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## Its Impact on Commercial Activity in Eritrea

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**Abbebe Kifleyesus**

IN SOCIETIES where numeracy or numeration is limited to a small minority, calculations are effected through the art of narration. Thus memory is here used to store socially and culturally salient information which can be semantically retrieved from their base linguistic forms within previous experiences (Ong 1978 : 14 ; Lakoff 1982 : 56). Following Crump (1982 : 121) and Friberg (1984 : 79), I distinguish two senses of the term numeracy. In an anthropological context, numeracy usually refers to the cultural fact that calculation using a written numerical system has been invented and that a segment of the society uses it for some specific purposes (Bennett 1973 : 604 ; Barnes 1982 : 14). Used in this sense, numeracy implies the contrasting idea of prenumeracy – a cultural stage in which calculation using numbers has not yet been invented or used. Brainerd (1985 : 106 ; 1987 : 242) and Menninger (1969 : 33-34) adopt this interpretation and offer an excellent discussion of the evolution of numeracy and its spread throughout the world. An intermediate stage of semi-numeracy is also recognised and

Preliminary ethnographic field research for this study was conducted in the towns of Mendefera and Áddi Khwala in Eritrea during the summers of 2000, 2001 and 2002. Archival research in Paris was made possible through a generous summer 2005 fellowship from the Maison des sciences de l'homme.
Without the cooperation, patience, and understanding of several of the Jeberti women traders I interviewed, the recording of the indigenous processes of calculation would not have been possible. From our intimate contact spread over the stretch of the whole summers of 2000, 2001 and 2002, all the consultants I interviewed in the market places of Mendefera and Áddi Khwala kindly accepted and answered the endless questions I asked. The collection of the data and much of the analysis are results of their contribution and collaboration. It is only because I have imposed my own form upon the data in order to provide it to professionals in the academe that my consultants appear not as co-authors, but as consultants. Otherwise I wish to confirm to the reader that the study is a product of a joint endeavour.

has been extensively studied by Bloor (1983) and Davis (Davis & Hersch 1983). When the implied contrast of numeracy is innumeracy, the referent is the degree of dissemination among a society's population of the dual skills of reading and writing as well as calculating using given numbers (Gay & Cole 1977 : 102). In this case, a numerate society is one in which most adult members can read and write numbers and engage at least in simple calculations. While the anthropological interpretation is often used to characterise variation in cultural tradition, the other is more commonly used in differentiating individuals or groups within the same population (Godelier 1974 : 19) [1].

## Numeracy and Innumeracy

Although much of the distinction made between non-numerate and numerate culture is largely speculative due to the absence of sufficient empirical investigations, many students and scholars of numeracy would agree to a few distinguishing features. Some of the distinctions usually made include those between oral and text transmission of mathematical knowledge (Hodes 1984 : 133 ; Hurford 1975 : 73) ; between numerical knowledge encoded for storage, retrieval, and reuse (Lancy 1983 : 16 ; Hurford 1975 : 29) ; between context-bound mathematical messages and decontextualised discourse (Lave & Taylor 1985 ; Sherzer 1987) ; between particularistic and generalistic mathematical lexicon and indigenous naming systems (Buckland 1986 : 98; Crump 1985 : 140) ; between high preoccupation with native number systems and concerns with written technicalities and aesthetics of numbers (Parry 1985 ; Hallpike 1979 : 22) ; and between a homeostatic organisation of cultural traditions and a tendency toward cumulative storage of numerical knowledge where events and cultural traditions are viewed as a continuum in time and space (Cole & Service 1981 : 73 ; Moroney 1961 : 15). Resnick and Ford (1981 : 85), Reed and Bernard (1979 : 875) have rightly pointed out that in the former (homeostatic) system only history that can be evoked in validation of ongoing events is considered useful. They argue that, because of the absence of a fixed reference point (such as provided by numbers), words, events, or myths could not accumulate the kinds of successive layers of historically validated meanings or sanctions that they acquire in a numerate culture (cf. Terray 1995 : 72). There are yet other

1. It should be noted, however, that the distinction between the two is being blurred by the existence of some numbering system or some numerate individuals in the majority of contemporary societies (see, for example, Bloch 1968 : 283 ; Amselle 1972 : 36 ; Launay 1982 : 51).

distinctions, such as those between negotiable oral-based numerical rules and inflexible text-based numerate regulations (Cook-Gumperz & Hudson 1978 : 64).

It should be stressed, however, that the distinctions made here are generally in degrees of more or less rather than of all or nothing. For one thing, all the distinctive features need not be present at all times or in the same degree in all cultures. For example, innumerate or oral cultures vary greatly in their methods of storage of numerical information (Vansina 1961 : 41 ; Clanchy 1979 : 48). Consequently, we should be able to talk about different types of innumerate or of numerate cultures according to variation in the salience of the distinctive features we have identified. Finally, as argued elsewhere in this study, cultural and contextual variations in the uses of reading and writing of numbers, the ubiquity of numeracy, and the widespread diffusion and persistence of aspects of innumeracy in numerate societies, all point not to a dichotomy, but to a multilayered continuum in which innumerate and numerate traditions blend and reinforce each other (Goody 1968 : 16). Although the causes of innumeracy are outside the scope of this study, it will be pertinent to mention a few. Perhaps the most important cause of adult innumeracy today is the poverty of the countries most afflicted and their inability to provide schools, teachers, facilities, and equipment for formal education. All over the world, one-half of those of school age are not in school ; and in half the countries of the world, one-half of the children enrolled in school fail to complete the primary level of education (Restivo 1981 : 681 ; 1982 : 135). This must lead to a discussion with regards the nature of numeracy. Put quite simply, what does the acquisition of numeracy involve, or what is *numerate knowledge* ? To recapitulate Crump (1978 : 511) again, it is knowledge sought from written numbers. To acquire this kind of knowledge, one fundamental cognitive insight is needed : that written numbers are meaningful and that with the introduction of numbering systems, the basic character of the storage and transmission of knowledge has altered (Rogers & Garretson 1976 : 197). Indeed the process of acquiring numerate knowledge requires a separation between the transmission and acquisition of mathematical knowledge and the processes of daily life (Bloor 1985 : 64-65).

As in any developing country, given the yearly population increase, innumeracy in Eritrea is bound to be a problem, operating in a vicious circle : child innumeracy results in adult innumeracy ; many of the adults in turn produce innumerate children. Moreover, most people of Eritrea live in scattered rural areas for which it is either too difficult to provide schools or impossible to provide mathematics teachers with adequate incentives to maintain existing schools. All over Eritrea, statistics shows that the highest incidences of innumeracy are usually to be found among women, and the rural poor (Ministry of Education 2003 : 4).

In Eritrea, as elsewhere I am sure, such knowledge is usually acquired through special schooling. Indeed, as Goody has rightly suggested in *The Domestication of the Savage Mind* (1977), the potentialities for graphic representation offered by numeration promotes unique classificatory skills. Yet, as Heath (1980) and Street (1984 : 85 ; 1993 : 32) have noted, there is recognition of variation in the cognitive consequences of numeracy according to variation in cultural context and that different forms of numeration activity require different kinds of intellectual operations. This means that encounter with expository text is not the only way in which numeracy could promote conceptual or logical skills, and more importantly, numeration does not necessarily promote general mental abilities instead it is a form of social practice with a multiplicity of values, uses, and consequences (Goody &Watt 1973 : 321 ; Scribner & Cole 1981 : 45). As a result, claims about the creation of new cognitive structures by numeracy will remain as wild speculations until it can be proved that certain cognitive structures are peculiar to particular numerate populations or individuals and that such structures came into being at a specific period of time after, and as a result of, the inception of calculation using numbering systems (Finnegan 1973 : 131 ; Akinaso 1981 : 1001-1002). Similarly, non-numerate cultures and individuals do not necessarily lack the insight and inspiration – the modes of thought – that we normally associate with societies that possess written numbering systems (Vygotsky 1972 : 53).

