ONE, TWO, THREE, ..., ZERO From Counting to Number

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What is the Purpose of Counting?

 How many like items are in a collection – Cardinality of a set
 To determine the relative order/position – Ordinality of a set

Act of Counting Depends on:

1. Identifying set
2. Carrying out a one-to-one mapping
3. Arriving at the cardinality

Early Counting People did not know how to count but had number sense

How many ticks? Without counting!

How Far Back?

- Homo Erectus (c. 1.5M 300 000 BC)
- Had relatively sophisticated tools
- Migrated from Africa to Europe and Asia
- Had seasonal camps
- Constructed shelters
- Hunted



Probably developed stick-counting

Can Animals Count?



• The jury is still out!

Record Keeping

• Earliest evidence: wolf bone 30 000 BC





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Tally Sticks

- Latin: *talea* or cut stick
- Still used up to 19th century French bakers
- Roman numerals derived from tally sticks?V from X
- C, D and M from Etruscan (X)

Finger and Body Counting

- Evolved with or from stick counting
- Convenient
- Digits from *digitus*, finger
- Roman "V" derived from hand?
- Allow for cardinality and ordinality
- Not appropriate for record keeping
- May only have gone up to eight
- Still used today by traders
- With some cultures progressed to toes and other body parts

Grouping

Consequence of finger and body counting
Allows for faster counting
Most basic is groupings of two

Number Words

Hands and fingers most commonly used number words

- Ten: deka (Greek); decem (Latin); dasa (Vedic); deich (Old Irish)
- From an original Indo-European *de kmt*, which "probably means two hands"?

Early people drew from their environment, e.g. mouth, eyes, head, ostrich toes, teeth
Spoken structure not necessarily same as written, e.g. 14, 24

Words for 11 and 12

English eleven
Gothic ain lif
Old Nordic ellifu
Old High German einlif
Dutch elf

twelve twa lif tolf zwelif twaalf

Number Word Formation

 Most common system of forming number words is by addition and multiplication
 Some used subtraction

Examples of Word Counting for 18

English: eighteen (8, 10)
Lithuanian: astuno-lika (8 over 10)
French: dix-huit (10,8)
Chinese: shih pa (10, 8)
Latin 1: decem et octo (10 and 8)
Mexican: caxtulli om ey (15 and 3)
Breton: tri ouch (3, 6)

Welsh: *deu naw* (2,9)

Latin 2: duo de viginti (2 from 20)

Finnish: kah deksan toists (2 from 2nd tens)



The Quinary System

Very few exist in a pure state The Api Language: 6. otai (other one) 1. tai 2. lua 7. olua (other two) 8. otula (other three) **3**. tolu 9. ovari (other four) 4. vari 10.lua luna (two hands) **5.** Juna (hand)

Vigesimal Systems: The Mayans

,	Up to 399:	
•	1. hun	20. hun-kal (one – twenty)
•	2. ca	21. hun-tu-cal (1 on the twenty level)
•	3.ox	22. ca-tu-cal (2 on the twenty level)
•	4.can	
•	5.ho	29. bolon-tu-cal
•	6.uac	30. lahu-cakal (10, 2 ,20, or 10 in the 40 interval)
•	7.uuc	31. buluc-tu-cal (11 on the 20 level)
•	8.uaxac	
•	9.bolon	35. holhu-cakal (15, 2, 20, or 15 in the 40 interval)
•	10.lahun	
,	11.buluc	39. bolon-lahu-tu-kal (19 on the 20 level)
,	12.lah-ca (lahun + ca, 10+2)	40. ca-ikal (2 , 20)
•	13.ox-lahun	50. lahu-y-oxcal (10, 3, 20, or 10 in the 60 interval)
,	14.can-lahun	60. oxkal (3, 20)
,	15.ho-lahun	70. lahu-cancal (10, 4, 20, or 10 in the 80 interval)
,	16.uac-lahun	
,		100. ho-kal (five – twenty)
,	19. bolon-lahun	200. lahun-kzl (ten – twenty)
,		300. ho-ilhu-kal (5, 10, 20)

For 400 and up

- 400. hun-bak (1, 400)
- 500. ho-tu-bak (5 (20) + 400, kal or 20 is omitted)
- 600. lahu-tu-bak (10 (20) + 400)
- 700. holhu-tu-bak (15 (20) + 400)
- 800. ca-bak (2, 400)
- ...
- 1000. lahu-y-oxbak (10 (20) from 3, 400)
- 1200. ox-bak (3, 400)
- 1600. can-bak (4, 400)
- ...
- 8 000. hun pic (1, 8 000)

. . .

- •
- 160 000. hun calab (1, 160 000)

The Aztec

1 2 3 4 5 6 7 8 9 10	ce ome yey naui chica or macuilli chica-ce $(5 + 1)$ chic-ome $(5 + 2)$ chicu-ey $(5 + 3)$ chic-naui $(5 + 4)$ matlactli	11 12 13 14 15 16 17 18 19 20	matlactli-on-ce $(10 + 1)$ matlactli-on-ome $(10 + 2)$ matlactli-on-yey $(10 + 3)$ matlactli-on-naui $(10 + 4)$ caxtulli caxtulli-on-ce $(15 + 1)$ caxtulli-on-ome $(15 + 2)$ caxtulli-on-yey $(15 + 3)$ caxtulli-on-naui $(15 + 4)$ cem-poualli (1×20)
30 40 50	$\begin{array}{llllllllllllllllllllllllllllllllllll$		
100 200 300 400 800 1200	macuil-poualli matlactli-poualli caxtulli-poualli cen-tzuntli ome-tzuntli yey-tzuntli	$\begin{array}{c} (5 \times 20) \\ (10 \times 20) \\ (15 \times 20) \\ (15 \times 400) \\ (2 \times 400) \\ (3 \times 400) \end{array}$	
8000	cen-xiquipilli	(1×8000)	•••••••••

Sexagesimal System The Sumerians

- 1. as
- 2. min
- 3. es
- 4. limmu
- 5. ia
- 6. as (ia as, 5,1)
- 7. imin (ia min, 5,2)
- 8. ussu
- 9. ilimmu (ia limmu,5,4)

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10. u 20. nis (ni as) 30. usu (es u, 3,10) 40. nin (ni min, 20,2) 50. ninu (ni min u, 20, 2, 10) 60. ges 120. ges min (60,2) 180. ges es (60, 3) 600. ges u (60, 10)

3600. shar (60sqr)

36000. shar u (3600, 10)

[»]

Clay Tokens: Sumerians (8000 BC)



Written Numerals



Subtractive Method Evolves



Chinese Stick System

Evolved from stick counting









Hindu Arabic Numerals



Thanks. I knew I could count on you!