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Memory and Markets, or Why Are You Paying \$2.99 for a Widget?

I. Introduction

The constraints introduced in the analysis of individual behavior in economics were mainly two: income and time. Although we do sometimes find references to biological constraints like stomach capacity (see Becker 1971, p. 54), it and other biological constraints' implications on market behavior were not investigated. The purpose of this paper is to show that consideration of the limited memory capacity of human beings sheds light both on specific features of literature and arts and on characteristics of advertising. In Section II the formal model, which is based on Becker's (1965) approach, is presented. In Section III the subject of advertising is discussed, while in Section IV we focus on the evidence from literature and arts. Section V contains the conclusions.

II. The Model

Our formal model is based on Becker's (1971) model of demand for basic commodities. The consumer is subject to two constraints: one on his total income, and the other on memory. More specifically, our consumer has a utility function:

$$U = U(Z_1, \dots, Z_n), \quad (1)$$

where Z_i are a set of commodities. Each commodity Z_i is "produced" by the consumer:

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$$Z_i = F_i(x_i, S_i, t_i, R), \quad (2)$$

where x_i is the input of purchased goods into the production of Z_i , S_i is the input of memory space, t_i is the input of time, and R comprises all the other "environmental" variables involved in the production of Z_i . The reason why memory space is an input in the production of Z_i can be rationalized in the following way: When producing a commodity in the household, a meal for instance, a housewife may either remember a recipe or look for it in a cookbook, a time-consuming and therefore costly activity, or buy a prepared meal, costlier in money than preparing the meal from scratch. Also, when buying the ingredients, she may either recall where she saw the lower prices or search for them. Thus the alternatives to memory are costly whether in time or money.

The consumer maximizes (1) subject to three constraints:

$$\sum p_i x_i = \omega t_w + V, \quad (3)$$

$$\sum t_i + t_w = T, \quad (4)$$

$$\sum S_i = S, \quad (5)$$

where p_i = market price of x_i , ω = wage rate of the consumer, t_w = time worked, T = time endowment of the consumer, S = memory endowment of the consumer, and V = nonwage endowment of the consumer. Equations (3) and (4) are not independent constraints and may be combined in one constraint:

$$\sum p_i x_i + \sum \omega t_i = \omega T + V. \quad (3')$$

Thus the consumer problem is to maximize (1) subject to (3') and (5).

The first-order condition of this maximization problem is of the form:

$$\frac{\partial U}{\partial Z_i} = U_i = \lambda \left(p_i \frac{\partial x_i}{\partial Z_i} + \omega \frac{\partial t_i}{\partial Z_i} \right) + \mu \frac{\partial S_i}{\partial Z_i}, \quad (6)$$

where λ is the marginal utility of money income, and μ is the marginal utility of memory. Equation (6) can be rewritten:

$$U_i = \lambda \left(p_i \frac{\partial x_i}{\partial Z_i} + \omega \frac{\partial t_i}{\partial Z_i} + \frac{\mu}{\lambda} \frac{\partial S_i}{\partial Z_i} \right), \quad (6')$$

where μ/λ is the shadow price of memory. Notice that $\Pi_i = p_i (\partial x_i / \partial Z_i) + (\partial t_i / \partial Z_i) + (\mu/\lambda) (\partial S_i / \partial Z_i)$ is the "full price" of Z_i , which takes into consideration the cost of each factor of production.

From (6') we can see how an increase in wealth will affect memory use. First, let us consider what happens when V , the nonwage income, increases. Then, if we assume that all the Z_i are normal commodities, the demand for each Z_i will increase as all monetary income is spent; thus both the value of goods bought and the time spent in commodity production will increase, and, *ceteris paribus*, the marginal productivity of memory is raised; memory becomes more valuable. Thus, in

household production there will be a shift away from memory-intensive toward more goods- and time-intensive production methods: More books, data banks, and so forth will be used in order to economize on memory. What happens to each and every S_i depends on the relative force of the income and substitution effects.

A rise in the wage rate, ω , would essentially have the same effect, except that in this case time also becomes relatively more expensive. Whether time or memory will become the relatively more expensive factor of production depends on the specific form of the production function. Production will shift toward more goods-intensive methods of production. Thus people with higher income tend to save on memory. This may explain why grandparents, placing a low value on time, told us fairy tales while our parents bought books to read from!

