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Viewing Formal Mathematics from Yoruba Conception of the Sky

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Abstract:

Yoruba Cosmology resembles a generative system at the foundation of concepts. The traditional thought, which derives from the reality of the identical pair incorporated from cosmology into real life, exemplifies all kind of existing knowledge, culture and practices. Previous studies by the author show in some detail the scientific interests in Yoruba cosmology. The present paper aims to view formal mathematics through the interpretation of Yoruba sky knowledge. It attempts to demonstrate that linguistic codes elaborated from the Yoruba conception of the sky are binary and hexadecimal codes that imply Algebraic Boolean structure or Group Structure. The system is in accord with classical mathematical properties of Group Structure. Finally, the review and interpretation of Yoruba cosmology may suggest the possibility of formal reasoning without any writing system in human history. The problem that has always been raised is that of knowing if symbols and configurations in the Yoruba interpretation of the sky are the result of implicit premeditated mathematical development. It is clear that behind the implicit oral discourse described hereafter lies a corresponding semiology elaborated with the corresponding formal mathematical reasoning that we claim.

Keywords: history: concept and logic; algebra: Boolean-group structure; astronomy: interpretation; formal mathematics; Yoruba cosmology; knowledge: tacit-implicit

Introduction

As Abiola Irèlè observed in *The African Scholar* (1991) and further in *The African Imagination* (2001), scientific and technical achievements of Classical African Cultures are under-studied. The focus of scholarship in African Studies is directed only towards the humanities and the social sciences. Hountondji (1990) also argues in *Scientific Dependence in Africa Today* (1990) that, even when studies on humanities and

social science take place, they only operate in terms of furtive descriptions of ideas and achievements that have been superseded. In such studies, described achievements and thoughts are best understood as historical markers and anthropological guides; rarely are they logical, well portrayed, dynamic transformations. For the substance of the state of the debate, we first recall the status of Western Science, which is identified by reference to its theories and systematic and dynamic character, as opposed to non-Western Science, which is associated with traditional practices, has no theory, and has a static character.

To challenge and differentiate the distinction between static and dynamic systems of thought, we need to give and show sufficient parameters. What orthodox or positivist critiques say is not only that there is no dynamic trend of knowledge in non-Western Science, but that there is a lack of visibility and an impossibility of demonstrating the presence of tangible outward signs and key concepts like objectivity, causality, deduction and induction. While on the Western side, the practices—symbols and cosmological as well as social backgrounds—are cut out, making knowledge there appearing thoroughly instrumental, systematic and dynamic; on the African side the practices are still reduced to their cosmological and social backgrounds, frequently narrowed down to the symbolic dimension. In these conditions, for modern anthropology, it is, for example, impossible to sort out from African belief accurate scientific knowledge and techniques like

mathematics. This makes Western Science look like it arrives at speculative and modern theorizing mysteriously from nowhere. Yet, science in Europe also originated from myth and rituals and moved from magic and religion only progressively; theoretical constructions in Western cultures logically also started from basic human traditional knowledge.

In the present essay, using foundational archaeology of concepts taken from Yoruba history and culture, we try again to make clear the dynamism of African traditional thought by bringing a case study of formal knowledge extracted from folk belief. By the way, included here is a demonstration again that African science can prove the accuracy of the stock of traditional knowledge and technologies (Sègla, 2015a, 2015b). We first present the Yoruba cosmological model and its elements. We then show their scientific interests and further, we present our mathematical interpretation of the Yoruba conception of the universe and the sky.

Yoruba Ethnoastronomy

Who are the Yoruba?

The Yoruba are about 50 million people living in West Africa, Nigeria, Benin Republic and Togo. Millions of others in Cuba, Brazil (Bahia) and the United States are descendants of Yoruba slaves. The origins of the Yoruba are lost in history. Their ancient history, sometime between 3000 BCE and 500 CE (Horton 1979; Obayemi 1979), is well known by the study of the pre-dynastic (pre-Oduduwa) Yoruba linguistic groups now mainly in Benin Republic, Togo or in the eastern parts of Yoruba land in Nigeria (Sègla 2003, 2006). Their recent history began with the foundation of Ifè between 500 and 800 CE, and later with the foundation of Oyo. Heritage is widespread with strong knowledge of social organization, agriculture, medicine,

