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In his provocative book The Domestication of the Savage Mind Jack Goody argues that the advent of writing has profoundly altered the growth and structure of human knowledge, and beyond that, human cognition itself:

> Writing is critical not simply because it preserves speech over time and space, but because it transforms speech, by abstracting its components, by assisting backward scanning, so that communication by eye creates a different cognitive potentiality for human beings than communication by word of mouth. (Goody 1977:128)

Goody argues that the making of written tables and lists has expanded the potential of cognitive activities. The list, he says,

> is connected in a direct and intimate way with cognitive processes. For the making of lists, actual or figurative, that I have called shopping lists is part of the more general process of planning human action. . . . It is not so much the making of plans, the use of symbolic thought, as the externalizing and communication of those plans, transactions in symbolism, that are the marks of man. . . . [list making]
> represents one aspect of the process of decontextualization (or better 'recontextualization') that is intrinsic to writing, not merely as an external activity but as an internal one as well. To put the matter in another way, writing enables you to talk freely about your thoughts. (p. 159)

The book concludes that writing

> encourages special forms of linguistic activity associated with developments in particular kinds of problem raising and problem solving, in which the list, the formula, and the table played a seminal part. If we wish to speak of the 'savage mind', these were some of the instruments of its domestication. (p. 162).

In this paper I suggest that Goody's argument fits well with a view of cognition which was dominant in the 1960's. But the last decade's developments in cognitive theory have made Goody's conclusions about the effect of writing on human cognition less tenable (of necessity my review here is cryptic; see Colby, Fernandez and Kronenfeld's [1981] coverage of the same ground from a slightly different viewpoint). I will illustrate these points with a brief example from well known facts about Maya arithmetic and chronological reckoning.

First, I should note that there are many of Goody's arguments that I find very convincing. Surely writing has facilitated an explosive growth in human knowledge stored in libraries, data banks, and other places. This growth in stored knowledge, along with the growth in size and role differentiation of modern society, makes learning even the small fraction of knowledge one must have to be a competent member of society a staggering task (D'Andrade 1980:2-3). And writing has changed many activities, such as most of the arts: the act of composing music, and of writing poetry and plays is now usually separate from the performance. This is so much so that Aaron Copeland noted recently that, as a composer, conducting for him was a great joy -- "... it might not be as good as somebody else's interpretation, but nevertheless it's the way you thought of it". And the performance of performances, as with the performances of many tasks, has changed radically with the advent of writing. It is hard to take exception to Goody's arguments on these topics.

It is Goody's extension of the argument to cognition itself that I want to question. His argument is very subtle: writing reinforces the cognitive facility to represent concepts by symbols (words) which can be moved around into lists, tables, and formulae. In purely oral speech one is always in the "flow of speech", and rarely conscious of individual words (Goody 1977:115). Writing, on the other hand, allows one to reflect on concepts, operate logically on them, and categorize them.

This view of Goody's is congenial with the view of language and cognition which was dominant in the 1960's. In anthropology frames which could be elicited in speech were used to generate lists, tables, and formulae which were thought to accurately reflect cognition. If this activity is a fundamental part of cognition, then surely Goody is right in thinking that writing reinforces an important type of cognitive activity. In anthropology and in transformational linguistics meaning was seen as being composed of the semantics of individual words (often representable in feature notation) plus the logical functions operating on the different parts of the sentence generated by the syntax. It was a view of language and cognition which was very precise and operational. Even anthropologists occasionally used the expression "machine translation" to express the ultimate goals of cognitive science. Again, if this is cognition, writing should train and expand it.

In the 1970's another view of the relationship between language and cognition asserted itself. This position was not new; F. C. Bartlett stated it in 1932, and it has always had advocates in some areas of philosophy. In essence this view argues that the main "work" in communication involves memory structures (schemas) often loosely connected with language. Semantics is thus demoted to the accessing of memory schemas. As I once put it,

> In schema theory the job of semantics is not to completely define words, but rather to show how words are related to memory schemas in the interpretation of sentences. When two people are talking they use arbitrary sound signals, words in sentences, and there must be some basis for agreement between them on what knowledge the words and sentences refer to. Semantics is the basis for this agreement. (Gladwin 1972, 3-5)

Roger Schank's first presentation of the conceptual dependency model of processes underlying the production and interpretation of conversation, as well as the later work by him and his colleagues, (Schank 1972, Schank and Abelson 1977) also posited a much looser view of the relationship between phonology/syntax on one hand and conceptual structures (memory) on the other. A branch of transformational linguistics, generative semantics, grew ever more elaborate semantic trees, which began to look more like models of cognitive process than semantic operations closely tied to syntactic and phonological rules. Few of these cognitive researchers deny the brilliant achievements of Chomsky and his followers in syntax and phonology, but they argue that the syntactic and phonological structures of speech are generated and interpreted almost automatically, outside the conscious attention of speaker or hearer. The thread of the conversation is carried by conceptual structures which seem unlike either syntactic trees or componential paradigms.