The argument that the presence or absence of widespread literacy constitutes the central criterion to distinguish *savage* from *domesticated* society, to use the words of Goody in a number of works (1968, 1969, 1977, 1980, 1986, 1987), makes close association between numerical literacy and the growth of mathematical knowledge and between restricted numeracy or unwritten numerical systems and traditional societies. In this study, I shall challenge these associations by presenting material from a Muslim trader society in Eritrea, in which the milieu of innumeracy or mathematical illiteracy is creative and does not lead to the revision of basic mathematical tenets. Second, I shall deal with some of the reasons for the vitality of innumeracy, concerning myself principally with the impact of unwritten numerical systems on the commercial activity of a Muslim Jeberti trader society in Eritrea.

A consideration of mother/daughter home-based traditional education in indigenous numeration and acculturation is vital for an understanding of the impact of innumeracy on commercial activity. Indeed, the specific case I wish to consider in order to elaborate these points is trade among the Muslim Jeberti of Eritrea. My principal reason for selecting Jeberti society for this study is due to the fact that among the Muslim Jeberti unwritten numerical systems are well understood and transmitted orally from mothers to daughters across generations. It is expected, therefore, that the differences we find in the use of unwritten numerical systems will stem from cultural approaches to innumeracy rather than the impact of innumeration itself. This means that a clue to the problem might be found in the way the Jeberti look at innumeracy and how the transmission of unwritten numerical systems of calculation is not considered uninspired, not learning which has little or no innovative dimension, but that it is a fluid process that involves individual invention and interpretation which eventually is crystallised in already existing and continuing tradition of oral numeration and computation.



For example, one of the startling facts of rural Eritrea is the ability of illiterate Jeberti women traders to deal effectively with customers who are illiterate like themselves and with shopkeepers who not only are literate in numbers but often also skilled in the traditional arts of unwritten calculations. This study analyses calculations executed by illiterate and unschooled women traders who like many of their illiterate neighbours, have devised an arithmetic of their own. The women traders are able to solve problems that require the use of both whole numbers and fractions and a variety of calculation techniques woven together into a single coherent strategy. In order to understand their ability to solve a mathematical problem of the complexity presented in this study, one must examine the underlying system of manipulative counting techniques, several arithmetic operations, three scales of magnitude, and the rules of conversion from one scale of magnitude to another. These issues will emerge from the material to be presented, but I shall for the moment deal exclusively with the numeracy/innumeracy debate in anthropological theory.

## Theoretical and Methodological Assumptions

The increased attention given to the study of numeracy and its consequences in the last few decades has important implications for anthropological theory. Indeed, in almost every aspect of human learning, the spread of numeracy and its attendant problems have altered or modified traditional methods of inquiry (Cippola 1969 ; Clammer 1976 ; Basso 1980 ; Goody 1980 ; Crump 1992). Hence numeracy or numeration has had a long history within the discipline of anthropology and anthropologists used it as one of the criteria for dichotomising societies according to degrees of civilisation (Portnov 1973 : 41 ; Oxenham 1980 : 116). However, it is only in the last few decades that ethnographic interest in systems of numbering started to accelerate. Perhaps most problematic for contemporary professional anthropology, is the effect of numeracy on sociocultural data and their interpretation (Colby 1966 : 10 ; Hymes 1974 ; Hammel 1975 : 221). The anthropologist is torn, as it were, between what the consultants say, what the records say, and what he or she thinks the consultants actually say and mean. And the problem seems to increase exponentially with the numeracy level of the consultants. Besides its effects on anthropological theory and methodology, numeracy has, by itself, nowadays become a fashionable subject of inquiry in anthropology (Crump 1992 : 1-14)[2].

The use of written numbers is instructive when considered in the context of Goody's approach to literacy, which stresses the place of writing in the rise of civilisation and the growth of knowledge and, in particular, in its place in the issue concerning the differences between Western and traditional societies (cf. Postill 2003 : 80). Goody and Watt, in « The Consequences of Literacy » (1973), and later Goody in *The Domestication of the Savage Mind* (1977), reject both the dichotomies drawn between the primitive mind and rational thought and the reaction against such dichotomies that denies any distinction between societies in terms of reason and rationality. One such distinction between forms of knowledge that Goody isolates for particular attention is that drawn by Levi-Strauss in *The Savage Mind* (1976) which opposes *savage* and *domesticated* or *cold* and *hot* systems of thought[3]. These correspond generally to styles of cognition that apprehend the universe in a concrete, practical, and immediate way common to savage societies and the abstract, detached, and formal style common to modern technologically advanced societies (Illich 1991 : 129). Goody rejects the blanket dichotomisation characteristic of Levi-Strauss' approach and reformulates the problem through an elaboration of the contrast between oral and literate or, as in the present study's case, numerate culture. Alphabetic literacy, which is equivalent to written numerical systems, he suggests, is responsible for the growth of knowledge because it makes permanent the relationship between the word or number and its referent, making it possible to scrutinise mathematical language and

2. In organising and analysing what I have learned from the Jeberti women traders in these towns, I found most of the anthropological literature, Crump's works in particular, I consulted invaluably insightful.

3. In other words, writing or numbering can both stimulate and suppress creative knowledge, not because of widespread or restricted literacy and numeracy, but because of different social and cultural approaches to the writing of words or use of written numerical systems.

subject the ideas it communicates to criticism and revision (see also Hildyard & Morton 1982 : 109) :

> « No longer did the problem of memory storage dominate man's intellectual life ; the human mind was freed to study static "text"… a process that enabled man to stand back from his creation and examine it in a more abstract, generalised and "rational" way » (Goody 1977 : 37 ).

Knowledge and rationality will not develop, however, in every sociocultural context in which writing or numbering is found (Sahlins 1976 : 22 ; Fairclough 1989 : 29). In *The Domestication of the Savage Mind*, Goody mentions two opposed consequences of the permanency of ideas that writing and numbering bring about : « criticism and commentary on the one hand and the orthodoxy of the book on the other » (1977 : 38). He deals with this apparent contradiction by citing the widespread and pervasive influence of restricted literacy and numeracy, in which writing or numbering are limited to magical and religious uses, and the meaning of words or numbers is penetrated, if at all, by a small minority of specialists. Under what conditions, then, do literacy and numeracy foster the growth of knowledge, the shift from myth to history, and the growth of complex bureaucracies and complex cultures ? As Goody says, writing and numbering traditions, although significant, are of course neither sufficient nor the only conditions necessary for the growth of knowledge. Only in particular sociocultural contexts will the constraining influence of restricted literacy or numeracy be overcome and the full impact of literacy and numeracy be felt. Those Goody cites most frequently are societies in which alphabetic and, by the same token, numerical literacy are fully developed and in which the ability to read and write words and numbers has much wider distribution than merely within scribes or other minority specialists.

