Seeing Yolŋu, Seeing Mathematics.

"One, two, three, big mobs", is a stereotyped notion of the extent of mathematics in Aboriginal cultures, with their languages held out in evidence. However the real picture is vastly different and the evidence is in the languages. The vocabularies of Aboriginal languages are in fact permeated with items representing concepts which Europeans would label as mathematical. Of equal significance is the way Aboriginal people use their languages to express mathematical ideas and processes.

In focussing on **Yolŋu** (North East Arnhemland Aboriginal) society, this paper attempts to:

- examine Yolŋu society in terms of Western notions of mathematics;
- identify the nature of mathematics within a Yolŋu context; and to
- discuss implications of the above for educators working with Yolŋu.

This paper could also be useful to Yolŋu readers, in providing examples through a context in which they are familiar, of **Balanda** (which is a Yolŋu word for European or non-Aboriginal) mathematical thinking.

The main tool of analysis will be the **Djambarrpuyŋu** language which is widely spoken throughout the region and which shares a great deal of vocabulary with other languages and their dialects in the region. The usefulness of language as an indicator of cognitive processes is of course based on the principle that language and culture are two sides of the same coin, with language being the main vehicle for the enculturation of a society's members and the medium through which a society negotiates and constructs its metaphors, its world view and ultimately its reality.

The approach I have taken is to extract from the Yolŋu world (with the inherent limitations and distortions that this requires) a variety of notions, concepts and behaviours which as a Western scientist I categorise as mathematical in quality. This will provide the reader with an overview of the range and depth of "mathematical" ideas within Yolŋu culture. The window is Yolŋu language.

An important implication of this process should be clarified at the outset. It should be noted that by removing words, concepts, and structures from their Aboriginal context and putting them into a European box called 'mathematics', I have inevitably lost much of the full significance of their meanings and have certainly not done justice to the intricacy and complexity of the Yolŋu world. The reader should thus be aware that in making meaning for the European mathematician standing outside Yolŋu culture, I have lost meaning from within the Yolŋu culture. Some of the ideas in this paper arose out of a workshop I conducted for a group of Yolŋu Teacher Education students from Batchelor College in

April, 1990. A few of them were quick to point out the strangeness of creating a mathematics category or 'box' for putting in pieces of their language and culture, though they saw after a while that it aided them in the process of de-mystifying what Balanda accept as mathematics, and they came to recognise the Western mathematical method in my madness.

Also by way of introduction it is important to remind ourselves that Aboriginal Australia is itself a multicultural society. The Yolŋu for example are set apart from most other groups by the strength of their interaction with Makassan people over two centuries up to 1900 (Cooke, 1987). There is a strong Makassan influence on Yolŋu language, including mathematical terms. Therefore whatever lessons Yolŋu languages hold for us in the context of this paper cannot automatically be generalised to other groups from other regions.

Even within Northeast Arnhemland there are significant differences between communities reflected in customs, language and community structures. Yirrkala for example is only twenty kilometres from a white population centre (the mining town of Nhulunbuy) which has had strong and varied impacts on the community. Apart from the obvious impacts of things like mining royalties and alcohol, there are more subtle implications arising from such things as the availabilty in Nhulunbuy of refrigeration facilities for corpses, thus removing one formerly overriding constraint on the timing and duration of funeral ceremonies at Yirrkala.

The linguistic items provided by way of example in this paper are not represented as an exhaustive compilation of all Yolŋu terms corresponding to Western mathematical categories. Rather they are intended as an illustrative compilation. Most of these items can also be found in various Yolŋu language materials such as the Yolŋu-Matha Dictionary (Zorc, 1986) and the Djambarrpuyŋu Wordlist (compilers Galpagalpa et al., 1984), and in pioneering research such as The Grammar of Gupapuyŋu by B. Lowe (1975, but prepared in the late fifties and early sixties).

