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## **The scientific mind and cultural articulation in an oral society: language as a mirror**

**Abstract.** *The contribution of non-western cultures, especially oral and traditional cultures, to the phenomena of civilizations remains controversial. Until recently, while modern anthropology was busy demonstrating the rationality of witchcraft, other practices in non-western cultures were considered devoid of scientific reasoning and therefore anthropologically uninteresting. The approach proposed here attempts to demonstrate the contrary. Indeed the study of the linguistic faculties of the Yoruba of West Africa shows that the system of language acts as a mirror of intuitive knowledge, providing a profusion of ontological proto-terminologies and proto-concepts encoded in language and cognition. Using them, one can establish the adequacy of human mathematical geometrical ideation in a particular cultural context where science and scientific development seem not to have existed as they did in Babylon, Egypt, Greece, India or Europe. From a comparative standpoint, the study shows that the beginning of theoretical constructions in the areas above was also in itself deeply intuitive, starting from basic human intuitive knowledge, the knowledge that forms the basis of ontogenetic development. The study postulates a universal human intuitive mind though the mathematical ideation examined is culturally and socially specific. As to the origin of that mind, the question is still open. Indeed, to understand the adequacy of mathematical ideation in this particular cultural context, we need to undertake interdisciplinary and thematic research on the origin of man, the way the brain works, languages and their origin, languages and mind, genes and anthropology. The present study illustrates a case of a culture of rationality in a non-western oral society that can serve as an empirical basis for theoretical constructions and innovations for the stabilization of cultural foundations.*

**Key words.** *Concepts in language and cognition – Human mind – Intuitive geometry*

**Résumé.** *La contribution des sociétés non-occidentales, en particulier celles de tradition orale, aux phénomènes de civilisations reste sujette à la controverse. Jusqu'à récemment, pendant que l'anthropologie moderne était occupée à montrer la rationalité inhérente à la sorcellerie, les autres pratiques traditionnelles dans les cultures non-occidentales étaient considérées comme étant dépourvues de raisonnement scientifique, et donc inintéressantes pour l'anthropologie. L'approche proposée dans le présent article tente de démontrer le contraire. En effet, l'étude des facultés langagières des Yoruba d'Afrique de l'Ouest montre que le système de la langue se comporte comme un miroir de connaissances intuitives et qui apporte une profusion de proto-terminologies et de proto-concepts ontologiques. Ces connaissances intuitives permettent d'établir une adéquation de l'idéation humaine mathématique en géométrie dans une aire culturelle particulière, celle où la science et son développement semblent n'avoir pas existé tels que nous les connaissons à Babylone, en Egypte, en Grèce, en Inde et en Europe. A partir d'une approche comparative, l'étude montre que les débuts de la science dans ces lieux avaient été aussi intuitifs en leur essence. Dans ces lieux en effet, les commencements de l'esprit scientifique ont été tous des tentatives de constructions théoriques prenant pour point de départ la base intuitive égale pour tous les humains dans le développement ontogénétique. L'étude conclut à un universel de l'esprit humain bien que l'idéation mathématique examinée soit spécifiquement culturelle et donc contextuelle. Mais quant à l'origine de l'architecture de cet esprit humain, il faut certainement toujours chercher dans les axes interdisciplinaires et thématiques portant sur l'origine de l'homme, la façon dont le cerveau fonctionne, les langues et leurs origines, les langues et l'esprit, les gènes et l'anthropologie. Sur le plan pratique, l'article attire l'attention sur une forme de culture de rationalité dans une société orale pouvant servir de base pour la construction théorique, l'innovation et la stabilisation des fondations.*

**Mots-clés.** *Concepts en langage et cognition – Esprit humain – Géométrie intuitive*

## **Introduction**

### *Situating the problem*

The question under discussion arises from an old preoccupation, which is the introduction of local-language teaching into the education systems of sub-Saharan black Africa. To summarize the relevant history, we can recall that, starting in 1899, the French colonial administration of what was then French West Africa, headed by the French Colonial Minister, Albert Sarraut, decided that French should be the only language used in schools, with the corollary that the use of the native language was forbidden (Bouche, 1975). Nevertheless the controversy continued until 1953, when it became

a major preoccupation of the United Nations Educational, Scientific and Cultural Organization (UNESCO). However, in the light of the findings of studies on educational achievement in Asia and Africa, which have consistently placed sub-Saharan African countries at the bottom, all UNESCO projects were abandoned, despite recommendations to the contrary by the International Congress on Mathematics Education in 1972, the International Commission on Mathematical Instruction, and the UNESCO Symposium of Nairobi in 1974. The key reason for the failure of such initiatives in black Africa is usually the idea that it is impossible to convey scientific and technological concepts in African languages. Such concepts are considered to be essentially western, a position this article aims to demonstrate is untenable. As Mmari has observed, reflecting the position held by some Tanzanian specialists in education, the explanation was that “modern mathematics had introduced certain concepts which are not adequately covered by existing vocabularies in the vernacular or in Kiswahili” (1974: 4). There are similar observations concerning West African experiences, especially in Nigeria and Ghana. The Six-Year Primary Project initiated by the University of Ilé-Ife (Nigeria) and the Ford Foundation in 1970, under the leadership of Professor Babs Fafunwa, was an imaginative and cautiously ambitious project. Its goal was to teach science and technology using the medium of the mother tongue, Yoruba. Nevertheless, it should be noted that the initiators of the project were quickly confronted with the problem mentioned above (see Sègla, 2003a, 2003c). In the project, new scientific terminology was coined based on the principle of borrowing words from English, the words being simply “Yorubaized” orthographically, facilitating their pronunciation in Yoruba (Fafunwa et al., 1989). The traditional symbolisms that reflected a particular form of rationality in contextual situations were lacking. And yet I maintain that scientific and technological concepts are not uniquely western phenomena. The languages in which scientific concepts are expressed may well be western, and the scientific and technological concepts that apply only to the West may likewise be specifically and culturally bound to the West, but the deep concepts these western scientific languages convey are universal (Wiredu, 1996: 13–33). Here I draw on Raum’s (1935) line of investigation, based on a considerable amount of “indigenous mathematical material” collected in central and southern Africa. Raum came to the conclusion that “natives possess a mathematical sense appearing however in a context very different

from ours” (1935: 167). The central idea is that mathematical concepts can be assumed to have universal features. But the question may be asked, if concepts are universal, how can mathematical ideation and linguistic devices appropriate for the expression of science and technology in oral traditional societies be assumed to exist where science and scientific development seem not to have existed as they did in Babylon, Egypt, Greece, India, or Europe? In some sense, the question is whether or not every human society has its own characteristic experiences, its intuitions and proto-terminologies on which its ontogenetic development is founded. If this is the case, where could one find them, apart from in the anthropological substratum that functions as a conceptual foundation for every human society? This brings us to the attitude of modern anthropologists towards the question raised here.

Starting at the beginning of the 20th century, the great battle between anthropologists propounding the classical evolutionary theory and those defending the cognitive approach has progressively marginalized the former. This move downgrades the whole of modern anthropology and its main concern, the rehabilitation of non-western cultures. Practically the whole scientific community accepts the postulate that every human being has – in principle – the same intellectual potential, in line with the structuralist position introduced by Lévi-Strauss’s innovation that defends the postulate of a sole humanity (Lévi-Strauss, 1958; Sperber, 1968). Foley’s interpretation of the key axiom of modern anthropology is the following:

The human mind is everywhere the same; what distinguishes French culture from, say, Yimas culture are the particular arrangements of the culture generating semantic oppositions. The surface differences are stripped away to reveal the underlying similarity of organization of all cultures. (Foley, 1997: 98)