III. Advertising, or Why Are You Paying \$2.99 for a Widget?

It is frequently observed that quoted prices in department stores, TV advertising, catalogs, and so forth are of the form \$2.99, \$399, \$1,098. . . . Clearly, marginal cost pricing cannot explain these prices: The probability that most marginal costs are just 1¢ or \$1.00 below a "round" dollar number is very small. Two alternative explanations can be given to this empirical observation.

1. Suppose that a 5% proportional excise tax exists on sales of a widget sold at 99¢ apiece. The amount paid by the buyer will be \$1.04, while the tax due on the sale is 4.95¢, or 5% of the sale price. Thus, on each widget, the seller's profit is increased by 0.05¢. On 10,000 units sold, this would represent an added gain of \$500—the result of the practical indivisibility of the cent and of the assumption that each widget is sold separately. For, if the seller had sold 10,000 widgets to the same customer, this added gain would not have been made. But, if the existence of a proportional excise tax were the explanation for the occurrence of prices 1¢ below a round number, we would not observe this type of price wherever the price is stated in integer dollar, for 5% of, say, \$199 is \$9.95. But prices like \$199 are frequent. Thus, this is at best only an incomplete explanation of the phenomenon. Also, if the excise tax were the explanation, then prices such as those would not occur when either there are no proportional excise taxes or when, as in European countries, the posted retail price includes all the taxes. But this type of price is also frequent there.

2. Our explanation is based on the existence of the biological constraint, namely, that people have only a limited amount of memory and a limited capacity for storing directly accessible information.¹ Being

1. By this we do not say that people have a rigid biological constraint on their memory capacity: While this is constrained by biology, diverse means like associations, books, and computers are used as an extension of memory. But compared with the actual memory, which by analogy with computer science we would call direct-access memory,

exposed to a continuous flow of information on prices, people store in their memories the more valuable message, in this case the first digits of a number. For instance, when a price is \$398, the digit 3 is more significant as information than 9, which in turn is more significant than 8. Thus the consumer will act so as to remember first that the price is \$300, then maybe that it is \$390, but rarely that it is exactly \$398. The question which immediately arises is why people do not first round the number (in our example, to \$400) and then store it. The answer to this *critical* question may be found both in the way information on prices is today transferred to the consumer and in the fact that rounding upward involves *one more* decision than storing the integer part of the number (or rounding downward). One may draw a parallel with the way a computer works: Storing *the integer part* of a number in the direct-access ferromagnetic memory is a very simple operation which almost does not involve the attention of the operating system. On the other hand, rounding a number upward involves a more complicated procedure: A separate routine must exist which first must be fetched, then run by, the operating system. If we compare the conscious mind to the operating system, we see why rounding upward is a costlier operation than merely storing the integer part of a number.

Information on prices is transferred to the individual by visual or written means: Prices are advertised on TV, newspapers, or stores, and one may glance at them there. But immediately after the message, one is exposed to additional information: Either another TV advertisement follows or the program is resumed and the criminal is caught, or an article in the newspaper page absorbs one's attention. Thus the information on the price must be stored in a very short interval, and the cheapest way to do so, in memory and attention terms,² is by storing the first digits.³

If this argument is correct, one would expect that the smaller the number of goods in the economy, or the smaller the number of channels of communication, the smaller the probability of finding these types of prices in the economy, for people are less exposed to continu-

all the mechanical and electronical extensions are costly in either money terms (computers) or time (search in books). Moreover, the storage of information in artificial memories is itself a memory-consuming operation: In order to retrieve a piece of information, one must remember in which book or tape it was stored.

2. A survey on memory and the distinction between conscious and unconscious memory is presented in Jaynes (1976), although the main thrust of the book is flawed (see Brenner 1980a, n. 28).

