Australian Aboriginal and Islander mathematics

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Introduction

The rich and interesting field of Australian Aboriginal and Torres Strait Islander mathematical concepts has been generally ignored by anthropologists, linguists and other researchers. Some mathematical knowledge has been lost forever, particularly where English or English-derived terms have replaced traditional terms. Much knowledge remains, however, where traditional languages are still spoken, and much can still be studied by those who are prepared to question the false and misleading generalisations in the literature.

A neglected field

The only truly substantial attempts of which I am aware to record the mathematical concepts of any Aboriginal group are Stokes' (1982) insightful paper on Anindilyakwa mathematics and parts of Rudder's (1983) important presentation of the idea of Yolngu qualitative thinking. In her paper, Stokes discusses a comprehensive range of mathematical concepts including cardinal number, ordering, position, time, dimensions such as length and mass, and shapes such as roundness and angularity. This contrasts starkly with the treatment of Aboriginal mathematical concepts in the great majority of general linguistic and anthropological works where it is usually reduced to a curt dismissal of the number system. Elsewhere (Harris 1982:155) I have listed a large number of such works which dismissed all or most Aboriginal number systems as lacking numbers above two or three, or even lacking numbers altogether.

...nor is their counting comparable to our elaborate numerical system. Indeed, it never exceeds 3...(Von Brandenstein 1970:13).

No Australian Aboriginal language has a word for a number higher than four. (Blake 1981:3-4).

Statements such as these, which do not even admit five, are not simply misleading; they are false. Even if ambigious cases are ignored, there is not such a dearth of information on numbers above four that serious scholars could be unacquainted with them. The existence of words for five has been known for at least a century. Taplin (1879:97) reported simple terms for one to five in the Kokata (Gugada) language of western South Australia; Tindale (1925:128) listed numbers to twenty in Anindilyakwa of Groote Eylandt; Osborne (1974), in a more recent study, records numbers to ten in Tiwi of Bathurst and Melville Islands. In anticipation of the unjustifiable but predictable criticism that Aboriginal higher numbers are "not real numbers" because they are compounded from smaller numbers or based on "hand", I have chosen the above three examples because they are not obviously compounded nor is the term for five related to "hand". There are many other such examples. There are also some references to "regular quinary" systems of numerals which seem to extend indefinitely upwards (Wurm 1972:64; Capell 1958:27). I have mentioned these, not because they are in some way exceptional or to be marvelled at, but simply to show that categorical, unqualified statements like Blake's (1981:3-4) are demonstrably false.

For those who are willing to look, there are hints here and there in the literature of the ability of both Aboriginal and Torres Strait Islander people to manipulate, when the need arose, numbers much higher than five, ten or twenty, for example:

1. Dawson (1881:xcviii), discussing the Tjapwurong language of South Australia, shows how words and signs in combination were used to count to one hundred—*larbargirrar*.
2. Haddon (1890:305) in the Western Torres Strait Islands, was given considerable information on numbers including one hundred—*maura*, and one thousand—*kai gasa*.
3. Tindale (1925:129) bargained with Groote Eylandters, demanding 150 spears which he indicated as 10 x 15 (10 fingers x 15 sticks). The Groote Eylandters brought him the correct number, 140 of them being tied in bundles of twenty because that was obviously how they preferred to group them.
4. Strehlow (1944:103) gives Western Aranda terms, normally used with hand signs, for ten, twenty, thirty and forty—*manurula, iloa, inoa, intijeritjera*.

One of the stranger aspects of the curious history of scholarly attitudes to Aboriginal and Islander mathematical concepts, is that descriptions like those above have generally not been believed. Curr (1887), for example, whose compilation of Aboriginal word lists has influenced generations of linguists, anthropologists, and mathematicians, chose what he wanted to believe from Dawson's lists of Tjapwurong number terms and discarded the remainder.

> No Australian Black in his wild state can, I believe, practically count as high as seven... I am aware that I disagree with Mr Dawson, who, in his *Australian Aborigines* speaks very differently on this subject. In fact, in a number of his statements that writer stands alone, though in many

particulars his work contains exact information. (Curr 1887 [I]:32).

In writing of his ethnographical studies of the Torres Strait Islands, Haddon did not even believe his own informants.

> I further had from the same island *maura* for 100 and *kaigasa* for 1,000... but *these and several other numbers I do not believe in.* (Haddon 1890:305. Emphasis mine).