Recent work further emphasizes the focus on conceptual structures. Lakoff and Johnson (1980), argue that metaphor, a cognitive analogy, is fundamentally important in the production and interpretation of speech and text; Quinn (1980) has employed the analysis of metaphor in understanding the conversations of people about their marriages. Most current work on folk tales emphasizes conceptual rather than syntactic structures (Colby 1981). Brown and Suchman (1981) have argued that the powerful concepts underlying skilled technical behavior are based on qualitative comparison with devices which are known to work in ways similar to the device involved in the task to be performed. Precise quantitative calculation and logical deduction seem relatively less important than had been thought.

The Brown and Suchman argument has much in common with other work on cognitive structures underlying highly skilled behavior, work which departs markedly from the logic and language-based model of skilled, intelligent thought. It was once widely assumed that chess masters, for example, could operate logically and deductively on the symbols and tokens of chess to evaluate many moves ahead to the consequences of current possible moves. But Chase and Simon (1973) found that the first moves master players attend to are usually the best moves: "Masters invariably explore strong moves, whereas weak players spend considerable time analyzing the consequences of bad moves. The best move, or at least a very good one, just seems to come to the top of a master's list of plausible moves for analysis" (1973:216). They also found that the memory context in which best moves are "recognized" is associated with known board configurations; when presented with randomly generated board configurations masters did much worse than when dealing with configurations likely to occur in actual play.

The Chase and Simon study illustrates two *aspects of cognitive processes underlying highly skilled behavior which have recently been noted. First, the memories recalled are highly dependent on task environments (e.g. board configurations).* Work by members of the Adult Math Skills Project at U. C. Irvine (1979, 1980, 1981, Lave 1981) has emphasized the interaction of task environment and skill knowledge, interaction resulting in a notion of "situational memory" closely analogous to the memory of board configurations in the Chase and Simon study. The Brown and Suchman study emphasizes analogies between devices engineers (and copier operators) know and ones they are trying to figure out. Devices become well known in a given task environment. Second, the process of figuring out what to do in skilled behavior seems to work much more like a recognition task than a deductive task. One "sees" the situation of the task, and "recognizes" what to do, like the chess masters see the board and recognize what to do. Much of the actual problem-solving is accomplished preattentively and before the setting up of what Newell and Simon (1972) would call the "problem space": the problem that people attentively consider and can verbally report on.

At this point in my paper some readers are bound to object that cognitive processes underlying skilled problem solving may seem like recognition, and may seem to be environmentally situated, but a model of the competence required to perform the task need not be concerned with where a task is situated, or whether its performance is consciously attended to or not. This objection may or may not be valid (it's not the purpose of this paper to debate it). My argument is rather that attention and performance greatly affect learning, and in the long run would affect the cumulative expansion of cognitive ability that Goody argues writing brings about. In other words, it's hard to learn something you don't understand or are not aware of. The research reported on here argues that understanding is based largely on conceptual operations, like metaphor and qualitative comparison. And awareness of a task is usually of a task in its environment. It thus seems to me unlikely the "recontextualization" of task instructions, for example, to printed formulae or tables, will in and of itself improve learning or cognitive skills in general. It is less likely to facilitate learning if the task context is completely removed from the written dscription of the task itself. Furthermore, the task is almost certainly unlearnable if the conceptual operations fundamental to its performance are not presented.

The argument can be restated in terms of a distinction made by Roy D'Andrade at the Cognitive Science Conference last year in New Haven. He makes a distinction between what he calls "content based" abstraction and "formal language" abstraction. Content based abstraction is abstraction situated in one context. He illustrates content based abstraction with a chess example similar to the one from Chase and Simon cited above. Formal language abstraction "involves recoding the problem into a different symbol system" (1980:13). On the face of it, formal language abstraction appears like the 60's notion of semantics and cognition discussed above. It is certainly close to Goody's notion of what would be encouraged by the development of writing. But the "70's" position would take exception to D'Andrade's implicit assertion that *only formal language abstraction can be recoded to a different semantic domain.* If we take the view that semantics includes only pointers to and from memory structures, the recoding will take place in memory structures, not in semantics or formal language. Metaphors and Brown and Suchman's qualitative reasoning are much more likely candidates for memory devices which permit "abstraction" from one domain to another.