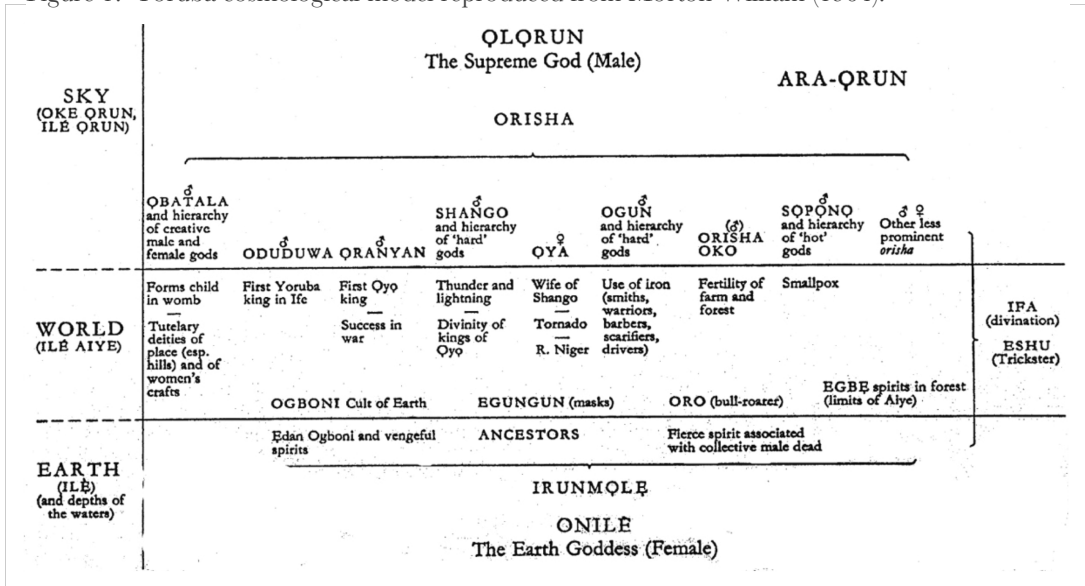
art, Nok iron civilization and technology. It is well known that Yoruba art, together with that of Benin, originated in the Ifè classical period (1000 to 1400 CE), had a tradition of excellence, and is comparable to the works of art of classical Greece and Rome (Willet 1967).

Beliefs and Knowledge

As Lawal (2008) points out, in “Ejiwapo: the dialectics of twoness in Yoruba art and culture,” the concept of “twoness—*ejiwapo* meaning ‘our two(s) are many’; the idea of the reality of an identical pair derived from cosmology”—exemplifies the idea of the reality of nature, constantly characterized, in faith, by two aspects: “spirit/matter, visible/invisible, male/female, good/evil, essence/existence.” About Yoruba’s cosmological vision, studies by Morton-William attest to a “twoness mental model.” Morton-William (1964) reported from the Yoruba Oyo country: “...The House of the Sky is the domain of the supreme God, Olorun or Olodumaré (Olorun means ‘Sky – Owner’)... The Earth is the domain of the Goddess Onilè, Earth-Owner, who is sometimes simply called Ile...” This observation from the Oyo Yoruba, apart from some variability, is available for all the other Yoruba.

From these observations, the Earth Goddess is recognized to be the conceptual counterpart of the Sky God, since Earth and Sky are in relation of a Female/Male duality. They are coeval, each of them being characterized by four correspondent spirits: matter, water, air and fire. Between them is the World of the humans (*Ilé Aiyé*), governed by the Orisha in Yoruba history and culture. Thus, Orisha are the Supreme God functionaries and ministering spirits in the World /*Ilé Aiyé*/ (Awolalu 1979). This means that the Orisha are intermediary deities between the Supreme God and humans. The Orisha, who are

Figure 1. Yoruba cosmological model reproduced from Morton-William (1964).



sent by the Supreme God to govern human life, thus constitute socially constructed institutions for scientific practices (Sègla 2015a).

