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# From One to Metaphor: Toward an Understanding of Pa'ikwené (Palikur) Mathematics

Alan Passes
alan.passes@tiscali.co.uk

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# From One to Metaphor: Toward an Understanding of Pa'ikwené (Palikur)[1] Mathematics

**ALAN PASSES**
**alan.passes@tiscali.co.uk**

> "1 is 1 and always 1 in any language; in English, of course, it is "one"; in French something different."
>
> —Jack Goody (1977:122)

Joanna Overing (2003:293) tells how the Piaroa, whom their neighbors dub the "intellectuals of the Orinoco," relish debate, particularly about the metaphysical aspects of everyday life. My interest here is with the physical aspect of everyday life as revealed through the mathematical and numerological discourse of the Pa'ikwené, who are perhaps a no less intellectual people of the Oyapock river, in North Brazil/French Guiana. Much of my past work on Pa'ikwené everyday speaking has examined the embodied practice and sociological value of *tchimap*, which means both "to hear" and "to understand" (Passes 1998, 2000, 2001, 2004:8, 2007). Here, I deal with another form of Pa'ikwené understanding and knowledge that is called *púkúh(a)*. *Púkúh(a)* signifies "to understand" and also mean "to count." In Pa'ikwené (an Arawakan language), it is possible to use numbers to describe social behavior, actions, and states of being. Thus, one can say of a withdrawn and isolated man that he has "one-ed" himself (*Ig pahavwihwé*) or that two individuals have "two-ed themselves" (*Egkis piyanméhwé*), i.e., they have gotten married.

This essay aims to throw some light on the phenomenon of mathematical metaphor in indigenous speech. Metaphor can be understood rudimentarily as one thing being expressed in terms of another, thereby implying (nonliteral) likeness. My essay suggests that Pa'ikwené numbers are jointly literal and figurative, having not only a fixed mathematical representational value as (sonic) symbols but also multiple meanings that relate to the imagery associated with different classes of things. With regard to the essay's mathematical component, I would like to record my indebtedness to the work of a fellow researcher, Diana Green, of the Summer Institute of Linguistics (Aikhenvald and Green 1998; Green 2001, 2002a, 2002b, 2005, n.d.). Most of the Pa'ikwené numerological and mathematical material presented here is the fruit of her labor, not mine.[2]

## ON METAPHOR AND MATHEMATICS

In Western rationalist thinking, metaphor and science, of which mathematics is conventionally a part, are considered hostile opposites. The one (science) is seen as universal, objective, rational, true, while the other (metaphor) is seen as culturally differentiated, subjective, irrational, and poetic. But, as Horton (1967), Overing (1985a, 1985b, 1990), Lakoff (1987) and others have shown, metaphor and science are not irreconcilable. Metaphor itself is in fact a thing of reason and logic that informs, and is instrumental to, not just the arts and religion, but philosophy and science as well. More recently, Lakoff and Nuñez (2000) propose a congruence between metaphor and mathematics specifically. They argue, moreover, that the latter is dependent on the former.[3]

When compared to Mesoamerica, with its well-known Mayan and Aztec mathematical knowledge, relatively little ethnographic attention has been paid to indigenous South American numerical systems. Particularly noteworthy are Urton's (1997) exploration of that of the Quechua, as manifested in the device of the *quipu*, and Ferreira's work (2002), which provides an interesting comparative survey of mathematical systems (see also for example Griffiths 1975; Costa de Souza 1995). In anthropology more generally, barring notable exceptions, such as found in the work of Lancy (1983), Lave (1988), Mimica (1992), Peat (1994) and Crump (1997), mathematics and numbers have been featured less as a subject of study than as a study tool applied to disciplines such as demographics and economics. Numbers are also of course central to Lévi-Strauss's work in kinship and mythology, which relies on the mathematical basis of structural linguistics. Here, I want to combine mathematics and language differently in order to see how they might together comprise a "trop(e)ical" process that is constitutive of the human being's cognitive relations with the world.

In the Platonic view (and as maintained by moderns such as Frege, Russell, and Whitehead), mathematical facts are disembodied, existing independently of the human world in an abstract realm beyond mind and matter, accessible only through rational thought. A contrasting view, which I support, is that mathematics, even "pure" mathematics that focuses on theory and ignores practical application, is initially a way of conceiving, understanding, and expressing the world itself, both human and extrahuman—and that it does so through metaphor.

Quantifying and measuring the world are not abstract actions, but are existential and pragmatic. These actions are rooted in perception, which include the physical, psychological, and sensory experience of the environment that begins in infancy and later applies to concrete social and practical concerns. Beyond such concrete concerns, quantification and measurement can apply to space, time, economics, and so forth; and from there project on to even larger issues such as the solar, lunar, and stellar systems, and supernatural cosmic spheres. Mathematical formulae, including the geometric and algebraic sort, are ways humans have of conceiving the environment based on their perceptual exploration and experience of it. The idea of a phenomenological or sensory basis to the mathematical sciences is not new in Western thinking. In the late seventeenth century, Locke understood geometry to be as much a matter of touch as of sight, while for Berkeley, at the beginning of the eighteenth century, it was an essentially tactile science (Rée 1999:335–337).

