



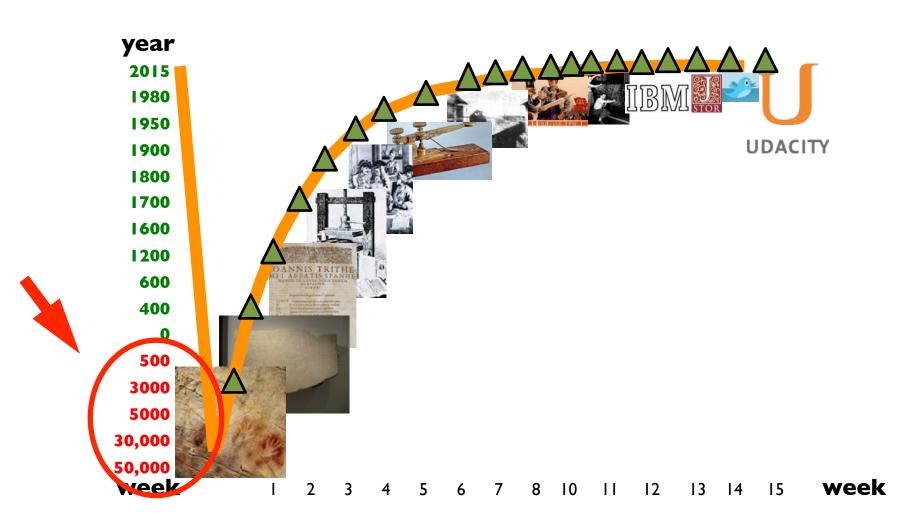
The First Information Technology: Writing Systems

Geoff Nunberg
School of Information, UC Berkeley

IS 103 History of Information Jan. 31, 2013



The journey begins...





Itinerary, 1/30

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"



THE
MATHEMATICAL
THEORY OF
COMMUNICATION

CLAUDE E SHANNON
WARREN WEAVER

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

The Emergence of Representation

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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



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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 1.5: Worldwide production of magnetic original content, if store	d 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 I Lo Esti	
Magnetic	Videotape	1,340,000	1,340,000	1,420,000	1,4	
	Audiotape	128,800	128,800	182,000	1	
	Digital tape	250,000	250,000	250,000	2	
	MiniDV	1,265,000	1,265,000	N/A		
	Floppy disc	80	80	70		
	Zip	350	350	Table 4 2-186		
	Audio MD	17,000	17,000	Table 1.2: Wo circa 2002. U assume digit		
	Flash	12,000	12,000			
	Hard Disk	1,986,000	403,000	Q.	0.000	

4.999,230

3,416,230

Source: How much information 2003

TOTAL

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
	Cbrestel	4 622 0	300 7	4 400 0	240.0	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%

Courses they much beforeather 200

Peter Lyman and Hal Varian, How Much Information? 2003



Quantifying "information"

The Beginnings of Information

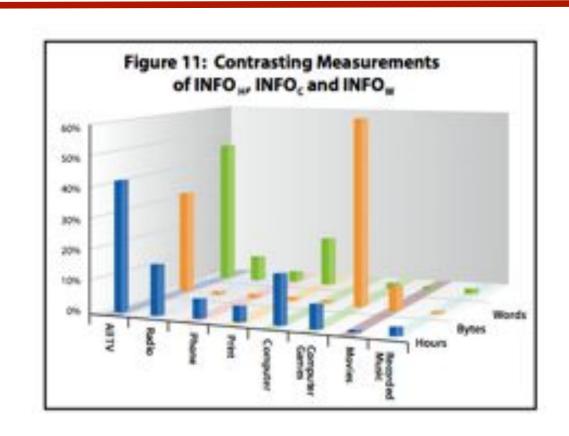
The Emergence of Representation

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How Much Information? 2009 Report on American Consumers



Quantifying "information"

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

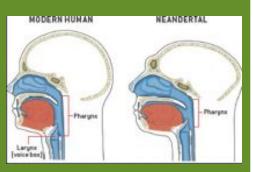
No direct evidence about origins of language No existing "primitive" languages



The 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."