What happens to the association between numeracy and the growth of knowledge when we find instances of widespread numeracy in which the meaning of written numerical material is understood by many but the « orthodoxy of the book » (Olson 1980 : 193) is nevertheless maintained without the systematisation and accumulation of ideas ? This possibility is vital for the theory of literacy that Goody proposes ; for if the impact of literacy is intimately bound up in the social structure or social conventions, then we must look elsewhere for the most significant conditions that lead to the growth of knowledge. *The Domestication of the Savage Mind* unfortunately does not elaborate on this problem but focuses on the positive impact of literacy on the development of critical thought and on the bureaucratic structuring of civilisations. The two do not always go together. This one-dimensional treatment of the relationship between literacy and innovation has left Goody open to the argument that he is treating writing systems as neutral technologies rather than social products (see Street 1984 : 56 ; Bloch 2003 : 101). Parry's (1985 : 17-18) commentary on Goody's work focuses on the brahmanical tradition in India in which widespread literacy and numeracy has not been associated with innovation, a situation similar, as we will see below, to that found among the Jeberti of Eritrea. Goody's critics have therefore focused principally on the excessively privileged status given to literacy and numeracy in the history of the growth of knowledge, on the tendency to make writing or numbering a necessary and sufficient condition for intellectual « take-off », and what Street (1984 : 16) has called the « autonomous model » of numeracy that fosters or enforces the development of logic.

Goody's more recent work on literacy, *The Logic of Writing and the Organisation of Society* (1986) and *The Interface between the Written and the Oral* (1987), puts less emphasis on the place of literacy in the great divide between the cognitive styles of societies with alphabetic writing systems and those without. Rather, he considers a wide range of social impacts of literacy and, by implication, numeracy. In the first book, he looks at the implications of writing and numbering for the development of early forms of religion, the economy, the state, as well as bureaucracy and law ; while in the second book, he discusses early alphabetic systems and early bureaucratic states as well as oral poetry, Islamic literacy and numeracy, and European schooling in West Africa. This work has a scope that defies comprehensive commentary. It does, however include an important theme – the « orthodoxy of the book » and its place in literate societies – that gives us the opportunity to re-evaluate Goody's earlier distinctions between oral and literate or numerate societies. In discussing the non-innovative static uses of writing, Goody again stresses the relationship between religious and literate orthodoxy. In contexts in which the book is a repository of sacred truth, literacy will act as a conserving force. It is, for example, « the fact that Islam is a written religion that makes and preserves it from disintegrating, not just into breakaway sects, but into numberless "local cults" » (Goody 1987 : 133 ; see also Kaba 1974 and Eickelman 1978).

The impression given so far is that numeracy or written numerical reference is everywhere beneficial to the recipients and the populations at large because it promotes classificatory and logical skills as well as the potentials for the cumulative storage of knowledge and the possibilities of accurate retrieval (Hodes 1984 : 128). In this regard, Menninger (1969 : 59), Reed and Bernard (1979 : 871) have rightly argued that the change from oral to written transmission of numbers engenders a shift from a conception of mathematical knowledge as a constant state (which can be learned through various open methods of creative retelling) to a view of mathematical knowledge as incremental, that is, where new knowledge can be added to the recorded store of available mathematical knowledge (Bloor 1983 : 179 ; Hurford 1975 : 71). There is no doubt that it is this latter conception of mathematical knowledge that makes comparative and analytical research possible (Appel & Rice 1978 : 176).

It is this search for cross-cultural comparison which facilitated anthropological interest in folk systems of knowledge and cognition over the last three decades which in turn resulted refinements in methods, substantive contributions on folk taxonomies, paradigms, and trees (Colby 1966 ; Spradley 1972 ; Sturtevant 1972 ; Hammel 1975 ; Heath 1980 ; Lancy and Johanson 1981 ; Resnick & Ford 1981 ; Restivo 1981, 1982 ; Werner & Shefly 1984 ; Lave & Taylor 1985 ; Turner 2000 ; Parliwala 2005). Continuing work in formal theory in ethno-semantics in time enhanced our ability to examine cross-cultural differences in the logical structure of folk systems (Crump 1992). Yet, clearly, folk systems of classification and cognition, and analysis of the logic that structure them, do not exhaust what we would want to consider folk knowledge. There are other symbolic processes more complicated than that of classifying and contrasting that we have tended to ignore, that we must examine if we are to carry out the aims of a new ethnography as Werner and Shefly (1984 : 107-108) have expressed them. This means that a society's culture consists of whatever it is one has to know or believe in order to operate in a manner acceptable to its members, and do so in any role that they accept for anyone of themselves. It is in fact the forms of things that people have in their minds, their models for perceiving, relating, and otherwise interpreting them. Ethnographic description, then, requires methods of processing observed phenomena such that we can inductively construct a theory of how our consultants have organised the same phenomena.

On the whole, it seems that most advocates of numerical systems have argued mainly from Western perspectives[4]. In societies where oral tradition is very rich, narrative or unwritten numerical discourse strategies continue to dominate the structure of written numerical systems (Lancy 1983 : 114). Brainerd (1985) and Friberg (1984) offer an excellent account of the influence of unwritten numerical traditions on written numerate strategies. It can even be argued that what reduces the practice of oral numerical narratives is not numeracy per se ; rather it is a combination of factors, which include : a) the institutionalisation of schools and the adoption of curricula that fail to provide adequate attention to traditional oral transmission of numerical systems ; and b) changes in social

4. For a lucid summary of these perspectives, see Crump, « Introduction » (1992).

organisation and wider societal structures that reduce the chances of peer-group learning of oral numerical systems as in traditional societies (see Restivo 1981 : 683, 1982 : 141). It is therefore perhaps more appropriate at this stage to address more fundamental questions concerning research about unwritten numerical systems : a) what are the effects of innumeracy on the individual and society ? ; b) what aspects of innumeracy undergo the most transformation when a community becomes numerate ? ; c) how is a written numerical system different from a non-written one, and what changes in educational policy are necessary in order to teach the mathematical features peculiar to innumeration ? ; d) how do abilities in non-written numerical systems vary with age, gender, social status, and the like, and from society to society, as well as from generation to generation ? ; e) what are the nature and degrees of these abilities necessary for individual and social competence in different types of society ?

While these questions may appear relatively simple, they must be considered as problematic until they are systematically investigated. Some of them are already cropping up as important issues in some research on innumeracy. For example, Crump (1982, 1992) and Lave & Taylor (1985) found that, when unwritten and written numerical systems converge, several aspects of the affected mathematical language structures undergo varying degrees of change. But of the several aspects of mathematical language use, the innumerate or unwritten numerical structure proves to be the most resistant to change (Reed & Bernard 1979 : 874 ; Brainerd 1985 : 105). However, in general, many of the preceding suggestions need further examination. This is especially necessary since a number of available research findings on written and unwritten numerical systems are often merely suggestive rather than conclusive (for example, Menninger 1969 ; Cole 1981 ; Hodes 1984), while others have looked at non-written numerical systems in isolation and without systematically relating them with sociocultural features (Finnegan 1977 ; Davis & Hersch 1983 ; see also the articles in the *Journal of Intercultural Studies* 2003).

Work on such a subject has focused on *a priori* distinctions between different processes of innumerate mathematical calculations, with less attention paid to how one form affects the other or how the putative differences vary both within and across different unwritten numerical systems[5]. In a way, these questions are indicative of the inadequacy of knowledge on the subject of unwritten numerical system and its effects

5. Barnes (1982), Lancy (1983) and Crump (1992) provide interesting discussions on the problem. But like some of the works they review, they too end up with putative typologies of formal processes of different unwritten numerical systems.

on thought and society. Let me then discuss this problematic of method of unwritten enumeration, computation, and evaluation and its relation to commercial transaction using an ethnographic experience among Muslim Jeberti women traders in Eritrea as a case in point. My analysis is an extension of the ethno semantic focus on the structure of logical relationships to the more complex level of defined operations of calculation found in a folk system of mathematics. It is written in a descriptive manner in order to capture the significance of these symbolic processes to individual actions and their social and cultural contexts.