The reason for this is that in the second half of last century the newly formulated theory of evolution lent scientific respectability to racist beliefs, the scientific and anthropological journals of the period abounding with "evidence" of the physical, cultural and intellectual inferiority of the Aboriginals. It became virtually an obsession with the influential *Ethnological Society of London*.

> ...in mixing with (the Aborigines) we feel doubtful whether we have to do with intelligent monkeys or with very much degraded men (Oldfield, 1865:227).

Indeed it was the President of the same society, John Crawfurd, who, in 1863, invented a "scale of civilisation" by which he ranked cultures of the world on the basis of their number words. His starting point on the ascent to the high degree of civilisation supposedly achieved by the Europeans was the Aborigines.

> I begin with the people among whom the numerals appear to be in the rudest form. These are the Australians...(Crawfurd 1863:84).

Crawfurd demonstrated his theory with examples of limited Aboriginal "numerals" drawn from reports in scholarly journals, calling them 'the rudest numerals of the lowest savages of which we have any knowledge' (1863:102). This concept, having entered the literature in the 1860s profoundly influenced the thinking of several generations of anthropologists and linguists. It is still a widely accepted premise and continues to be stated, not only in the popular press but even in scholarly publications. Crump (1982) is a recent

example who, in discussing the concept that two is greater than one, claimed that the principle 'could be made intelligible even to the Aranda" (Crump 1982:286). This idea is particularly evident in the writings of mathematical historians and mathematics educators.

> Where the extent of man's mastery over nature is slim, his number system reflects his ineptitude:
> 1. Neecha(1)
> 2. Boolla (2)
> 3. Boolla Neecha (2 + 1)
> 4. Boolla Boolla (2 + 2)
>
> A primitive chant? The sequence furnishes a fine accompaniment to the boom-boom drone of the tomtom (sic!). Yet it is actually the complete counting system of a native Australian tribe (Bourke, Darling River) (Swain and Nichols 1965:1).

As I have shown elsewhere (Harris 1982:153-54), the main reason for such statements is that even the most recent mathematical historians base their discussions either directly on Crawfurd and Curr or, if not, upon other authors who did, particularly Conant (1896) whose study of numbers was reprinted many times. It is interesting to trace specific examples back to their written origins.

1. The cover of *Counting I*, a course material book produced by the Open University (1975) displays these words:
   1 urapon
   2 ukasar
   3 ukasar-urapon
   4 ukasar-ukasar
   5 ukasar-ukasar-urapon
   6 ukasar-ukasar-ukasar

   Inside is the statement that "the fact that many Australian Aboriginal tribes cannot count beyond 2 is indicative of a comparatively primitive state of civilisation." (p.12) This claim is exemplified (p.15) with the words from the cover, said to be the *Gumulgal* language of Australia. The example was taken from Seidenberg (1960:216) whose sources included Schmidt (1919)

and many nineteenth century writers such as Curr (1887) and Conant (1896).

2. Bunt, Jones and Bedient (1976:3) writing for mathematics teachers, make the following claim:

Anthropological studies reinforce our belief in the existence of prehistoric number ideas. A study of the western tribes of the Torres Straits, reported by A.C. Haddon in 1889, describes a tribe that had no written language which counted as follows:

1 *urapun*
2 *okosa*
3 *okosa-urapun*
4 *okosa-okosa*
5 *okosa-okosa-urapun*
6 *okosa-okosa-okosa*

Everything greater than 6 they called *ras*.

Where did Bunt, Jones and Bedient find this example of what they consider to be "prehistoric number ideas"? An examination of their bibliography indicates that they too found reference to the Torres Strait example in Seidenberg (1960) who in turn obtained his information either from Conant (1896) or directly from Haddon's (1890) ethnography of Torres Strait. By arbitrary use of such references, Seidenberg (1960:281) refers to three supposed languages (Kauralgal, Gumulgal and Torres Strait) which are virtually the same language.

In fact, it was Conant (1896:105), illustrating a point by haphazardly choosing Haddon's Torres Strait example from his collection of forty three "binary" counting systems, who was responsible for ensuring its survival in dozens of mathematics texts as an example of "primitive" counting.