But this noble ideal rapidly turned into a sweeping denunciation of non-western cultures as being devoid of scientific reasoning, and therefore providing nothing of scientific interest (Horton, 1993). The absolute cognitive presupposition of modern anthropology has subsequently deflected attention away from more sophisticated questions, such as how “to reveal the underlying similarity of organization of all cultures” (Foley, 1997: 98), and towards the question of how exactly universals are translated across cultures into specific ideas and practices. While cross-cultural studies have provided new data, making the processes of language acquisition

and cognitive development more clearly understandable, reflection rarely gets beyond the barrier of cognitive and conceptual relativism. In other words, most relevant cross-cultural comparisons of modes of thought conclude with linguistic relativity, the existence of a panel of linguistic variations across cultures and objectively existing problems. One of the most common conclusions concerns the specificity of the quantitative characteristics of traditional thought in non-western cultures, without reference to the contingent context of each individual society. Drawing on Verran (2001: 124), one may ask the question: is the “cognitive failure” of non-western children a biological shortcoming or a social disability? Modern anthropology has remained silent on this issue, giving the impression that conceptual relativism is a synonym for the impenetrability of cultures. If, on the one hand, modern anthropology were to defend the cause of biological shortcoming, it would be in contradiction of its most fundamental assumptions. If, on the other hand, cognitive failure is attributed to social disability, and the absolute presupposition of human cognitive potential is valid, it implies that some contingent factors in society, which cause social disability, have to be overcome in order to enable linguistic development, as well as cognitive and conceptual improvement more generally, implying the wholesale reorganization of education. Paraphrasing Wiredu (1980: 37–50), I want to point out here how not to compare in just any way two different things, to say how it is more useful to find and compare equally contextual contrasts. Western traditional thought passed from an unwritten to a written stage, moving successively through unwritten proverbs and maxims to speculative logics in linguistics, while most relevant non-western cultures did not follow the same path. And we know that, even in 17th-century Europe, Pacioli, Galileo and Descartes, owing to the contingent linguistic situation in their countries, deliberately decided to write their reflections using the Italian or the French vernacular language (Dahan-Dalmedico and Peiffer, 1986: 32). Instead of seeing the quantitative features of traditional ways of thinking as typifying traditional thought in all cultures comprising western culture, modern anthropology has mistakenly considered them as peculiarly non-western. Comparing speculative and logico-linguistic performances in western cultures with pre-scientific thinking, modern anthropology has arrived at a doctrine of inherent comparative anachronism, because “African traditional thought should in the

first place only be compared with western folk thought” (Wiredu, 1980: 48). It follows then that, for scientists convinced of the universal character of natural laws, the approach should be to look at how different languages interpenetrate despite linguistic variations, making communication possible between cultures. Furthermore, as Wiredu points out,

If one starts with the recognition that each nation has some background of traditional thought – and remember by traditional thought that here I mean pre-scientific thought of the type that tends to construct explanations of natural phenomena in terms of the activities of god and spirits – then the interesting anthropologically illuminating comparison will be to see in what different ways the belief in spirits is employed by various people in the attempt to achieve a coherent view of the world. (1980: 39)

The rehabilitation of non-western cultures consists in principle of the demonstration of the internal rationality of non-western practices. But in general some of these practices were more highly valued only when they themselves could be subsumed under the rubric of magic, ritual or myth. This approach meant that a very large part of non-western practices was neglected. While modern anthropology was busy demonstrating the rationality of witchcraft, for instance, it lost sight of most of the other rational practices. Even in these case-studies of so-called magic, ritual or myth drawn from integrated narratives, the conclusions usually left aside the links between the internal rationality of these practices and their intellectual incorporation into metrology, oral mathematics or rationalization of life. Except for research on “ethnomathematics” by Palau-Marti (1957), Raum (1935) and Gerdes (1993), when talking about black Africa these non-western practices have been ignored by anthropological research. But, for instance, re-assessing the Yoruba Ifa divination system in West Africa as a form of oral mathematical questioning in a traditional oral society, it appears that Yoruba cosmology provided the empirical basis for a valid theory of numbers with a premeditated positional system of numeration (see Sègla, 2003b). It is then plausible to expect that, in classical and late antiquity, when abstract and conceptual mathematics were emerging in the medium of written languages, other mental models of the same kind might have occurred without any systems of writing. The so-called religious, magical or mythological views and practices of non-western cultures would perhaps be better understood as a pre-scientific background for theoretical, scientific and technology constructions. I do not think there is an opportunity

here to challenge sufficiently “ethnomathematicians” and in particular Gerdes’s work on “ethnogeometry”. Apart from the fact that the notion of “ethnomathematics” or “ethnogeometry” is itself strongly debatable, I maintain briefly that what could be more interesting in Gerdes’s work is certainly not the idea according to which African craftsmen – and before them their forefathers – do mathematics, which is probably an exaggeration, but rather to see how the figurative processes found in objects made by African craftsmen are translated in context or to say how they are encoded in language, in cognition and in the local technologies. It is probably in this direction that the impressive work of Gerdes should be reoriented in order to understand the intuitive knowledge predating any scientific and technology construction. Sibum (1998) has given a wonderful example of this in his discussion of Joule’s experimental work on the nature of heat, in which he shows that “what has conventionally been regarded as Joule’s ‘personal’ or ‘tacit knowledge’ is better conceptualised as embodied knowledge, rooted partially in a hitherto unknown knowledge tradition of early Victorian brewing culture” (Sibum, 1998: 745).

Is the misinterpretation of such systems by modern anthropology deliberate? This is not clear, but it is interesting to note that the hidden price for dividing the world into a western world that is predominantly scientific and a non-western one that is mainly magical and religious has been the exclusion of western rationality from the anthropological inquiry of western scientists. Western traditional philosophy, or more precisely traditional practices – which do exist – are not taught in western universities, although their serious investigation might have great importance for understanding the material and cultural preconditions for the emergence of science in Europe. Thus the rehabilitation programme championed by modern anthropology makes it seem as though Europe arrived at modern science mysteriously from nowhere. Science in Europe originated from myths and rituals, and freed itself from magic and religion only progressively. The present study of language faculties in an oral African society attempts to demonstrate how a traditional society can arrive at a scientific culture without importing a ready-made western scientific language. It shows that a system of concepts, of proto-concepts and of intuitions, as encoded in a non-western language, Yoruba of West Africa, forms part of a universal “common human possession” (Chomsky, 2000: 78) that is also

found in the initial stages of western theorizing. Wiredu, quoting Robin Horton, reminds us that

[m]any Western anthropologists and even non-anthropologists have often been puzzled by the ubiquity of references to god and all sorts of spirits in traditional African explanations of things. Robin Horton has suggested that this failure of understanding is partly attributable to the fact that many Western anthropologists “have been unfamiliar with the theoretical thinking of their own culture”. I suggest that a very much more crucial reason is that they have also apparently been unfamiliar with the folk thought of their own culture. (Wiredu, 1980: 38, quoting Horton, 1993: 197)

I suggest that theoretical constructions of geometry in western cultures also started from basic human intuitive knowledge. From a comparative perspective, the question is whether, starting from the analysis of traditional oral thinking in a traditional culture, we can generate a contextual version of modern conceptual logic. The study of the language and the language abilities of the Yoruba in sub-Saharan Africa tends to show that the intuitions, the proto-terminologies and proto-concepts that retain the original core of the historical fact have precise and describable empirical conceptual foundations and correspond to intuitions in western cultures. The examined quantitative thinking as extracted from a non-western language is deeply imaginative, emerging “from our bodily experiences” (English, 1997: 4) and is, as in western culture, “a natural consequence of an everyday folk theory and a collection of conceptual metaphors that has played a major role throughout Western philosophy: The Folk Theory of Kinds and the Metaphors of Essence” (Lakoff and Núñez, 1997: 24). This article seeks to illustrate this claim through selected examples drawn from interviews and community observations. These bear on elementary, plane, and solid geometry, and more particularly on their figures.

### *Briefly concerning Yoruba society, culture and life<sup>1</sup>*

The total Yoruba population in West Africa, in Nigeria, Benin and Togo, is at least 40 million. Millions of others, the descendants of Yoruba slaves, are established in Cuba, Brazil (Bahia) and the United States. In Benin, Yoruba people live in the regions of Porto-Novo (Ajàse), Kétou (Kétù), Pobè (Ìpòbè), Sakété (Itàkété), Dassa-Zoumé (Igbó-Idáàcha), Savè (Cáàbe), Banté (Báàte) and Manigri (Mànígíri). In Togo, they are mainly in the regions of

Kabolé (Kàbòlè) and Ifè (Ifè). In the Nigerian Federation, Yoruba form the states of Oyo (Oyó), Ogoun (Ogùn), Ondo (Ondó), Lagos (Ekó), Osun and Ekiti. A good many Yoruba live in other states of the Nigerian Federation, but they are in a minority, for instance in Kwara state mainly in the regions of Ilorin (Ilòrin) and Kaba (Kàbá).

According to the classification established by Akinkugbè and adopted by Alo (1991), the Yoruba language contains five groups of dialects: the South-East group in Nigeria, the North-East group in Nigeria, the Central group in Nigeria, the North-West group in Nigeria known as standard Oyo, and the South-West group, mainly in Benin and Togo. Within any group, several sub-groups of speakers can be identified. The South-East group is composed of the Ilàjè, the Ikálè, the Ijò-àpòì, the Ijèbú, the Owò and the Ondo. The North-East group is composed of the Yàgbà, the Gbèdè, the Ijùmù, the Ikirí, the Kàbà, the Egbè, the Bònu, the Awòro and the Igbòmínà. The Central group is composed of the Ifè of Nigeria, the Ijesà, the Ekèti, the Obà, the Akùré, the Ifàkì, the Irùn, the Ukàrè and the Akokó. The North-West group (standard Oyo) is composed of the Oyó, the Osùn, the Ibàdàn, the Egbá, the Egbádò and the Ibàràkápá. The South-West group, found mainly in Benin and Togo, is composed of the Ifè in Togo and in Benin, while, when one looks at Benin, there are the Chabè, the Icha, the Manigiri, the Kétu, the Idààcha, the Ajasè of Porto-Novo, the Egun and the Anago or Awori-Ifohin-Ohori family group in Sakété and Pobè.