As with language, and with music—to which it seems to have an affinity (Crump 1997:105ff., 112ff.)—mathematics is at one level abstract. As with words and notes, numbers may be formal codes and arbitrary, meaningless signs (cf. Rée 1999:116, 258, 261). But, at another level, each operates meaningfully within concrete and social contexts. Again, like words (and musical notes), numbers are also sounds. In fact, numbers *are* words—spoken before they were ever written, at least in the conventional graphic forms they possess today (Crump 1997:41ff.).[4] Sometimes numbers are also letters, as in Hebrew where the same sound/visual sign can be used for either. Unlike written numbers, which are decontextualized socially and fixed by the very act of annotation, spoken numbers in oral societies such as the Pa'ikwené still operate in a world free of what Goody terms "graphic reductionism" (1977:122). As he notes, visual graphic formulae such as logograms for numbers, in replacing phonemes and lexemes, have made things more abstract and have also universalized numbers at the cost of their different culturally specific particularities. Thus, Goody's observation that, when independent of any particular phonetic system, the written symbol 1 is 1 in any language, but that the English spoken "one" is not the same as French spoken "one" (1977:122). In French, of course, "one" is *un* or *une,* depending on the gender of the referenced item. As we will see, there is a multiplicity of morphologically distinct types of Pa'ikwené "one," depending on the different classes of thing (including gender) to which this number refers. Parenthetically, it seems to me that, while stressing the monosemic character of numerical signs, Goody overlooks their polysemic status as symbols that accord to numbers meanings beyond the fixed mathematical one. In some cultures, for example, written numerals such as 0, 1, 3, 4, 5, 7, 666 possess sexual, sacred, magical, or other metaphysical connotation.[5]

We should be wary of characterizing the mathematics of so-called primitive societies as no more than a rudimentary arithmetical exercise in counting fingers or adding shells or coconuts (cf. Peat 1994:153–218; Crump 1997:31–46; Ferreira 2002). Nor should mathematics be seen as a specialty limited to so-called higher civilizations (Western or Eastern). It appears that some peoples do employ a very simple numerological system. For instance, in Native South America, the Kampa have just three number words, "one," "two," and "three," according to Green (2002b; n.d.), who also points out the frequent use of the same term for "three" and "many," a practice that exists in Latin (Koestler 1964:622). In the Canela language there are but four general terms: "alone," "pair," "some," and "many" (Green 2002; n.d.). Similarly, Campbell reports, the Wayapi, neighbors of the Pa'ikwené, also have no words for numbers greater than four (1989:32). The Pa'ikwené do not share this numerical minimalism. They have terms for numbers one to ten and a hundred, and by grammatically building onto these bases with classifiers they can amplify their numerical order from ten to ninety-nine and extend it from one-hundred-and-one into the thousands. At the other end of the scale, the Pa'ikwené also know "zero" (*yúma*). Before describing this numerical system, which Green (n.d.:2) calls "perhaps the most complex system of all" (as far as the indigenous peoples of Brazil are concerned), there are two issues I need briefly to address: classification and metaphor.

Some propose that classification originates not within the individual but, as with the Platonic idea of mathematics, from without. According to Durkheim's interpretation of the of the "social," classificatory systems are the reflections of their society, which are not derived, a priori, from any cognitive structure. Or, following the relativist Sapir-Whorf hypothesis, different languages determine culturally specific ways not only of expressing reality, but also of thinking about and categorizing reality. Thus, language is thought to shape the perception of reality. For others, though, classification is grounded in the human being. Thus, in the Lévi-Straussian model, the deeper structures of culturally acquired symbolic classificatory systems are already unconsciously present in the mind. A contrasting universalistic approach maintains that the perception of reality (and reality itself) is culture free and everywhere the same, and while cross-cultural conceptions of the real world often differ (albeit with limited diversity), the cognitive action involved is also identical. Moreover, encoded in our biological makeup, and preculturally and prelinguistically underlying both perception and conception, are shared principles of cognition that predispose humans toward classifying the world (Berlin and Kay 1969; Berlin 1992; Ellen 1993, 2006).

According to Ellen (1993), an innate embodied cognitive aptitude enables classification, the cultural organization of perception, to evolve from an interaction of context (e.g., natural, social, material), personal experience (somatic and other), and cultural factors such as tradition and, crucially, language. One aspect of the latter, metaphor, is deemed particularly instrumental in shaping nomenclature and classification (cf. Lakoff and Johnson 1980; Fernandez 1982; Lakoff 1987). Fernandez (1982) suggests, furthermore, that by helping individuals clarify their often vague bodily experiences, "metaphorization" also allows them to construct through the exchange of trope-based narratives a conceptual understanding of identity and alterity that is concrete and more easy to grasp.

For Lakoff (1987; Lakoff and Johnson 1980), metaphor itself is embodied. It is rooted in human perception of the environment interacting with the knowledge of our bodies that we develop from babyhood. The first experiential knowledge and perception we humans have is of our own body, and from this there derive conceptual schemas relating to basic phenomena such as gravity, linkage, and movement, i.e., notions of up/down, front/back, in/out, here/there. We transform these schemas by metaphorically extending the root concept attached to the domain of bodily experience to extrabodily domains that fan out from the concrete and social to the increasingly abstract. For example, interpersonal relations are often experienced in terms of the prime image of linkage, namely the umbilical cord attaching newborn self and mother. Thus, the existence of the phrases "breaking social ties," "tying the knot (in marriage)," et cetera. Another example is the perceptual experience of one's rising body temperature, which leads to such metaphors as "flaring tempers" and "my heart melted with love."

According to this thesis, metaphor is not just integral to language (*contra* Aristole). It is also constitutive of conceptualization, and as such plays a pivotal cognitive role in defining everyday realities. As evidence, Lakoff (1987) cites the many cross-cultural examples of classification systems that are based on radial metaphoric association rather than on vertical noun hierarchy, as many Western ones are.[6] Being somatically grounded and active in the conceptualization of reality, metaphor is therefore both "experiential" (i.e., subjective) and "imaginative" (i.e., creative). These properties enable many culturally differentiated knowledges of perceptible reality, as opposed to the objectivist idea of a single true reality.

Lakoff and Nuñez's book, *Where Mathematics Comes From* (2000), posits the metaphorical and, *contra* Plato, the embodied basis of mathematics. Unlike Lévi-Strauss or Polanyi,[7] they do not define embodiment as a thoroughly brain-situated condition. However, they do rely on the premise that, prior even to speech, human infants have a capacity for computation, for being able to distinguish the size of groups of up to four items, and to recognize addition and subtraction. For Lakoff and Nuñez, mathematics derives from the extension of this faculty to larger numbers through the use and combination of body experience metaphors.