## Ethnography of Jeberti Folk System of Innumeracy

The word Jeberti is a generic term for Muslims scattered throughout the Christian Tigrigna-speaking south-central highlands of Eritrea and the Christian Amharic-speaking north-central highlands of Ethiopia[6]. The name comes from a similar usage among Tigrigna and Amharic speakers and, for some, seems to originate from an association with immigrants from southern Arabia to this side of the Red Sea coast sometime before the XII^th^ century (Trimingham 1952 : 138). Others (Levine 1974 : 37, 42) mention that the Jeberti originate from local converts to Islam during the period of Gragn in the XVI^th^ century. Historically, the Jeberti had limited access to land rights, but over time they were able to develop trade as an alternative occupation to further economic and entrepreneurial advantages (Abbebe Kifleyesus 1997). Since ancient times the Muslim Jeberti thus rendered services to the Christian Tigrigna and Amhara as merchants and artisans (Shack 1974 : 73).

Throughout the last millennium the Muslim Jeberti traders of Eritrea played a critical role in linking the diverse reaches of the plateau districts of Hamasien, Seraye and Akkele Guzay (Zoba Debub in present day Eritrea) to carry their goods and, in the process, ideas and news from one region to another (Abir 1978 : 412). As the Red Sea trade increased in volume and momentum in the late XVIII^th^ and XIX^th^ centuries, the Jeberti confronted commercial competition from coastal peoples (Abir 1980 : 56). Yet the Jeberti who at present represent some seven percent of the Tigrigna population of Eritrea have as Muslims always felt a divine mandate to be merchants and have traditionally posited a high institutional affinity for commercial undertaking using folk systems of numbering as a means for achieving upward mobility, social respect and upholding family economic benefits (cf. Foster 1974).

6. Both Tigrigna and Amharic fall within the southeast semitic cluster of languages (see Faber 1997 ; Kogan 1997 ; Hudson 1997).

The Jeberti are thus Tigrigna-speaking traders, cultivators and craft-workers who for centuries have been living among the Christian Tigrigna speaking populations of the south-central highlands of Eritrea. As noted earlier, most Eritrean Jebertis were traditionally engaged in trading or in artisanal occupations like weaving, gold and silver-smithing as well as tailoring because they were largely barred from land owning. Today, however, this Tigrigna-speaking Muslim Eritreans are not only a dispersed group plough cultivators of grains who own and farm land of cereal crops ranging from *ṭaf (Eragrostis abyssinica)*, wheat and barley to maize, millet and sorghum, but they are also devout Muslims particularly well-represented among religious scholars and wealthy entrepreneurs and merchant urban dwellers engaged in craftworks in towns like Dibarwa, Mendefera and Áddi Khwala, and in cities such as Asmara and Massawa. The urban Jeberti who are mostly involved in the clothing and sewing business and engaged in the management of big and small retail or wholesale shops in these towns and cities are among the wealthiest of the population. The poor state of some Muslim Jeberti reflects not only old traditions and commercial competition, but also their lack of education caused, for most, by the stopping of schooling at an early age so that children can assist in family enterprises ranging from farming to petty trading.

In the different villages and towns of the plateau district of Seraye in southern Eritrea and particularly in and around Mendefera and Áddi Khwala they are organised into patrilineal descent kinship groupings where parallel cousin marriage is allowed but frowned upon as marriage between close kin and as such not widely practiced. This kinship organisational system creates distinct local identities reflected in varying systems of Islamic law *(sharï'a)* and land tenure where land rights is still based upon descent and disputes are resolved through either legal systems or through some other collective customary structures (Tronvoll 1996 : 26-29). The family owned land thus remains with the family ; even when sons move away to Asmara or to somewhere outside Eritrea, they are always welcome to their villages and expect a share of the land when the head of the family dies ('Umar 2000 : 9).

Here therefore the Jeberti are patrilocal and land passes from generation to generation patrilineally. When a son marries, he brings his bride to his father's residence after a wedding ceremony which takes place in both the bride's and groom's parents' homes following *sharï'a* and *'idda*. At the time of the wedding, gifts are exchanged with careful notation of which family gives what. Generally, the bride's family pays a sum of money or makes a gift in kind to the groom's family to help the groom support the bride. Although Jeberti wedding songs and dances are typical of their Christian

Tigrigna counterparts, intermarriage between the Muslim Jeberti and their Christian Tigrigna neighbours is forbidden for religious reasons.

The Jeberti, like most other Muslims, accept polygyny, but this is only practiced by the relatively few wealthy who involve in it for curiosity. A successful Jeberti is one who piously attains status in his community by being able to obtain material possessions, but even more by being able to take care of his family, raise respectful sons and marry off his daughters to worthy Jeberti families (*Ibid.* : 16). In Jeberti society, women are not veiled or secluded, although when they go out in public they wear a shawl in such a way that no head hair appears, nor any skin exposes except face, wrists and ankles. When non-kin male visitors dine in Jeberti homes, the host wives do not join the meal ; the men eat together, waited upon by daughters. Similarly, Jeberti women do not go to the mosque except during *Ramadan* and then enter it only through a separate entrance and never when men are present.

The Jeberti live in close proximity with the Christian Tigrigna, and such a situation often makes it impractical, and certainly difficult, to raise their children fully enculturated within *Qur'anic* traditions and the idealised Islamic codes of conduct. The Jeberti thus refrain from sending their children to public schools for fear and suspicion of non-Islamic influences. For them public schools are non-Islamic institutions of learning that create a *de facto* attrition in access to education. Traditionally, education in the Jeberti heartlands of the Seraye district of southern Eritrea where they are visible in large numbers thus meant catering instruction in the *Qu'ran* and other religious texts. The establishment of modern education started only recently and by and large attracted a limited number of young women while the rest were and still are reared to believe in the conjugal family and household economy as the ultimate destiny. The history of young Jeberti women's mathematical education is thus one of Islamic constraints reflected in differential access to government schools and in its Muslim ideology of women's seclusion and domestication, later overlaid by the priorities and interests of a market transaction, and more recently by fundamentalist intervention in the processes of numeracy education.

Primary field findings indicate that socioeconomic status and success in commerce is directly related to mothers' concern about the necessity and desirability of transferring unwritten mathematical knowledge to their daughters so that they invest rationally. As Handwerker (1973) has shown for Liberia, Jeberti women in Eritrea with access to unwritten numerical systems exerted greater effort in trading, engaged in improved registration of credits and debts of customers and calculations of sales and purchases during cash transactions, bargained harder in profiteering, used better business techniques and received higher economic returns from commercial engagements, and effected a greater degree of care and welfare for family members using household funds and commercial resources. Mothers thus tend to train or tutor their daughters in trade lines which they, themselves, know. In this regard, innumeracy offers alternative strategies for daughters trapped in lines of goods that have limited economic prospects and face competition from other traders. The market places of Mendefera and Áddi Khwala therefore provide vital trade resources for women increasingly squeezed by shrinking family incomes and reduced opportunities in other sectors.