The origins of the Yoruba people are lost in history. Their well-known and recent history began with the foundation of Ifè, some time between the 8th and the 10th centuries AD, and later with the foundation of the Oyo empire. Oduduwa, who is said according to the oral tradition to have been sent by God /*Olodumaré, Olorun*/ to create the universe, founded the city of Ilé-Ifè and established an influential dynastic group. Under Oduduwa, the will to form a nation led to a very widespread human settlement around Ilé-Ifè. Ifè developed with the emergence of kingdoms established in different parts of modern-day Yorubaland by princes coming from Ifè as early as the 11th century. Some of these early kingdoms are Owu, Oyo (which later became the capital of the new Yoruba empire), Ijebu, Igèdè, Ketu, Chabè, Ifita-Idààcha and Iloji. Igue and Yai maintain that

[o]ne does not need to be a prophet to say that the movement towards the formation of a vast Yoruba empire largely under the control of Oyo was far advanced, and would have led to the political, economic and linguistic unification of all the various Yoruba sub-groups, despite the interventions of the Fon and the Fulani. In other words, a macro-nation would have been created . . . (Igue and Yai, 1973: 6)

But the advent of Oduduwa is only part of the Yoruba story. It is interesting to note that current research with archaeological evidence supports a pre-Oduduwa period. Atanda (1996), drawing on Beier (1960), Olomola (1976) and Shaw (1980), shows the antiquity of Yoruba human settlement and organized society around Ilé-Ifè, the cradle of the Yoruba people. Shaw's (1985) archaeological findings show that a "Neolithic" man inhabited the Yoruba country, and Adédiran (1998: 3) could report that "a skeletal remain dated to c. 9200 BC from Iwo Eleru (near Akure) in the southeastern part of Yorubaland is believed to belong to a later New Stone age creature". According to Zaslavsky (1973: 200), the Nok culture, which was based on the Iron civilization in northern Nigeria and influenced Yoruba art, is dated approximately to between 400 BC and 200 AD, nearly what would seem to be confirmed by recent excavations at Ilé-Ifè dated to 410 BC (Atanda, 1996: 8).

Linguistic evidence established by glotto-chronology analyses does not deny the antiquity of the Yoruba settlement. Indeed, it proves that the Yoruba language emerged as a distinct language, which separated from the Kwa group in the Niger-Congo family of languages (Greenberg, 1970) at least as long ago as between 2000 and 1000 BC (Armstrong, 1964). This shows that Yoruba-speakers originated from the Kwa group home base. Even if we consider that Bennet and Sterk (1977) classify the Yoruba language as belonging to the Kwa group, but in the Bénoué-Congo family of languages as opposed to the Niger-Congo, Yoruba-speakers would still originate from an area within the present-day region of Niger-Bénoué-Congo. In any case, Yoruba are not from Arabia (Mecca), or from ancient Egypt, or Nubia, or Greece or somewhere else, as has been formerly claimed. The hypothesis of the Yoruba coming from the Great Scientific Orient and ancient Egypt is not very probable because, parallel to the carbon-14 dating, Yoruba oral traditions also indicate autochthonous origins in situ associated with the four-fingered hominids (Bergé, 1928: 725-6) as characteristic of the early Stone Age. As the fieldwork of Adédiran (1984: 72; 1998: 5) shows, the forefathers of the Màmàhun /*Mo n mo hun*/,

*/I don't know him/*, in the Isalu *quartier* of Igbo-Idààcha (Dassa-Zoumé) in the present-day Benin Republic, are said to be the very earliest human inhabitants and people who simply emerged from the ground or from the hill. Similar settlements in situ are also known from the Oba-Ile near Akurè in Nigeria (Beier, 1960) and from the Igbo, the Ifore and the Efene, in eastern Yorubaland in Nigeria (Olomola, 1976). Akinjogbin (1980), reconstructing the Ikedu tradition, the oldest Ifè tradition of origin, indicates that some 93 or 97 kings reigned at Ilé-Ifè before Oduduwa. Akinjogbin's reconstruction reinforces the hypothesis that state-formation and organized Yoruba society began several centuries before Oduduwa, and within the last millennium BC at the latest. This information about human settlements in situ in Yorubaland is very important because it helps one appreciate, with regard to anthropology, philosophy and history of science, the structure of the human mind in situ as opposed to the "diffusionist" approach to knowledge acquisition.

Despite the Yoruba being in a constant state of war – because the various Yoruba kingdoms frequently opposed each other inside the empire – and warfare against the Fulani, the Nupe and the Fon of Dahomey up to the 19th century, commerce and contacts with the neighbouring peoples provided an important stimulus to cultural and scientific activities. But the Oyo empire was finally dissolved by the British at the end of the 19th century. In present-day Yorubaland, the heritage of the pre-Oduduwa and post-Oduduwa periods is widespread, for instance, their knowledge of social organization, agriculture, medicine, art, iron technology and abstract references. To put it briefly, it is known that Yoruba art, together with that of Benin, originated in the Ifè classical period (1000–400 AD), and had a tradition of excellence, well known all over the world and comparable to the works of art of classical Greece and Rome (Willet, 1967). The system of government in Yorubaland is unchanged from the time the Yoruba kingdoms were under the leadership of Oyo. The remaining Yoruba kingdoms in Nigeria or in Benin and Togo have their own head, the king called */Obà/*. The kingdoms are composed of cities and villages governed by the */bàálè/* or the */Olu Ilu/*, the */Chiefs of the lands/* or */the Owner of the town/*. The Yoruba village is composed of neighbourhoods */adu agbo (adugbo)/*, that is */several neighborhoods/* and each neighbourhood consists of a group of families at the centre of which are located the */baale agbo le/* */the chiefs of houses in circles/*. The Yoruba believe in a supreme God called *Olodumaré* or *Olorun*, */the owner of the*

*heavens*/. They communicate with the Supreme God through several other deities called *Orisa*. Yoruba mythology merits particular attention. Apart from some variables found throughout Yorubaland, the Oyo Yoruba model of the cosmos studied by Morton-William gives a general view of Yoruba cosmology:

The House of the Sky is the domain of the supreme God, Olorun Olodumaré (Olorun means “Sky-Owner”) . . . The Earth is the domain of the Goddess Onilé, Earth-Owner, who is sometimes simply called Ile . . . Life in the third cosmic realm, *ilé aiye*, the House of the World, is good only when good relationships are maintained with the gods and spirits of the other two. (Morton-William, 1964: 254–6)

The model offers a considerable number of ontological concepts and a scale of standard number values /1, 2, 4 and 8/, popularly known as sacred values, which are taken over into logical representations and into rationalization of life as a kind of incorporation of Yoruba cosmology. In the forefront of Yoruba abstract references is the development of literacy and the study of the language. To give an idea of the many centuries of development of Yoruba civilization and its sophisticated system of language, let me say that traditional Yoruba numeration is a system belonging to such linguistic groups as the ancient Chinese, the Maya and the Japanese, apparently very early peoples for whom it has been established that the concept of number as an abstract entity (cardinal) appears first, before the ordinal and the other classifiers understood by them as “a separate noun number” (Calinger, 1999: 8).

What is now considered standard Yoruba – namely the Oyo dialect – was transcribed for the first time into a written form at the end of the 19th century by Anglo-Saxon Protestant missionaries in Nigeria. This was and still is expected to be an important factor for the creation of a common standard Yoruba language, which would take in account all the Yoruba dialects for the promotion of a modern Yoruba culture. In Benin and Togo the Catholic religion during the French colonial period did not contribute to such development of the local Yoruba dialects. Thus the Yoruba-speakers of Benin and Togo could not benefit from the linguistic development. But as Igue and Yai (1973: 7) point out, if the “Protestant religion had a late start in Dahomey and Togo and its penetration among the Yoruba speaking peoples was somewhat haphazard”,<sup>2</sup> one nevertheless observes that, among the Yoruba-Chabè and the Yoruba-Idààcha and Icha in Benin, who were influenced by the Protestant evangelicals, an “intellectual development”

and “a linguistic awareness similar to those of Yoruba elite in Nigeria” is fortunately manifest (1973: 7). Nevertheless, it is important to note that even in Nigeria, Benin and Togo the Yoruba language is not the medium of modern education; English and French still remain largely the languages of administration, education and science. Furthermore, if one combines this situation with the paradoxical failure of modern schooling in black Africa as described by Belloncle (1984: 27), it becomes obvious that traditional education, through the medium of the oral language, is still prevalent in any Yoruba town or village in Nigeria, Benin or Togo.