3. One can argue that, once one has the catalog at home, one does not have to rely on memory. But consider the following scenario: A consumer receives the catalog and glances at it. Some time later, he sees one of the items in the catalog in a store at \$15. However, he recalls that in the Sears catalog it was "fourteen something." Of course, a consumer will remember numbers which he frequently uses more than numbers which he does not frequently use. And some numbers he will not round: phone numbers, e.g., are of no use if rounded.

ous information. This prediction is supported by the following casual empirical evidence: The occurrence of this type of price in the 1900 Sears catalog (1970) when both the number of goods available and the number of communication channels were smaller than today, is very small. On the other hand, they are frequent in the 1980 Sears catalog. Another result is that goods which have fewer substitutes on the market, like luxury goods on the price of which the consumer will thus be subjected to less continuous information, will be less likely to be priced in this pattern. Thus, a very expensive precious stone or an expensive fur coat or a Rolls Royce does not have a close substitute,⁴ and the search for them will not involve as many communication channels as, say, the search for a regular coat.⁵

Notice that the discussion on "conscious" and "unconscious" decision is relevant here: The meaning of the formalization of consumer's behavior in Becker's consumer-producer model (see Becker 1971, pp. 8-15) does not necessarily mean that one consciously decides at each step what to remember and what to forget. Such decisions may well be the result of customs and habits which are the optimal adaptation to one's environment.

If the scarcity of the memory resource of consumers plays this role in explaining some features of price formation,⁶ it could also help to explain another market feature: the specific characteristics of advertising. In the economic literature, there is controversy about whether advertising provides information⁷ or is a species of brainwashing (see Galbraith 1972). The empirical evidence for the brainwashing hypothesis is alleged to be the existence of frequent advertising messages for, say, MacDonald's, Coca-Cola, etc., which do not seem to provide any information. However, our previous argument can help to emphasize what kind of information is provided by these messages: Our capacity to remember is limited, and knowledge stored in our memory, like any other capital, depreciates (we simply forget things).⁸ Thus, reminding us of brand names and products does provide us with some information. Indeed, the term "information" does not necessarily refer to "new" information: What we once studied is also stored in textbooks and encyclopedias, but retrieving this knowledge is time-consuming.

4. This can be casually observed in the 1970 Neiman-Marcus Christmas catalog: A fur coat is \$100,000; jewels, \$5,000. On the other hand, a nightgown (item with more substitutes) is priced at \$19.95.

5. One can also argue that the prices discussed here may help in advertising: One can claim that all one's prices are below \$10, which may mean nothing more than that all one's prices are \$9.99. But basically, this explanation is similar to our own: Implicitly, it is based on the assumption that people will *remember* the below \$10 statement.

6. The role of scarce memory as explanation of distinctive features of primitive societies has been investigated by Brenner (1980a) and Posner (1980).

7. For a review of the controversy, see Comanor and Wilson (1979).

8. In part because we are constantly exposed to new information.

We use memos and shopping lists and even banks to remind us of relative's birthdays (for a fee), all this information which is not "new."

Also, the role memory plays in one's allocation of resources can explain why advertisements are accompanied by a catchy tune or a catchy line (another form of music) or made by a public figure. According to some preliminary experiments, rhythm, rhymes, and associations facilitate the memorizing process (see Brenner 1980a). Thus, consider the frequent messages in praise of MacDonald's and their possible role: People who had already decided that MacDonald's is a good alternative to having a meal at home will "file" this information. The advertising may only be a way of reminding one of an opportunity which he did not necessarily have in mind. Without the message, the possibility that the information will be lost exists. Thus, in this role also advertising provides information and is not brainwashing.

These arguments may also shed light on an additional controversy in the economic literature.⁹ Some argue that advertising causes a movement *along* a demand curve; others argue that the demand curve shifts, and thus elasticities are irrelevant for discussion on advertising. Both statements may be correct—*depending* on what is exactly the price we take into consideration when we speak about the demand curve. If we speak about the "full price" of the commodity, as defined in Becker (1971), which also includes the shadow price of the memory used, then advertising lowers this price and we move along the demand curve. In this case, elasticity is relevant to the discussion. However, if one looks at the demand curve as a function of the quoted price, then advertising shifts the demand curve, and elasticity is irrelevant to the discussion.