Similarly there is a body literature, published and unpublished, reporting studies and research by Balanda and Yolŋu concerning mathematical and related pedagogical issues in the Yolŋu context (e.g. Action Group of Yirrkala School, 1989). It includes references for example to mathematical patterns within the Yolŋu kinship system, and to the potential value for Aboriginal tertiary students who examine these patterns in attempting to come to terms with Western mathematics as a conceptual system (e.g. Stanton, 1990a). A major (and distinct) section of this paper however is devoted to making these patterns quite explicit in Western mathematical terms and describing them in some detail. The amenability of the Yolŋu kinship structure to

mathematical analysis and the elegance of the geometric patterns which emerge, provide tangible demonstration of a highly abstract conceptual sophistication in Yolŋu culture of a mathematical nature. This quality is otherwise quite hidden from the Westerner because it is integrated into a total Yolŋu cultural schema based in premises and metaphors which are not recognised from the standpoint of Western science and mathematics. This raises the issue of how to define the term mathematics in cross cultural contexts. Given that this paper is centred on a mathematical analysis of aspects of Yolŋu culture it is important that this issue of definition be clarified.

One definition of mathematics could arise from its characteristics and prominence as a basis for the schema of European culture. In this context it can be seen as a characteristic system of meaning based originally in classical logic, growing and developing within the European philosophical framework (exemplified by the influences of theorists like Descartes, Liebnitz and Frege), and coming to take pride of place as the purest of sciences during the emergence of empiricism and rationalism as dominant forces in changing the style of European thought. The search then for a mathematics defined under these terms in an Aboriginal culture, implies a search for signs of European/Western ways of thinking, and given what is known of Aboriginal world views, is unlikely to be fruitful.

Another way of looking at mathematics is to hypothesize that mathematical activity is a human characteristic and thus pan-cultural, with the qualification that the degree of mathematical development and the prominence of mathematical thinking varies widely from culture to culture. Such a hypothesis can arise from observations for example, that all societies show behaviours of measurement; that all languages include terms which encode numerical qualities (i.e. counting words); and that all societies produce articles which can be recognised for their pattern, symmetry or other similarly mathematical (i.e. 'orderly') qualities. From such a standpoint industrialised European societies have developed mathematics to the point of being a cornerstone of Western world view, with their languages containing a vast number of terms encoding precise concepts concerning the measurement, relation and properties of quantities.

Using a definition of mathematics derived from this perspective of mathematics as a pan-cultural phenomenon, a search for mathematics within Aboriginal cultures produces definite results (as in the linguistic survey which follows). However there is one crucial implication. This is that whilst an analysis of the mathematics in a Western industrialised society would go a long way towards explaining and describing its cultural schema, an analysis of the mathematics of an Aboriginal culture, where the definition of mathematics is still restricted to that which is recognisable in terms of Western mathematical categories and

notions, sheds little light on Aboriginal cultural schemata. It does not reveal the true nature of the Aboriginal systems for creating order out of human experience.

Thus a third and far broader way of defining mathematics is to view it as a society's system for encoding, interpreting and organising the patterns and relationships emerging from the human experience of physical and social phenomena. The emergence of a cultural schema is then a manifestation of the continual negotiation and refinement within a society of a framework for discerning patterns and for describing/ defining their governing rules and interrelationships as a coherent, ordered system of meaning. Whilst this process is common to all cultures the resulting schemata can be fundamentally different.

Under the terms of this broad definition an investigation of Yolŋu mathematics becomes a study of **gurruṯu**, which can only inadequately be translated into English as a study of Yolŋu kinship. It is under the umbrella of **gurruṯu** that the Yolŋu human, physical and spiritual world is organised. **Gurruṯu** is as difficult a concept to express in English language as Western mathematics is in **Djambarrpuyŋu** language. They share in common that they are both ordered systems of meaning characteristic of the respective cultures in which they are embedded.

The section of this paper dealing with Yolŋu kinship represents an attempt to reveal some of the order within the system in terms accessible to the Western reader (i.e. in terms of Western mathematical patterns). It also allows me the opportunity to share with the reader some of the glimpses I have myself experienced as to the nature of this Yolŋu orderliness (or mathematics). This is of particular importance to those Western educators who have Yolŋu as their clients and who can be seriously handicapped by the fogginess of their notions as to what and how their clients know. For the mathematics educator in particular, there is the need to be clear about what system of ordering (i.e. what mathematics) Yolŋu bring with them to the formal Western educational situation. Such knowledge is not revealed by a test of Western mathematical proficiency.

This paper then also aims to go some way towards filling this gap. It begins with a somewhat superficial mathematical survey of a Yolŋu language from the perspective of mathematics as a common form of human activity and thinking (i.e. the second of the three perspectives on mathematics described earlier).