Henri Breuil





Robot & Jacques Marsal

The Beginnings of Representational Artifacts





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

"Man's first affirmation of himself"

Maurice Blanchot



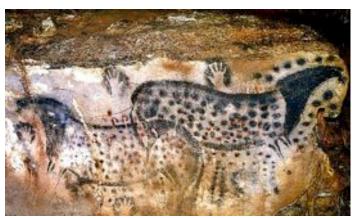


The Beginnings of Representational Artifacts



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





Spotted Horses, Peche Merle





The Beginnings of Information

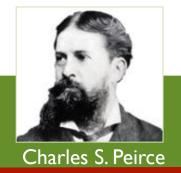
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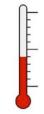


Icon: relation of resemblance (more-or-less) to signified. E.g,





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/.

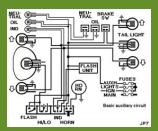






Icon: sign stands in relation of resemblance or similarity to signified (though often only roughly).





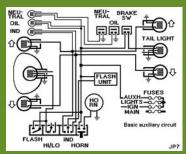
















Icon: sign stands in relation of resemblance or similarity to signified (though often only roughly).









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

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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

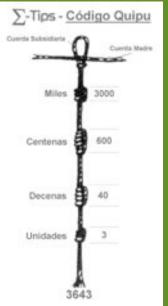


Notched bone, Congo, ca. 25,000 BC -- may represent lunar calendar



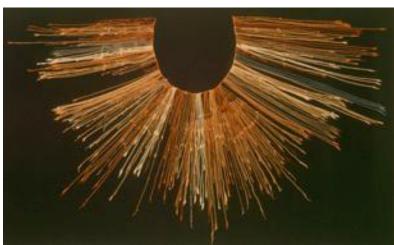
Elaborated Indexical System: The Inca *qipu*







Knots of varying colors in Ilama or alpaca hair
Limits: can record only quantity and category; requires extensive convention for intepretation





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

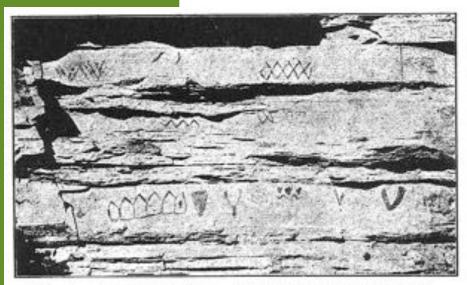
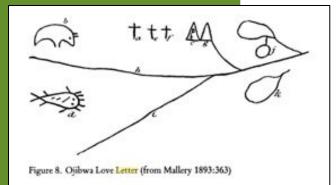


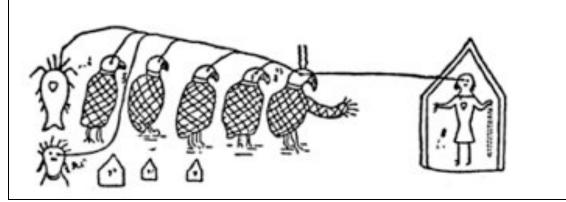
Fig. 4 .- Geometrical forms. (From a photograph of rocks).





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

The Beginnings of Information

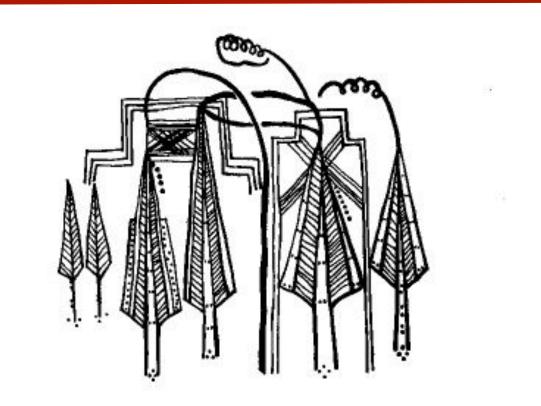
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Yukaghir (Siberia) "love letter," late 19th c.