That is, adding, subtracting, multiplying, and measuring, along with notions of zero, negative numbers, and infinity, unfold from metaphors grounded in the basic body experiences of the developing child, such as collecting and piling up objects, gauging the environment in relation to one's own body, and moving through space, i.e., crawling then walking.[8] Thus, the innate ability to distinguish quantities, together with the internalized inferences of early embodied experience and its projected "metaphorization" onto extrabodily domains, underlies our creation of ever more complex and abstract mathematical ideas.

## PA'IKWENÉ NUMBERS

Diana Green's (2002b; n.d.) work on indigenous numerical terms in Brazil notes the existence of systems based on one (e.g., Kampa, Kulina, Makú), two (e.g., Xavante, Arara, Bororo, Kayapo), three (e.g., Atroari), five (e.g., Munduruku), ten (e.g., Pa'ikwené) and twenty, apparently the most prevalent (e.g., Karaja, Kadiwéu, Makushi, Tikuna, Paresi). Green (2001, 2002a, 2005) suggests that it is possible that the Pa'ikwené's ten-based number system replaced a prior seven-based number system after contact, which dates from the mid-seventeenth century and possibly earlier (see Passes 2002:179ff.). Terms for "seven" (and "six") are apparently rare in Brazilian indigenous languages, but seven seems to have had cultural significance for Pa'ikwené, as suggested by the recently lapsed practice of interclan exchanges of artifacts called *imti,* a sort of combined calendar and invitation card featuring seven decorated strings with which one counted down the days to important events such as the annual ceremony of mourning the dead. Historically, too, the Pa'ikwené counted in series of seven days as well as in a series of ten. The seven-day series is called *paka*, which signifies "week" and nowadays also means "Sunday." It is the only weekday to retain its native name, the others are called by Créole loanwords. This use of seven is possibly related to another important Pa'ikwené time, that is, the brief dry period of some seven days between the first and second rains (that occur towards the end of February and the beginning of March).

The root for "one" is *paha.* The root for "two" is *pina.* The word for "three" is *mpana*.[9] These terms are consistent with proto-Arawakan roots as reconstructed by Payne (1991): *pa* or *ba*, *pi* or *bi*, *mapa* or *mada*. As we will see, Pa'ikwené "one" and "two" undergo extensive morphemic transformations by taking suffixes and, in the case of "two," infixes that accord with any given class with which the numbers are connected. "Three" and "four," *pashnika*, are also modified by affixes according to class, though not as much. Other numerals are modified even less. The Pa'ikwené word for "five" is *pohowkú,* which is made up of *paha* (one) + *ú* (our) + *wakú* (hand). "Six" is *púgúnkúna*. "Seven" itself is *ntéúnenké*, and "eight" and "nine" are respectively *ntéúnenké akak pahat arauna* and *ntéúnenké akak pitana arauna* (etymologically "seven and one more added" and "seven and two more added").

"Ten" is *madikaukú,* meaning "end (of) hands." The term for "tens" is *madikwa;* "twenty" is "two tens," *pina madikwa*, and "thirty" is "three tens," *mpana madikwa,* and so on until "eighty" and "ninety" are reached, where root structure and affixing both get much more elaborate. "One hundred" is either *madikaukú madikwa* ("ten tens") or *sah,* a Créole loanword. Terms for multiples of a hundred are bilingual, e.g., four hundred is *pashnika-pút sah*, "four times a hundred." This is made up of the native *pashnika* ("four") + *-pút* (morpheme indicating multiplication) + the imported *sah.* "One thousand" is *madikaukú sah* ("ten hundreds") or, when not used for counting money, *madikaukú-pút madikaukú madikwa* (ten times ten tens).

Pa'ikwené, like many Amazonian languages, is agglutinative. Most words are formed by a root plus one of a multiplicity of affixes, or morphemes, designating/expressing concepts, both basic and sophisticated, which indicate an extremely developed capacity for abstract and analytical thought, including thought in the field of mathematics. Most Pa'ikwené words for numbers between one and a hundred carry affixes (usually, but not always, in the form of suffixes) that modify the noun or verb to which a numeral refers. As a number word can be used with an assortment of classifiers, modifiers, arithmetical affixes, syntactical affixes, and in the case of "one," gender agreement markers, many Pa'ikwené numerals have more than two hundred forms current in everyday conversation. I will not be naming each and every numeral or every affix. For numbers one to ten alone there are more than a hundred terms, each number word modified by a minimum of twelve affixes. The affixes serve as classifiers identifying twenty-one different classes of things[10] that relate to five major semantic categories pertaining to the following mathematical concepts: units, sets, fractions, abstractions, and series.

There are eleven tangible "units." The first comprises animate things: persons, spirits, animals, birds, fish, moon, sun, stars, and various natural phenomena. This unit's numeral classifying suffix for "one" is *-v* or *-p* (alternate pronunciation). The numeral classifying infix for "two" is *-ya*. Numbers from "two" onwards carry no classifiers, thus we have *paha-v-ú himano* ("one girl"), *pi-ya-na gú-kebi-kis himano-pyo* ("two girls"), and *mpana gú-kebi-kis himano-pyo* ("three girls"). The term *kebi* means "unit" and is often affixed to numbers over "one" when referring to tangible units. With animate things the term is inflected by other pronominal affixes that agree with the noun in gender, person, and number, e.g., *pashnika gú-kebi-kis bakimnai,* "four infant girls" (four + feminine + units + pluraliser + child + pluraliser). For inanimate things, the term becomes *a-kebi,* meaning "neuter unit." Thus *mpana a-kebi paït,* "three houses" (three + neuter unit + house).