In viewing the Yolŋu culture from my Western mathematical standpoint, it will be convenient to notionally sub-divide the mathematical world into a series of conceptual sub-domains. As a Northern Territory school curriculum area, mathematics is broken into the conceptual sub-domains of space, measurement and number. Within this paper I will use the

following categories: Time, Number, Measurement, Space, Money. The Yolŋu kinship system is dealt with separately.

TIME

For Europeans time is seen very much as a linear notion. Thus time lines are a common way for Europeans to summarise develepmental processes and historical events. For Yolŋu there is a more dominant cyclical aspect. Thus one Yolŋu metaphor which was explained to me, describes the duration of a human life in cyclical terms. It begins with the entry into a woman of a spirit from a special place (**wäŋa-malŋ'thunawuy**, literally 'the place associated with appearing') which might be a sacred waterhole, or from a totemic entity (e.g. a specific fish) which is significant to the father's clan. It is an event which the father learns of through a dream. This spirit can be referred to as **wuŋuḻiyothu** (literally 'shadow or spirit child'). This spirit is manifested in the baby and remains with the individual until death. For a short period of time after death (e.g. during the period of funeral ceremonies) the spirit can manifest itself as the voice or apparition of the deceased, but upon burial of the body the spirit (now called **birrimbirr**) returns to the place it came from. It is then available to enter another woman and the cycle can occur again.

In other respects there are strong parallels between the way Balanda and Yolŋu conceptualise time. As with Yolŋu, basic Balanda time concepts (day, month, year, season) are derived from natural cycles involving the sun, moon, tides, seasons and weather. Balanda mark or map these events using clocks, tables, charts and calendars. Nowadays Yolŋu also make reference to calendar months and clocks although their primary orientation tends towards the natural cycles which underlie them.

A clear example of this difference in orientation was provided during a recent (September, 1990) sitting of a coronial inquiry at Galiwin'ku community (where I served as interpreter). The court was interested in Yolŋu evidence linking episodes of mental illness from which the deceased person suffered, with the phases of the moon. A Yolŋu witness was asked to indicate the particular phase of the moon operant at the time of death, and he did so by drawing a crescent moon on a blackboard. This provoked a murmur of assent from the Yolŋu audience, but not from the eight lawyers present in the room, since they had already heard from one of their members that the charts indicated that the moon was full at that particular time. The witness was thus challenged, in spite of the fact that he was able to further specify that it was a waxing (and not waning) crescent, and justifying his statement by drawing attention to the behaviour of the tides at the time (which was remarkable considering he was referring to a time five months earlier!).

The accusation that he was fabricating his evidence was only rebuffed after the earlier lawyer referred again to the phases of the moon tables in his diary and corrected his earlier misreading.

Yolŋu Time Terminology

Yolŋu often express the passage of years in terms of the re-occurence of the monsoonal rains (**waltjaŋ**), though **dhuŋgarra** is an alternative term for year (this is borrowed from the Makassan *tuŋgara* which also refers to a seasonal event, the southeast wind - Zorc,1986).

The Yolŋu word which expresses the notion most closely identified with the English word time is **walu** (literally sun, derived from Makassan *allo'*, also meaning sun). An alternative Yolŋu term is **ḏaykun**. Both words share a similar range of extended meanings which include day, time, and clock. A Yolŋu idiom which is commonly used to indicate impatience at being delayed, is **walu-buma** (literally time killing, i.e. wasting time).

The following is a selection of Yolŋu words which express time concepts:

Yolŋu Word	Literal Meaning	Extended Meaning
walu.ḏaykun	sun	day, time, clock
munha	dark	night
ŋalinḏi	moon	month (lunar or calendar)
waltjaŋ	rain	rainy season, year
dhuŋgarra	year	(year)
goḏarr'	morning	tomorrow
yalala	later today	later on
gäthur	today	earlier, earlier today
boŋguŋ	tomorrow	another day or some later time
barpuru	yesterday	a recent day or time

The time concepts which some of these words are able to express can be illustrated by setting them into some common expressions:

Nhätha nhe dhu marrtji?
(When you will go)
When will you go?

Yalala.
(Later today)
Later

Yurr nhaliy waluy?
(But by means of which time)
But what time?

Ŋula nhaliy.
(By whichever means)
Whenever.