Indeed, the Jeberti system of market place trading depends upon the assistance of daughters. Whereas some are spared for numeracy education in schools when it appears that this can improve their future chances for commercial success, for others, literacy in numbers is seen as a temporary diversion before entering into connubial relation, reproduction, and subsistence production. When marriage and child bearing become possible the termination of girls' formal schooling in mathematical education becomes probable. This limits young women's access to written numerical knowledge and information and does not also create an environment conducive and supportive to young women's future commercial operation. Although formal numeracy education may thus serve to postpone early marriages and allow women to have better control of their lives and their trade activities, market-based independent participation in commercial transaction is also equally and powerfully made possible through the use of an indigenous unwritten numerical system or method of calculation and computation.

Because of Jeberti cultural norms and women's trustworthiness and ability to strike profitable bargains, trading and money handling devoid of swindling are works and/or prerogatives usually considered appropriate for young female adults (cf. Robertson 1974). Women's pursuit of trade is thus related to the availability of daughters who are delegated with commercial tasks. In these engagements, young Jeberti females learned business tactics, interacted with people of their own age groups, attracted prospective husbands and used their independent incomes as insurance for frequent divorces, and for the purchase of « extra » needs whose expenses surpass family allowances. Traditional schooling or oral transmission of mathematical training has in this case not only an effect on the pattern of women's trade activities and on the economic enterprises of their families whose dependence on daughters is well noted, but it also, as Ferraro (2004) has shown for the Ecuadorian Andes, places them in a better position to collect debts from customers and manipulate the immediate commercial networks, and to expend their profits on the perpetuation of unwritten mathematical education of their daughters.

As noted earlier, the large majority of Jeberti women traders in and around Mendefera and Áddi Khwala are illiterate. For some years they have been trying, though without success, to learn to replace their thumb finger print with a signature. Many have not yet mastered the relationship between the time sequencing of sound utterances and the spatial sequencing of the written letters in words. While they have mastered the individual letters with which the Tigrigna language may be written, they have yet to memorise and retain the particular patterned way in which these letters of the alphabet are combined to form individual words.

During my first period of field research in the market places of Mendefera and Áddi Khwala in the summer of 2000 and 2001, I met many innumerate Jeberti women traders. I wanted to know the extent of these women traders' competence in unwritten mathematical computations because I was unaware of the extent of these traders' ability in working out arithmetic computations in their head. I had observed them *counting the finger joints* but, as I was simultaneously attempting to calculate in my own way, I failed to grasp that and, given the time, I was unable to work out alone the problem that engaged the women traders and myself but they were capable, of working out alone any problems that engaged them and me. It is the fascination with native mathematical calculations that triggered the need to revisit the folk system of arithmetic and examine it in relation to formal mathematical training in order to understand systematically the basis of possible traditional computational skills. During my second visit, in the summer of 2002, I took a woman trader friend with me to the market place of Áddi Khwala where I intended to purchase some amount of onions which the Tigrigna speaking Jeberti call *shigurti (Allium cepa)*.

I found out that Jeberti women traders commit mathematical problems to memory, and if some of their efforts to solve them failed, they always begin again or involve themselves in several steps, using unwritten number relations with which they liked to work. Onions are priced by kilograms. One kilogram of onion, at the time of research, was costing 5,75 *naqfa*[7]. The seller put some on the scale and the weight amounted to 375 kilograms and I agreed to pay and take it. I took my pencil and twice figured out the total amount of *naqfa* I owed the onion seller, using fractions the first time and decimals the second. I arrived at two different answers. The seller used her long years of training in the traditional art of calculating and system of memorising to come up with a solution that agreed with one of mine. I said : « Fine, we shall take your solution as the amount I owe you ». As we got up to leave, my woman trader friend turned and said

7. The official exchange rate at the time of preliminary fieldwork was 1 US dollar = 14 *naqfa*.

forcefully to the seller : « Okay, we shall trust your answer for now, but I shall go and work out this problem, and if I find you have erred I shall return ». As soon as we were back in the street, I asked my friend whether she was serious about solving the problem. Surely she had put the male seller in her place, but was she really planning to check our solutions ? « Certainly », she replied.

The streets of Áddi Khwala were wet that summer. Winds blew out of the north and west, bringing the heavier rains rather than the lesser rains that are blown south-easterly from the direction of the Red Sea. For five consecutive mornings my host, her husband, her children and me, huddled in the muddy floor of the hut in which we were living. In the persistent drizzle neighbours came and went. My fascination and my host's infinite patience filled these hours with endless arithmetic problems and calculations, step by step spoken out loud, discussed, and reviewed until the folk system of mathematics of my illiterate friend began to emerge in my head. I tried to match my own training in logic, formal mathematics, set theory, algebraic formulae, and formal development of the number system with the host's memory and continuous play with numbers in order to understand systematically the basis of her unexpected competence. It took my host many hours to work out the problem. First she committed the problem to memory, so if some of her efforts to solve it failed, she could always begin again. Then she planned a strategy of calculation involving several distinct steps, using number relations with which she liked to work. Her strategy was to work out one step of the problem, then memorise the result. At this point she could, if she wished, go off to do some other task. I would find her hours later, taking up her calculation where she had left off. She could review the step and solution already worked out, then take up the next planned step. Part of the strategy of working out the whole problem evolved after having worked out several steps. Steps already worked out could prove valueless in finding the solution. They might be dropped, but more commonly they would be reused later in an altered form, perhaps in solving an altogether different problem. To illustrate what I learned from her, I shall focus on the specific skills involved in her solution of the problem of cost price of the onions.

## Counting

The primary skill involved is that of counting in whole natural numbers. Counting into the hundreds *(mi'titat)* and thousands *(ashihat)* is a common skill among Jeberti women traders in Mendefera and Áddi Khwala. Ten thousand *(áserte shih)* and one hundred thousand *(mi'ti shih)* are also frequently used units, customary in estimating population figures, such as the number of cattle in qolla Seraye, or, the number of refugees who fled from Eritrea to the Sudan as a result of the liberation war with Ethiopia. My host also proved capable of closely estimating the population of cities like Asmara and Massawa, cities to which many Jeberti from Mendefera and Áddi Khwala have gone to take up jobs as traders, weavers, and tailors.



## Counting the Finger Joints

To determine the sum of two or more numbers Jeberti women traders use two distinct operations. The most common operation involves a counting procedure and is called accordingly *betsabi'e miqutsar*, or *counting the finger joints*. The other operation is what I call *addition*, involving the memorisation of pairs of numbers and their sums. Although each operation, carried out correctly on the same numbers, gives the same results, the procedures pursued are different. I have chosen to distinguish the operations in the presentation of the problem, but have found no easy and versatile way to refer to this folk operation of *counting the finger joints*. Accordingly, I have chosen the phrase counting into so that I may write number a is *counted into* number b, in the same way one may write in colloquial English, *number* a *is added to number* b, when one is referring to addition[8]. The procedures involved in *counting the finger joints* are as follows : each hand has 15 joints, three on each finger and three for the thumb whose large central joint is counted as two. To find the sum of two numbers, a woman trader counts off the first number on her joints. She begins with the lowest joint of the thumb, moves upward to the tip of the finger, and then proceeds to the lowest joint of the next finger, until finally the baby finger is reached. Each joint is marked by touching the tip of the pointing finger to the palm-side of the joint of the opposite hand. When the baby finger is reached, one marks the joints of the baby finger by jerking the hand three times, and then proceeds to the next hand, marking the joints with the pointing finger of the other hand. One marks off the final joint at which the first number is reached. This may have required counting off several hands, so that the final place is noted in terms of the number of hands and joints involved. Thirty-three, for example, would be two hands and the two joints of the thumb of the third hand.