The number "one" also takes the suffix *-mpú* with dead items belonging to the "animate" unit. Again, and alone among all the numbers, "one" agrees with the gender of living items, e.g., *pahavwi awaig* ("one man"), *pahavú tchino* ("one woman"), et cetera. Men, large animals or fish, and "bad" spirits and "bad" creatures such as snakes, rats, and insects are male, as are living "human" entities such as the moon, sun, stars, and thunder and lightning. Women, small animals and fish, "good" spirits and "good" creatures such as birds, turtles, and butterflies are female. However, other female things like plants and natural phenomena such as fire, rivers, and rainbows, and virtually all round, square, and concave objects, as well as those made of wood or metal, are classed as inanimate and so there is no gender agreement. The gender of all other inanimate things, such as other shapes, abstract ideas, and actions, is neutral, and again there is no gender agreement where numbers are concerned. In short, male things tend to be big and bad, whereas female things are small, good, and strong. Neutral things are soft, flexible, and weak.

There are eight tangible "inanimate" units, all classed in terms of geometric form according to native conceptualization of the three dimensions—height, breadth, depth—plus, when appropriate, the perimeter of objects, which Green sees as evidence of a native notion of a fourth dimension.[11] These units are: (1) round or square objects, (2) round and long (i.e., cylindrical) objects, (3) flat objects, (4) flat and deep (concave) objects and metallic objects, (5) extended objects (in terms of linearity), (6) extended objects that have extremities in terms of height or depth or breadth or perimeter (e.g., field, waterfall, hole), (7) irregular objects, and (8) irregular objects that are foliform (i.e., with offshoots). For each of these classes of inanimate units, number words take one or more affixes. These are attached in all instances to "one," to a relatively lesser degree to "two," and sometimes to other numbers as well (see Appendix 4). There are also two tangible units relating to body parts: hand(fuls) and mouth(fuls). Each has its own numeral classifier (see Appendix 4).

There are six "sets" of tangible units, animate or inanimate, each with a specific numeral classifier (see Appendix 4). These include (1) set of inherently unconnected items, e.g., groups of individual units (herd of animals, flock of birds, crowd of people), (2) set of inherently connected items, i.e., firmly connected items (a stalk of bananas, a bead necklace, et cetera), (3) set of noninherently connected items that are tied together, i.e., for bundles of things (arrows, leaves, a broom or string of fish), (4) set of noninherently connected items that are wrapped together, (5) set of noninherently connected items that are joined in a basket, and (6) set of noninherently connected items that are potted together.

The "abstractions" category has a single numeral classifier (affix *-t*) for referring to intangible things such as illness, work, words, or any specific action. As the names of abstract things tend to occur with the term for neutral units, *a-kebi*, the classifier probably indicates intangible units, e.g., *pitana a-kebi yúwit* ("two words").

Numbers in the "series" category take the classifying affix *-i*. Since Pa'ikwené understand time in terms of series rather than in cycles, the classifier is also used for time words (hour, day, night, week, month …) and for sets of numerals. Also, the multiplication classifier, *-pút,* is used for indicating repetition (multiplication) in relation to such things as actions and events.

The "fractions" category has a numeral classifier for "one" and a different classifier for "two," which are for indicating the sides of an object. Other numbers have no classifier. For indicating a part or a piece of something, there is a dedicated classifier for "one" only (see Appendixes 2 and 4).

On top of the ones used with respect to multiplication and fractions, there are also special classifier affixes for use with the other arithmetical concepts of numerical order, numerical limits, addition, subtraction, totality, and mathematical sets of units, simultaneous actions and sequential actions (see Appendixes 2 and 4).

## PA'IKWENÉ NUMERAL CLASSIFIERS AND POSSIBLE METAPHORS

When I first encountered Pa'ikwené number words, their hyperactive phonetic transformativity, their spectacular agglutiveness and inflectiveness, and sheer taxonomical profusion, both amazed and confused me (cf. Grinevald and Seifart 2004). Trying to get a grasp on the system, it struck me that it might be an example of metaphoric conceptualization. I did not pursue the matter until years later when, looking for a subject for a paper, I found myself returning to my original question: is a Pa'ikwené number a metaphorical expression? Has the number become metaphorical because of its connection to the objects it is used with? Have the qualities of the referenced thing (as perceived by the human referrer) been mapped onto the referring numerical oral symbol because of the various classifiers appended to it? The answer, I believe, has to be in the classifiers themselves, for what are they if not embodied figurativeness, if not encoded, meaningful images?

Diana Green (2001:7–8) informs us that Pa'ikwené numeral classifiers are not quantifiers but qualifiers. This is because Pa'ikwené suffixes for quantity and size are not classifiers but modifiers, as they can occur not just with numerals but with any noun. However, a numeral operates inside the semantic parameters of the twenty-one classes pertinent to the five categories of units, sets, fractions, abstractions, and series. Therefore, it is not expressing "how many" or "how big." Rather, it is qualifying, or modifying, the things to which it relates by behaving syntactically like an adjective. It achieves this by virtue of the affixes appropriate to the function of adjectives that supplement any other relevant classifiers that a numeral may have in a given context. When affixes function as adjectives it indicates such things as gender, negation, emphasis, and different conditions of action.[12] Such affixes also express qualities proper to classes such as space, shape, time, and animation.