Mak milmitjpa bäy. wo yuwalktja nhaliy ... five-dhu waluy.
(Maybe afternoon perhaps, or truly when ... by means of five time,)
Maybe this afternoon, or really though, at five o'clock,

bili balanyamirriynydja ŋarra ŋuli ga dhawar'yun djämaŋurnydja.
(because when it is like that I usually am finishing from work.)
because that's when I usually knock-off work.

Times of the day can be expressed by reference to the clock (these days), but also commonly by means of expressions relating to environment.

For example:

walu-gärrinyaray	(when the sun goes inside)	sunset
wuŋuli-gal'yunaray	(when the shadows are crawling)	early afternoon
dhulmu-milmitjpa	(deep afternoon)	dusk
ḏämbu-walu	(head sun or sun over head)	midday

Times within a month are indicated by the state of the moon:

yuṯaŋaḻindi	(new moon)	beginning of the month
ḻikan	(lit. elbow, also crescent)	new moon, old moon
birrku'-ŋaḻindi	(full moon)	full moon

Times of the year are expressed in terms of named seasons, seasonal wind directions, or environmental conditions.
For example:

ḻuku-nhäranhamirriy	(when the feet burn)	late dry season (Aug- Oct)
bärra'mirriy	(time with the west wind)	early wet season
dharratharra	(named season - early dry)	May to July

Ages of people are expressed in terms of stages of development or stages of life. For example:

ŋapa-raŋanmirr	(back having paperbark)	new born baby
bilyunamirr	(one who turns)	baby that can roll over
gal'yunamirr	(one who crawls)	
marrtjinyamirr	(one who walks)	
gaḏaku	(boy before circumcision)	
gurrmul	(boy after circumcision)	
ŋamini-dhärranha	(breasts standing)	pubescent girl, no child
ḏukitjmirr	(with new shoots, grey hair)	old person

NUMBER

I have commonly asked Yolŋu women during the course of conversation how many children they have. Almost invariably, when they have a number of children they respond by naming or describing their children one by one as they count them off on their fingers. Recently I asked a Yolŋu lady how many people were in a tour group that was planning to go overseas. She responded by identifying more than twenty people either by name or relationship. When I ask a parent about the age of a young child the response is commonly to hold out the hand indicating the height of the child or to tell me that the baby can now crawl or walk. In other words my quantitative enquiries are commonly met with qualitative responses.

This is consistent with a world view which sees people very much in terms of their relationships, their individual and group identities and their stages of development. However this is not to say that numerosity as a concept or quantification as a process, is absent or unimportant. Houses are usually described and evaluated in terms of the number of rooms or their size. Money is certainly valued in terms of its sum. Once when visiting an outstation an old man observed me eating and enjoying

freshly killed wallaby and I overheard him ask another about me specifically in terms of how many years (**waltjaŋ**) I had been living with Yolŋu . Turtle hunters recall in fireside stories how many turtles they caught on each expedition going back for several years. People ask of others who are going somewhere how many nights they plan to spend away.

Numerosity as a quality is in fact encoded in many ways within Yolŋu languages apart from the obvious counting words. Singularity, duality and plurality are normally made explicit in Yolŋu languages for nouns through the form they take and/or through the words which qualify them. The various strategies include the use of plural suffixes, dual markers (i.e. markers expressing duality), reduplication, plural nouns, and dual/plural pronouns (substituting for numbers). There are also pluralised forms for some verbs (though reduplication of the verb stem is more common) and for some adjectives. As a general rule in **Djambarrpuyŋu**, unmarked or unqualified nouns are taken as being singular. These are some examples:

Word	Meaning	Strategy
yothu	(child)	unmarked
yothu maŋda	(two specific children)	dual pronoun
märrma'(2) **yothu**	(two children)	counting number
djamarrkuli'	(3 or more children)	plural noun
miyalk	(woman, or women as a class)	
miyalk mala	(woman plus 'group', i.e. women)	plural descriptor
dharrwa miyalk	(many x woman, i.e. many women)	plural adjective
miyalkkurruwurr	(women)	plural suffix
yolŋu	(person, or people as a class)	unmarked
yolŋu'-yulŋu	(a group of people)	reduplication
wäwa	(brother)	
wäwa'manydji	(2 brothers or brother and sister)	relationship suffix
wäwa'manydjiwurr	(a group of people in brother or brother/sister relationship)	relationship plus plural suffix.
ŋayi	(he, she and sometimes, it)	singular pronoun
maŋda	(they - two people)	dual pronoun
walal	(they - 3 or more people)	plural pronoun
Dhärri!	(Stand up! - one person)	
Dhärri'-dharri!	(Stand up! - more than one)	reduplication
ŋurrkam	(throw - one thing)	
djalkthun	(throw - many things, or substance)	plural verb
nyumukuŋiny	(small, little)	singular adjective
yumurrku	(small, little)	plural adjective

Counting in **Djambarrpuyŋu**.

