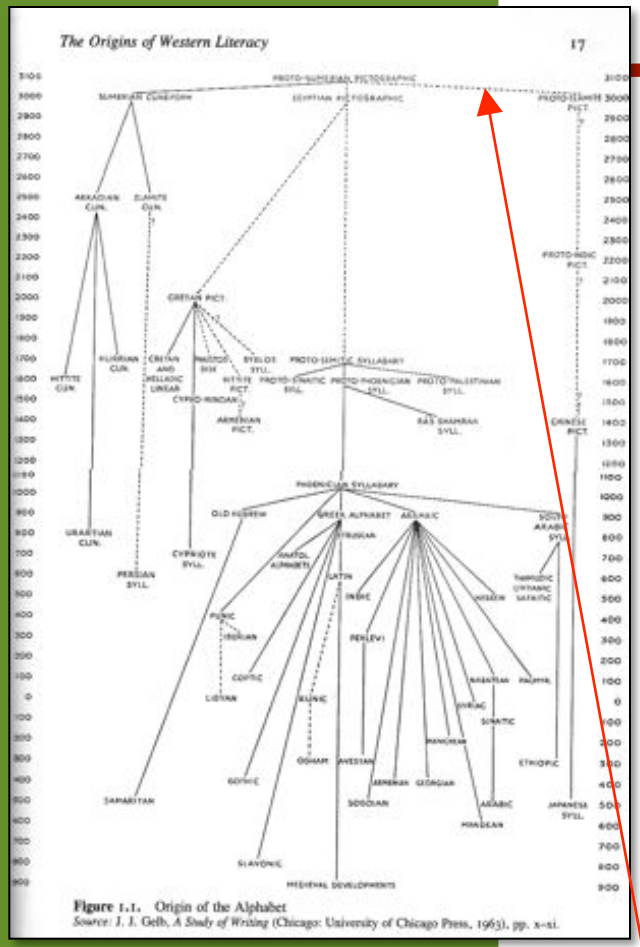
logographic syllabic alphabetic

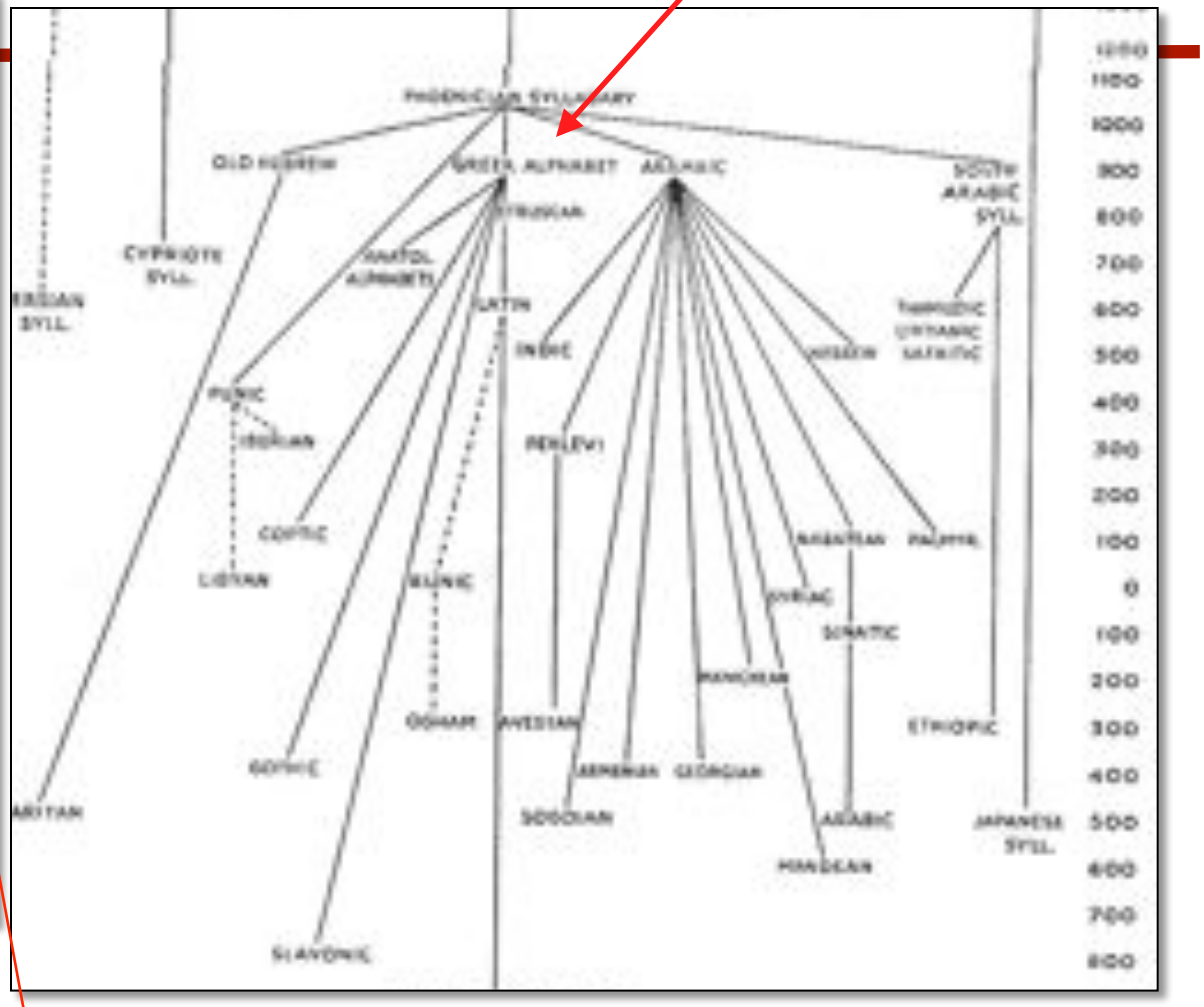
Proto-writing

"True" (glottographic) Writing

Geneology of Writing Systems

Invention of the alphabet





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

Later Developments

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

Not fixed till early age of print. Reduce ambiguity, make writing increasingly accessible to wider community or in absence of immediate context,

Later Developments

ΦΑΝΟΔΙΚΟ
ΚΟΜΦΟΤΙΜΕ
ΡΑΤΕΟΣΤΟ
ΗΝΙΝΟΚΟΠΠ
ΣΙΟΚΡΗΤΗΡ
ΚΟΠΥΙΑΚ:ΕΔΑ
ΡΗΤΗΡΙΟΝ:Κ
ΠΣΕ:ΝΟΜΘΗΙΑ
ΡΥΤΑΝΗΙΟΝ
ΕΚΥΣ:ΝΕΚΩΔΕ
ΕΥΣΙΝ

boustrophedon

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The Licenses for most software are designed to take
away your freedom to share and change it. By contrast,
the GNU General Public License is intended to guarantee
your freedom to share and change free software--to make
sure the software is free for all its users. This General
Public License applies to most of the Free Software
Foundation's software and to any other program whose
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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 [ə]
D a	R e	T i	Ꭷ o	ᑌ u	i v
S ga Ꭶ ka	Ꮁ ge	Ꭹ gi	A go	J gu	E gv
Ꮒ ha	Ꮓ he	Ꮕ hi	Ꮗ ho	Ꮖ hu	Ꮘ hv
W la	Ꮮ le	Ꮯ li	G lo	M lu	Ꮰ lv
ᙢ ma	Ꮱ me	H mi	Ꮳ mo	Ꮄ mu	
Ꮎ na Ꮏ hna G nah	Ꮑ ne	h ni	Z no	Ꮥ nu	Ꮤ nv
Ꭴ qua	Ꮓ que	Ᏽ qui	Ᏼ quo	Ꮻ quu	Ꮹ quv
Ꮝ s Ꮥ sa	Ꮞ se	Ꮟ si	Ꮠ so	Ꮡ su	R sv
Ꮭ da W ta	Ꮣ de Ꮦ te	Ꭵ di Ꭲ ti	V do	S du	Ꮷ dv
Ꮼ dla Ꮮ tla	L tle	C tli	Ꮹ tlo	Ꮾ tlu	P tlv
G tsa	Ꮴ tse	Ꮶ tsi	K tso	Ꭻ tsu	Ꮸ tsv
G wa	Ꮾ we	Ꮿ wi	Ꮼ wo	Ꮽ wu	Ꮺ wv
Ꭿ ya	Ᏸ ye	Ᏹ yi	Ꮋ yo	G yu	B yv

Independently invented writing systems: The Cherokee Syllabary

CHEROKEE PHŒNIX.

VOL. I. NEW ECHOTA, THURSDAY MARCH 6, 1828. NO. 3.

EDITED BY ELIAS BOUDINOTT.
PRINTED WEEKLY BY
ISAAC H. HARRIS,

CONSTITUTION OF THE CHERO-KEE NATION,

Formed by a Convention of Delegates from the several Districts, at New Echota, July 1827.

ARTICLE VI.