Having discovered where the first number falls when counted on the hands and finger joints, the woman trader memorises this position. The first number is now represented by this position. To add a second number

8. For use of fingers but not finger joints during counting, see Birch (1981).

to this number, she returns to the first joint and begins counting until she reaches again the position representing the first number. This time, however, she begins counting from the second number. The second number is recited as she flashes the open palm of the hand. The second number plus one is recited for the first joint ; the second number plus two, for the second joint, etc. When she has counted to the position representing the first number, she has counted the sum of the two numbers. Other derived arithmetic operations such as multiplication, doubling, halving, and quartering are worked out by memorising the results obtained in counting the finger joints. Each of these operations is painstakingly learned, first through calculations, and then memorisation. Learning these operations is worthwhile because they help in a variety of traditional and customary activities that require calculations like rotating credit associations (‘Iqqub). Doubling, for example, facilitates the weighing of grain and pulse crops. Quartering is important in traditional practices of cooperative farming. Dividing numbers into five is a necessary and common experience, for the Eritrean monetary unit, the naqfa, is broken into five components[9].



## Doubling and Halving

In rural Eritrea, doubling is a common operation because of the particular manner in which grain, pulses and other products are weighed. The scales used throughout the countryside are simple balances that consist of two pans dangling from a bar. In weighing linseed *(in a i’e* : *Linum usitatissimum)*, for example, one places in a pan an official metal weight with its numerical value cast onto its surface. As Jeberti rural people usually do not own a full set of weights, they must make use of the few marked weights they do possess. One weight may be used to weigh in a single weighing amounts two, four, and eight times its marked weight. This is accomplished in a most direct fashion. The woman trader weighs an amount of linseed equal to the known weight. The linseed so weighed is then spilled into the pan containing the marked weight. In so doing, she has doubled the weights of the pan. She now fills the empty pan with enough linseed to balance the doubled weight in the weighing pan. This new weight of linseed is now spilled into the weighing pan, thus quadrupling the original amount. The numerical value of this quadrupled amount remains to be calculated. This is done by doubling and redou-

9. For similar explanations using other field experiences, see Halle (1967), Lancy & Johanson (1981), Buckland (1986).

bling the numerical value on the marked weight. A one-kilogram weight in this manner may, for example, be used for weighing four kilograms of linseed in a single weighing. A woman trader reduces to one-quarter the number of weighings required to measure the harvest yield of a field, saving herself considerable time and effort. For such pragmatic reasons the operations of doubling a whole number and doubling it again are all mental operations so frequently performed that most Muslim Jeberti women traders have committed to memory what we call the multiplication tables of two and four.

## Quartering

Another operation commonly performed is quartering. Large sums in the hundreds may be broken readily into four equal parts. This operation is a corollary to the operations of doubling, and doubling again. One commits to memory sums that are the results of doubling twice a variety of whole natural numbers. Since the halves of a great many numbers are memorised, or can be discovered by guessing possibilities and doubling them to see if one is correct, quartering is often broken down into the operations of halving and halving again. This operation is performed commonly because of the traditional pattern of cooperative farming among cultivators in and around Mendefera and Áddi Khwala in the south-central highlands of Eritrea. Four separate families normally cooperate in working in the grain fields. Each family supplies one full-time worker and a pair of oxen as well as additional manpower at the time of weeding and harvesting. In the field, four men and two working pairs of oxen are required in order to maintain a constant flow of labour for ploughing in the field. The schedule of ploughing goes on continuously for the necessary eight to ten hours. These four men and their respective families share the costs of grain and labour, and they share the yields equally. Accordingly, they must know how to quarter the costs and the yields.

## Scales of Differing Magnitude

To handle the complexities of fractions, Jeberti women traders work out problems on different scales of magnitude. The scales of magnitude relevant to the problem of the onions, for example, are the positive whole numbers, and the fourths *(hade rib'i)* and the fourths of fourths *(nay rib'i rib'i)* of whole numbers. The various mathematical operations can be performed on numbers in each scale of magnitude. The scale of whole numbers is the primary scale in that all calculations are made as though the units are whole numbers. The scale of fourths (*rib'i)* of whole numbers consists of one fourth *(hade rib'i)*, two fourth *(kilte rib'i)*, three fourth *(seleste rib'i)*, etc. One normally does not count fourth units beyond three, but converts them into whole numbers instead. The lower registry of the scale is marked by special words or prefixes or is immediately converted into whole numbers thus : one fourth *(hade rib'i)*, two fourth *(firqi)*, three fourth *(n'mulu'e rib'i gweddel)*. As one may observe, *hade rib'i, firqi*, and *n'mulu'e rib'i gweddel* commonly are prefixed to whole numbers to refer to a fourth more, a half more, and a fourth less, respectively. These words are not used in the abstract, but only in conjunction with whole numbers. The terms facilitate the conversion of numbers from the scale of fourths into the scale of whole numbers. Indeed Jeberti women traders either will have memorised multiples of four or will mark off on the finger joints blocks of four. The multiples of blocks covered become whole numbers on the scale and the remaining units of one, two, or three *rib'i* are affixed as hade *rib'i*, *firqi*, and *seleste rib'i*, respectively.

The scale of fourths of fourths[10] is counted in whole numbers, with the monetary unit *rib'i* affixed when it is necessary to indicate the scale involved. The basic monetary unit in Eritrea, as noted earlier, is the *naqfa* which is comprised of four *rib'i*. Coins are minted for one cent, five cents, ten cents, twenty-five cents *(rib'i naqfa)*, and fifty cents *(firqi naqfa)*. To construct three fourth of a *naqfa*, women traders added *rib'i naqfa* to *firqi naqfa* through simple memory. The use of money in the Mendefera and Áddi Khwala economy encourages facility in calculating with the use of the concept of *rib'i*. It is common knowledge therefore that twenty-five cents is one-fourth *(rib'i)* of a *naqfa*, fifty cents is one-half *(firqi)* of a *naqfa*, etc. This indigenous knowledge is abstracted from monetary units and used in converting from the scale of fourths of fourths *(arba'ite rib'i)* to fourths *(hade rib'i)* and to whole numbers.

Four *rib'i* on the scale of fourths of fourths is one on the scale of whole numbers. Two on the scale of fourths of fourths *(kilte rib'i)* is one half *(firqi)* on the scale of fourths while three fourths of fourths is three fourths *(seleste rib'i)*.

## Mathematical Solution of the Sale of Onions

I have explained enough of Jeberti women traders' mathematical system for understanding how they arrived at solutions to the problem of the sale

10. I have chosen the expression « fourths of fourths » *(nay rib'i rib'i)* in order to convey Jeberti women traders' sense that they are operating on a scale of one-fourth of the previous scale of calculation, rather than on a scale of whole numbers. The transformation from one scale of magnitude to another, in this case, takes place in leaps of four, so that there are two separate steps of transformation from the scale of fourths to that of whole numbers.

of onions. In the following discussion I present an explanation of how women traders worked it out, with their presentation structured in terms of the strategy they developed. I focus on the description of the abstract strategy and mathematical operations in order to identify each step and to place it in logical relation or sequence to the other steps. The steps are also labelled descriptively for ease of comparison.