Yolŋu follow a base five counting pattern. However it is rare to hear Yolŋu enumerate beyond ten or so using Yolŋu numbers. The English counting system has been adopted. The **Djambarrpuyŋu** counting system is formed as follows:

1	**wangany**	
2	**märrma'**	
3	**ŀurrkun'**	(also means a few)
4	**ḏämbumiriw**	(lit. without a head)
5	**goŋ-waŋgany**	(**goŋ** means hand, i.e. one hand)
6	**goŋ-waŋgany ga waŋgany bäythinyawuy**	(one hand and one left over)
7	**goŋ-waŋgany ga märrma' bäythinyawuy**	(one hand and two left over)
8	**goŋ-waŋgany ga ŀurrkun' bäythinyawuy**	(one hand and three left over)
9	**goŋ-wangany ga ḏämbumiriw bäythinyawuy**	(one hand and four left over)
10	**goŋ-märrma'**	(two hands)
15	**goŋ-ŀurrkun'**	(three hands)

These counting numbers could be used in responding to the question **nhämunha** (how many). Thus a man who is interested in acquiring a fishing line from another might first ask, "**Nhämunha nhuŋu raki'**?" (literally, "How many your string?").

These numbers can be transformed into adverbs by using the suffix -**mirr**. This suffix is added to **nhämunha** to ask the question, "How many times?". So to ask a question like "How many times did he hit you?", one uses the construction **nhämunha'mirr**. The answer could be given as follows:

waŋgany'mirr	(lit. with one)	once
märrma'mirr	(with two)	twice
ŀurrkun'mirr	(with three or a few)	three times (or a few times)
dharrwamirr	(with many)	many times
ŋula nhämunha'mirr	(with however many)	however many !

This suffix -**mirr** (which is also used generally as a possessive marker) is being used in the above context to express a multiplicative function. Multiplication and the reciprocal notion of division can be identified as processes within traditional behavioural contexts. Perhaps the most clear example arises during the gathering and sharing of turtle eggs.

As many as 70 or 80 turtle eggs can be found buried quite deeply in beach sand in a single nest. A single beach can yield several nests so that the harvest can extend to several hundred eggs. It is quite common for men who are on a turtle hunting expedition to take time out to gather eggs which are highly valued as food. The way in which turtle eggs are shared though, is quite different from the way in which the meat of the adult sea turtle is distributed. The carving of turtle meat is a skill which follows a specific procedure resulting in a number of cuts of meat, with each member of the hunting party being entitled to specific cuts of meat according to his role in the hunt as harpoon thrower, spotter and harpooner's assistant, or boat captain. The distribution of eggs on the

other hand has a distinctive mathematical quality. This can be illustrated by way of an anecdote concerning a turtle hunting expedition in 1984, where I was one of a party of three men.

> We had in our boat one adult turtle but were keen on getting one or two more. However the tide was against us, so while waiting for the tide to turn we went to a small island where we had seen recent turtle tracks on the sand, indicating nests of turtle eggs. Carrying a couple of sacks we proceeded to walk around the island (two in one direction and one in the other) to gather eggs. On meeting together again we emptied out the eggs to share them out. First the eggs were arranged in groups of five by placing four eggs together on the sand and placing the fifth on top. This arrangement of five eggs called a **rulu** (this being one of several meanings for the word). As this was done one of the men proceeded to "deal out" eggs to each of us **rulu** by **rulu** until they were all gone. Each of us took what we wanted to eat from our own shares and the rest were put in our private containers to take back home.
>
> Two more turtles were caught that day and so late in the afternoon we stopped at an island close by to cook, eat and rest. Two turtles were cooked and the other left alive in the boat to cook back in the community the next day. One of the cooked turtles was carved and distributed according to the individual roles we had adopted on the hunt. The other cooked turtle was given to the country which had provided such a bountiful catch - it was left on some rocks on the island. (This followed a discussion between the two Yolŋu men, one of whom had to overcome his reluctance to leave such good meat behind.) The day after returning home the live turtle was killed, cooked, carved and distributed according to customary pattern. That is, it was first distributed to the hunters and we then shared our portions among our families.