"Pictographic" Systems

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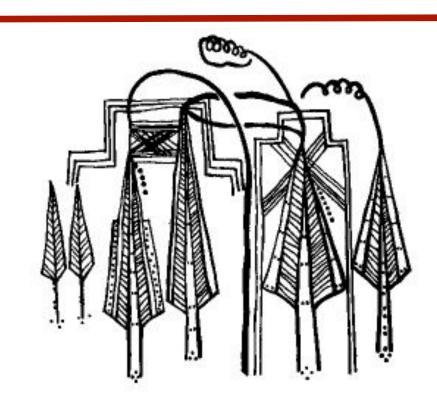
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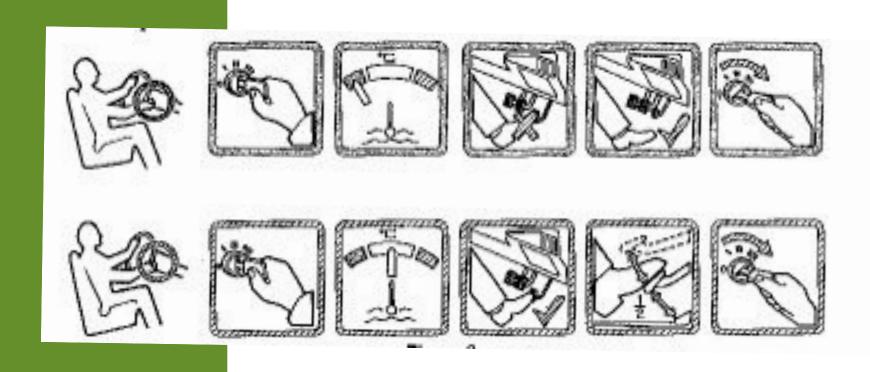
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"I know you're fighting with that Russian girl you broke up with me over. I'm unhappy in my house as I think of you, but you should know there's another guy hitting on me, so get your act together before I get married and have children."

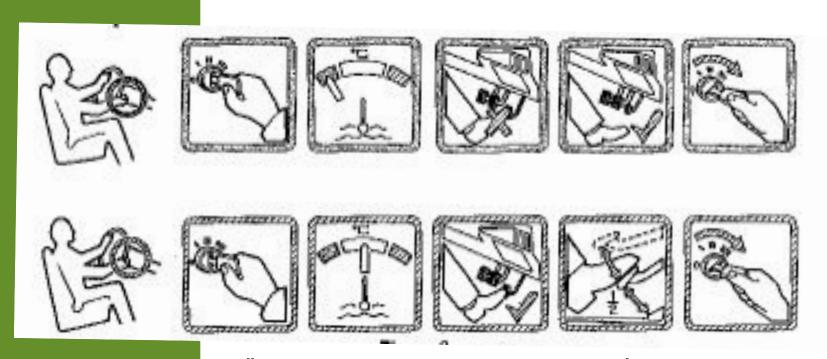


Ideographic (Semasiographic) Systems: the importance of context





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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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





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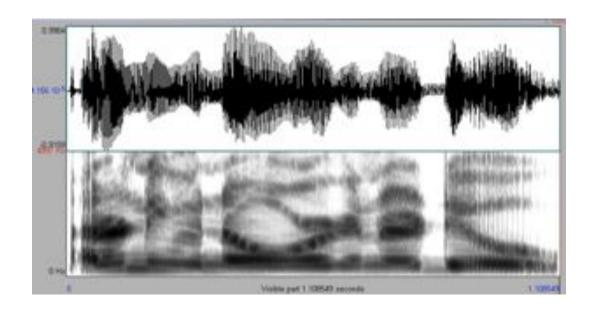
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Writing – what a concept!