Sec. 1. Whereas the ministers of the Gospel are, by their profession, dedicated to the service of God—and the care of souls, and ought not to be diverted from the great duty of their function, therefore, no minister of the Gospel, or public preacher, of any religious persuasion, whilst he continues in the exercises of his pastoral functions, shall be eligible to the office of Principal Chief, or a Seat in either house of the General Council.

Sec. 2. No person who denies the being of a God, or a future state of rewards & punishments, shall hold any office in the civil department of this Nation.

Sec. 3. The free exercise of religious worship, and serving God without distinction, shall forever be allowed within this Nation: Provided, That this liberty of conscience shall not be so construed as to excuse acts of licentiousness or justify practices inconsistent with the peace or safety of this Nation.

Sec. 4. Whenever the General Council shall determine the expediency of appointing delegates, or other public Agents, for the purpose of transacting business with the Government of the United States; the Principal Chief shall have power to recommend, and by the advice and consent of the Committee, shall appoint and commission such delegates or Public Agents accordingly, and, on all matters of interest touching the rights of the citizens of this Nation,

VI.

LAWS OF ARDENT SPIRITS.

Cherokee Phoenix: First American Indian newspaper (1828)

Independently invented writing systems: Korean Hangul

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

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. Possibly influenced by central Asian scripts.

Only "featural" system: symbols representing sounds as features (i.e., "labial,' etc.) are clustered into a single "block" representing a syllable.

Assignment for 2/5

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. On the basis of the specific evidence presented by Havelock and Gough, would you say it is largely true, largely false, or true in some respects?

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