IV. Memory, Arts, and Literature

The role memory plays in the information or the communication market (and advertising is just one branch of this market) comes to the fore when we examine societies which were illiterate. In these societies, all knowledge, accumulated for generations, was stored only in human memory. These societies were relatively isolated, the number of participants in the exchange of goods and services relatively small—we would thus expect them to be illiterate. For the benefits of literacy are relatively low where the stock of knowledge can be transmitted by face-to-face oral and visual communication.¹⁰ The benefits from literacy increase when population or its mobility increases, or a once-isolated economy is opened up to international trade.¹¹ In these

9. See, e.g., Goldschmid et al. (1974), pp. 156–57.

10. This relationship is discussed in Brenner (1980a).

11. Empirical evidence supporting this relationship is presented in Brenner (1980a); also see Goody (1968), p. 207.

cases, the costs of face-to-face communication increase, decreasing the relative, or the shadow price, of writing. In order to support our argument on the role memory plays in understanding human behavior and the allocation of resources, we must therefore look at writings which preserve oral cultures and at features of information markets in such cultures, contrast them with the writings and features of information markets in literate societies, and show that some of the differences correspond to the predictions of a model which introduces the constraint of a limited capacity to memorize.¹²

Since only memory fulfills the role of "human capital" in illiterate societies, in contrast to literate ones where this capital is also embodied in books and computers, we would expect technological innovations in speech and in the education of youngsters which facilitate memorization.¹³ The drum is mentioned in anthropological studies as one of the principal instruments possessed by primitive societies, or a rhythmic clapping of hands is mentioned as a background for songs.¹⁴ The reason for these characteristics is that rhythm facilitates memorization of songs and rituals. It is also noted that songs consist of monotonous refrains which are chanted hour after hour, until they would drive anyone but a member of such a primitive society to absolute distraction (see Hambly 1926, p. 47). Again, this evidence fits the prediction of the hypothesis: Repetition facilitates remembering rituals, songs, and so forth. In another context, Goody found that, among the LoDagaa of northern Ghana, the days are reckoned according to the incidence of neighboring markets; the very word for day and market is the same; the "weekly" cycle is a 6-day revolution of the most important markets in the vicinity.¹⁵ In English and French, the names of weekdays are derived from names of deities, the moon, and the sun. The explanation for these phenomena is the same as given in the previous section: Associations facilitate acquiring a stock of memory.

That speech in primitive societies was different from today's has been emphasized by many anthropologists, and Posner (1979) has attributed the difference to the lack of privacy. The hypothesis advanced here sheds light on another aspect of the specific technology of speech: Since this was the way knowledge was transmitted, we would expect this art of communication to be developed and elaborated. The Homeric epics are not unique empirical evidence of the decorum of

12. The discussion that follows is based on Brenner (1980a), sec. 2.

13. See Becker (1970), pp. 129-34, on the relationship between the relative price of a good (in this case, oral communication) and technological change in that good (in this case, speech).

14. Repetitions, associations, and categorizations facilitate memorizing; see Farb (1978), pp. 319-27; also see Hambly (1926), chap. 1.

15. See Goody (1977), p. 30. Also, notice that prayers today still consist of rather monotonous singing and not a few repetitions.

speech of what was first oral poetry.¹⁶ Parry (1951) has found the same type of evidence in another oral culture, represented in the Yugoslavian ballads. Lord (1960, p. 20) also found that it is the illiteracy of the epic singers "which determine[s] the particular form their composition takes and which distinguishes them from the literary poet. In societies where writing is unknown . . . the art of narration flourishes, provided that the culture is in other respects of a sort to foster the singing of tales. . . . On the other hand, when writing is introduced . . . this audience seeks its entertainment and instruction in books rather than in the living songs of men, and the older art gradually disappears." Ong (1971, p. 49) has argued that rhetoric, which means the art of composing as well as delivering a speech, was "the art developed by a literate culture formalize the oral communication skills which had helped determine the structure of thought and society before literacy." That rhetoric also meant the art of composing stems from the fact that oral transmission could hardly be verbatim, and the deliverer of songs or of the history of the tribe generally made adjustments which fitted the circumstances.¹⁷

Three further implications of the role memory has in isolated, illiterate societies should be emphasized:

1. We would expect old people to be respected (i.e., to be considered more valuable) since they embody the stock of knowledge.¹⁸ This is, indeed, a common feature of all agricultural and fishing primitive societies.

16. Here, however, I must note a rather startling theory which was offered by Jaynes (1976) to explain this same set of phenomena: the fact that people in the past memorized, the ornamented language of the Homeric epics, and so forth. He writes: "(W)hen musical accompaniment is no longer used, as it is not in later Greek poetry, it is, I suggest, because the poem is no longer being sung from the right hemisphere. . . . It is instead being recited from left hemispheric memory alone, rather than being recreated in the true prophetic trance. This change in musical accompaniment is also reflected in the way poetry is referred to . . . (M)ore early poetry is referred to as song (as in the *Iliad* and the *Theogony*), while later poetry is often referred to as spoken or told" (p. 369). Jaynes explains this change, as well as the start of civilization, by a rather abrupt biological mutation. He emphasizes the role memory played in primitive societies and the role "rational" thinking plays in modern societies. Our analysis shows that no such drastic (and rather implausible) assumption is necessary to explain the fact that primitive men mainly memorized. In those conditions memorizing was simply efficient.