Most prominent social institutions, under the authorities of the intermediary Orisha, that enable humans to penetrate natural phenomenon and establish their inner laws are: *Obatala*, the knowledge of forming a child in womb (fertility); *Shango*, thunder and lightning; *Ogun*, use of iron; *Oko*, fertility of farm, forest and environmental science; *Shapona* or *Sapata*, curing of smallpox; *Esu*, philosophy, part of the divine which tests and tries out people; and *Orunmila/Ifa*, the whole encyclopedia that gathers all oral knowledge produced within every existing Orisha (Sègla 2015a). There are many Orisha; scholars count thousands and thousands of them, but according to oral tradition and very well developed studies (Bascom, 1969; Abimbo 1975, 1977), the most famous Orisha are the Sixteen (16) so-called Fundamental or Primordial and the Two Hundred Forty (240) Secondary Orisha. The total gives two hundred and fifty-six Orisha.

Studies of the Orisha in Yoruba his-

tory lead us to the main proposal for a universal scientific theory because they show how a people's conception of the sky constructed science (Sègla 2015a), whereby Orisha (or Vodun, as named by the Yoruba's neighbors, the Fon) is conceived as a variant of several existing world views. They give evidence of a "science of the local" within a common universal scientific theory (Sègla 2015a). However, a detailed study of the Orisha is not our concern here. This article aims to concentrate on mathematical interpretations of the Yoruba cosmological model. It is therefore interesting to ask why and how the original coders count sixteen most important intermediary deities (the Orisha)—also called the Primordial Deities—and why and how the Sixteen Primordial Deities have under their control the other Two Hundred and Forty Secondary Deities.

Scientific Interests

We propose that the study of the Yoruba-Idààcha Divinatory Calendar (Sègla 2006, 2008) gives evidence of a pre-Ifa (Encyclopedia of Yoruba Knowledge) divination system that remained immune from to-

day's 'confusing' and permuted Ifa hegemony, which has already been observed by Maupoil (1943). In modern days, semantic truthfulness from the original Ifa knowledge system's coding still shares claims of aboriginal status with a cluster of associated cults. Or it shares evidence of archaic ritual language forms that echo earlier spoken dialects—Ifè/Icha Tutu (the Ifè/Icha of earlier time, close to today's Idààcha dialect of Yoruba)—that re-surfaces in the voice of possessed devotees in Idààcha lands (Sègla 2006, 2008). Beginning in ancient times ca. 200 BCE and particularly from the Classical Yoruba period of 500 – 700 CE at the latest (Sègla 2006, 2008)—on the basis of archaeological findings in Ilé-Ifè (Obayèmi 1979; Horton 1970), the society had to meet a growing number of complex demands in terms of healings, techniques, predictions, epidemics, agriculture, celebrations, augury and more. In these urgent conditions, circles of initiates invented a mode of classification of at least 256 chapters of prescriptions of all kinds of knowledge. This classification grouped together all the accumulated knowledge from all fields within 256 chapters, each of which is under one of the intermediary Gods (Orisha), sent on earth by the Supreme God (Olodumaré / Olorun) to help humans face real life. The classification is conceived in a way that each of the Sixteen Primordial Deities stands for a kind of Big Living Room governing again fifteen other rooms under its control. The original coders, therefore, obtained 16 Great Chapters of knowledge corresponding to the 16 first Primordial Deities (Orisha) and a further two hundred and forty other chapters corresponding to the Secondary Deities, giving a total of 256 chapters of the whole encyclopedia of knowledge.

Above all, insofar as cosmogony teaches that in order to succeed in the real

world, one must take into consideration the Two Masters of the Universe, that is *Ejé Omí-Ilé* or 'the Two who own the World' (or 'two possessors of the universe') as Morton reported (i.e. the Sky or Supreme God and the Earth Goddess), the search for solutions in society could only come through a probabilistic approach. Being able to invent a classifying mode that integrates all the factors that allow the highest rate of success for humans necessarily implied intellectual activity and formal reasoning. Naturally, with a new generalist dashboard, the Orisha Priests could, insofar as they faced new elements of diseases, consult the contents of the chapters of the classifying corpus (encyclopedia). As with Vygotsky (1974) who studied concepts and representations of autochthonous people of Siberia, it is clear that original Yoruba people also used inscriptions to represent concepts they had of the universe and cosmos. Referring to the two deities who own the universe, the Supreme and the Earth Goddess, the first sixteen inscriptions are coded. Being only two at the original creation, the original coders gave one of the two the inscription code of 'II' and the second one was given the inscription code of 'I' (Sègla 2004). From there, the sixteen Main Deities on which the Yoruba Ifa Encyclopedia is based are named. They are represented in the Table 1.

