

Tokens and Writing: the Cognitive Development

Denise Schmandt-Besserat
The University of Texas at Austin, USA

Traditional archaeology aims at reconstructing the culture, economy and technology of past societies. In recent years cognitive archaeology has added a new dimension to our investigation of antiquity by focusing upon artifacts documenting the development of cognitive skills. Foremost among these objects, the Near Eastern prehistoric tokens and the earliest archaic tablets, exemplify the gradual mastery of the power of abstraction necessary to achieve numeracy and literacy. (Malafouris)

Archaeological sites in the Near East are called “Tell” or “Tepe” in Arabic, “Huyuk” in Turkish and “mounds” in English. The mounds are artificial hills formed by the accumulation of debris over the centuries, or millennia, as a result of human occupation. In other words, they are the accumulation of remains of villages upon villages and towns upon villages. Excavators have given prime attention to the architectural features unearthed in the mounds in order to estimate the size and lay out of early settlements and find out whether the inhabitants were fully or semi-sedentary. Organic materials discarded in antiquity, such as bones and charred ears of grains, have been carefully studied because they disclose not only people’s diet but the economy at a given site, namely, how much a community relied on hunting, fishing, farming or pastoralism. Other artifacts indicate the degree of technology reached by a society, whether tools and weapons were made by chipping stone or alloying and casting metals. Jewelry illustrates the fashions of yesteryear. For example, the excavations of the cemetery of Ur, in Mesopotamia, dating from about 2500 BC, showed that women of the Sumerian elite wore gold wreaths made in the shape of beech leaves. Lastly, figurines and divine representations suggest the beliefs and rituals of a society.



Figure 1. Plain tokens, Mesopotamia, present day Iraq, ca. 4000 B.C. The cone, spheres and disk represented various grain measures; the tetrahedron stood for a unit of labor. Courtesy Denise Schmandt-Besserat, The University of Texas at Austin.

In contrast to the above artifacts, the tokens I studied are unique in providing evidence for the development of cognitive skills between 7500-3000 BC. (Denise Schmandt-Besserat 1992, 1996) The objects, made of clay, modeled into many shapes such as miniature cones, spheres, cylinders, disks and tetrahedrons, were counters (Fig. 1). They were tools of the mind, and as such, give us some insight on human cognition. In particular, the tokens give information on numeracy - the way of counting practiced in the cultures that created or adopted them.

The Function of Counting in Prehistory

Before dealing with the cognitive significance of the token system, I first discuss its origin and cultural background. Tokens started to appear in the Fertile Crescent of the Near East, from Syria to Iran, around 7500 BC. This means that counting coincided with farming, and in particular, the redistribution economy that derived from agriculture. Tokens were probably used to pool together community surpluses for the preparation of the religious festivals that constituted the lynchpin of the redistribution economy. The tokens helped leaders to keep track of the goods in kind collected and their redistribution as offerings to the gods and the various community needs.

The Cognitive Significance of Tokens

The tokens used a way of counting fundamentally different from ours. We use abstract numbers, which means that our numbers “one”, “two,” “three,” are independent of the item counted and therefore universally applicable. “One,” “two,” “three” can serve to count people, animals as well as inanimate objects and anything else possible. It was not so at the time when tokens were used. Between 7500 - 3100 BC, counting was restricted to selected units of goods, mostly

measures of grain, jars of oil, animals and units of labor (time? task?). Moreover, each category of item was counted with its own counter, reflecting the fact that counting was “concrete,” meaning that each category of item was counted with a special numeration or special number words specific to that particular item. For instance, small and large units of grain were counted with cones and spheres, oil with ovoids, animals with cylinders and the units of labor with tetrahedrons. Perhaps the single most archaic feature of the token system was to be used in one-to-one correspondence. Two jars of oil were shown by two ovoids and three jars of oil were marked by three ovoid tokens.



Figure 2. Complex tokens representing (above, from right to left) one sheep, one jar of oil, one ingot of metal, one garment, (Below, from right to left,) (?), one garment, (?), one honeycomb, from Susa, Iran, ca. 3300 B.C. Courtesy Musée du Louvre, Département des Antiquités Orientales

The tokens illustrate the unceasing cross-fertilization that took place between the redistribution economy’s increasing demands and the development of counting. For example, the number of token shapes, which was limited to about 12 around 7500 BC, increased to some 350 around 3500 BC, when urban workshops started contributing to the redistribution economy. Some of the new tokens stood for raw materials such as wool and metal while others represented finished products, among them textiles, garments, jewelry, bread, beer and honey. (Fig. 2) These so-called “complex” tokens sometimes assumed the shapes of the items they symbolized such as garments, miniature vessels, tools and furniture. These artifacts took far more skill to model compared to the former geometric shapes such as cones and spheres, suggesting that specialists were then manufacturing them. (Schmandt-Besserat 1992)

