From A, B, C to 1, 2, 3: What counts in early numeracy?

Peter Gould 2008

Early quantitative reasoning

What is number that a man may know it, and a man that he may know number?

W. McCulloch, 1963

Are children born ready to learn number?

Early quantitative reasoning

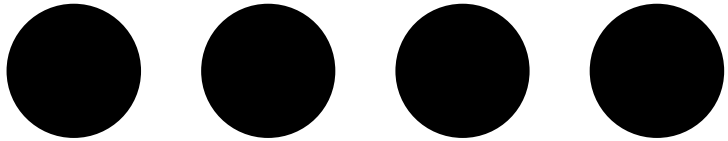
The first stage is formed by the natural arithmetical endowment of the child, i.e., *his operation of quantities before he knows how to count*.

(Vygotsky, 1929/1994,

The Vygotsky reader, p.67)

Operation with quantities

makes



Quantification in infancy (< 18 months) does not make use of number.

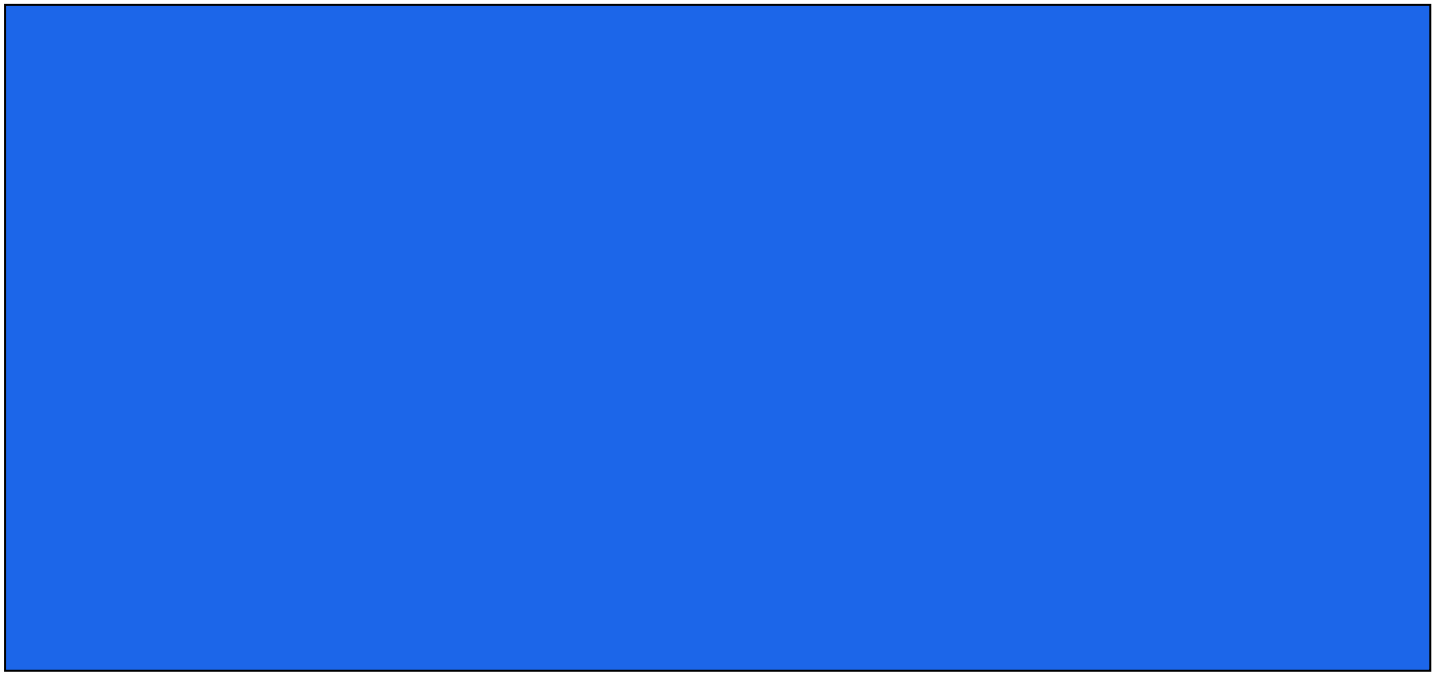
Early quantitative reasoning

Habituation studies.