Astronomy and Interpretation: mathematics and the concept Yoruba People have of the universe/sky

Base Two: The foundation of the Encyclopedia of Yoruba Knowledge

The original coders inscribed the Sixteen Elders (the Sixteen Primordial Deities) using two main foundational cosmological concepts, the Supreme God and the Earth Goddess. As they are two, the original coders understood they have to encode all ab-

Table 1. Sixteen main signs at the basis of Yoruba Ifa Encyclopedia of Knowledge

Sign	Name	Sign	Name	Sign	Name	Sign	Name
II		II		I		I	
II	<i>oyèku</i>	I	<i>ika</i>	II	<i>obara</i>	I	<i>irosun</i>
II		II		II			
II		II		II			
II		II		II			
II	<i>okanran</i>	II	<i>ofun</i>	I	<i>odi</i>	I	<i>irètè</i>
II		I		II		II	
II		II		II		II	
I		I		I		I	
II	<i>otuuruṣon</i>	II	<i>iwori</i>	I	<i>osè</i>	I	<i>ogunda</i>
II		I		II		I	
I		I		I		I	
II		II		II		II	
II	<i>owonrin</i>	II	<i>osa</i>	I	<i>otua</i>	I	<i>ogbè</i>
II		I		II		I	
I		I		I		I	
I		I		I		I	

stract figures and the Sixteen Primordial Orisha starting from a base two. And in base two, the symbols that help encode every other number are ‘nothing’ and ‘one’—the number ‘two’ itself not being included. The original coders then coded ‘nothing’ by II and ‘one’ by I, which means they counted two by two, “they bless in pair” as reported from one verse from Ifa Encyclopedia of Knowledge, the Eiji Ogbè Verse which is the 256th Chapter, i.e. the last one:

One ese Ifa belonging to this Odu reveals that the ancient Yoruba used the binary system to develop the Ifa Literary Corpus. Like the people of Queens land, the Ifa people counted “one,” “two,” “two,” “two” and “one,” “two two”... I bless in pairs... I no longer bless one by one... (Opeola 1986)

In fact, being able to inscribe the symbols of base two (one and nothing), the original people had the power to inscribe all the other numbers. Not surprisingly, the inscribed Sixteen Intermediary and Primor-

dial Deities as presented in the Table 1 are really consecutively abstract mathematical modern figures 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15. And yet, oral traditions confirm that:

- *oyeku* means the ‘number that disappeared, that died,’ standing here for ‘0’ in modern mathematics;
- *okanran* means ‘may one shine!’ standing for ‘1’ in modern mathematics;
- *ika* means ‘the five fingers,’ standing for ‘5’;
- then *ogbè* meaning ‘completed life, accomplishment’ stands for ‘15,’ making sense because 15 is the last symbol in base sixteen.

The following sign:

II
II
II
II

then, can be transcribed as:

(II) (II) (II) (II)

that is:

0 0 0 0 (base 2)

which is equivalent to:

$$0x2^3 + 0x2^2 + 0x2^1 + 0x2^0 = 0 \text{ (base 10)}$$

the Yoruba *oyèku*.

While:

I I

I I

I I

I

can be transcribed as:

(II) (II) (II) (I)

which is

$$0x2^3 + 0x2^2 + 0x2^1 + 0x2^0 = 1 \text{ in the decimal system (the } \textit{okanran}, \text{ '1 shines')}$$

Similarly:

(I I) (I) (I I) (I I)

is

$$0x2^3 + 1x2^2 + 0x2^1 + 0x2^0 = 4$$

(*ika*, 'the 5 fingers').

And

(I) (I) (I) (I)

is

$$1x2^3 + 1x2^2 + 1x2^1 + 1x2^0 = 15$$

(the *ogbè*, 'the accomplishment, the summit').

We can observe here that the semantics are in accord with the formal mathematics and the logic. Indeed, 0 in base 2 is 1 (one) for the Yoruba original coder. And one shines, say *oyeku* giving 2 that is *okanran*, which is 1 in base 2 and 2 in base ten in modern mathematics. Consequently, and logically, 4 which is *ika* as inscribed in base 2 is cautiously 5 in base ten (10). It makes sense when *ika* is named by the original coders

'the five fingers.' Finally, *ogbe* which is 15 as inscribed in base 2 is really sixteen in base 10, say 'the summit,' meaning that we reach the Sixteenth Primordial Deity as we have a total of Sixteen Primordial Deities as defined by Orisha theory.