Table I Women Traders' Strategy and Solution of a Mathematical Problem

| Strategy and Operation | Mathematical Notation |
|---|---|
| Problem: | |
| The value of onion is *naqfa* 5 ¾ (5,75) per kilogram. | |
| What is the cost of 3 ¾ (3,75) kilogram of onion? | 5 ¾ x 3 ¾ = |
| Strategy: | |
| I. Triple 5 ¾ and | 3 (5 ¾) |
| II. ¾ of 5 ¾ | ¾ (5 ¾) |
| III. Combine the above | 3 (5 ¾) + ¾ (5 ¾) |
| Solution: | |
| I. Tripple 5 ¾ | 3 (5 ¾) = 2 (5 ¾) + 5 ¾ |
| A. Double 5/3 | 2 (5 ¾) = 2 (5) + 2 (¾) |
| 1. Double 5 | 2 (5) = 10 |
| 2. Double ¾ | |
| a. Convert to scale of fourths *(rib'i)* | 2 (¾) = 2(3) on the scale of fourths *(rib'i)* |
| b. Double 3 | = 6 *rib'i* |
| c. Convert results to scale of whole numbers | = 1 ½ |
| 3. Combine results of **1** and **2** above | 2 (6) + 2 (¾) = 12 + 1 ½ = 13 ½ |
| B. Count 5 ¾ on to the results of A above | Counting 5 ¾ onto 13 ½ = (Counting 5 onto 13) and (¾ onto ½). |
| 1. Count whole numbers onto one another | Counting 5 onto 13 = 18 |
| 2. Count fourths onto one another on the scale of fourths | |
| | Counting ¾ onto ½ Counting 3 onto 2 on the scale of fourths *(rib'i)* |

| | |
|---|---|
| | $^3/_4$ = 3 *rib'i*<br>$^1/_2$ = 2 *rib'i*<br>3 *rib'i* + 2 *rib'i* = 5 *rib'i*<br>= 1 $^1/_4$ |
| 3. Combine **1** and **2** above by<br>a. Converting from scale of fourths to the scale of whole numbers | |
| b. Count whole numbers onto one another | 18 + 1 $^1/_4$ = 19 $^1/_4$ |
| c. Memorise results and put aside | Memorise that<br>3 $^3/_4$ (5 $^3/_4$) = 19 $^1/_4$ |
| II. Find $^3/_4$ of 5 $^3/_4$ by redefining $^3/_4$ in terms of the operation of halving : | $^3/_4$ (5 $^3/_4$) = $^1/_2$ (5 $^3/_4$) + $^1/_2$ ($^1/_2$) (5 $^3/_4$) |
| $^3/_4$ is the same as $^1/_2$ and $^1/_4$<br>$^1/_2$ is the same as $^1/_2$ of $^1/_2$.<br>Hence, $^3/_4$ is the same as $^1/_2$ and $^1/_2$ of $^1/_2$<br>Therefore to find $^3/_4$ of 5 $^3/_4$ : | |
| A. Find $^1/_2$ of 5 $^3/_4$ | $^1/_2$ (5 $^3/_4$) = $^1/_2$ (5 + $^1/_2$ + $^1/_4$)<br>= $^1/_2$ (5) + $^1/_2$ ($^1/_2$) + $^1/_2$ ($^1/_4$) |
| 1. 5 $^3/_4$ is composed of 5, $^1/_2$, and $^1/_4$.<br>Find $^1/_2$ of each : | |
| a. $^1/_2$ of 5. Remember solution | $^1/_2$ (5) = 2 $^1/_2$ |
| b. $^1/_2$ of $^1/_2$. Remember solution | $^1/_2$ ($^1/_2$) = $^1/_2$ *(rib'i)* 1 *rib'i* |
| c. $^1/_2$ of $^1/_4$ requires converting $^1/_4$ into the scale of fourths *(nay rib'i rib'i)*<br>1. $^1/_4$ is *rib'i nay* 4 *rib'i*<br>2. $^1/_2$ of 4 *rib'i* . Remember solution | $^1/_2$ ($^1/_4$) = $^1/_2$ (4 *rib'i*) |
| 2. Combine results of **a**, **b**, and **c** above, retaining different scales of magnitude | $^1/_2$ (5) + $^1/_2$ ($^1/_2$) + $^1/_2$ ($^1/_4$ =<br>2 $^1/_2$ + 1 *rib'i* + 2 *rib'i* |
| B. Find $^1/_2$ of the results of A above, that is $^1/_2$ of (2 $^1/_2$ + $^1/_4$ and 2 *rib'i*) | $^1/_2$ ($^1/_2$) (5 $^3/_4$) = $^1/_2$ (2 $^1/_2$ + 1 *rib'i* + 2 *rib'i*) = $^1/_2$ (2 $^1/_2$) + $^1/_2$ (1 *rib'i*) + $^1/_2$ |
| 1. 2 $^1/_2$ + $^1/_4$ and 2 *rib'i* are composed of 2 $^1/_2$ and 1 *rib'i* and 2 *rib'i* each on a | |

| | |
|---|---|
| different scale of magnitude | |
| a. Take $\frac{1}{2}$ of 2 $\frac{1}{2}$ | $\frac{1}{2}$ (2 $\frac{1}{2}$) = 1 $\frac{1}{4}$ |
| b. 1 *rib'i* on the scale of fourths is one fourth of fourths of fourths | $\frac{1}{2}$ (1 *rib'i*) = $\frac{1}{2}$ (4) = 2 *rib'i* |
| c. Take $\frac{1}{2}$ of 2 *rib'i* | $\frac{1}{2}$ (2 *rib'i*) = 1 *rib'i* |
| Combine results of **a**, **b**, and **c** above, retaining different scales of magnitude | 1 $\frac{1}{4}$ + 2 *rib'i* + 1 *rib'i* = 1 $\frac{1}{4}$ + 3 *rib'i* |
| C. Combine results of A and B above and remember solution | $\frac{1}{2}$ (5 $\frac{3}{4}$) + $\frac{1}{2}$ ($\frac{1}{2}$) (5 $\frac{3}{4}$) = 2 $\frac{1}{2}$ + 1 *rib'i* + 2 *rib'i* + 1 $\frac{1}{4}$ + 3 *rib'i* = 3 + (1 *rib'i* + 2 *rib'i*) + 4 *rib'i* = 3 + 3 *rib'i* + 4 *rib'i* = 3 $\frac{3}{4}$ + 4 *rib'i* |
| III. Combine the results of tripling 5 $\frac{3}{4}$ and taking $\frac{3}{4}$ of 5 $\frac{3}{4}$ | 3 (5 $\frac{3}{4}$) + $\frac{3}{4}$ (5 $\frac{3}{4}$) = 17 $\frac{1}{4}$ + 3 $\frac{3}{4}$ + 4 *rib'i* = 17 + 3 + 1 *rib'i* + 3 *rib'i* 4 *rib'i* |
| Combine numbers on each scale of magnitude separately and convert and recombine | |
| 1. Combine whole numbers | 17 + 3 = 20 |
| 2. Combine *rib'i*. Convert to scale of whole numbers | 1 *rib'i* + 3 *rib'i* + 4 *rib'i* = 2 |
| B. Present final solution in whole numbers | 20 + 2 = 22 |

## The Strategy

Jeberti women traders construct such a strategy out of a derived operation of doubling and its reciprocal operation, halving. Throughout the problem the traders use counting and *counting the finger joints* to operate on three levels of magnitude (whole numbers or fourths – *rib'i*). The final of their solution is the conversion from the scale of fourths to the scale of whole numbers. Their strategy consists of tripling 5 3/4, finding three fourths of 5 3/4 and combining the results. In the first step they triple 5 3/4 by first doubling 5 3/4 and then *counting* on another 5 3/4. The second step must be seen as a reciprocal of the first. Doubling and halving are reciprocal operations. Jeberti women traders normally keep this in mind when they are doubling or halving a specific number. If one commits to memory what is the sum of a number doubled, one also commits to memory what is half of the sum. In the second step, instead of tripling on the scale of fourths and converting this back to whole numbers – a strategy other illiterate calculators might have chosen – women traders choose to work out a series of operations that, in part, are reciprocal to the first step.