It is regrettable that mathematical historians should continue to promulgate the myth of Aboriginal inferiority, even in the most recent major text of mathematical history (Burton 1985). Calling on anthropology because history sheds no light on the counting practices of

our remote ancestors, Burton (1985:1) cites "certain Australian aborigines tribes" to illustrate groups "destitute of number words". Not only do these mathematicians adopt the very dubious practice of substituting ethnography for history, they rely on very questionable ethnography. It is also regrettable that linguists assist to perpetuate the same view by unclear or even incorrect generalisations. When Blake (1981:3) claims that "no Australian Aboriginal language has a word for a number higher than four" he is wrong. Dixon does not really avoid the issue merely by reporting what is "usually said".

> The one obvious gap in Australian vocabularies is the lack of any system of numbers. It is usually said that there are only numbers 'one', 'two', 'several', and 'many'; some languages appear also to have 'three' although this is frequently a compound form. (Dixon 1980: 107–108).

Dixon and Blake are linguists and they are talking about words. If they believe that an apparent lack of number words does not indicate an inability to count, they should clearly say so because their statements are generally taken to mean that Aborigines can't count. This is only to be expected because their claims are read in a context where many readers still presume the inability to count to have been long proven. Another linguist, Von Brandenstein, is prepared to go beyond words;

> ...nor is their counting comparable to our elaborate numerical system. Indeed it never exceeds 3... (Von Brandenstein 1970:13)

Here we have a very clear illustration of what the misconception is. It lies in the presumption that counting is an exclusively verbal activity.

What is counting?

One of the sources of confusion is that the term *counting* means different things to different people. It appears that in this context linguists and anthropologists use counting

only to mean the recitation of numbers in ascending order—what Freudenthal (1973:170) calls "the reeling off in time of the sequence of natural numbers". This is not, in itself, a meaningful activity. Children of many cultures are taught to do it long before they can actually enumerate a set of objects. Children, of course, eventually discover that the recitation of the number names can be used to determine the numerosity of a set.

Etymologically, the English term *to count* is derived from the Latin *computare*, "to calculate" and this is what I take to be still its basic meaning. The three dictionaries I consulted all gave as the first meaning "to find the number of"; "to add up each unit in a set", "to enumerate".

When I raised this subject before, in a "working paper" (Harris 1982), I was endeavouring as strongly as possible to make the point that Aboriginal people were not incapable of handling numbers. I was concerned firstly to correct the false statements that no Aboriginal languages had words for numbers higher than two or three or four. This was relatively easy to demonstrate, but I was also concerned to show that statements about limits to counting were misleading. Early statements of this type were made in the belief that Aborigines were intellectually inferior to Europeans, a position also clearly evident in some relatively recent writing. Unfortunately, this point of view is capable of influencing the interpretation of otherwise quite objective research. When linguists like Yallop (1982:145), who obviously do *not* believe in the mental inferiority of Aborigines, refer briefly to the "paucity of numbers" or the lack of a system of counting, it is virtually certain that some of their readers will take this to mean that Aborigines cannot conceptualise the numerosity of anything—that they cannot count in the basic sense of enumerate. This was taken to an extreme by Menninger (1969:75), a leading

authority on the origin of numerical terms, when purely by examination of Haddon's (1890) list of Torres Strait number words he declared that the Islanders could "count beyond two without being able to count to three"!

It is quite evident that before the coming of Europeans or Macassans or anyone else, Aborigines and Islanders could and did count in the true sense of the word, that they were capable of enumerating the items of any set which they wanted to enumerate and that at all times their mathematical resources, both verbal and non-verbal, were capable of extension to cope with any new set which they may not have previously needed to enumerate.

In discussing my earlier paper (Harris 1982), Rudder (1983:93–94) states that he "is in conflict with Harris... not in his claim that Aboriginal people have numbers, but in his assumption that these mean the same as the numbers in our Western quantitative systems". I willingly concede the possibility that in my zeal to counter the many popularly-held fallacies concerning Aboriginal number systems, I may by the use of the term "number system" have given the impression that I believed all Aboriginal groups used sequential number names, reciting them one by one in counting (enumerating) a set—that is, that they used a set of verbal counting tags. It is true that many Aboriginal groups did not use sequential verbal tags in counting, but this does not mean that they did not count.