Hexadecimal Codes in Yoruba Inscriptions: the other 240 Secondary Orisha Encoding.

To code the other 240 Secondary Orisha, the original coders cross-composed at a first stage each Primordial Deity with himself and at the second stage each Primordial Deity with each of the 15 other Primordial Deities. The first stage composition ('double composition') gives 16 and the second ('hybrid composition') gives 240. They consequently have 256 composed Inscriptions. The Orisha Encyclopedia of 256 Chapters of Knowledge suggests deliberate cognitive performances as a result of their cosmological mental model, which have a broad concern with divinatory calendars, numeration systems and medical prescriptions. In fact, a chapter of knowledge that has been composed in this way, like *Ogunda.Ogbè* (composed by *Ogounda* and *Ogbè* is like 14|15 in a hexadecimal code system. That is:

I	I
I	I
I	I
I I	I

Ogounda appearing first at the left side and *Ogbè* following at the right side. *Ogounda* is ascendant having under its control *Ogbè*. That is why the original coders also inscribed *Ogounda* appearing at an upper position as shown below.

The left inscription or upper side being ascendant, we have *ogunda.ogbè* giving in base ten (10) = 239, that is the 240th chapter of the General Encyclopedia of Knowledge.

I
I
I
I I

I
I
I
I

To address the origin of this system, let us recall briefly that The *Supreme God* who owns the Sky, and the Goddess Onilè who owns the Earth, are called “Eeji Oni-Ilè,” which means ‘The Two Who Possess the Universe,’ as noted above. Each of the two forces, ‘the Earth force’ and ‘the Cosmic force,’ has four symmetric correspondent signs on Earth and in the Sky. These are ‘fire,’ ‘earth material,’ ‘air’ and ‘water’ (Sèglà 2006). Earth and Sky being in a relationship of a Female/Male duality, the system gives a total of eight signs ($4 + 4 = 8$), which interact and give inspiration for the diviner to use an eight-cowry-shell rope for prediction. Again, each sign also having two sides, the concave side and the convex side in virtue of the dialectics of the “*twon-ess*” in Yoruba art and culture, there is evidence of a total of 256 configurations or probabilistic possibilities each time the diviner throws down the ‘divining chain’—or *opèlè* in the Yoruba language. Earlier research reported the way the present-day Babalawo (the old man who possesses the knowledge), in the right tradition of the forecaster, original coder of the Ifa corpus, facing the divining chain and geographic north, calls for four elements that characterize the two owners of the universe, the earth and the sky: these elements being matter or earth, water, air and fire (Sèglà 2006). The Babalawo reproduces them by marking out the four cardinal points which symbolizes the beginning of the creation in

faith, the *Orita*. He can henceforth begin the divination.

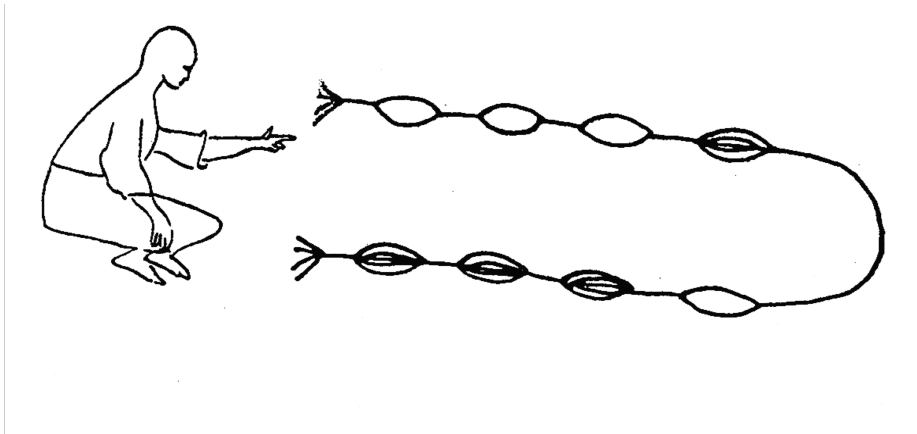
A similar practice among the Chaldeans has been reported by Oppenheim:

A sign that portends evil in the sky is (also) evil on earth; one that portends evil on earth is evil in the sky [. . .]. These are the things you have to consider when you study the two collections... (Swerdlow 1998).