wwbencentwewener:a



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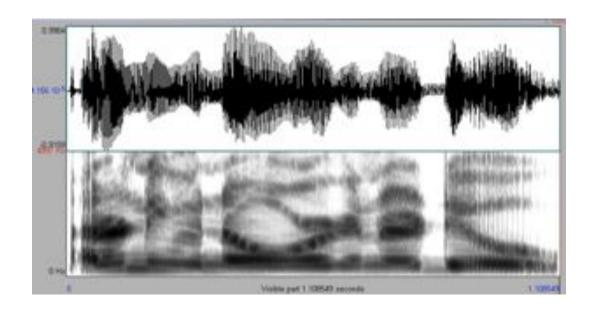
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Writing – what a concept!



a:renowe?wirgonedww I don't know what we're going to do



The Beginnings of Information

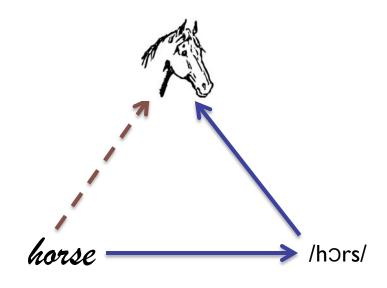
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<u>True Writing:</u> symbols represent elements of language rather than directly representing things in the world.



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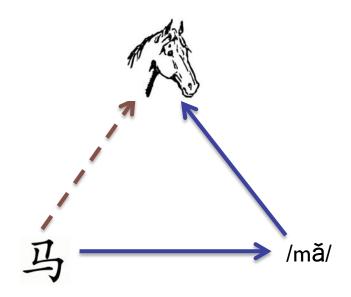
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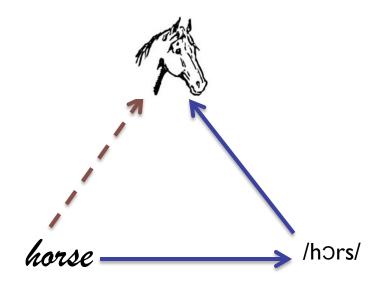
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Glottographic writing: rather than referring directly to reference/ideas, signs are associated with elements of the language (words, morphemes, syllables, phonemes).

Cf "5" vs five, cinque, fünf, wǔ, etc. "\$" vs "dollars," etc.



Origins of Writing in Sumer

The Beginnings of Information

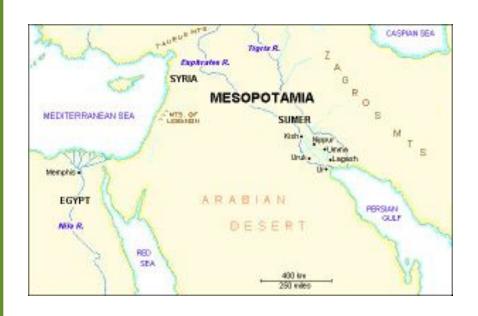
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Origins of Writing in Sumer

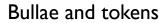
8-5000 BC -- earliest use of clay tokens.

4,000 BC -- earliest clay bullae 3500-3300 BC -- earliest clay tablets from Uruk.











Early cunieform



Tokens as origins of Sumerian writing?



Figure 7 Picrographic tablet from Uruk, Iraq, late fourth millennium is 6. The account in the upper control case, for example, shows the sign for sheep and five wedges standing for the abstruct numeral 5. Courney Vordenniatisches Museum, Stantische Museen en Berlin, East Germany.