In the first step they double a number and *count* it *onto* itself. In the second step they halve a number, halve the results, and *count* the final results *onto* the earlier results of halving. The first operations of the two steps are reciprocals. The final operations involve shifting from *counting* a number *onto* the double of itself in the first step to halving a number that is already one-half itself and then combining the two in the second step. What is striking about the second step is that women traders visualise three-fourths as a composition operation. They recognise that they can work with the operations of halving and quartering. Taking three fourths consists of combining the results of the operations of halving and quartering, and quartering itself consists of a sequence of halving. Viewed in this manner, Jeberti women traders have simplified this step to the use of one major operation, performed on the results of prior results. Since each part of the strategy is built directly upon the prior step, the difficulties of memorising and putting aside earlier derived results are avoided.

## Discussion

This is a mathematics that contrasts with that of literate societies where a standard abstract calculation technique is enforced in the first years of school. Jeberti women traders' mathematics, however, involves both culturally shared techniques and individual inventions[11]. The basic techniques of counting and *counting the finger joints* are known and used by almost all

11. The data for section, in which I discriminate between the individual inventions of my consultants and the techniques culturally shared with other Jeberti women traders, is based upon loose and open ended discussions with peasants in and around Áddi Khwala. My conclusions would have been better if I had posed the problem of the cost of onions to other consultants and explicitly contrasted their strategies for solution. Unfortunately, at the time of preliminary field research, I did not expect consultants other than Jeberti women traders to have the motivation to resolve someone else's problem that required several days of repeated effort. I was, however, able to contrast their efforts on simpler problems.

illiterate Jeberti in and around Mendefera and Áddi Khwala. The derived operations of doubling, quartering, multiplying by ten and by fifteen are commonly shared, for they are part of the repeated calculations rooted in the daily or seasonal events of rural life in Eritrea. Doubling is a common operation, for all Jeberti share the recurrent problem of weighing large amounts of pulses and other products with a simple balance. Quartering is a common performed calculation among cooperative peasants who, in the area of study, share the costs and yields among themselves. A shared interest in the multiples of ten, for example, appears to derive from the number of digits on hands and feet, and thus illiterate rural women traders perceive their number system in the morphemes recurring in the sequences of ten. Similarly figuring multiples of fifteen is a common enough operation because of the shared conception of the hand of fifteen joints. The different scales of magnitude – fourths, halves, three fourths, and fourths of fourths – derive from the shared Eritrean currency in which the *naqfa* unit is broken up into four scales. To handle currency, women traders learn similar rules for converting from one scale of magnitude to another, as they must in order to handle common transactions in these market places (cf. Trager 1981).

While women traders commonly perform these derived operations and conversions, they differ in the particular number of relationships that they know in any operation, for the knowledge of each relationship requires calculations and memorisation. Each woman trader's focus reflects her own disposition and life experience. An individual trader chooses whatever relations seem to enhance her ability to solve the problems at marketplaces, with a money lender, a tax collector, working partners, or indebted clients/customers in this otherwise « unstable market conditions » to use the phrase of Clark (1991 : 32). A woman trader's choice also involves an element of play. A trader may, for example, memorise sums and multiples simply because of fascination with specific operations and number relationships and the enjoyment and entertainment of fiddling around with them.

Most strikingly, each woman trader has a unique set of experiences in problem solution that must be tapped in solving a new problem. Since each trader has faced a different series of problems, and has worked out distinctive strategies to solve them, each trader confronts a new problem with a different repertoire of calculation skills than another fellow woman trader faced with the same problem. Each woman trader works out a strategy for solving the new problem that will take fullest advantage of previous experiences and skills. In this respect, Jeberti women traders are conservative, in that they work with new operations and number relationships only in order to maximise the use of skills already learned. These new operations and relationships become a part of the repertoire to bring to the next problem. The longer any trader has worked with the traditional arts of calculation and computation, the more divergent her system may become from that of other women traders.

❖

Every time Jeberti women traders solved a problem and caught my astonished look, they pulled themselves out of their slouch of concentration. They were many times accompanied to the market places of Mendefera and Áddi Khwala by daughters or younger sisters. Every week they walked some distances to these market places from within and the surroundings of these towns and returned home by about mid afternoon. They were mostly illiterate traders unable to work out their mathematical problems in a book. Instead they added, subtracted some numbers, and did a bit of multiplication using the traditional strategies discussed in the previous pages of this study. Given that one of the skills usually associated with numeracy is that of mathematical computation, we are tempted to assume that illiterate or, in this case, innumerate people are necessarily incapable of computation that we perform symbolically with mathematical notation. This study of one part of the cognitive system of illiterate (innumerate) women traders demonstrates the sophisticated conceptualisations of which they are capable, independent of a written numerical system. For the lay reader in general and the sociocultural anthropologist in particular, the study then holds two lessons. First, it is significant as an investigation of the cognitive map of an unschooled, but not uneducated, women traders that detail their strategies for the symbolic manipulation of their social environment. Second, it suggests that schooled individuals do not hold a monopoly on the skills usually associated with schools – even the basic conceptual skills associated with numeracy.

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Abbebe Kifleyesus, *L'"innumeracy" des négociantes jeberti, et son impact sur les activités commerciales en Éythrée.* — Cet article étudie, de manière critique, l'incidence des traditions culturelles de comptage et de calcul sur les transactions normales entre des femmes négociantes, pour la plupart illétrées et ne sachant pas compter, et leurs clients paysans, que ce soit sur les marchés de Mendefera et d'Áddi Khwala, ou de leurs alentours, en Érythrée. Il montre aussi comment des systèmes de numération non écrits et transmis oralement sont mobilisés par ces femmes non seulement pour toutes leurs opérations commerciales mais dans leurs propres mécanismes de défense contre des formes de malhonnêteté pouvant survenir avec l'introduction de chiffres et de mots écrits, ou dans leurs rapports avec la comptabilité de l'administration fiscale. L'accent est notamment mis sur la question de savoir si ces négociantes font socialement et culturellement un large usage de ces méthodes de comptage et de calcul afin d'accroître leur commerce, en dépit de la prédominance et de l'ampleur de l'« innumeracy ».

Abbebe Kifleyesus, *Jeberti Womens Taders' Innumeracy. Its Impact on Commercial Activity in Eritrea.* — This study examines critically how cultural traditions of counting and calculating effect normal transactions among illiterate (innumerate) women traders and peasant customers in and around the market places of Mendefera and Áddi Khwala in Eritrea. It looks at how non-written or orally transmitted numerical systems help women traders in business operations, and how such systems make them more capable of defending themselves against any form of dishonesty that comes with the use of the written word or number or in dealing with official accounts of government income taxes. Attention is basically given to the question of whether women traders make wide use of such socially and culturally relevant methods of counting and calculating in enhancing commerce despite the wide prevalence of innumeracy.