Because the eight cowry shells appear on two sides of the divining chain and are aligned (Sky and Earth giving 2×4 spirits; and two strokes representing concave side, one stroke for convex side), viewed by the original coder from the left to the right (always facing geographic north), from the end of the chain to the center (the higher power value conferred to the low position, while the low value is conferred to the position that declines towards the top; as in the Euclidean division), there is a resource for the hexadecimal system to occur. Indeed, in Ifa, it is the divining chain as a medium and form of inscription that allows a place value numeration system.

In fact, it is precisely because each of the two poles of the universe has 4 corresponding spirits that the 8 spirits ‘Earth and Sky’ implies the *instrumentalization* of the divinatory chain. It is because the cowries, in concave or convex modes, are aligned on each branch of the rosary that the hexadecimal codes appeared in the imagination of the original coder. It is these factors of inference and causality and only these that are necessary to render the results valid and formal. The concept or notion of order here is fundamental. It is the chosen order that is one of the causes without which the results that are obtained would be impossible.

Figure 2. A forecaster in front of a divinatory rosary with eight nuts. The striped ovals represent the ‘empty’ side with a value of II; the white ovals represent the convex side with a value of I.



One example of possible configurations among 256 is given in Figure 2. Using the above stated principles of viewing (writing) the configuration after the diviner throws the divining chain *opèlè* (from left to right), the diviner obtains the following:

Left side / Right side

(II) (II) (II) (I) / (I) (I) (I) (II)

The ‘Left side’ of the configuration appears as the first stage before the ‘Right side.’ A comparative reading through modern mathematics—when the couple (concave, convex) or (II, I) is compared to the binary couple (0, 1)—allows us to consider the couple (II, I) as a Boolean Algebraic Structure. And thus, we can write the following for each viewed side (left and right):

0 0 0 1 / 1 1 1 0

or

$$0x2^3+0x2^2+0x2^1+1x2^0 / 1x2^3+1x2^2+1x2^1+0x2^0$$

In modern mathematics, each side is written with binary codes using four (4) positions. The left side gives integer [1] when

converted into a decimal representation and the right side gives the integer [14]. When they are associated, [1] and [14] give, in modern hexadecimal notation, not ‘one hundred and fourteen’ but 1E, where each digit 0-9 corresponds to its decimal equivalent, but 10 is represented by ‘A’, 11 by ‘B’, 12 by ‘C’, 13 by ‘D’, 14 by ‘E’ and 15 by ‘F’.

$$1 / 14 = 1E_{16}$$

It is interesting to note that, in Yoruba Ifa Ordu, when we consider (II, I) and not (0,1), the left viewed side is named by the original coder as *Okanran*, while the right viewed side is given the name *Ogunda*. They respectively correspond to the linguistic code of (II) (II) (II) (I) and (I) (I) (I) (II). This means that the composed word [Okanran-Ogunda]/Yoruba Ifa linguistic codes and 1E₁₆/Hexadecimal codes are the same.

In modern mathematics, we can translate 1E₁₆/Hexadecimal into the more common decimal system, to give the integer thirty (30) [1x16¹ + 14x16⁰ = 30₁₀]. Okanran- Ogunda is also thirty 30, in Yoruba Ifa Ordu.

There is a second way of calculating using modern mathematics: if we do not view two sides but we view each on one

unique line, using eight positions and not two times four positions (2 x 4), we arrive at the same result. Reading and viewing from left to right, the transfer from uniquely binary codes to decimal codes also gives the integer 30.

(II) (II) (II) (I) (I) (I) (I) (II)

$$0x2^7 + 0x2^6 + 0x2^5 + 1x2^4 + 1x2^3 + 1x2^2 + 1x2^1 + 0x2^0 = 30$$

Ifa Ordus would systematically count by dividing the divining chain into two, thus, privileging hexadecimal codes, Okanran-Ogunda.