Following the work of Green (2001), I offer examples of ways in which numbers are used in the language of the Pa'ikwené:

***Examples of numbers as adjective:*** (1) *Ner-as bakim-nai mpana-nené gi-kebi-kis*: Literal translation, "Those male children being three" i.e., "Those three boys." [Analysis: *Ner* (that)+ *-as* (affix for masculine plural) + *bakim* (child)+ –*nai* (pluraliser) + *mpana* (three) + *-nené* (affix for continuous action and durative state in relation to masculine) + *gi-* (male) + –*kebi* (units) + *-kis* (pluraliser)] Here, "three" is an adjective. (2) *Ig ner kaibúné ig paha-iwotneyé*: Literal translation, "That snake he one," i.e., "That snake [is a] one time only [kind]," i.e., "poisonous." [Analysis: *Ig* (he singular) + *ner* (that) + *kaibúné* (snake) + *ig* (he) + *paha* (one) + *-i* (affix for series class) + *wot* (affix for limitedness) + *-né* (affix for continuous action) + *-yé* (affix for durative in relation to masculine)]. Here, "one" is an adjective.[13]

In such cases there is, I believe, a two-way process for creating numerical adjectives. Classifiers give the characteristics of an object to a numeral, which allows the numeral in turn to describe the object. Thus, in example two, according to Pa'ikwené logic, the snake's poisonousness is stated not by the use of a specific adjective attached to the word "snake," but by the use of the various suffixes attached to the word "one" (namely, series class, limitedness, continuous action, durative state). Here, "one" indicates this snake's condition of being toxic.

Syntactically, Pa'ikwené numerals also act as adverbs, pronouns, nouns and verbs when carrying appropriate classifiers for those parts of speech, e.g., "nominalizers" for nouns and "verbalizers" for verbs.

***Example of a number as adverb:*** *Úsúh ai pi-ya-nma-pú*: "We're both here together." Analysis: *Úsúh* (we) + *ai* (here) + *pi* (two) + *-ya* (infix for animate class) + *-nma* (two) + *-pú* (plural classifier).

***Example of a number replacing a noun in the manner of a pronoun:*** *Donna gú-pashnika-n ka-kagahiyé* (literal translation: "Donna's [her] fourth [male child] has illness," i.e., "Donna's fourth child is ill." [Analysis: *Donna* (Donna) + *gú* (female) + *pashnika* (four) + *-n* (relational affix) + *ka* (have) + *kagahi* (illness) + *-yé* (affix for durative state in relation to masculine)].

***Example of a number as noun:*** *Igkis keh paha-tra-min-ka a-dahan parek-wiyé* (literal translation: "They make one for enter," i.e., "They formed a line in order to enter." [Analysis: *Ig* (he) + *-kis* (pluraliser) + *keh* (make) + *paha* (one) + *-tra* (affix for extended class) + *-min* (affix for amplification) + *-ka* (nominaliser) + *a* (affix for neuter) + *dahan* (for) + *parek* (enter) + *-wiyé* (affix for inchoative action)].[14]

***Examples of numerals performing as verbs:*** (1) *Ig pahavwihwé*: Literal translation, "He one-ed himself," i.e., "He withdrew/isolated himself." [Analysis: *Ig* (he singular) + *paha* (one) + *-v* (affix for animate class) + *-wi* (affix for male) + *-h* (verbalizer) + *-w* (affix for reflexive) + *-é* (suffix for completive action)]. (2) *Egkis piyanméhwé* (literal translation: "They two-ed themselves," i.e., "They married." [Analysis: *Eg* (she) + *-kis* (pluralizer) + *pi-* (two) + *-ya-* (affix animate class) + *-nmé* (two) + *-h-* (verbalizer) + *-w* (affix for reflexive) + *-é* (affix for completive action)].[15]

In all these instances, the inflection of Pa'ikwené number words has a semantic as well as a syntactic function. Inflection, I believe, conveys semantic value because a modified number appears not only to denote "qualification," but also to connote something of the identity of the item with which it conjugates. This suggests to me the occurrence of what I will call "metaphoric osmosis," that is, a movement between domains, where the item's perceived properties (designated by classifiers) transfer to the numeral. Each numeral that functions as an adjective, noun, or verb is fixed semantically in terms of a computational formula. But, morphological transformation also allows each numeral, in given contexts, the creative capacity for multiple qualitative meanings (particularly where "one" and "two" are concerned). Thus, a number is not just a monosemic symbol, and it is more than a logical abstract index. It is also a variety of images grounded in the physical world and concretely expressed in spoken words.

As Lévi-Strauss (1974), Overing (1985b, 1990), Lakoff (1987), and others have stated, although the classification systems of so-called "primitive peoples" are typically metaphorical, it does not follow that they are illogical and irrational, let alone untrue. However, despite this recognition of metaphor's rationality and logic, the acceptance of an affinity between metaphor and classification can sometimes be uncertain. Take for example Yalman's (1968:71) remark about the conceptual tools of native abstract thinking: "[I]nstead of the [symbols] *p* and *q* of mathematical thinking, we […] have Jaguars and Wild Pigs related to each other in formal logic." In my view, the juxtaposition made here between the different types of representations is ambiguous. Is Yalman saying that Western people use mathematical signs and Amerindians use animals for the same purpose of classificatory logic? Or is he also saying, and perhaps unconsciously implying, that, unlike Western people, Amerindians do not think mathematically but (only) metaphorically? Yet, as we have seen, according to Lakoff and Nuñez (2000), not only does a human being think both metaphorically and mathematically, but the two are cognitively interrelated, since mathematics, itself a type of classification, derives from embodied metaphor. This prompts the question, might not Western mathematics itself be a form of metaphor?

It is true that Pa'ikwené do not represent mathematics symbolically or metaphorically in terms of jungle creatures or Western-style equations. Nor do they seem to relate the physical to the metaphysical as intensively as in traditions such as the Blackfoot (Peat 1994) or, to name a non-Amerindian one, the kabala, the Jewish mystical system that conjoins physics and metaphysics, the human and the infinite, through the action of numbers (Halevi 1995; Crump 1997:57–59). However, Pa'ikwené perception and knowledge of both animate and inanimate objects of their social, natural, and supernatural environment, have clearly provided the conceptual and linguistic devices, including metaphor, with which to express the world numerically and mathematically. Consider, for example, the figurative extensibility of the Pa'ikwené notion of roundness. Adding a suffix, *-patip,* meaning "equal," to the word root for "round," *húwi*, allows round and square objects to be in the same inclusive class.[16]

Regardless, then, of whether "one, two, three, four" is *paha*, *pina*, *mpana*, and *pashnika* rather than boa, armadillo, toucan, and tapir, I think some kind of metaphorization is taking place in Pa'ikwené mathematics. As I understand it and have attempted to show here, an indigenous number does not, thanks to its classifiers, simply enumerate or simply qualify (or both). It also expresses qualities, originating in and transferred from the objects to which the number refers, at least in the case of concrete (tangible or intangible) things. Thus, not all Pa'ikwené "ones" are necessarily the same. Putting aside its quantifying and class-qualifying aspects, *pahavú*, the Pa'ikwené "one" in "one woman" is, I speculate, qualitatively different from *pahampú*, the "one" in "one dead animal," or *pahakti*, the "one" in "one flower."