> The use of unique tags to mark or tick off the items in a collection is intrinsic to the counting process. Further, the tags must be used in a fixed order. Finally, the tags must have an arbitrary status; they cannot be the names or descriptions of the items in the collection being counted. The set of count words meets these criteria, but then so do other sets of tags. One obvious candidate is the alphabet, and it is noteworthy that many languages have used the alphabet as count words (Greek and Hebrew, for example). But the tags need not be

verbal. They may be any of a host of entities, including short-term memory bins. (Gelman and Gallistel 1978:76)

By the use of both verbal and non-verbal tags[2], Aboriginal people counted. Furthermore, the end product of the counting (enumerating) of a set of items was a number in the Western quantitative sense. In the next section I shall argue this from an examination of real examples.

Actual counting methods

Most, if not all, Aboriginal and Islander groups counted by fives. The use of five and ten, based on the five-fingered hand, is basic to the vast majority of the world's counting systems. To enumerate sets of five or less, adults of all cultures do not generally count, they subitize—that is, they more or less immediately recognise the numerosity of a set as 0,1,2,3,4 or 5 unless of course the members of the set are widely separated in space or time. For sets greater than five, Aborigines generally grouped items by fives thus:
1,2,3,4,   5 1,2,3,4,   10
1,2,3,4,   15 1,2,3,4,   20

This is a particularly good method of counting—that is, of enumerating the items in a set. It is a grouping technique virtually used universally. Counting coins is a well-known example. Given a large number of one-cent pieces, most people would group them in tens and count the groups. Even though they may never actually name a point like 37 cents or 84 cents on the way to the total, it can hardly be claimed that they do not count the money.

Aboriginal counting by fives was very common indeed and there were a variety of different ways of doing it e.g. (using English symbols and terms).

1,2,3,4,   5 1,2,3,4,   10
1,2,3,4,   15 1,2,3,4,   20
.,2,.,4   5 .,2,.,4   10
.,2,.,4   15 .,2,.,4   20
1,2,3,4   hand 1,2,3,4   2 hands
1,2,3,4   3 hands 1,2,3,4   4 hands

There are a few clear examples of this kind of counting in the literature. Dawson (1881:xcvii–c) is perhaps the most outstanding, giving detailed information on counting up to one hundred in Tjapwurong and Gurnditjmara. Ridley (1875:32) provides a clear example of counting to twenty in Kamilaroi, using words for "hand" and "foot" although he does not provide a description of the mechanics of how an actual counting task proceeded. Haddon (1890:303–306) gives one of a number of tantalisingly incomplete descriptions. Counting in the Torres Strait Islands clearly included verbal tags, five-counting using fingers and toes, and body counting, but Haddon dismisses their techniques as not being real counting. A host of other writers are even more brief, giving one of two number words and then truncating the ethnographic description with the statement that "beyond this they resort to fingers" or some similar statement.

The word for hand is as suitable a source of a term for five as any word could be and I have already argued (Harris 1982:157–58) that to discard counting systems which involve the term "hand" for five is to discard most counting systems in the world, including, if one wishes to be pedantic, English where "five" can be shown to be etymologically related to "fist" and "finger".

Some writers who do acknowledge words for higher numbers dismiss them as being imprecise. Strehlow (1944:104) gives Western Aranda words for ten, twenty, thirty and forty. He says two important things about them: "they had only approximate numerical values" but that their precise values were also known. *Intitjeritjera*—"forty", for example, was "shown by four men each holding out both hands together". This is a very important statement, indicative of just what would be expected to be the case—that is, a number like forty could be used precisely when necessary, but, mostly, absolute precision was not necessary. Obviously, the ex-

act distinction between, say, thirty-nine, forty or forty-one objects may have been only rarely important to the Aranda people, so the term was mostly used generally as English-speakers might do in reference to "dozens" of people or "hundreds" of trees. On the other hand, when the Aranda people needed to be precise, they could be, as their pantomime for Strehlow's benefit clearly shows!

It is also true that in many Aboriginal languages, small numbers were named by combination of one and two. As I have shown (Harris 1982:161–64), the proposition that compound terms are not numbers is indefensible and illogical. There was, across Australia, considerable variety. Some languages had special terms for three, some for four and so on. In many Aboriginal counting systems, the basic verbal tags are one, two and hand. Theoretically, an English language model for counting to ten verbally would proceed like this:

one
two
two-one
two-two
hand
hand (and) one
hand (and) two
hand (and) two-one
hand (and) two-two
two hands

However, the following generalisations usually applied in such counting systems.