Except for the Ajasè in the town of Porto-Novo, who are rich traders, the Yoruba of Benin and Togo are in general poor peasants living in savannah, in contrast to the economic situation of the Yoruba of Nigeria, especially those from western Nigeria, who benefited “from the introduction of cocoa to raise themselves to the ranks of the bourgeoisie whose role in the creation and development of Nigerian elite has been preponderant” (Igue and Yai, 1973: 12).

Despite the objective differences between the Yoruba dialectal sub-groups, the common history, the “internal dynamism” that characterizes every sub-group and the “effect of literacy” provide the foundations for a cultural continuity. Every Yoruba man claims descent from Ilé-Ifè. In this respect the language is a sort of cement binding Yoruba people together. In all Yoruba dialects, the roots of Yoruba words are most often the same. For example, the word /*omiran*/, which means /*other*/, is Yoruba Oyo (Ibadan). But the same word is /*imii*/ in Lagos and its regions. It is /*imuren*/ in Egba (Abèokuta), while in Igbo-Idààcha (Dassa-Zoumê) in Benin it is /*omirin*/, exactly as in Ijesa in Nigeria (Ekundayo, 1982). The following expressions in the various dialects with their corresponding accents by Yoruba speakers, /*omo rere*/ or /*omo re*/, which means /*child good*/, /*e maa kalo*/ or /*kalo*/, which means /*let us go, go, follow me*/, /*mo béri fun o*/ or /*m’ beri fun*/, which means /*I bow my head*/, are all understandable by any proto-Yoruba.

### *The procedure*

In the area under discussion, Yoruba informants were first met between November 1995 and February 1996, and then for a second time between April and May 2002. Mr Yacoubou is an Idààcha-Yoruba from Magoumi in Benin. He is a 75-year-old

farmer, married with several children. In his village of Magoumi, Mr Yacoubou is a highly respected man. He rallied many other men and women around him during the interviews as is customary in the traditional African milieu. He has never been to modern school. He does not speak French, which is still the official language in Benin, but the Yoruba of Lagos, in Nigeria. Mr Jayesimi is a woodworker, a Yoruba from Ijebu, in Nigeria. He is also 75, is married and has several children. He has some elementary school background and has worked for several years as a woodworker at Lagos State University in Nigeria. He understands and speaks English, the official language of Nigeria. Among the informants, there is also a young scrap-dealer called Afolabi, from Ilorin in Nigeria. He is about 43 years old. He has never been to a modern school, but speaks popular English, as many Nigerians do. He is married with children, and manages a small workshop, which earns him a living. Community observations complemented the interviews, principally in markets, transportation, community meetings and with relatives in Benin-Nigeria Yoruba villages and cities. These different approaches enabled me to cross-check the data. I focus on intuitive knowledge, the knowledge incorporated in the individual, in other words the apprehension of things without reversibility and operational thinking. Intuitive knowledge is the knowledge one has without any preliminary intellectual background. The field interviews show that the woodworker from Ijebu and the scrap-dealer from Ilorin both use metrological instruments, the ruler, the compass and the square, but practical knowledge does not come into consideration here. I target only the intuitive knowledge of craftsmen in order to make a comparison with the intuitive knowledge expressed by non-professionals during collective meetings or during community observations. As a Yoruba native – *Idààcha* is the group I belong to – I have long experience observing the social processes in question. It is necessary to mention that, as Saussure argued (1995: 231), nothing is taken into language without having been first tried out in speech, and all evolutionary phenomena are rooted in the individual sphere. In other words, knowledge is embodied. Furthermore, every natural language has the capacity for storing up knowledge, and when we study a language we reconstruct the general philosophical conceptions that lie beneath it. Intuitions, concepts, proto-concepts and proto-terminologies are buried within language, popular songs, litanies, proverbs, folk

stories, etc., the stuff of everyday life. Of course, I would not want to suggest that my approach is the only way to survey a traditional milieu. Indeed, in respect to practical knowledge, this work should be complemented by a longer stay with traditional interlocutors in their farms, homes, workshops and other activities, to fill in the picture.<sup>3</sup> In concrete interview situations, informants and I regularly discussed general notions in the Yoruba language, for instance we would talk about the walls in a house, about its corners or about a road between villages. After that, if the interlocutor was a craftsman, he was asked to show the same representations in his concrete work. If the interlocutor was a non-professional, as was the case during collective meetings and community observations, a geometrical figure was drawn on a blackboard, and the interlocutor was then asked to identify such things as line, angle and segments. As will be shown, intuitive knowledge is commonly shared in society, where it is encoded in language. I believe that it is this intuitive knowledge that provides the empirical basis for both practical knowledge and science, and will examine this specific cultural intuitive knowledge as particular concepts related to the social conditions of the Yoruba and compare it with the intuitions involved historically in theoretical and scientific constructions in Europe, before concluding with some hypotheses concerning their universal nature.

## Data and comments

### *Concerning the geometrical point*

In Yoruba, according to data collected during interviews and community observations, any point on a line is *|ipilè|*, or *|beginning|*, *|foundation|*, *|premise of the thing|* or *|ami|* which means *|mark|*. In real life in Yoruba culture, if, for example, a Yoruba man wants to build a house or give his daughter in marriage to a person, he starts with sacrifices called *|Ebo Ipilè|*, or *|sacrifice foundation|*. Awolalu writes that

foundation sacrifice is based upon the idea that all new enterprises undertaken by a man – setting out on a journey, beginning a new career, taking a wife, laying the foundation of a house, building a new bridge, or cultivating a virgin land – are to be committed to the care of the Supreme Being or other spiritual beings. (Awolalu, 1979: 159–60)

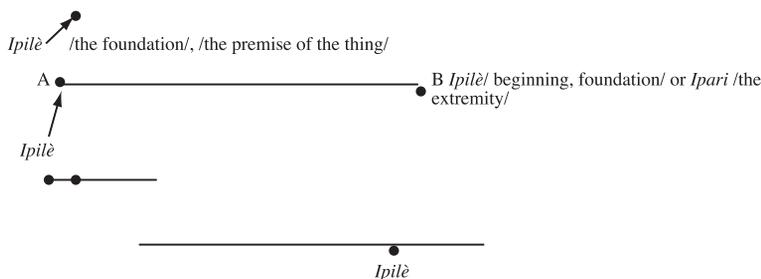


FIGURE 1

The same representation is incorporated when designating the first point of a line or any point on a line (see Figure 1).

For some of the commentators on Euclid's works, like Vitrac (1990) and Caveing (1990), the point is described as the end of a line. But the authors do not deny the general concept of the point as one that can potentially be considered as the beginning of a straight line. As it is conveyed by the interviews and the community observations in Yoruba, the ideation of the point in this case corresponds to the last meaning, the concept of the point as the beginning of a straight line. According to Aristotelian logic, the attribute of this definition of the Yoruba concept of the point would call for an entity that precedes */ipilè/*, that precedes */the beginning/*, */the foundation/*. No such thing exists in Yoruba. As a result, the designation of the point */ipilè/* translates the order of the logical succession of things, the order of the genesis. Mr Yacoubou, the 75-year-old Yoruba-Idààcha farmer whom I interviewed in Magoumi in Benin, claims that the first stone in the foundation of a building is */ipilè/* (*beginning*). When I drew a straight line for him on a board, he identified the point at the beginning of the line as */ipilè/*. When I distinguished, starting from the same straight line, several segments of this line, he identified the first point of each segment as */ipilè/*. The man from Ilorin in Nigeria, Mr Afolabi, the young scrap-dealer whom I interviewed in his workshop, designated the point at the beginning of the line as */ami ni ibèrè ila/*, which means, */mark it is beginning line/*. He also used the word */ipilè/*, saying */bi nkan bere/* */if something starts/*, whereas the man from Ijebu in Nigeria, Mr Javesimi, the 75-year-old woodworker, confirmed the use of the word */ipilè/* like the Idààcha. However, he added that */ipilè/* is

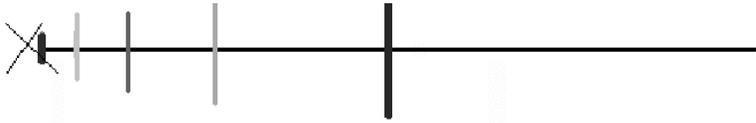


FIGURE 2

also */ipari/*, which means */end/*. The meaning of */ipilè/* is thus principally provided by the Platonic second type of definition for geometric entities, the genetic-ontological approach. To understand the point, not as the end of the gradual reduction of the dimensions of the sensible body but rather as its contrary, the genesis of the entities that constitute the line, the plane, and then the solid, and so on, means starting with the unit, which comes first, and then reconstituting the entities by extending the dimensions. */Ipilè/*, in Yoruba as in Aristotelian logic, is absolutely indivisible, but it has a position. The young scrap-dealer from Ilorin attests to this as well. Indeed, when I asked him, like Zeno, to divide the straight line indefinitely, he said:

*/apin ila si meji/*, which means */one divides line into two/*  
and then,

*/apin idaji si meji, apin idamerin si meji; apin ida mejo si meji . . . bi a ba pin titilo, o ti pari si ibèrè/*, which translates as,

*/one divides cut two in two, one divides cut four in two, one divides cut eight in two. . . .  
If one keeps on dividing, it ends up at the beginning/*. (See Figure 2.)