17. Lord (1960) shows how a young man gets acquainted with the art of metrical singing not by verbatim remembering but by constructing a song out of phrases, themes, and narratives that he has heard before. "The singer cannot and does not remember enough to sing a song; he must and does learn to create phrases" (p. 43).

18. See Hambly (1926), chap. 5. Also, Hayek (1973) wrote: "Another consequence of this basic fact . . . is that only in the small groups of primitive society can collaboration between members rest largely on the circumstance that at any one moment they will know more or less the same particular circumstances. Some wise men may be better at interpreting the immediately perceived circumstances, or at remembering things in remote places unknown to others. But the concrete events which the individuals encounter in their daily pursuits will be very much the same for all, and they will act together because the events they know and the objectives at which they aim are more or less the same" (pp. 13-14).

2. What constitutes history would have a different meaning than it has for us. Although the limited amount of information that can be stored in a human mind implies that information which is not relevant will be forgotten, the process of generation continuously lengthens the line of genealogy. However, if the population is stable despite its increasing length, the genealogy may refer to a constant number of ancestors. Goody (1968, p. 32) takes note of this genealogical shrinkage; it has been confirmed by many studies of primitive societies.

3. The third implication is suggested by the statues of the gods in primitive societies, which seem to have one element in common: They always have some unusual characteristic—disproportionately big eyes or mouths, eight legs, several hands, and so forth—in contrast to the Greek or Roman gods, who have rather human shapes. This basic similarity also exists between mythical animals from different societies. The griffin, phoenix, centaur, sphinx, mantichore, Ganesha, and Ch'i-lin have one common characteristic: They are all creatures consisting of familiar parts in unfamiliar combinations. This pattern can also be related to the role memory plays in such societies, since it is easier to remember unusual shapes than ordinary ones.¹⁹ However, once societies become literate, this task of memory is less important since one can remember the gods by reading the texts they have dictated rather than by their visual forms. In a further study, this issue of myths and religion will be more closely examined.

That the existing stock of knowledge is stored in memory rather than in written texts has further implications: Since memory is subject to depreciation (we simply forget things), in each generation the stock of knowledge will slightly differ from that of the previous generations. The process which takes place is of the following type: "A person appeals to a shrine and perhaps obtains relief from suffering, but then witchcraft is seen to return because children still die and people fall ill. . . . [Then one] may switch one's attention from one aspect of a deity to another. This latter solution is adopted in many simple societies and accounts for the turnover phenomena, the circulation of certain types of shrine."²⁰ . . . The agents who introduce or invent these new shrines are often responding to the pressures from below, the demand for new ways" (Goody 1977, pp. 29–30). Or, in the case of ordinary songs, the

19. Farb (1978) notes that "(t)he full recollection of an experience can be triggered . . . by evoking the symbol for it" (p. 326), and he gives Proust's *Remembrance of Things Past* as an example; he also refers to several articles in the psychological literature supporting this view. Also, notice that the point made in the text is related mainly to the fact that association facilitates memory, and association can be achieved only (by definition) with an unusual, rather than an everyday, phenomenon or object.

20. Consider also the Bible on the Sinai episodes, where the Jews shifted from God to deities whenever their expectations were not fulfilled. Many inconsistencies in the Bible can probably be explained by the approach advocated in this study—this would, however, be the work of a lifetime.

process found by anthropologists was this: "[A] young man gets acquainted with the art of metrical signing, not by verbatim remembering but constructing a song out of the phrases, themes and narratives that he has heard before. The singer cannot, and does not remember enough to sing a song; he must and does learn to create phrases. So phrases get adjusted; there is no rigidity in what he hears and certainly none in what he does."²¹