The Transition from Tokens to Writing

By 3300 BC, tokens were still the only accounting device to manage the redistribution economy that was now administered at the temple by priestly rulers. The communal offerings in kind for the preparation of festivals continued, but the

types of goods, their amounts, and the frequency of delivery to the temple became regulated, and non-compliance was penalized. The response to the new challenge was the invention of envelopes where tokens representing a delinquent account could be kept safely until the debt was paid. The tokens standing for the amounts due were placed in hollow clay balls and, in order to show the content of the envelopes, the accountants created markings by impressing the tokens on the wet clay surface before enclosing them. (Fig. 3) The cones and spheres symbolizing the measures of grain became wedge-shaped and circular impressed signs. (Fig. 4) Within a century, about 3200 BC, the envelopes filled with counters and their corresponding signs were replaced by solid clay tablets which continued the system of signs impressed with tokens. By innovating a new way of keeping records of goods with signs, the envelopes created the bridge between tokens and writing.



Figure 3. Envelope showing the imprint of three ovoid tokens with an incised line representing jars of oil, from Habuba Kabira, Syria, ca. 3300 B.C. Courtesy Museum für vor- und Frühgeschichte, Schloss Charlottenburg, Berlin.



Figure 4. Tablet showing the impression of spheres and cones representing measures of grain, from Godin Tepe, Iran, ca. 3200 B.C. Courtesy Cuyler Young Jr. Royal Ontario Museum, Toronto, Canada.

Tablets and Counting

With the formation of city states, ca. 3200-3100 BC, the redistribution economy reached a regional scale. The unprecedented volume of goods to administer

challenged writing to evolve in form, content and, as will be discussed later, in cognitive ability. First, about 3100 BC, the form of the signs changed when a pointed stylus was used to sketch more accurately the shape of the most intricate tokens and their particular markings. The sign for oil, for example, reproduced the ovoid token with its circular line at the maximum diameter. (Fig. 5)



Figure 5. Pictographic tablet featuring an account of 33 measures of oil, (circular = 10, wedges = 1) from Godin Tepe, Iran, ca. 3100 B.C. Courtesy Dr. T. Cuyler Young, Royal Ontario Museum, Toronto, Canada.

Second, plurality was no longer indicated by one-to-one correspondence. The number of jars of oil was not shown by repeating the sign for “jar of oil” as many times as the number of units to record. The sign for “jar of oil” was preceded by numerals – signs indicating numbers. Surprisingly, no new signs were created to symbolize the numerals but rather the impressed signs for grain took on a numerical value. The wedge that formerly represented a small measure of grain came to mean “1” and the circular sign, formerly representing a large measure of grain meant “10.” Figure 5 illustrates an account of 33 jars of oil indicated by 3 circular impressed signs (10 + 10 + 10) and 3 impressed wedges (1 + 1 + 1) followed on the right by the incised sign for “jar of oil.”

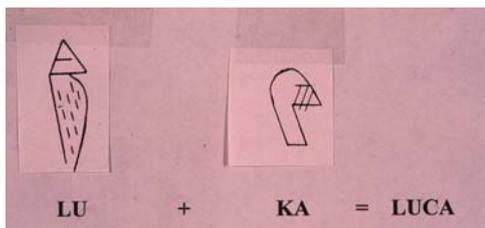


Figure 6. Example of the rebus principle used to record names.

Third, about 3000 BC, the state bureaucracy required that the names of the recipients or donors of the goods be entered on the tablets. And to record the personal name of these individuals, new signs were created that stood for sounds – phonograms. The phonograms were sketches of things easy to draw that stood for

the sound of the word they evoked. The syllables or words composing an individual's name were written like a rebus. The drawing of a man stood for the sound "lu" and that of the mouth for "ka," which were the sounds of the words for "man" and "mouth" in the Sumerian language. For example, the modern name Lucas, could have been written with the two signs mentioned above "lu - ka." (Fig. 6)

The state administration could no longer deal with the approximate quantities of informal containers and this prompted the standardization of measures. The resulting adjustment in accounting was to assign new signs to indicate the standard measures of grains (*ban, bariga* etc...), liquids (*sila*), and surface areas (*ikus, eshe3, bur, etc...*). (Nissen, Damerow and Englund 64-65) The standardization of measures brought accounting to an unprecedented precision, while putting an end to dealing with informal hand-manufactured containers. (Fig. 7)

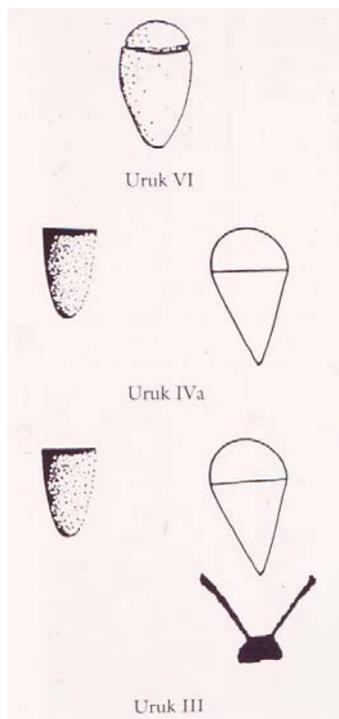


Figure 7. The representation of "one sila of oil" in 3500 BC, 3100 BC and 3000 BC.