### *Concerning the straight line, the notions of continuity and mathematical infinity*

As far as the straight line is concerned, the concept is derived from the point and corresponds to what was said above. The notion of “straightness” in Yoruba is conveyed by the words */tito/*, */rirun/* and */gbooro/*. The man from Ijebu confirms the use of the first and the second words in oral and everyday practice. According to Abraham, in his *Dictionary of Modern Yoruba* (1962), the word */rirun/* means */to hurry in a crowd/*, */to move forward/* or */to squeeze/*. The word is constituted from the root of the verb */rin/*, which means */to walk/*, and the nouns */iré/* and */irin/*, which mean respectively */racing/* and */walking/*. The line being translated as */ila/* in Yoruba, the term */rirun/* justifies the designation of the */straight line/* by */ila*



FIGURE 3

*rirun*/, which means */line running along a track/*. The woodworker from Ijebu understands this. To his mind, any point in a straight line is */idani duro/ /dani duro lati fi nkan miran kun/*, which means, */a stop/ /a stop until something else is being added/*. The man from Ijebu compared this to */oju ona/*, saying */itinerary, path/*, a trip from village (A) to another village (B) (Figure 3). Walking from village (A) to village (B), a man stops at a place (C) to have a rest and then restarts his trip from the same place (C) with no jumps. The place (C) is */idani duro/*, */a stop on the road until the rebeginning/* from (C), say from (C'). The proto-concept of the straight line as described by the man from Ijebu reflects the thought process of the man from Magoumi. I asked the man from Magoumi: “you said that any point on the straight line is a beginning, how can you then distinguish the last point on the straight line and a point that immediately follows it, say (C) and (C’)?” His answer was: “*/o yato die, o sunmo e/*, */o mu/*”, which means “*/it changes course very little/*, */it is fond of it, it catches it/*” (See Figure 3).

In other words, one holds a pen drawing a straight line, but the pen cannot mark the point after which it is always running. In the study of the ideality of the point and the straight line in Yoruba, it is interesting to note that, for the woodworker from Ijebu or the scrap-dealer from Ilorin or even the Idààcha farmer from Magoumi, what is being reconstituted here is the intuitive conception the Greeks had of the notions of continuity, limit and mathematical infinity, a conception that would later be also intuitively fundamental to the differential calculus of Leibniz and Newton. We know that Aristotle contested the idea that the line was constituted of consecutive points, as well as that of time being constituted of instants. It is in this context that he develops, via the notion of potential infinity by division, the idea of continuity, which can then be related to his reflections on Zeno’s paradoxes. According to Brunshvicg (1993: 153–5), Newton, while developing the idea of fluxions and the preservation of the continuity or “gaplessness” of the intuitive line, reconstitutes Zeno’s argument of the dichotomy (see Figure 4).

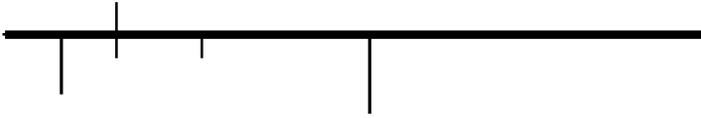


FIGURE 4

When Zeno emphasizes “the necessity for the moving body before covering the whole of the straight line to cover half of it, then a half of the half that is left, and so on, ad infinitum”, he assumes that the unit is  $1/2 + (1/2)^2 + (1/2)^3 + (1/2)^4 + \dots$ . There is a paradox, however. The sum  $1 - (1/2 + 1/4 + 1/8 + 1/16 + 1/32 + \dots)$  is not zero. But as the difference  $1 - (1/2 + 1/4 + 1/8 + 1/16 + 1/32 + \dots)$  is less than any given number, this result does not prevent us from asserting that  $1 = 1/2 + 1/4 + 1/8 + 1/16 + 1/32 + \dots$ . Thereby, according to Brunshvicg (1993: 208), Fermat can say that equality may be considered an infinitely small inequality, and one can bring inequality as close to equality as one wants.

The Yoruba-Idààcha in central Benin use the term, */ila ojuro/*, */line eyes straight, line eyes fixed/* to designate the straight line as well. It is this word that the man from Magoumi and his people used to designate the straight line I had drawn on the board. Brunshvicg (1993: 504) quotes Plato’s *Parmenides* to remind us that the practice has been the same since the very beginning of geometrical speculation. Since its beginning, he writes, “we call a straight line, the line whose center is located on the trajectory between the two ends”. And in order to ensure the straightness of the drawn line, the Greeks placed an eye at the end of the line in the same way a sergeant would in order to line up his soldiers. When the unevenness has been corrected, the line becomes straight and can be assimilated to a plumb line, what can be described as */ila ojuro/*, which means */line eyes fixed/*, in Yoruba-Idààcha (see Figure 5).

The proto-concept of the point and the straight line, as it finds expression in the metaphor “a point runs its course”, “a path” */ila ririn/*, is ubiquitous in the actual practice of the populations. When the Yoruba man from Ijebu says */Eko to irin ese ogbon kabi jube lo/*, which can be translated as */The city of Lagos equals walking feet 30 or more away from here/*, he refers to the experience of the elders, who measured distances and dimensions in */ese/*, */feet/*. For

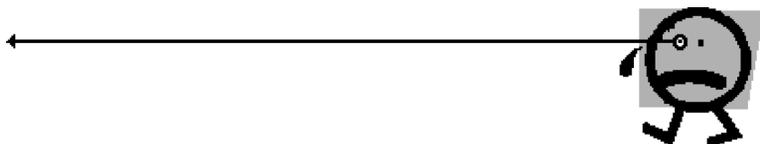


FIGURE 5

the Yoruba-Idààcha of Benin, the practice of the elders also consisted in measuring a distance and expressing it in a number of feet. The community kept a standard in the form of a piece of string */okun/*, or a ribbon, or sometimes a stick */opa/*. This tool was meant for daily use in the same way as the Greeks could say a drawn line could be “a foot long”. Although the practice of measuring by the foot is today obsolete, having been replaced by the metric system introduced by the western world, the means of expressing scales of distances has remained intimately linked with the use of the foot and the idea of walking. The man from Magoumi in Benin expressed it. He says that their forebears had their own instrument for measuring dimensions, which was the foot of the headman of the construction work.<sup>4</sup> Even today, when they travel a certain distance from one point to another, upon reaching that point they express their position in relation to the depth of the road, */ijinna/*. The arrival point is deeper than the starting point and so the depth is estimated with respect to the length that was walked. As their means of transportation is their feet and, being in the habit of walking, they know how far the villages are from one another, they say */Magoumi ko jin ona si Igbomina/ /Magoumi no deep way to Igbomina/* to mean that Magoumi is not a long walk away from Igbomina. The concepts or the meanings thus bear the mark of traditional practices.