## CONCLUSION

It is difficult to know to what extent the metaphoric process is conscious or unconscious in humans, and there is always danger, especially in anthropology, in peddling universals. Nevertheless, the use of metaphor ("metaphorizing") does appear to be a natural, universal, and innate aspect of human cognition, albeit not, I think, in terms of Lévi-Strauss's (1974) absolutist dichotomy: "savage mind" metaphoric/ "scientific mind" metonymic. This essay has argued that mathematics itself is metaphorical and that indigenous numerical terminology imaginatively describes the elements composing the world just as much as it denotes and computes them. In other words, I propose that Pa'ikwené numbers are literal *and* figurative, with both a determinate numerical significance and plural meanings attaching to the imagery that is connected with different classes of things.

The Pa'ikwené case reveals, as Green (2001, 2002a, 200b) points out more generally, the close link between linguistics and mathematics, which has become overshadowed by the world of written mathematics. It also shows the mathematical concepts of some oral and so-called primitive cultures to be actually highly developed, sophisticated, and of potential value to world science.

Pa'ikwené mathematics does not exist in a vacuum. Far from being a Platonic abstraction—and beyond having a probable phylogenetic cognitive base—it is firmly planted in the practice and the context (phenomenological, sociocultural) of the "lived in" world that shapes and reflects what it is to think and act Pa'ikwené (see Lave 1988 for a masterly exposition of the interplay between mind, practice, and context in relation to arithmetic). Thus, Pa'ikwené mathematics is part of the rich, diverse, and (thanks to the unremitting pressures of transnationalism and acculturation) endangered store of Native Amazonian perceptions and understandings of reality that underpin the various distinctively Amerindian ways of being human in the world. These are the knowledges—mundane and arcane, profane and sacred, embodied and intellectual, emotional and moral—that Joanna Overing has labored long and creatively to illuminate and to bring to the attention of the wider world. Following her example, this essay—along with the other contributions to this collection—has tried to celebrate one such knowledge.

## Appendix 1: Some Pa'ikwené numerals.

1 *paha-t* (one-affix abstract class)
2 *pi-ta-na* (two-infix abstract class-two).
3 *mpana*
4 *pashnika*
5 *pohowkú* ("one hand")
6 *púgúnkúna*
7 *ntéúnenké*
8 *ntéúnenké akak paha-t arauna* ("seven and one more")
9 *ntéúnenké akak pi-ta-na arauna* ("seven and two more")
10 *madik-aukú* ("end (of) hands")
20 *p-i-na madikwa* ("two-affix series class-two tens")
25 *p-i-na madikwa akak pohowkú arauna* ("two tens+five")
50 *pohowkú madikwa* ("five tens")
100 *madikaukú madikwa* ("ten tens"), or *sah*
199 *madikaukú madikwa akak ntéúnenké madikwa akak pina madikwa arauna akak ntéúnenké akak pitana arauna akiú* ("ten tens+seven tens+two tens+seven+two")
1000 *madikaukú sah* ("ten hundred"), or *madikaukú-pút madikaukú madikwa*

## Appendix 2: Varieties of Pa'ikwené "one" (according to classifiers).

Category "units" (animate):
*Paha-v-wi* one-animate unit class-masculine
*Paha-v-rú* one-animate unit class-feminine
*Paha-mpú* one-animate unit class dead

Category "units" (inanimate):
*Paho-ú* one-round/square class
*Paha-t* one-cylindrical class
*Paha-k* one-flat class
*Paha-mkú* one-flat & deep class
*Paha-tra* one-extended (linear) class
*Paha-ikú* one-(extended (high/deep/broad [and perimeter]) class
*Paha-a* one-irregular class
*Paha-kti* one-foliform class
*Paha-úkú* one-hand(ful) class
*Paha-biyú* one-mouth(ful) class

Category "sets":
*Paha-brú* one-group class
*Paha-twi* one-cluster class
*Paha-ki* one-tied together class
*Paha-imkú* one-wrapped together class
*Paha-ih* one-basketed together class
*Paha-yap* one-potted together class

Category "fractions":
*Paha-bak* one-side class
*Paha-úhri* one-part/piece class

Category "abstractions":
*Paha-t* one-abstractions class

Category "series":
*Paha-i* one-series class

Numerical order:
*Pitat-yé* "first" (adjective, not numeral)

Numerical limitation:
*paha-i-wo-wa* "one time only/once"

Addition:
*paha-kti-wa* "one more (foliform) thing"
*paha-úhri-wa* "one more (piece)"

Subtraction:
*paha-twi-é* "one left over"

Multiplication:
Does not apply to "one"

Totality:
*paha-vwi-té* "one whole (animate male being)"

Sets of units:
*pahavwi-t* ("each one animate male being")
In Pa'ikwené there exists the mathematical notion of a "set" consisting of only one element.
(The morpheme indicating "set" is *–t* or its allomorphs *–it* and *–mat*)

Sets of sequential actions:
*paha-i-impi* "one by one"
(Morpheme *–empi* or its allomorphs, indicating "sequential")

Sets of simultaneous actions:
Does not apply to "one"