Token	Pictograph	Neo-Sumeroni Die Bebylonien	Nec-Assyrian	No-Patylonian	English Sheep	
1	Œ	田	TH	Ж		
4	\$\$	♦>	#	<	Cathe	
*	8	Mai	J=Q(D+III	Li-m	Dog	
411		\$	4₩	4	Metal	
9	0	À	ÂT.	4	Oil	
	0	Jant.	Tette	<u>, 144</u>	Garment	
•	•	1	受蛀	例	Bracelet	
a	>	各值	;iit	華	Perlume	



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

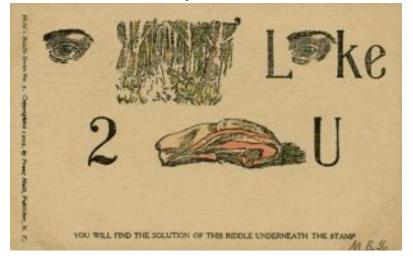
saw

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" $/a/ \rightarrow$ "in" /a/

T "oracle" /me/ → plural suffix /-me/



Logography to Syllabic System

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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 everyday life?

•



Logography to Syllabic System

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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@*\$, 2G2B4GO10, ne14Xs?





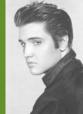


Signs come to stand in for syllables







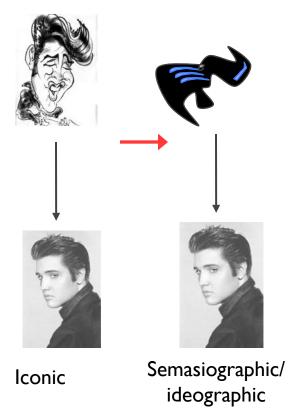


Iconic

52



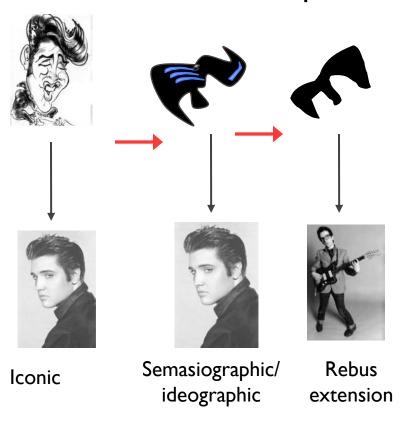
Simplification of sign —



Proto-writing

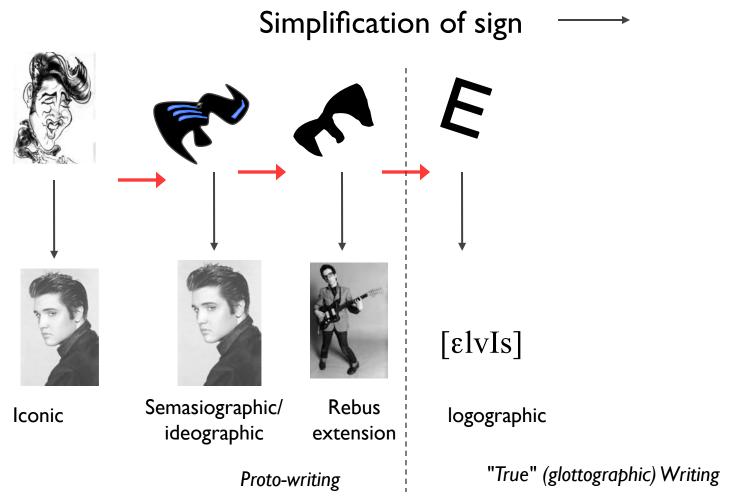


Simplification of sign —

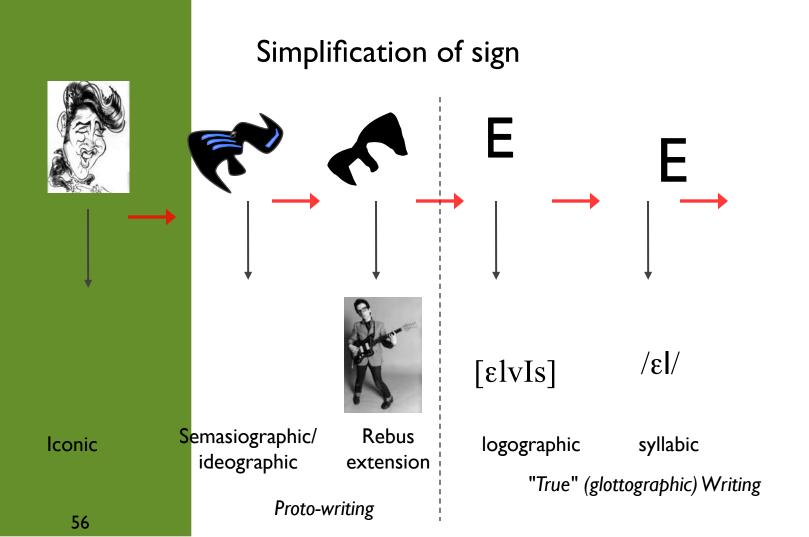


Proto-writing

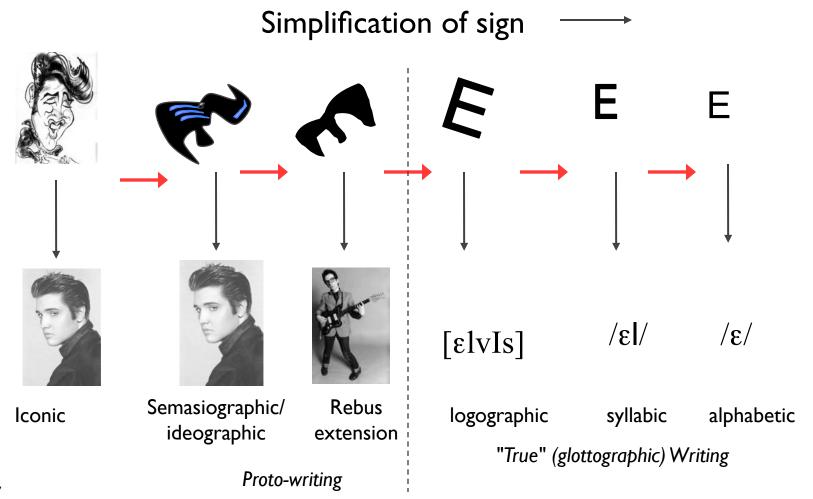






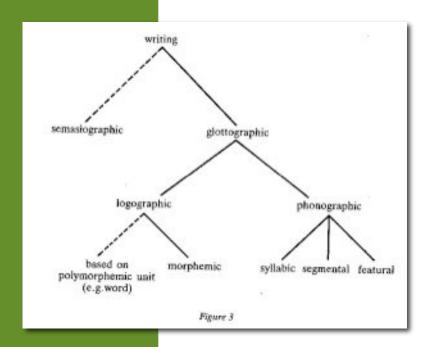








Types of Writing Systems



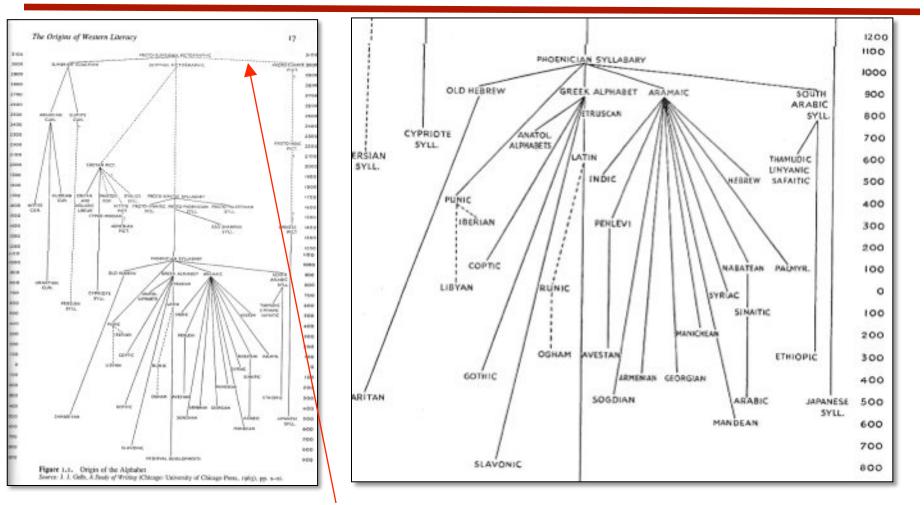
Logographic: mod. Chinese (logosyllabic), Japanese kanji