### *The notions of surface, plane and solid (3-D)*

The notion of */surface/* derives from Platonic and Pythagorean considerations. The word */aju/*, which designates */the surface/*, means etymologically */the eyes/*. It relates back to perception. The Greeks designated it */the colour/* and thereby also made reference to eyesight. The man from Ijebu confirms and explains how the surface in Ijebu dialect, */ila to teju/*, means */line accumulating its eyes/* or

*/line spreading/* or */lines piling up/*. He uses the noun-phrase */ila teju pelé/* (*ojupele*), which means */line spreading added/ /line spreading attached/* to designate the plane. The term */pelé/* (*to add*) specifies the existence of a second dimension. Meno thus provides the means to express the surface and the plane, for, in addition to eyesight, the sense of touch offers the possibility of establishing a uniformity by removing the object from visual perception, an intuitive idea which is also used by Euler, as Lakoff and Núñez reported:

The fictive-motion concept of a line as traced by a moving, pointlike object has a long history within mathematics. For example, . . . Euler characterized a continuous function as a curve in the Cartesian plane “described by freely leading the hand”. (Lakoff and Núñez, 1997: 61)

To move from the plane to three-dimensional space, however, eyesight and touch are no longer sufficient. In Yoruba there is another dimension, which expresses the horizon and the darkening of the surroundings. It is the sense of depth, as expressed by */oninu/ /oju inu, ojinu/* (Ijebu), */olinu/* (Idààcha), which means */having belly, having depth/ /eyes of belly/* (*oju inu, ojinu*) (see Figure 6). Serres (1993: 211) points out too that the definition of the ideality of the pyramidal tetrahedron, the first of the five Platonic solids, was imagined in the same way by the Greeks as “the intuition of the transparent void”. As the man from Ijebu attested, volume in Yoruba is */iwon oninu/*, which means */measure which has belly, which has a depth/*, but also typically in Ijebu */ogbun/* or */gbohun gbohun (gbo ohun/* (Ijebu), */agbohun/* (Idààcha), which is equivalent etymologically to */get voice, give sign of presence/* and expresses the meaning of */carrier of echoes/* or */carrier of the voice/*. Indeed, the void does carry echoes. In everyday life, */ojinu/*, */oninu/* or */gbohun gbohun/* communicates the same idea throughout all the Yoruba territory. Thus when a Yoruba says */bi emi ba so ohun ti wa ninu mi/*, */if I were to tell the voice (what’s) that is on my stomach/*, he means that he is withholding certain secrets and that if he started to really talk, it would make a lot of noise thereby provoking echoes */gbohun gbohun/*.

As if it were a grammar of geometry, Yoruba geometrical ideation starts with the point, */ipilé/* (*foundation*). The point then describes a straight line, */ila rirun/*, and these straight lines come together to form a surface */oju/*, two */oju/* form a plane */ojupele/* and so on, to give the more complex forms of the solid bodies as if we were drawing the same intuitive Euclidian representation in Greek geometric tradition. Thus in the system of the Yoruba language, the elements

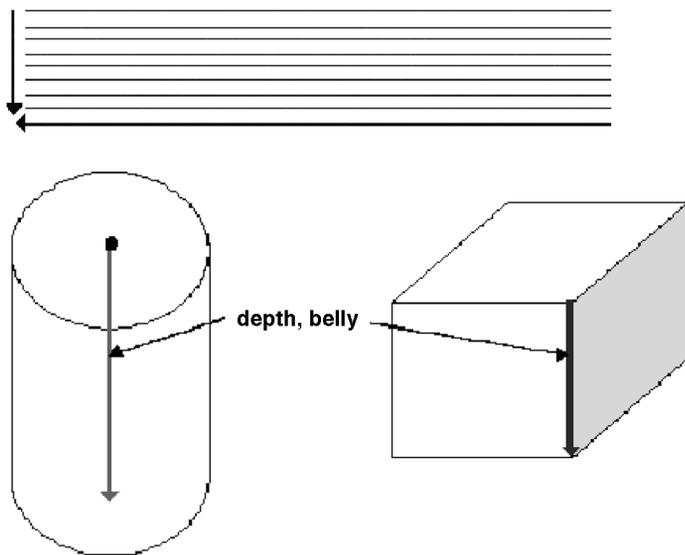


FIGURE 6

of geometry are notions that are derived from one another. In the rest of this article, I will focus on the particular cases of parallel lines, the diagonal, the triangle, the parallelogram, the rectangle, the square, the circle and one more complex figure, the pyramid.

*Notions of parallelism – the diagonal, triangle, rectangle and parallelogram*

For the parallel line, the Yoruba language uses the expression */ila ikoju si/*. The word */paralel/* or */paraleeli/*, suggested by certain Yoruba linguists, has been borrowed directly from English. */Koju si/* means */eyes fixed/*, */stiff pose/*, */look straight ahead/*, */confront directly/*. Here, we surely have Hestia, the word that designates the Greek woman who, like Penelope, weaves by the fireside, a symbol in the ancient Greek language signifying the fixed point, the calmness of repose, which was adopted in Greek science to mean */stationary* or */static/*. Thus, */Koju si/* has a meaning, making the detour via the borrowed English word unnecessary. The Yoruba term */koju si/* conveys an accepted sense and is itself sufficient without the English.

In Yoruba, the diameter is to the circle what the diagonal is to the rectangle. In Yoruba, diameter *|idagbagbara|* or *|ida gbaragbara|* means *|division equality equality|* *|division half-half|*. It also designates that which divides the area of a rectangle into two strictly equal parts. A poem of praise (litany) from the Ifè lineage in Idààcha-Igbo country in Benin provides evidence for the concepts of simultaneity, dichotomy and symmetry associated with the term *|idagbaragbara|*. Here, I will cite only a few lines of this litany:

*Omo Oji li Kere*  
*Omo isa Omo Ikee*  
*Omo aji kutu f'iri boju*  
*Omo gbaragbara aa pa oju ni*  
*Omo oju ko li ologbo, . . .*

Translated into English, this means:

*Descendants of the Oji from the village of Kere d'Iloji*  
*Descendants of the Icha from the Ikee group*  
*Descendants of those whose mountain is always covered in fog in the morning*  
*Descendants of those who know that the eyelids always close simultaneously*  
*Descendants of those who know that both eyes are the same age . . . (Boko, 1997: 177)*

Euclid uses the same word for parallelograms and, remarkably, Vitrac (1990: 163) signals the intention of the Greek geometrician to bring out the properties of the diagonal, namely both to divide the figure exactly in two and to measure out the greatest possible length across it. Thus the term *|idagbagbara|* or *|idagbaragbara|* quite logically dispenses with the word *|diamita|* or *|dayamita|* – another word borrowed from the English – thereby keeping this artificial import at a distance. From this point, logical deduction leads to the terms for the triangle, conceived of intuitively in Yoruba as the division of a quadrilateral by the diagonal *|idogba-meji |equality twice|*, the square as *|ogba-idogba|*, *|rectangle of equality (all sides and all angles)|*, and the rectangle as *|ogba|*.<sup>5</sup> Here we will be looking in particular at the figure of the parallelogram.

I asked Yoruba peasants in Magoumi to describe the techniques used to lay the foundations for traditional houses before the arrival of the Europeans. Their descriptions show that they know intuitively that a parallelogram with two equal diagonals is a rectangle, although they have no conscious and theoretical knowledge of this result (for details, see Sègla, 2002). They know how to distinguish a rectangle, which their language system terms *|ogba| |enclosed|*, from a parallelogram, which the same language system designates

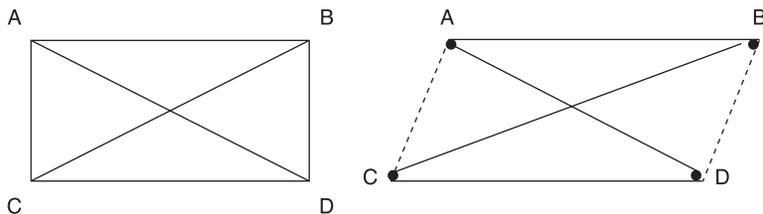


FIGURE 7

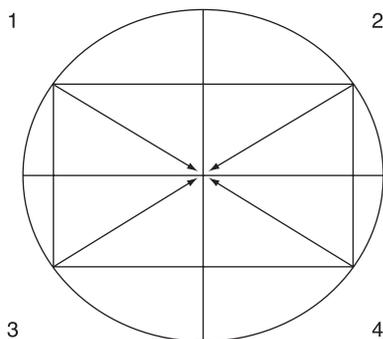
as *|iwalogba|*, which means *|the situation of everything that is in symmetrical and equal relation|*. The expression *|iwa li ogba, (iwalogba)|* is used primarily in everyday life to say, for example *|to be of the same generation|*, or *|to be the same age|* or *|to have the same social standing|*. In fact Yoruba expresses symmetry as *|idogba|*, which could be translated into English as *|equality|*. Although some Yoruba linguists might choose the word *|paralo|* or *|paralelogiraamu|*, borrowed from English, to signify *|parallelogram|*, in their daily practice the local populations use the term *|iwalogba|*, from their language system, conveying a relationship of equality and symmetry, of which the rectangle represents just one particular case.

Indeed, the theory of the parallelogram (see Figure 7) specifies that, if the symmetrical homologue of AB in relation to the diagonal is DC and if the symmetrical homologue of AC in relation to the diagonal is BD, then the straight lines AB and DC on one hand and AC and BD on the other are pairwise parallel, and so ABDC is a parallelogram. Thus, symmetry is what leads to the parallel nature of the constituents of the figure. The language system therefore justifiably denotes *|parallel lines|* by *|ila ikoju si|*, or in other words *|lines perfectly facing each other|*, *|symmetrical lines|*, rather than by *|paraleeli|* or *|paralel|*. Symmetry itself is *|idogba|*, *|equality|*, in the sense of *|straight lines that are parallel to one another|*, implying  $AB = DC$  and  $AC = BD$ , the conditions for a parallelogram. What is more, if the diagonals *|idagbaragbara|* *|that which divides into two equal parts|* that supply the symmetry are equal, we have the particular condition of the rectangle  $AD = BC$ , which is sought by the peasants by empirical means after they have already identified the parallelogram. We may notice that the empirical and intuitive representations of the Yoruba here are reproduced theoretically in Alexandrov's axiom of the rectangle drawn from Euclidian intuitive geometry. Indeed, as Gerdes (1993: 29–32) also reported

from a similar observation with Mozambican peasants, if  $AB = DC$ ,  $AC = BD$  and  $AD = BC$ , the angles  $ACD$ ,  $CDB$ ,  $DBA$  and  $BAC$  are right angles.