1. "Hand" and "two hands" could be used specifically on those occasions when it was necessary.
2. "Hand" and "two hands" were used non-specifically to mean "about five" and "about ten" on other occasions.
3. In most counting systems, visual tags such as raised fingers or tally marks were used in conjunction with verbal tags, especially between two and five and for all numbers between five and ten (and between ten and fifteen, fifteen and twenty and so on).

A modern example is the Martu

Wangka[3] counting system (Jigalong, WA).

one	kuja
two	kujarra
three	kujarra kuju
four	kujarrakujarra
five	marakuju (hand-one)
ten	marakujarra (hand-two)

Marakuju and *marakujarra* are often used to mean approximate numbers

| *marakuju* | about five, a few |
| *marakujarra* | about ten, a small mob |

for example:

marakujarraya pakarnu
A small mob came

Larger generalisations could be indicated by *jina-mara*—"foot- hand" repeated however many times were necessary. Again it was normally non-specific. It is my view that although the need to be specific beyond ten or even five may have been rare, it was understood and dealt with when necessary.

Furthermore, in Martu Wangka visual tags were used rather than words. Asked how many children someone has, a person will typically reply using fingers or marks on the ground.

I have children thus: girls II, boys III.

This response has *none* of the deficiencies normally alluded to in the literature. The person *can* count the children, *does* know there are three boys and two girls, *does* know that two and three make five. Researchers, not all of them in the past, have generally taken absence of verbalisation to mean absence of counting, so we find the literature full of false statements:

...in various...parts of Australia, the natives show habitual uncertainty as to the number of fingers they have on a single hand. (Smith 1923 [1951]:7)

Smith obtained his information on

Australia from Crawfurd (1863).[4] It is easy to see how, with poor ethnology and preconceived low expectations, this misconception was reached. In many Aboriginal languages the word for five *is* "hand". Asked how many fingers they have, apart from finding it a stupid question (who doesn't know that?), these Aboriginal people would hold up five fingers. This would not be accepted by the researcher, who would try to elicit a *verbal* response, which could only be "hand". It is the researcher who is ignorant, not the informant.

I am reminded of a school in the Northern Territory in an area with a counting system like this. An impasse arose between a white infants teacher and her Aboriginal assistant. Having had 1+1=2 taught to the children in the local language, the teacher asked her Aboriginal assistant to introduce 2+1=3. Her assistant said there was no need, as the Aboriginal children already knew that and they might as well move on to combinations adding up to five. The teacher insisted that they should not skip 2+1=3, not realising that the sum would be recited:

"two and one makes two-and-one".

The Nunggubuyu counting system of Eastern Arnhem land is another interesting example. Its basic features were reported in the literature as early as Tindale (1925:128), by Capell (1964:68–69), and recently by Heath (1982:337).

one	*anyjabugij* (or anybaj)
two	*wulawa*
three	*wulanybaj* (two + one)
four	*wulalwulal* (two + two)
five	*marang-anyjabugij* (hand-one)
seven	*marang-anyjabugij [mari] wula* (hand-one [and] two)
ten	*marang-anyjabugij [mari] marang-anyjabugij* (hand-one [and] hand- one)

Tindale, Capell and Heath all carried out field work in the region (in the 1920s, 1940s and 1970s). It is interesting to note that both the earlier researchers, while agreeing on the basic structure as shown above, found evidence of more specific ways of naming higher numbers which have now become obsolete.

An important analysis of the verbal components of this kind of system from a grammatical perspective is Hale (1974:295–96) which I have discussed in detail in Harris (1982:166). Using Warlpiri as his example, Hale argues that the words for one and two are not primarily counting numbers but grammatical numbers. This distinct possibility I freely acknowledge. I have already argued that the origin of a verbal or non-verbal counting tag is irrelevant. A counting tag is a counting tag and a grammatical number is as good a source as any other.

Despite Haddon's (1890) inadequate and biased ethnography, it is evident that when he visited the Torres Strait Islands in the 1880s, the most prevalent counting system was also based on one, two and five (hand). Thus the much maligned *"urapun, okasa, okasa-urapun ..."* represents only the elementary verbal tags in a system which used both verbal and non-verbal tags. Haddon (1890:305) mentions terms containing *get*—"hand" and *koko*—"foot" but dismisses them (*'Nabiget* can hardly be said to be the name of the number five, but that there were as many of the objects referred to as there are fingers on one hand'). As noted already, there were terms for higher numbers as well which Haddon did not believe. Haddon (1890:304) also recorded that on some islands there was a special word for three. This was not uncommon in Australia although perhaps less common than the combination "two-one".