But Okanran-Ogunda being 30_{10} , indicates the 31st chapter of the Ifa corpus. In fact, because we deal here with a positional numerical system, the 256 configurations possibilities are not listed from One to Two Hundred and Fifty-Six but from Zero to Two Hundred and Fifty-Five (Sègla 2004). It means that 255, as the abstract figure of Ifa, indicates the 256th chapter of Ifa Corpus. In fact, 255 in Ifa is linguistically coded Ogbe-Ogbe = FF in modern hexadecimal notation or Eiji-Ogbe, Ogbe-Meji, which means Two-Ogbe / Two-Fifteen, the exact equivalent of the integer 255, or (I) (I) (I) (I) / (I) (I) (I) (I), Ogbe-Ogbe, in Ifa.

The 256 Yoruba linguistic codes in Ifa are thus all hexadecimal and are therefore convertible to binary codes. The entire Ifa Encyclopedia is linguistically coded this way (Sègla 2004).

The US army developed and used the same principle to improve its computer data system and organization in the 1960s. It is the same principle which has been generalized and is currently at the basis of the great computer data and audio revolution. It is this very principle that was the basis of the research of English mathematician Boole at the end of the 19th century

in England—research that originated the discovery of Boolean algebra. It is therefore interesting to explore the parallel between the subtle and elaborate Yoruba way of thinking and the computer ‘machine language’ that also has a hexadecimal base at the foundation of the sharpness and precision of the prescriptions of the 256 chapters that help solve problems in Classical Yoruba society. In machine language, a structurally identical system represents all numbers and all alphabetical characters that is also the base of high modern computing, in the manner of structured and constituted Yoruba “architecture of thought” (Verger 1997). Verger (1972, 1997) shows quite well how the Babalawo/Baba oni awo/Ifa priest (the man ‘who owns the knowledge,’ ‘who owns the secret’), after throwing the divinatory chain facing the sick man, refers to the corresponding chapter in the Encyclopedia of knowledge, which contains the appropriate medical prescription. He then can prescribe. For example, Verger (1972) who was accepted and initiated by a Yoruba Convent in southern Benin Republic, city of Ketu, reported:

1. Prescription against cough: this prescription is classified or arranged in the Chapter named Obara.Ofun, that is (I) (II) (II) (II) / (II) (I) (II) (I) or $1000/0101$ or 85_{16} which equals 133_{10} and so represents the 134th Chapter of Verse of the Encyclopedia. The 134th verse says: mix the leaf of *ojà* (given botanical name which is *hannoa klaieneana*) with *orombo* (lemon); drink the obtained mixture when pronouncing the following incantation: “*ojà*, take out from my mouth this bad cough!” (Verger 1972). And, *ojà* really takes it out and away!

2. Prescription number 56 is (II) (II) (I) (I) / (II) (I) (I) (I), or 37_{16} , and 55_{10} , thus

represents the 56th Chapter of the Encyclopedia, and exposes clearly how to strengthen the body with additional blood. The Verse which is called also *imu èjè po l'ara*, 'making blood many in the body' is arranged under the Verse Owonrin.Osa. It says: *ewé apèjè pè èjè pupo wa si ara mi*, or 'leaf of *apèjè*, call blood a lot into my body' or *ewé amùjè mù èjè wa si ara mi*, 'leaf of *amùjè*, bring blood to my body' (Verger 1972). The two leaves, *apèjè* and *amùjè*, when used separately, bring blood to the body, really! (*apèjè* is not identified taxonomically; but *amùjè* is '*harungana madagascariensis*')

It is interesting to see how the name given by the ancestral original coders marries very well with their function in real life. In the case of cough, *ojà* (the leaf used) means in Yoruba 'to break, rupture, cut,' so 'cutting' or 'breaking' the cough. In the case of blood bringing, the leaves *amùjè* or *apèjè* mean respectively 'bringer of blood' and 'caller of blood.' It may be that the leaves strengthen the body by reinforcing the rate of hemoglobin in blood. All the other Yoruba ancestral medical prescriptions found in the Encyclopedia are equally clear and referenced to Ifa Ordus (Verger 1972, 1997; Sègla n.d.).