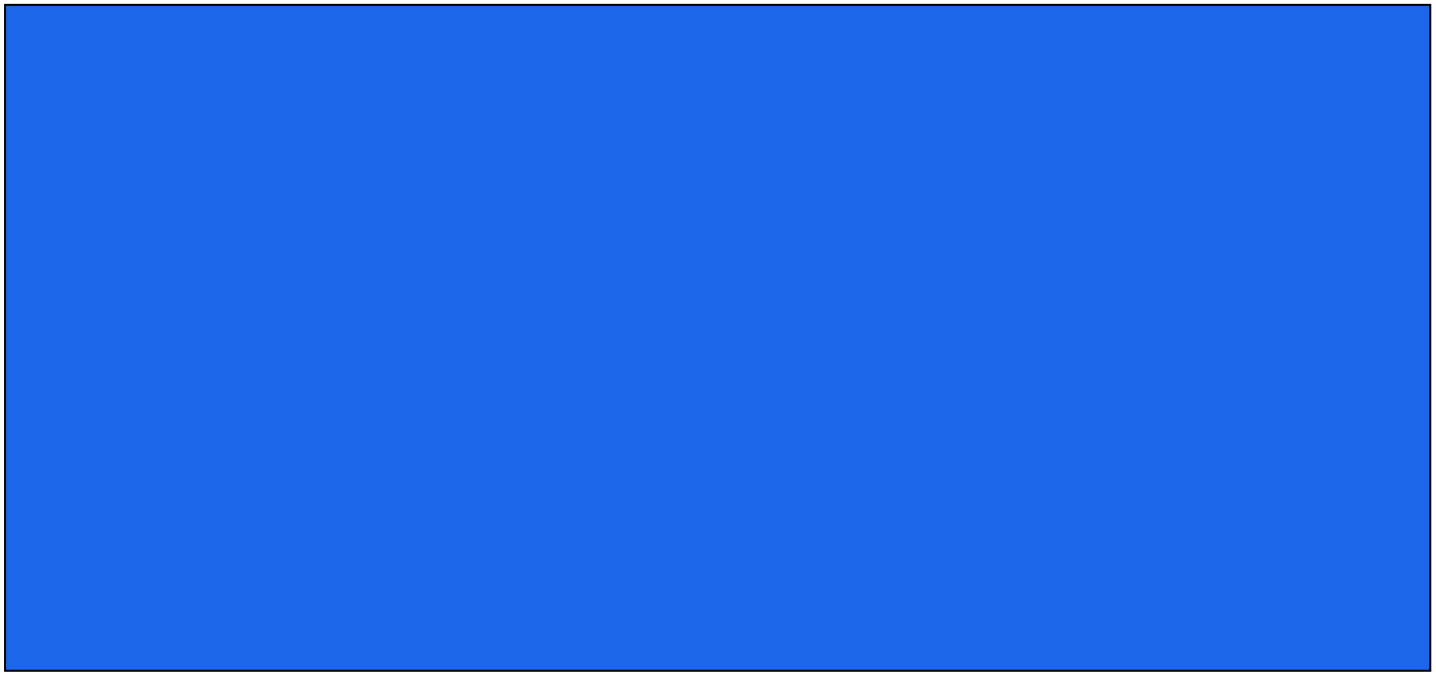
Infants have a tendency to look at a stimulus less after it has become familiar.

Recent studies indicate that infants use perceptual cues (such as contour length and area), rather than number in quantitative comparison tasks. That is, infants perceive quantities in terms of amount rather than number.

What do you expect?



What do you expect?



Current research

- Recent reviews of research have concluded that young children (< 3 years) tend not to represent any numbers except 1 and 2 precisely (Baroody, Lai, & Mix, 2005).
- For example, infants up to 5 months old could discriminate between 1 and 2, 2 and 3 but not 3 and 4 (Antell & Keating, 1983), and 10- to 16-month-olds successfully discriminated between 2 and 3 but not between 3 and 4 or even 2 and 4.

Current research

Children match numerically equivalent sets before they have acquired even a minimal level of counting proficiency (Mix, 1999)

Learning the number-word sequence

- Learning to count and learning to say the alphabet have some similarities and some differences.
- Both start out as an ordered sequence of sounds (and later symbols)…but this is where the similarity ends.

The number-word sequence

The oral count develops over time. It usually has an accurate portion, a stable incorrect portion, and a variable incorrect portion.

A diary of number development

Age	Diary entry
1yr 11mth	Tonight we counted steps going up to bed. We were on nine and you said, “One, two, three, four, five, six”. First time so many numbers were correct.
2yrs	“One two three eight jump”.
2yr 7mth	Putting prunes back into a box, you correctly counted them up to nine. When asked how many prunes you said “three” (your favourite answer to “How many?”).

Fuson, 1991

Learning to count

One use of the term *count* is to produce the sequence of number words in the correct order…