During four millennia and a half, from 7500 to 3000 BC, tokens and writing constituted the backbone of the Near Eastern redistribution economy. Both recording systems were closely related in material, form, and function. They shared clay as a raw material; the token shapes were perpetuated by the written signs; both types of symbols kept track of similar quantities of the same types of agricultural

and industrial goods for an identical socio-economic function. The difference between the systems was cognitive, namely the degree of abstraction used to manipulate data.

Tokens and Abstraction.

The major cognitive significance of the tokens was fostering abstraction. The fundamental principle of the token system was the substitution of a small clay counter for each unit of goods to be counted. As a result, merchandise could easily be counted and accounted for because the tokens abstracted goods from reality.

- Tokens abstracted the bulk and weight of merchandise so that heavy loads of grain could be effortlessly budgeted
- Tokens abstracted life or movement, thus allowing unruly animals, difficult to control, to be easily registered.
- The tokens abstracted time, making it possible to the Near Eastern accountants to manage goods whether they were still in the field or stored in the granary, and whether they were pledged or delivered.
- The Near Eastern accountants could perform simple and complex operations just by moving or removing tokens. For example, they could add, subtract, multiply and divide.
- Patterning, the presentation of data in lines and columns, further promoted abstraction (Justus 2004, 1999a, 56,64, 1999b. Hoyrup 1994,70). With tokens, the Near Eastern accountants could organize the budget for a festival in columns according to
 - Types of goods
 - Entries and expenditures
 - Donors or recipients
- Goods symbolized by tokens could be lined up according to their relative value
 - Large units above
 - Small units below

In sum, the invention of tokens in the Near East, about 7500 BC, provided a useful tool to manage communal goods. There can be no doubt that people acquired new cognitive skills by using tokens over 4500 years to count and recount sheep and baskets of grain in abstraction. When these cognitive skills had been internalized for several millennia, the human mind was ready for new strides in abstraction.

Concrete counting with tokens was the necessary foundation for the invention of writing.

Writing and Abstraction.

Writing meant three extraordinary developments in abstraction that occurred in close succession, probably within the century between 3100-3000 BC. These abstractions concerned the creation of 1) two-dimensional signs, 2) abstract numerals and 3) phonetic signs. The magnitude of these strides in the mastery of abstraction can be realized by comparing and contrasting the degree of abstraction between tokens and writing.

1. The tokens were tangible but the signs of writing were intangible. They abstracted the tokens that abstracted goods. The awkward piles of three dimensional tokens could disappear.

2. The tokens were used in one-to-one correspondence but writing abstracted numbers.

For the first time, signs expressing numerals abstracted the concept of number from that of the item counted. For example, a sign for “one” was placed next to the sign for “jar of oil.”

The invention of abstract numerals made obsolete the use of different counters and numerations to count different products. With the abstraction of numbers, counting had no limit.

3. The tokens were strictly limited to representing concrete units of real goods, whereas writing abstracted immaterial sounds of speech. The phonetic syllabic signs used to record individuals’ names started the process of emulating speech. As a result, writing was no longer confined to recording goods but could strive to communicate the most abstract ideas.

Conclusion.

Tokens were designed to count goods. Over its evolution of four and half millennia, the token system evolved to compute in abstraction an ever greater volume of more and more complex data, and thereby paved the way to writing. Cognitive archaeology makes it clear that the immense value of the token system was to bring mankind, in the course of its millennia long development, to the level of abstraction necessary for literacy and civilization.

BIBLIOGRAPHY

- HOYRUP J. 1994. *In Measure, Number, and Weight*. New York: State University of New York Press.
- JUSTUS, C., 2004. On Language and the Rise of a Base for Counting. *General Linguistics* 42, 17- 43.
- JUSTUS C. 1999a. Pre-decimal Structures in Counting and Metrology. In Gvozdanovic J. (ed), *Numeral Types and Changes Worldwide: 55-79*. Berlin: Mouton de Gruyter, 55-79.
- JUSTUS, C., 1999b. Can a Counting System be an Index of Linguistic Relationship? *Journal of Indo-European Studies*, Monograph 33, 219-240.
- MALAFOURIS, L. forthcoming, Grasping the concept of number: How did the sapiens mind move beyond approximation, in Colin Renfrew, ed. *Measuring the World and Beyond*, The McDonald Institute for Archaeological Research, Cambridge, England.
- NISSEN, H. J., DAMEROW, P., ENGLUND, R.K., 1993. *Archaic BookKeeping*, Chicago: The University of Chicago Press.
- SCHMANDT-BESSERAT D. 1996. *How Writing Came About*. Austin: The University of Texas Press.
- SCHMANDT-BESSERAT. D. 1992. *Before Writing*. 2vols. Austin: The University of Texas Press.