## Appendix 3: Some more inflections (following Diana Green).

| | |
|---|---|
| "the second (orange)" | *a–ves–rú* |
| "the second (man)" | *gi–vev–ri* |
| "one more orange" | *pahow–wa úwas* |
| "two more men" | *piyanma–wa awaig* |
| "one remaining orange" | *pahow–ré úwas* |
| "two men left" | *piyanm–é awaig* |
| "a whole orange" | *pahow–té úwas* |
| "all two (both) men" | *piyanma–té awaig* |
| "only one orange" | *pahow–wo–wa úwas* |
| "only two men" | *piyanm–o–wa awaig* |

| | |
|---|---|
| "The price of the orange is two times as much" (orange price two–MULT more) | *úwas atiwnih pima–vút akiú* |
| "He tossed the orange three times" (He throw orange three–MULT) | *Ig padak úwas mpana-vút* |
| "He counted the oranges in sets of two" (He count orange two–PAIR–SET) | *Ig púkúh úwas pisoya-m-at.* |
| "They are sitting in groups of two" (They sit two–PAIR–SET people) | *Igkis bat piyan-m-at hiyeg.* |
| "He squeezed the two oranges simultaneously" (He squeeze orange two–SIMULTANEOUS) | *Ig pidik úwas pisoya–nam.* |
| "The two pulled at the same time" (They pull two–SIMULTANEOUS) | *Igkis kah piya-nam.* |
| "He [has] two jobs" (He two–MULT–SIM 3M–job) | *Ig pi-vút-nam g-anivi.* |

| | |
|---|---|
| "The oranges fell one by one" (orange fall one–SEQUENTIAL) | *úwas túgúhé pahow-rúmpi* |
| "They passed by two by two" (They pass two–SEQUENTIAL) | *Egkis mpiya piyan-empi.* |

## Appendix 4: Pa'ikwené categories of numeral classifiers (following Diana Green).

**Category of animate unit and its numeral classifiers:**
The classifying suffix for "one" is *-p* or *-v*. The classifying suffix or infix for "two" is *-ya*. Bigger numbers carry no classifiers. Alone of all the numbers, "one" (root: *paha*) agrees with the gender of items included in that unit, e.g., *pahavwi awaig* (one man), *pahavú tchino* (one woman). For dead items in animate unit, the classifier is *-mpú* (applies to "one" only). Numbers over "one" are often followed by the term *kebi* (unit), and inflected by other pronominal affixes that agree with the noun in gender, person and number, e.g., *mpana gú-kebi-kis bakimnai* (three girls): three + feminine + "units" + pluraliser + child + pluraliser.

**Category of inanimate units and their numeral classifiers:**
1) Round or square objects. Classifiers *-ú* for "one," *-so* for "two." No affixes for numerals greater than "two."
2) Round and long (i.e., cylindrical) objects. Classifier *-t* (applies just to "one" and "two").
3) Flat objects. Classifiers *-k* for "one" and "two," and *-bú* for larger numbers.
4) Flat and deep (concave) objects and metallic objects (ascribed to same class). Classifier *-mkú* for all numbers.
5) Extended objects (in terms of length). Classifier *-tra* for all numbers.
6) Extended objects with extremities (in terms of height or depth or breadth or perimeter [e.g. a field]). Classifier *-ikú* for all numbers (allomorph *-rik–* for "two").
7) Irregular objects. Classifiers *-a* for "one," *-sa* for "two." Higher numbers carry no affix.
8) Irregular and foliform objects. Classifier *-kti* for all numbers.

Numbers greater than "one" take the classifier *a-kebi* (meaning "neutral unit") when referring to tangible inanimate things, e.g., *pashnika a-kebi paït* (four houses): (four + neuter unit + house).

Two further tangible units relate to bodily parts: (1) <u>hand(fuls)</u>: classifier *-wakú*, for "one" and "two" only. (2) <u>mouth(fuls)</u>: classifier *-biyú,* applies to all numerals.

**Category of sets and their numeral classifiers:**
1) Set of inherently unconnected items: classifier *-brú*, alt. pronunciation *-dgú* (for groups of individual units, e.g., herd of animals, flock of birds, crowd of people).
2) Set of inherently connected items: classifier *-twi* (for firmly connected items such as a stalk of bananas, a bead necklace …).
3) Set of noninherently connected items that are tied together: classifier *-ki* (for bundles of things like arrows and leaves, or for a broom or string of fish).
4) Set of noninherently connected items that are wrapped together: classifier *-imkú.*

5) Set of noninherently connected items that are joined in a basket: classifier -*psi*.
6) Set of noninherently connected items that are potted together: classifier -*yap*.

**Category of abstractions and their numeral classifiers:**
The "abstractions" category uses one classifier, affix -*t,* for reference to intangible things such as illness, work, word, custom, or any specific action. As the names of abstract things tend to occur with the term for neutral units, *akebi*, the classifier probably indicates intangible units, e.g., *pi-ta-na akebi yúwit*, meaning "two words."

**Category of series and their numeral classifiers:**
Numbers in the "series" category take the classifying affix -*i*. As Pa'ikwené understand time in terms of series rather than cycles, the series classifier is also used for time words (hour, day, night, week, month…) and for sets of numerals. Also, the multiplication classifier -*pút* is used in relation to repetition of such things as actions and events.

**Category of fractions and their numeral classifiers:**
The "fractions" category uses the classifier -*bak* on the numeral "one" and -*bkak* on "two," for indicating the sides of an object. Other numbers do not carry a classifier. For indicating a part or a piece of something, the classifier is -*úhri*, for "one" only.