A language with specific terms (i.e. non-compound) for three and four is Kunwinjku of Western Arnhem Land.[5]

one	*na-kudji*
two	*boken*
three	*danjbik*
four	*kunkarrngbakmeng*
five	*kunbidkudji* ('hand one')
ten	*kunbidboken* ('hand two')

The Anindilyakwa language of Groote Eylandt is an example of a language with specific terms for one to five, ten, fifteen and twenty which are not based on hands or feet (Stokes 1982:38).[6]

one	*awilyaba*
two	*ambilyuma*
three	*abiyakarbiya*
four	*abiyarbuwa*
five	*amangbala*
ten	*ememberrkwa*
fifteen	*amaburrkwakbala*
twenty	*wurrakiriyabulangwa*[7]

Many nearby Arnhem Land languages also have specific terms for three. The Yolngu languages of north eastern Arnhem Land are a good example.

one	*wanggany*
two	*marrma'*
three	*lurrkun*
four	*marrma' marrma'*
five	*gong wangany* (hand-one)
ten	*gong marrma'* (hand-two)

Rudder (1983:78–82) discusses these terms in some detail. I agree with him that the words do not, alone, comprise a counting system— that is, a verbal system, complete in itself, for counting or enumerating things. In common with what was virtually an Australia-wide phenomenon, however, I consider these words to be the backbone of such a system. Together with non- verbal tags, they make up a counting system by which, I suggest, the Yolngu people could and did count or enumerate things. Rudder's use of the concept of "qualitative thinking", although providing an insightful perspective on Yolngu world-view, loses some of its power when applied to counting.

To speak of "qualitative classifications for precise quantities" instead of "numbers" seems to be a contradiction in terms. Rudder claims that the number terms are essentially groupings such as "duo" or "trio". I do not for one moment doubt the importance of duality (and triality) in Aboriginal language and world view, nor the possibility that "pairs" and "threesomes" could be the origin of terms now used in the counting system. It does not, however, follow that these terms cannot function in a variety of ways just as in other languages. My own experience of discussing number terms with Aboriginal people of many language backgrounds is that number terms, whatever their etymology or semantic associations or grammatical functions, can and do mean numbers when the activity is counting ie. the task of enumerating a set and, if necessary, labelling the answer.[8]

Perhaps the Yolngu have a very special and unique concept of numbers but when Rudder's conclusions about Yolngu numbers are examined, it is as well to recall that the Yolngu did not live in isolation. They dealt, in their extended speech communities, with speakers of other languages. Furthermore, long before the Europeans came, they dealt with the Macassans, travelled to Macassar (Macknight 1972:286), spoke the 'Macassan' Pidgin (Urry and Walsh 1981; Harris 1986:85–109) and used Macassan numbers (Macknight 1972:297). As the Macassans obviously did have a verbal number system, it would seem difficult to sustain an argument that the Yolngu thought quantitatively in dealing with the Macassans and qualitatively when dealing with each other. It has, of course, often been argued that Aboriginal counting systems of the northern coasts were of Indonesian origin (eg. Wurm 1972:167), a presumption for which the evidence is very scant indeed (Harris 1982:159).

Aside from the Macassans, the Yolngu had also to deal with their

Aboriginal neighbours. I have often observed, in studying the early writings, that an Aboriginal group said to be able to count only to two or three were neighbours of a group, said by some other observer, to be able to count much higher. An understanding of the complex multilingualism of Aboriginal speech communities makes these statements incompatible. Observations restricted to number words are much more accurate. Tindale (1925:129) states that there are "special names for each numeral up to ten" in Nunggubuyu but that "the Mara, Ngandi, Rembarunga and other mainland tribes have words only for one and two". Tindale is referring to the immediate neighbours of the Nunggubuyu people, neighbours with whom they intermarried, members of their multilingual speech community. It would be quite wrong to conclude that, say, a Ngandi woman married to a Nunggubuyu man could count to ten when thinking in Nunggubuyu, but only to two when thinking in Ngandi. Such a claim would be ridiculous and Tindale certainly does not make it. The Ngandi woman would, of course, code-switch between Nunggubuyu and Ngandi and therefore between two counting systems. She would not, however, in shifting to Ngandi, find herself unable to perceive the idea of ten. Here I do not intend to make any particular point about Ngandi and Nunggubuyu, but to stress the principle involved. Being multilingual, Aboriginal people can and do code-switch, but when that switch involves counting, this does not mean that their perception of number changes, although the labelling method does. Considerable caution must therefore be necessary in claiming a unique conception of number for the Yolngu people, for one would also have to claim a conceptual switch in their interactions with the Macassans and even with some of their Aboriginal neighbours.