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

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



Genealogy of Writing Systems



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



Later Developments

ΟΧΙΔΟΝΑΦ ĒΜΙΤΟΡΜΟΚ ΟΤΖΟΞΤΑΫ ΠΡΟΚΟΝΝΗ 4ΗΤΗΥΑΟΙΣ ΑΔΕ:ΚΑΙΥΠΟΚ ΑΙΘΜΟΝ:ΕΣΠ ΑΙΗΘΜΟΝ:ΕΣΠ ΜΟΙΗΝΑΤΥΫ ΕΔΩΚΕΝ:ΣΥΚΕ ΜΙΖΥΞ

boustrophedon

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Does direction of writing influence cognition?



Later Developments



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

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SÉN. MARÉER DUENÉROM & SPECIANA, PRINTENTON. MR. MAGNELLINA . MARYONA & PRINTE, NUTRA . 411 MAS.



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

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Independently invented writing systems: The Cherokee Syllabary



EDITIOD BY ELIAS BOUDINGTY. PRINTED WHEELY BY

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fanacurage, I CONSTITUTION OF THE CHERO.

KEE NATION, Furnal by a Controller of Delegates from the several Districts, at New Edists, Jaly 1805.

Sec. I. Whereas the ministers of the Grapel are, by their profession, dediented to the service of God-and the rare of tools, and ought not to be directed from the on, now young manuscreases were great duty of their function, therefore, as initiar of the Guipel, or public preacher, "PREMER TRANSPALE ASSAUL, DE of any religious personales, whilet be contiones in the exercises of his purceral fourtime, shall be eligible to the office of Principal Chief, or a Sent in either boxes of the General Council.

Sec. 3: No person who desire the being of a God, or a future state of reveneda & validments, shall held say office in the elvil department of this Nation.

Sec. 2. The free energies of religious worship, and serving God without distinction, shall forever be allowed within this Notice: Provided, That this liberty of conscience shall not be an exectaced as to excost acts of licentiquesess or justify proctions increasistant with the pence or sode-

Sec. 6. Whenever the General Counall shall determine the expediency of appetiting delegates, or other public Agencs, the the purpose of transacting business with the Government of the United States; the Principal Chief shall here pearer to recemranul, and by the salvice and current of the Committee, shall appoint and commission such delegates or Public Agents occordings sages of a Magazine protect in the year. It, and, on all metters of interest touching. Were in the parameters as interest touching. Were in the property of the chipmen of this Nation.

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Nor. 13. The General Council may at oy time propose such assendances to this Countration as two thirds of each home sholl doom expedient; and the Principal Chief shall beau a preclamation, directory all the civil efficers of the several Districts to premulgate the unite on extensively us subtle within their respective Districts, at least size mostle province to the next Central election; and if at the first sension of the General Council after such General election, two thinks of such house shulf, by present ups, ratify such proposed as a water, amazan panarantpol mendusors, they shall be valid to all intests and perpend reports of this Court | mount maps present necessarily teting Previded, That such proposed or mendments shell be read on three several dops, in such haven, to well when the mine are proposed, so when they are faully rot-

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Cherokee Phoenix: First American Indian newspaper (1828)

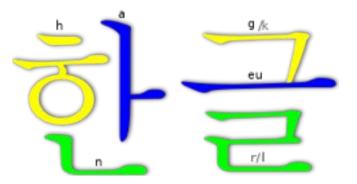




Hunmin Jeong-eum Exemplar (1446): Earliest Hangul text

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



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 prealphabetic 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, I