These two such different patterns of distribution for turtle eggs and adult turtle, by the same people, on the same day an in the same overall context are quite remarkable. According to the Western standpoint there is not a mathematical basis for the sharing of the meat with the land. According to Western world view it is not even rational since it involves the personification of the land in the act of including it as a beneficiary in providing it with food prepared (i.e. cooked) for humans.

On the other hand the Westerner can immediately identify the mathematical notions underlying the distribution of turtle eggs. There are several steps which can be labelled in Western mathematical terms. For example:

- Eggs were taken away (subtracted) five at a time from the total until there were none left. Westerners define this uniform repeated subtraction as division.

- The redistribution of the eggs in lots of five by repeated allocation (i.e. repeated addition) is defined in Western maths as multiplication.

This purposeful equal sharing and the strategy which is used to accomplish it, lie within the Western notion of arithmetical division. Indeed there appears to be a conceptual equivalence.

The sharing of turtle eggs is not the only traditional example of mathematical division (equal sharing). Stingray meat is also commonly shared amongst people in equal portions. The stingray is first cooked by placing it on a fire. The flesh is then removed and kneaded (like dough) with fresh water to leach out the ammonia. The fatty liver is then kneaded with the flesh and the mixture is divided into balls (called **reny**) of uniform size (usually about the size of tennis balls). These are then shared out equally. If there is one left over then it is broken apart and shared out. This not only represents arithmetical division, but also illustrates the fraction as a Yolŋu notion.

I have also heard an account of wild yams (**gulaka**) being shared out equally by an old lady at an outstation, where she first sorted the yams into three groups (categories) according to size. Then she gave each person one from each category (that is a large, medium and small yam to each person), and then as one pile emptied, continued with the other two, and so on until there were none left (Munyarryun, 1990).

The word **rulu**, which defines a specific arrangement of five turtle eggs, is abstracted to represent the quality of fiveness. (The most general meaning of **rulu** is a group, or bundle.) The word **waŋgany-rulu** (**waŋgany** means one) thus comes to mean five, just as **goŋ-waŋgany** (hand-one) means five. Multiples of five are given by using counting numbers (**waŋgany, märrma, l̲urrkun'**) as prefixes. Predictably, as a base five system there is a change in form for the number twenty-five. Using **rulu** as a base, twenty-five can be expressed as **rulumirr-rulu**, using the same suffix **-mirr** as is used to construct once (**waŋganymirr**), twice (**märrma'mirr**) and thrice (**l̲urrkun'mirr**). Thus the appropriate translation for **rulumirr-rulu** in this context is five times five.

I should make it clear that **rulumirr-rulu** is not an expression I have heard myself. It is recorded as an expression in the Zorc dictionary (Zorc, 1986). It is worthwhile elaborating on an observation I made earlier on the use of Yolŋu counting numbers. **Waŋgany** (and its alternative **wid̲ipiya**), **märrma', l̲urrkun', dämbumiriw, goŋ-waŋgany** (that is one, two, three, four, five) are Yolŋu number words that are commonly used at least in the Galiwin'ku community, though children will rarely (spontaneously) go past **l̲urrkun'** in Yolŋu language (except to say **dharrwa** which means many). Adults not uncommonly will use **goŋ-**

waŋgany and **goŋ-märrma'** and will occasionally use **bäythinyawuy** in constructing the numbers six or seven.

There is one interesting construction which I have heard now on several occasions relating to the giving of telephone numbers in **Djambarrpuyŋu** conversation. I have heard the Batchelor College number (760002) given as follows: "Seven, six, zero **lurrkun'** (i.e. "triple" zero), **ga** two last-**tja**". The simultaneous use of the two counting systems here is a purposeful strategy for disambiguation. In other telephone numbers with double digits, **märrma'** is used to carry the meaning of double.

There is a number of other terms which Yolŋu use to represent operational processes in the context of number. They include:

bothurru	count (from Makassan *botoro'* - gamble, play dice)
luŋ'maram	gather together in one group
manapan	add together, place together (e.g. to compare length)
barrkuwatjkum	make separate, place apart
djaw'yun	subtract, take away, steal.
gurrupanmirr	share (not necessarily equal; lit. give to each other)