### *The circle*

The conception of the circle */agbo/* is quite unusual. According to the legend recounted by the man from Magoumi, a Yoruba man who wanted to avoid having his four sons each hide in a corner of the rectangular */ogba/* hut preferred to build a hut that was circular */agbo/*, a word associated with the expression */ilé eniyan merin/* or in an elided form */amerin/* (Idààcha), meaning */house people four/*. In this way, the father ensures the unity and power of his family, added Mr Yacoubou. In fact, for the man from Magoumi the four corners of the rectangle drawn on the board are gathered together at the centre of the circle. This is also the origin of the name given to the centre of a circle, */eerin/*, which means */four/*. In traditional Yoruba enumeration, the series *one, two, three, four, five, six, etc.* corresponds to the sequence of cardinal numbers */ookan, eejì, eeta, eerin . . . /*. The equivalent numeric adjectives are */mokan, meji, meta, merin . . . /*, which are noun-phrases containing a verb. The verb that acts in them is */mu/*, which means */take or separate/*. Thus the sequence is */mu ookan/ (take one), /mu eejì/ (take two), /mu eeta/ (take three), /mu eerin/ (take four), . . . etc.* The imagining of the circle in the language system starts from the conception of the rectangle with its four corners (see Figure 8). Thus, taking these corners away one by one, the figure of the circle is like */four corners dissolved in the centre/* or */four corners taken to the centre/ /amu eerin/* (Idààcha) meaning */having taken away four/*. The idea is intuitively present in Yoruba cosmological belief. According to Yoruba belief, the universe is round, and its creation starts with four corners, the four points of the compass encoded in the language system as */igun merin/*, or */angles four/*. This Yoruba model corresponds to the belief that the universe was created in four days, a belief that inspires the Yoruba traditional calendar with the four-day market cycle and the Yoruba four-day week, the four days having been given the name of the four most important Yoruba deities who created the universe, Orunmila, Obatala, Oduduwa and Shango, (Zaslavsky, 1973: 213–21).



**FIGURE 8**

In the expression */igun merin/*, */angle four/*, */igun/* is a noun in which the verb */gun/* expresses the idea of */meeting/* or */bringing together/* and so */igun/* signifying */corner/* expresses the notion of making two walls meet, giving a right angle. Thus, in Yoruba */igun/* is in principle a right angle, and indeed the traditional Yoruba house is rectangular */ogba/*, with four right angles. Here we see how the conception of the circle is obtained, starting with the centre defining the totality, meaning the circle and all its other elements in the ‘powerful’ centre. The traditional organizations of a Yoruba village and the family group can serve for the social illustration. The chief of the family group, in a Yoruba town or village, is */baale aglo le/* */chief circle houses/*; the wives of the chief have their rectangular houses on a perimeter that forms the circumference of a circle */agbo ile/*. Furthermore, this shows how the mnemotechnical device of geometrical and spatial order is also a landscape of memory.

Do the historical traditions that apply to construction among certain peoples in the world intersect? Mr Yacoubou’s remarks remind us of Black Elk’s ironic observation, cited by Marcia Ascher, about “those square boxes” that the culture of white people (Waischus) had brought as a substitute for the round houses of the American Sioux. Thus, he exclaimed:

... there can be no power in a square. You have noticed that everything an Indian does is in a circle, and that is because the Power of the World always works in circles, and everything tries to be round . . . (Extract from a declaration on the circle, *Black Elk Speaks*, Niehardt, 1972, cited by Ascher, 1991: 125)

In the same way, the description of the circle and the calculation of its perimeter by the Bantu tend to confirm the reflections of Mubumbila (1992) and those of Fourche and Morlighem (1938), according to which, in the Bantu psychic symbolism of the circle, the circle is also the sign of God and Power. *Nkuembia*, the name given to the circle by the Bantu, is also that of a spirit. Magnified and materialized in real life by the Yoruba, the Sioux Indians in America or the Bantu in Central Africa, the circle as a spirit has been the object of meticulous observations by other rational cultures. The Bantu, for instance, believe that the circle has an eye on its head. As a matter of fact, the centre of the circle is that eye. They also say that it possesses a body of 10 *diboku*,<sup>6</sup> which is the diameter of the circle. When the circle is torn open, the Bantu give it a dimension that is equal or inferior to 40 *diboku*, which we would describe today as a 40-metre perimeter. The Bantu feel that this is why one cannot come any closer to *nkuembia* (*circle*) than 40 metres. This description reveals that the relationship ( $\pi$ ) between the circumference of 40 *diboku* and the diameter of 10 *diboku* is equal to or inferior to 40/10 or 4. Generally among ancient peoples this relationship ( $\pi$ ) is placed somewhere between 3 and 4. According to Haudricourt and Needham (1957), the ancient Chinese took it to be 3, while the Egyptians determined it to be 3.1605 by the graphical method of inscribing a circle inside a square (Lefèbvre and Vercoutter, 1957).

*Briefly concerning one complex figure, the pyramid*

When it comes to the designation in Yoruba of a complex geometrical figure, the pyramid, one might think that its designation would pose insurmountable difficulties, thus lending weight to the idea that languages are impenetrable or to the idea of indeterminacy. But this does not seem to be the case. One of the most difficult features to describe is bound to be the side of the pyramid. As the pyramid is not a two-dimensional object, one cannot describe its side as */iha/* or */egbe/*, */agbe/* (Idààcha), which means */side/* and is normally used for a simpler figure. But the Yoruba do. The community observations show that the Yoruba use the word */egbe/* to describe the side of the pyramid or the side of any complex figure. To understand the origin of this, we need to see that the Yoruba

intuitively use metaphors, which consist in the reliance on information ideally shared in an area that is well known as a model for describing the properties of areas that are not as well known and mastered. Foley (1997: 179–87), drawing on Lakoff (1987) and Johnson (1987), shows that the elements which are mastered in the initial area are very often borrowed from the vocabulary referring to the body, the most intimate parts of the human body and its positions. He writes:

Human understanding of any target domain is structured first and foremost in terms of the human body and its everyday practical interaction with the physical world; this is the pre-eminent source of metaphor. This statement is well in accord with the claim of the enactionist school that embodied practical understanding in structural coupling is the nature of cognition. The features of the human body and its orientations with the physical world provide many of the basic dimensions for source domain in metaphorical extensions. (Foley, 1997: 183)

In the case in point, we draw on the comments of Olawole Jayesimi, the woodworker from Ijebu. To understand more about the use of */egbe/* by the Yoruba woodworker for describing the side of the pyramid, I asked him about the left- and right-hand sides of the universe. He was at first embarrassed and then he answered: “*It depends where is your head and how is your position*”. As he rose and stood facing in the direction of the city of Lagos, the Yoruba man from Ijebu said:

*/Eko wa niwaju wa, bi Eko ti wa niwaju wa, okun wa l’egbe otun, Ocha wa ni egbe osin, tori beni, Kutonu wa lehin wa/*,

which means:

*/The city of Lagos is in front of us, if the city Lagos is in front of us, the sea is on the side right hand, the lagoon Ocha is on our side left hand, and the city of Cotonou is behind us/.*

I asked him to change his position and then asked the same question: where can one find the right- and left-hand sides of the universe? He re-adapted himself to the new position and named the geographical positions in relation to the places previously defined. I then asked him about why the left- and right-hand sides of the universe change every time. He answered: “*It is because the direction in which we are looking changes*”.