The meaning of such demands becomes clear from the following examples: (a) Goody describes this evidence from Nigeria. The British administrators, being aware of the importance of genealogies, wrote them down. Forty years later, the natives maintained that they were incorrect (see Goody 1968, p. 32). The explanation consistent with the hypothesis presented here is this: The knowledge stored in memory was readjusted to the existing marriage pattern, eliminating members of the tribe who had left and remembering only those who mattered for the present pattern of social relationship (for insurance or other purposes). (b) At the beginning of the century, some myths in northern Ghana were recorded. The founder of the state at that time had, according to the myths, seven sons. Sixty years later, the myths mentioned only five. An examination revealed that one division of the tribe had become separated by boundaries set by the British, and another had been absorbed by a neighboring tribe (see Goody 1968, p. 33). This points out that, when knowledge is stored in memory, history becomes a flexible tool serving the present rather than a mere collection of data.

These arguments also shed light on why the first written documents of civilization abound in inconsistencies and contradictions, dates are rarely mentioned, and the concept of time is rather blurred. The explanation for these characteristics stems from the same source: These are written documents which preserve the form and style of oral communication at one particular time, and when communication is oral, it is relatively hard to discover inconsistencies. Goody, for example, writes: "Members of oral societies find it difficult to develop a line of sceptical thinking about, say, the nature of matter or man's relationship to God simply because a continuing critical tradition can hardly exist when sceptical thoughts are *not* written down, *not* communicated across time and space, *not* made available for men to contemplate in privacy" (italics in original).²²

21. Goody (1977), p. 117. On pp. 26–27, he writes: "If the reader interprets oral learning as listening to something repeated in exactly the same form many times, if he equates it with oral memorization by rote, then he will fail to grasp the peculiar process involved in learning oral epic. . . . (W)ith oral poetry we are dealing with a particular and distinctive process in which oral learning, oral composition and oral transmission almost merge." The same point of remembering things depending on their utility is made on the various methods of calculation on pp. 13–14.

22. Goody (1977), p. 43. The issue of privacy is also noted by Posner (1979), and its precise definition is given in Brenner (1980a, 1980c).

Also, if the first texts with which we are acquainted today were written down in different periods when most of the population was still illiterate, we would expect to find inconsistencies; while the oral text was adjusted to replace depreciated knowledge, the written document preserved the "objective" past. That the concept of time is unclear is related to the fact that it is hard to memorize lists (see Goody 1977, chap. 5), and so the history we find is that of relationships or some specific phenomena or special events.

Finally, one further empirical piece of evidence should be mentioned which supports our hypothesis. Since it is easier to memorize texts with rhythm and rhyme, we would expect that the first written documents we are aware of would be lists, accounting sheets, and laws rather than literature or poetry. Goody, for example, writes: "... literary documents in any quality did not appear till the first half of the second millennium, that is, at a time when Sumerian was no longer a spoken language but only a written (or 'dead') one. . . . Even in Assyrian times it is not the main 'stream of tradition,' either in the form of literary creations or the recording of myth and folktale, but rather the administrative and economic documents including deeds of sale and purchase, rental, loan, adoption, marriage bounds, and wills together with the ledgers, lists and memoranda of shopkeepers, secretaries and bankers . . ." (Goody 1977, pp. 79-80).

V. Conclusions

The purpose of this paper was to show that additional insights can be gained in understanding market, in particular communication market, behavior by introducing into the individual's maximization problem the existing biological constraint on our memory capacity. The predictions stemming from a model which takes into account this constraint shed light on specific features of ancient oral cultures as well as on characteristics of modern advertising, which is just one particular branch of the information market.

Although the economists did not pay much attention to these constraints, other social scientists did. Lévi-Strauss (1968), for example, noted that people in primitive (meaning illiterate) societies invest much time in memorizing: "I see no reason why mankind should have waited until recent times to produce minds of the caliber of Plato or an Einstein. Already over two or three thousand of years ago there were probably men of a similar capacity, who were of course not applying their intelligence to the solution of the same problem as these most recent thinkers; instead they were more interested in kinship" (p. 351). Lévi-Strauss, however, does not note that this situation is a result of the relationship between literacy and population size, namely, that when people live in small isolated communities, all information can be conveyed efficiently by face-to-face communication, in which case the

benefits of literacy are small,²³ and kinship plays more important roles (see Brenner 1980a, 1980c; Posner 1980).

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23. One probably could follow this analysis one step further and argue that we have a limited capacity to transfer information by gestures. The shadow price of "speech" in this case decreases when population increases.

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