I am thus arguing that we are most of the time more like Goody's savages than domesticated people (excepting, of course, logicians and poets). Can the written word help a savage? It can, but only if it allows easy translation in terms of the powerful memory devices needed to perform a task. This is why, as D'Andrade notes, humans often have difficulty learning procedures which require formal language abstraction. In the Adult Math Skills Project we have found that important among of the powerful memory devices for performing measurement calculation and estimation are highly overlearned structures and operations in which the perception of a measure is associated with a quantity. We have called these "canonical units". An example would be knowing that a football field is as big as an acre. Unfortunately British/U.S. measure, while it does access canonical units, does not usually translate well. Most Americans do not know how many feet are on the side of an acre, or how many acres are in a square mile. The corresponding facts are probably known by a much larger proportion of the people who use hectares instead of acres. My argument, then, is that the use of the metric system might very well improve its user's cognitive procedures for spatial calculation and estimation. But I doubt if the ability to write down numbers in and of itself improves the ability to calculate.

There is one area (besides logic and poetry) where formal language abstraction and writing per se is important. That is the environment where formal abstraction and deduction is required whether or not it facilitates learning: school. But that is a subject for another paper.

I will conclude with a comparison of the Western and the Maya systems for calculating dates and elapsed time between dates. Both systems permit the generation of lists, tables, and formulae linking dates and events, operating calendars, etc. But the Maya system appears much more likely to have facilitated the "domestication" of the cognition of its users than the Western.

It should be first noted that the Maya were not so concerned as we are to be able to calculate to a given point in the solar year. In our system most everyone knows that January 1st falls at the same time in the solar year (i.e. in the same part of winter in the U.S.). They were more concerned with "translatability" in the sense that I have used it here. That is, they wanted to have the units of the calendar correspond to canonical units of time. They also wanted the units of time to correspond to basic arithmetic operations. An example of correspondence with arithmetic operations is the metric system of measure, in which most measures are multiples of ten, corresponding to a base ten arithmetic. For the Maya the 360 day year was sufficiently close to the solar year to serve as a canonical unit, and 360 translated both into the Maya arithmetic system and the calculations astronomers wished to perform.

Maya arithmetic is most commonly written in a bar and dot notation. Dots are units and bars are marks for tallying at five. Tallying at five is important for a commercially useful arithmetic since five is within the subitizing range (Klahr 1973, Adult Math Skills Project 1979). Given the growing appreciation of the importance of trade in Maya history (Rathje 1971), we can understand why a tally at five system was very useful. The abacus is another commercially used example of a system which tallies at five. An "integer" in Maya arithmetic is composed of a combination of bars and dots up to 19. This is followed by a shell-like figure for zero. The system is base 20, and the "digits" ("vigits"?) are usually written vertically.

Only a slight modification is then needed to bring the system into correspondence with the canonical units of time. The third "digit" is base 18 rather than base twenty, giving a unit of 360 days (the tun). The calendar thus has the following units:

baktun
400 "years"

katun
20 "years"

tun
one "year", 18 "months", 360 "days"

kin
one "month", 20 "days"

uinal
one "day"

What the metric system does for spatial and weight measure, the Mayan system does for time. Given two dates in the Western calender, on the other hand, it is a tedious task to figure how many days elapsed between two dates. Most people have to resort to counting. But in the Maya system calculation of the interval between two dates is done almost as easily as a user of the metric system can find the difference between 238 cm. and 5.126 m. More information on Maya arithmetic and calendrics can be found in Thompson 1960, Marcus 1976, Aveni 1976, and in the delightful but, alas, out of print book by George I. Sanchez (1961).

I can thus conclude that both Western and Mayan calendars heavily employ writing, list making, and tabulation. But I would argue that the Mayan system is a powerful amplifier of chronological cognition, while the Western calendar is not. Goody is right in seeing writing as "domesticating" the savage mind. But he is wrong in thinking the effect is global; it only works when the writing system translates powerful memory processes well.

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