Sobek (1981) observed and recorded an extension of the Yolngu (Gumatj) counting words by Galarrwuy Yunupingu to enable the labelling of all numbers up to one thousand two hundred and fifty (see Harris 1982:169-73). It has been suggested to me that Galarrwuy Yunupingu was only able to do this because he had grasped the principle of an infinitely extendable number system from Western schooling and that such an innovation had never been done before. Rudder (1983:94) claimed that Galarrwuy must have been using "quantitative thinking". All this may be true but some caution should be exercised in passing judgement. Galarrwuy himself said that he was making the numbers to show that they could be created without European influence and using only Gumatj resources. He certainly demonstrated that it could be done and that linguistic raw materials were not lacking. According to Sobek (1981:26) the higher numbers were generally less meaningful even though their creation was understood, there being no traditional activity to which they could immediately be attached. This serves to illustrate the fact that although higher numbers may have been necessary only rarely, we should not conclude that they were never used or created at all.

We do not, in any case, need these Gumatj numbers, innovatory or not, to show that Aboriginal people could and did handle numbers much higher than those with which they are usually credited in the literature. I have described several examples already and there are plenty of others. The Gurindji people have a *1,2,2+1,2+2, hand...*system like Martu Wangka which is adequate both for generalisation and precision, particularly, although not, exclusively with smaller numbers. They have developed, as well, an alternate system (Harris 1982:168-69) with discrete (non-compound) counting words for one to fifty. The older people describe situations in which the system was used and can carry out subtraction operations using a combination of the words and tally

sticks. It is definitely not an innovation due to Western mathematics and is, in fact, being replaced by it. When the Groote Eylandters brought 150 spears to Tindale, bundled in twenties, it involved what was, to them, a rather unremarkable counting task. On the other hand, it was far removed from the 'one-two-many' myth, and it also had little to do with duality, triality and qualitative thinking.

Concluding discussion

Aboriginal and Torres Strait Islander people counted as far as they needed or wanted to count. Early ethnographers, searching for substantial sets of consecutive verbal tags (counting words), failed to find them. Ignoring compound terms, terms for body parts, and terms which seemed to them to refer to numbers too high for their informants to understand, and ignoring as well all non-verbal tags, they concluded that Aborigines and Islanders were virtually incapable of counting. This accorded with their notion that these people were, in any case, very low on the scale of human development.

This false notion of Aboriginal and Islander mathematical inadequacy has been curiously persistent. The biased early writings are still the sources for generalisations by mathematical historians. The situation has not been helped by linguists who comment generally on the lack of number words in Aboriginal languages. Indeed a number of modern linguists have clearly not even searched the relevant literature let alone carried out adequate field research. Had they looked in the obvious places, they would have discovered that their generalisations were false.

Of course mathematics in the Western sense was of little interest to traditional Aboriginal and Islander people. Counting was a meaningful practical activity, not an abstract science. They counted what was necessary to count, but in other

facets of life were not interested in modern Western precision. If, for example, in a caring extended family, you knew exactly who was sleeping in your camp, you did not need to know the precise number present. Yet hesitation in expressing this kind of total was the type of anecdote frequently adduced in the literature in support of claims of restricted mathematical competence. Early—and not-so-early—researchers often posed their informants what amounted to trick questions. Removing or adding members of an array of sticks was a frequent technique to endeavour to elicit mathematical responses, an exercise not unlike our Western matchstick tricks, which must have seemed a ridiculous and meaningless task to people who only counted for meaningful purposes. In any case, when people did provide verbal answers, they were as often as not discarded for the inadequate reasons already discussed.