Yoruba Ifa System of Inscription, a Boolean Group Structure

The materiality of the zero (0) in Yoruba history and culture implies the evidence of Class {II, I} conceived as an algebraic group structure. If stroke (II) is 'nothing' (zero) and stroke (I) represents 'unity' as incorporated from Yoruba cosmology, then the pair {II, I} is able to represent all other existing figures. This attests to the concept of the whole that cannot exist without its constituent parts, as is theoretically expressed in modern mathematics' group

theory (Thiry 1998; Piaget 1968; Permingeat & Glaude 1991). The dynamism of the dualistic principle, which is not haphazard, generated the 16 Primordial Deities and the 256 Chapters of Knowledge. We see here how a parallel can be drawn to Boolean algebra with perfect structure of a class that we name {II, I}. Having gotten a total of 256 Chapters of Knowledge all inscribed by the means of II (nothing) and I (one), again, the mathematical structure of class represented by {II, I} is consistent with the major property of a class structure that is theoretically defined in modern mathematics as:

When elements of a class are composed by means of a mathematical operation, the combination of elements from the class always returns an element of the class (group) (Thiry 1998; Permingeat & Glaude 1991).

This finding is also characteristic of formal reasoning in Yoruba linguistics and architecture of thought. Indeed, within the 16 first signs, all formed couples of non-consecutive signs are complementary two by two. These are (Sègla n.d.): 0 and 15, *oyeku/ogbè* (0000/1111 = 0F); 1 and 14, *okanran/ogunda* (0001/1110 = 1E); 2 and 13, *otuurupo/iretè* (0010/1101) = 2D); 3 and 12, *owonrin/irosun* (0011/1100) = 3C); 4 and 11, *ika/otua* (0100/1011 = 4B); 5 and 10, *ofun/osè* (0101/1010 = 5A); 6 and 9, *iwori/odi* (0110/1001 = 69); and 7 and 8, *osa/obara* (0111/1000 = 78).

And again, when they are associated by a group operator, say 'or' which is '+' in Boolean algebra, they all give the sign *Ogbè* 1111, which is 15 or F in modern computer data theory (Sègla n.d.).

There is a second way the original coders coined configurations. This way is not often practiced but when viewed, gives more evidence of the zero in Yoruba num-

ber concept development (Sègla n.d.). And because the zero in Yoruba number theory was missing in their works, McClelland (1966), Longe (1983) and Opeola (1986) who first attempted to see a number theory in Ifa Ordu misinterpreted the entire figure's semantics and their corresponding hexadecimal and binary codes in the Ifa Encyclopedia (Sègla n.d.).

We can thereby conclude that the Yoruba system of classifying knowledge is originally constructed in binary. Evidently, these are the mental constructs that attest to a proof of cognitive performance. In conclusion, the form of abstraction here observes the same assumption that is at the basis of modern computing.

Conclusion

Astronomy and interpretation through the history of a Yoruba ancestral technique clarify how cosmology, in shaping human well-being, dictates human cognitive capabilities. A revisiting of Yoruba cosmology in light of a new indexical approach demonstrates the archetypal genius of the Ifa system in terms of techniques of epistemological compression and expansion in which a minimal structure of symbolic forms—a relationship between one and two, Sky and Earth—encapsulates an entire cosmogony. This cosmogony is itself represented in terms of an unfolding series of numbers, from two to sixteen and from sixteen to two hundred and fifty-six, with an infinite range of literary texts of all sorts of prescriptions including medical ones, associated with each number that emerges through this numerical unfolding. These associations demonstrate the process of the creation of infinite possibilities of meanings from the most limited initial means which are Sky God (Olorun), its correspondent on Earth (Earth Goddess, Onilè), and its ministering intermediary spirits or deities on Earth (Orisha).

Consequently, we can conclude that, in contrast to classical theses, this work calls for the possibility of formal and abstract mathematical constructions in oral societies without any written language system. We then question the common Western view that states that theoretical mathematical knowledge was exclusively transmitted by written systems which show a tendency for definition and formalism. The problem that had always been raised was that of knowing if *inscriptions and configurations in classifying Yoruba knowledge* are the result of implicit premeditated mathematical development. Behind the development and the oral discourse studied here, lies a semiology elaborated with a formal corresponding reasoning that we claim. Again, it is possible to demonstrate the accuracy of the stock of African implicit/tacit knowledge by concentrating on logical and structural transformations in traditional African thought and systems of knowledge.

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