**Unique numeral affixes:**
Along with the numeral classifiers for multiplication (-*pût*) and fractions (-*bak; -bkak; -úhri)*, special affixes are reserved for use with other arithmetical concepts, namely:

*Numerical order:*
The Pa'ikwené term for "first," *pitat-yé,* is not a numeral but an adjective. The other ordinal numerals ("second," "third," "fourth," etc.) are given a pronominal prefix (either *gi*- [his], or *gú*- [hers], or *a*- [its]) and a suffix that either indicates the gender of or a genetive-like relationship with the object being referenced. With ordinal numbers in a noun phrase, the conventional adjectival suffixes -*pi* (indicating stative state) or -*yé* (durative state) are required. For terms greater than "seven" one can use the phrase, "one (noun) making (required numeral)," e.g., *paha-i haukri keh-pi-yé ntéúnenké akak p-i-na arauna*: "one day making seven with two more," i.e., "the ninth day."

*Numerical limits:*
Morpheme -*o* or its allomorph -*wo*.

*Addition:*
Morpheme -*wa.*

*Subtraction:*
Morpheme -*é*

*Totality:*
Morpheme -*té*

*Mathematical sets of units:*
Morpheme -*t* or its allomorphs -*mat* and -*it*.

*Mathematical sets of simultaneous actions:*
Morpheme -*nam.*

***Mathematical sets of sequential actions:***
Morpheme -*empi* or allomorphs -*ímpi*, -*rúmpi*.

## NOTES

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1. The Palikur, or Pa'ikwené to use the autonym, are an Arawakan people of North Brazil and French Guiana with a present population of some 2,000 members living on either side of the Oyapock river.

2. My own research on the subject was conducted during fieldwork with the Pa'ikwené from 1993–1995.

3. Cf. Black (1962:242): "Perhaps every science must start with metaphor and end with algebra; perhaps without the metaphor there would never have been any algebra."

4. In the Amerindian context, one should also note nonwritten visual representations of numbers such as *quipu,* the Andean knotted string devices (Urton 1997). Likewise, in Native North America, numerals and systems of mathematics were traditionally recorded on rocks, tree bark, wooden panels, talking sticks, and *wampum* belts (Peat 1994:155–156, 269).

5. "Zero" ("0," etymologically "emptiness") has great symbolic force in Arab thinking, while 1 and 7 possess magical power in Jewish mysticism, as does 5, which indicates the pentagram. 666 is held to symbolize the Devil. The number 3 polysemically represents the Holy Trinity in Christian lore; carnal knowledge (Adam, Eve, snake, and also vagina and breasts, penis and testes); and, existentially, the family (mother, father, child), with 1 the self and 2 the male-female pair or parental unit (Bettelheim 1987:106). For Mohawk and many other Native Americans, the graphic representation of the sacred number 4 expresses a state of balance and harmony, and the dynamic movement of spiritual forces within cyclical time. It is the four directions, the four winds, and the four quarters of the Sacred Hoop (Peat 1994:161–162).

6. Lakoff (1987) shows that cross-culturally classifications of nature tend to be more metaphorical than the objectivist (Linnaean) model of Western biology—with members of classes attributed not on a basis of hierarchy but "prototype." This works on the principle of metaphoric association with "good" exemplars

linked "radially" with progressively "poorer" ones. This occurs informally in the West anyway, for example: sparrow (prototypical bird); albatross (poorer exemplar); penguin (even poorer exemplar). Apropos of mathematics, for Lakoff (1987, see especially Chapter 9), single digit numbers, following the "prototype model" principle, are better exemplars of numbers than double digit, and double digit better exemplars than larger numbers.

7. For Lévi-Strauss (1974:248), mathematics resides in and unconsciously reflects the workings of the cerebral cortex. For Polànyi (quoted in Koestler 1964:588), it is latently present in the brain's neural traces and realizable through physico-chemical activity. There is, too, the recent discovery that numerals are materially represented by a line of neurons in the brain (Ramachandran, as reported in Anonymous 2002).

8. It has been pointed out to me by Peter Gow (personal communication) that in some cultures, such as the Piro, children do not crawl.

9. Peter Gow suggests (personal communication) that *mpana* is probably "not two," and indeed *ma-* is a common Arawakan (including Pa'ikwené) privative.

10. Green builds on Keith Allan's (1977) cross-cultural study of numeral classifiers, which identifies seven major categories describing the semantic bases of classifiers, plus two more.

11. According to Green (2001:2, 6, 11-13, 15, 42–43; 2005:2, 7, 13–14, 50–51), the Pa'ikwené fourth dimension is based not on time but perimeter, with the latter referring to the outer boundary of a figure and denoting the whole of the boundary rather than just its length.

12. Continuous action, completive action, inchoative action, durative state, stative state are examples of differing conditions of action.

13. A third example of a numeral acting as an adjective is: *Paha-k-ap washri aité a-napi waik*: literal translation, "One vast land there under ground," i.e., "[There is] a vast world under the ground" [Analysis: *Paha* (one) + *-k* (affix for flat class) + *-ap* (affix for vastness) + *washri* (land) + *aité* (there) + *a–* (affix for neuter) + *–napi* (under) + *waik* (ground)]. "One" is adjective.

14. Another example of numbers acting as a noun is: *Igkis pahadgúpú aige abet pahadgúhka,* Literal translation, "They are one there in one," meaning, "They have gathered together in the meeting."

15. Interestingly, the "plural she" is used here as Pa'ikwené grammar demands that when you refer in the third person plural to groups of two or more people of both sexes, then the female plural form takes precedence over the male.

16. To explain this more fully: Pa'ikwené notions of roundness and squareness share the same numeral classifiers (*-ú* for one and *-so* for two, e.g., one orange: *pahú úwass*, and two gourds: *pisoya túgúkú*), which permits each to belong to the single class, "round and square objects." This is achieved by adding the suffix -*patip* (equal) to the word root, *húwi* (round), thereby producing *húwipatip*, "round with all sides equal," i.e., square. Giving *húwi* another suffix, -*bakúp,* (unequal), produces the word "round with unequal sides," i.e., rectangular. Rectangular objects, however, belong to the class of "irregular objects."

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