Stephen Levinson (1994) has studied the process of naming the parts of the human and animal body in Tzeltal, a Maya language spoken in Central America. The similarity with the Yoruba case here shows that the term */egbe/*, which means */side/* of any given object, is first that which designates the right-hand or left-hand

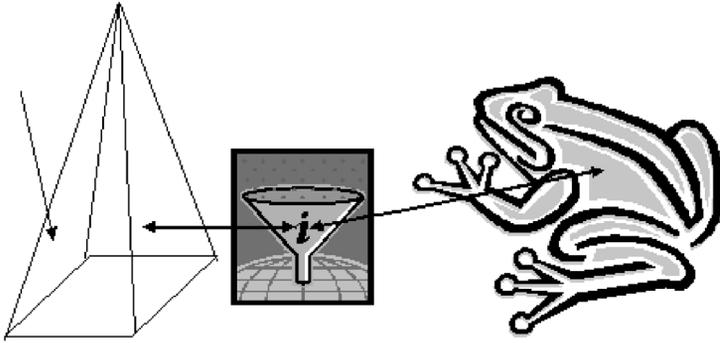


FIGURE 9

side of the human body, or the flank. We observe that the Ijebu man uses the term *|egbe|* (*egbe osin*) to mean left and (*egbe otun*) to mean right. Other examples drawn from the vocabulary of the terminology of the human body in Yoruba, like *|the mouth|*, *the nose|*, *|the neck|*, *|the head|*, *|the back|*, *|the front|*, *|the body|*, etc., were equally applied by the man from Ijebu and the man from Ilorin to the mouth of a cow, the front of a chair, the neck of a calabash, etc. in any position, vertical, standing, head upwards or lying down, horizontal or upside down with the head downwards. That is why the sides of two- and three-dimensional objects are naturally referred to as *|egbe|*, as is illustrated by the conversations with the scrap-dealer from Ilorin and the woodworker from Ijebu. For them, the term *|egbe|* can be used for a table, a bottle or a geometric figure. Olawole Jayesimi, the Yoruba woodworker, says: “*|Egbe ile, egbe malu, egbe tabili, egbe ni egbe je|*”, which means *|side house, side cow, side table, side that is side is|* (see Figure 9).

In the translations of biblical texts into Yoruba at the end of the 19th century, the Anglican missionaries<sup>7</sup> preferred the word *|iha|* to that of *|egbe|* to designate *|side|*. But as the term *|iha|* does not intrinsically belong to the vocabulary of the human body, people do not actually use it in their ordinary lives. The naming of the pyramid in Yoruba must thus be understood as an exercise in entering into a domain that is not as well known. The use of the term *|egbe|* is in this case a metaphor. It is thus acceptable to name the side of the pyramid *|egbe oloju|* (*egbe toloju*) or *|egbe oni oju|*, which means *|side which has a surface|* or *|side surface|* and the

pyramid /*aworan oni egbe-toloju pupo*/ which means /*the figure that has several side-surfaces*/.

## **Conclusion**

The case-study shows that the system of knowledge related to geometry and spatial thinking is not the subject of speculation, but is culturally bound up with the traditional empirical foundation. At the beginning of the construction of an Arab scientific language in Egypt (Crozet, 1996), Rifà àl-Tahtâwî attempted to compensate for the lack of specific words needed for scientific Arabic to be understandable, just as similar efforts have been made by the Yoruba scholars who borrow from English. Nevertheless, at root it is not a matter of a lack of words or concepts. Indeed, it is the words found in common usage that won out over the artificial solution adopted by Rifà àl-Tahtâwî and his students. In the case taken from the Yoruba language system, anthropology allows us to avoid an artificial solution. In Meiji Japan, too, a perfect convergence between oral language practice and the language of translation of western scientific and technical books was the aim (Horiuchi, 1996; Sègla, 2001).

The Yoruba language system has identifiable representations of quantitative thinking in a variety of domains, and people know how to adapt them to a geometrical environment even though they may not have a qualitative understanding of what they are doing. To what should we credit these regularities observed among the Yoruba? Is it a case of Pavlovian learning, or Skinnerian behaviourism? Or are there innate constraints regulating the ontogenesis of proto-concepts and proto-terminologies in a particular context? While these thoughts in Yoruba might be intuitive, I maintain that they nonetheless indicate intrinsic properties of the human mind and are the purest expression of its universal features contained in a specific cultural lexical archive. But to understand the origin of that mind, we need to undertake interdisciplinary and thematic research on the origin of man, the functioning of the brain, languages and their origin, languages and mind, genes and anthropology. In *Descartes' Error, Reason and Emotions*, Antonio Damasio (1995) shows how culture is the product of the mind, which is itself the result of a brain integrated into a living body. Is the mind the beginning or the end? Biological studies using brain-

imaging techniques are confirming that the human brain functions mathematically. And Calinger, drawing on Stanislas Dehaene, writes:

While the British mathematical physicist Roger Penrose claims that humans have an intuitive grasp of mathematics, cognitive neuropsychologist Stanislas Dehaene is weaving together a rich study of biological, cultural and psychological evidence to indicate that the mind and brain create a number sense, which culture and associated technologies . . . profoundly shape. (Calinger, 1999: 5; see Dehaene [1998])

Unlike Foucault (Chomsky, 1977: 91–5), Geach (Geach, 1957; Anscombe and Geach, 1967) is not sceptical about the idea of intrinsic properties of the human mind as a psychological and biological concept, properties that are relevant and independent of social and historical conditions. He explains how, for Thomas Aquinas, the issue raised here would also translate into the question of whether or not the universality of thought is compatible with other ontological hypotheses, including those derived from the dialectical sphere.

Another question remains. How might one qualify the traditional conceptual system of thought? What is its status? Is it simply observational or expressive and not at all theoretical? Taking the example of the quantitative mapping of the theory of parallelogram by Yoruba peasants, is there a difference between what is expressed by oral language and what is exposed by means of writing in Euclid or Alexandrov? This poses the question of the relation between writing and oral tradition. But the picture may be even more complex. Mary Hesse (1974: 9–44) does not make a distinction between observational or everyday language and theoretical language as Horton does. Nevertheless, Horton writes that:

Mary Hesse has argued convincingly that “everyday” concepts like “earth”, “sky”, “man”, “tree”, “earth”, “fish”, are as indissolubly linked to causal laws as are “theoretical” concepts like “proton”, “atom”, “wave” and “electric current”, and that in this respect they are neither more nor less “theoretical” than the latter. (Horton, 1993: 312)

Horton, however, being more prudent than Hesse, cites a complementary coexistence of “everyday” and “theoretical” languages “as one of the most important continuities between African traditionalism and Western modernity” (1993: 312). But what are the instances of what he calls “continuities”? In other words, how does theoretical construction emerge from intuitive knowledge? I suggest here that what makes western culture move to a high “mechanistic” and modern type of thought is simply conscientiousness and constant improvement of the links between observational and theoretical

languages. To my mind, science is nothing but what brings more and more rationality into real life, a process within which the old is constantly turning into new. In light of this, the cultural perspective on science and technology and its development in a traditional society can draw on anthropology. The Yoruba case-study illustrates a form of rationality serving as empirical basis for theoretical constructions and technological innovations resulting in the stabilization of traditional foundations. The approach proposed might thus open new lines of research in non-western cultures. Non-western traditional thought, proto-science and technology could then be re-assessed. Anthropology, history, philosophy and sociology of science will clearly gain insights from these new lines of work. Traditional culture might well benefit from intuitive and concrete knowledge which, if “combined with an analytical and experimental inclination” (Wiredu, 1980: 12), could put traditional non-western cultures in the forefront of knowledge, science and technology. On the other hand, the understanding of the non-verbal intuitive and practical knowledge in non-western cultures could provide data that would illuminate the preconditions for the emergence of science in Europe.

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## Notes

1. Concerning the transcription of standard Yoruba language, one must be aware that there are three tones – high, medium and low. The vowel is at the centre of the syllable, the tone constitutes an essential feature of the vowel or the syllable and there are as many syllables as there are tones. The symbols that have been used in

the present text are as follows: high tone (/), low tone (\) and medium tone (-). Nevertheless, because of difficulties related to computerized transcription, several tones have been omitted.

2. Dahomey changed its name to Benin in 1975.
3. Concerning practical knowledge in traditional milieu, the author is preparing a book: *Les Galilée montants d'Afrique noire: quand le savoir pratique rencontrera la science* (*The Rising Galileo of Black Africa: When Practical Knowledge Meets Science*).
4. In the community of the Yoruba-Idààcha in Benin, /*Ogan*/ is a high-ranking person in the Omojagun royal dynasty that rules the Yoruba Kingdom of Igbo-Idààcha (Benin). He is consulted on all manner of issues (land problems, funerals, construction, etc.). He is, in a sense, the repository of all practical knowledge. In former times, it was his foot that served as the standard for measuring dimensions.
5. For a detailed explanation of the ontology of the names proposed to designate geometrical figures, see Sègla (2001) and Sègla (2003a, c).
6. The /*diboku*/ is equivalent to a Bantu measure of dimension that is taken to be the length of an arm, a bit like the Yoruba where the unit of measurement is the /*ese*/, /*feet*/.
7. Exodus, chapter 39, verse 9, translates the square in Yoruba language by /*oniha merin ogbogba*/, which, in its completely pronounced form is /*oni iha merin ni idogba*/ [*having four sides equal*] (*Holy Bible*, 1900).

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