On the other hand, in culturally meaningful ways Aboriginal and Islander people did use numbers with precision when the situation demanded it. Some of the many such contexts which people have described to me include trading activities, calendar calculations, battle strategies and distributing turtle eggs. It may be true to say that preoccupation with counting did not enter into the very fabric of Aboriginal and Islander society as it does in Western society. It is not true to say that Aboriginal and Islander people lacked the ability to count.[10] They counted what they wanted and needed to count. As well, they engaged in other kinds of mathematical activity, with their own unique and culturally appropriate ways of dealing with space, time, position, shape and so on. It is high time this interesting aspect of Aboriginal and Islander culture was acknowledged.

NOTES

1. These examples are listed below. The authors' original spellings have been retained except that Osborne's spellings have been amended to use only English lettering.

Language	Kokata	Anindilyakwa	Tiwi
Locality:	Western S.A.	Groote Eylandt, NT	Bathurst and Melville Island, N.T.
Literature Source:	Taplin 1879:97	Tindale 1925:128	Osborne 1974:passim
one	kuma	auliaba	natinga
two	kutthara	ambilima	jirara
three	kabu	abiakalpia	jiraterima
four	wima	abuiabua	jatapinta
five	ngerla	amukugle	punginingita
ten		amambaruku	wamutirara
fifteen		amabwukuale	
twenty		ogripulung	
(hand)	(murra)	(ayarrka)	(wamuta)

2. The reality of non-verbal tags has never been demonstrated to me so clearly as it was in the case of a profoundly deaf Groote Eylandt girl in grade two at Angurugu school at a time when the language of instruction was English. She was unable to speak either Anindilyakwa or English. She lip- read a little and communicated by gesture. She was by far the most competent mathematics student in her grade. She was very fast at all counting, grouping and sorting activities with structured materials and readily transferred the concrete tasks into written numerals. However she counted, whatever conceptual tags she used, they were not number words. She lacked what would normally be considered to be the language of counting but she could certainly count. I am not claiming that she had been uninfluenced by Western mathematics through school experiences. Rather, I am using her as a striking example of the fact that words are not necessary for real counting to occur.

3. Information on Martu Wangka was provided by Bill Langlands.

4. Crawfurd (1863) does not acknowledge all his sources but his examples are traceable to travellers' tales, notes in learned journals and various amateur observations of the 18th and early 19th centuries. (It is thought- provoking indeed that this data still influences scholarly thinking today. See Harris 1982:153–54).

5. Information on Kunwinjku was provided by Peter Carroll. It is interesting that *Kunkarrngbakmenq*, "four", is analyzable to refer to a hand less the thumb.

6. Stokes (1982:41) describes Anindilyakwa counting by an elderly woman who demonstrated by first gathering together a heap of pebbles as if she were distributing turtle eggs. It is thought provoking that Aboriginal people in this context saw *division* (sharing) rather than *addition* (accruing) as the essential role of counting.

7. Stokes' information is based on almost a lifetime of field work and the Anindilyakwa numbers are here listed in modern orthography. They do not, however, differ substantially from Tindale's 1925 list (see note 1.).

8. The concept of "qualitative numbers" derived from spatial arrangements such as "duo" and "trio" is particularly hard to justify in counting items which are non-material or removed from each other in space and time. Consider the following examples from Anindilyakwa (Stokes 1982:56).

yabiyakarbiyu	—	manja	yimawura
three (in three months)	—	in	month

arngk	—	unmangbala	ningiridanguma	eka
times	five	I. chopped	tree

(I chopped the tree five times)

9. Information on this Gurindji set of counting words was supplied by Norm McNair.

10. Christie (1985:21) claims that "Western mathematics is alien to the Aboriginal mind" and that the teaching of mathematics is destructive of Aboriginal culture—"counting represents the tip of the iceberg". This is a significant claim which I cannot deal with in this paper. I do not, however, believe that learning to count in English—that is, learning a counting system with extensive verbal tags—is alone destructive. Like Hale (1975:296), I believe that the idea of counting is universal. I agree, nevertheless, with Christie that the constant Western demand for quantification, of precision; is foreign to Aboriginal thought. The implications of this for education in contexts of cultural change need much study but I suggest that what is finally destructive is the acquisition of those Western cultural traits, such as acquisitiveness, which provide the purpose for quantifying, rather than the acquisition merely of the tools with which to quantify.

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