Learning to count

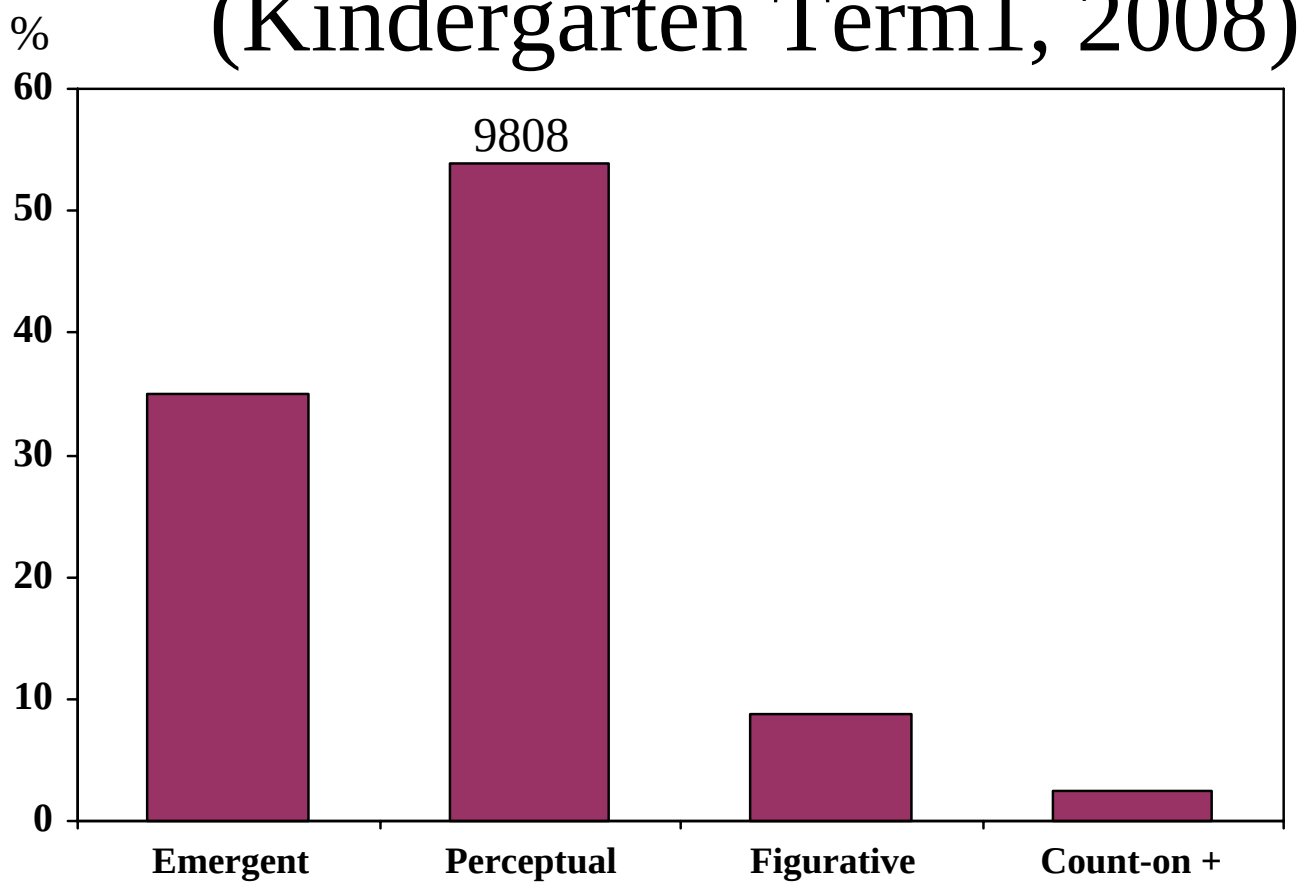
The number words are initially learnt as a fixed sequence.

Learning to count how many

Another use of the term *count* is to produce the sequence of number words in the correct order matched one-to-one with the objects present…

We call this perceptual counting

(Kindergarten Term1, 2008)



N = 18 265

Learning to count how many

Counting can mean determining the total number of objects when they cannot be seen, by forming perceptual replacements for the objects.

Learning to count how many

Counting can also mean determining the total number of objects when they cannot be seen, by reconstructing the numbers starting from one, to find the total.

The number-word sequence

Learning to count varies with the language in which the number system is learned.
Chinese, like many East Asian languages, has a more regular sequence of number words than does English.

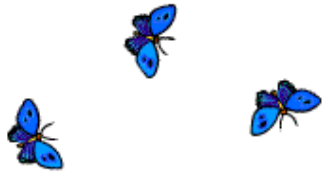
The number-word sequence

Children in the various cultures learn 1 to 10 similarly; however, those learning English learn the “teens” more slowly and with more errors.

In many Asian languages rooted in ancient Chinese, the decade names are literally “two-tens”, “three-tens”, etc and the numbers from 11 to 20 follow a regular pattern (similar to ten-one, ten-two, etc).

Irregular number-words (English)

Eleven		Intelligent errors
Twelve	Twenty	*Twenty-nine*
Thirteen	Thirty	*Twenty-ten*
Fourteen	Forty	*Twenty-eleven*
Fifteen	Fifty	*Twenty-twelve*
Sixteen	Sixty	…
Seventeen	Seventy	…
Eighteen	Eighty	



Using ten fingers

- Knowing the *next number* in the teens is important in moving from counting to addition. Imagine finding 19 and 4 more.
- Rather than avoiding the use of fingers with counting, they can become a powerful means of understanding how students interpret numbers.

Implications of *teens* trouble

As the ten and ones structure of the teens is not transparent in English, more teaching time must be devoted to expressing the numbers 11 to 19 as one group of ten and a particular number of ones.

Ten in the teens

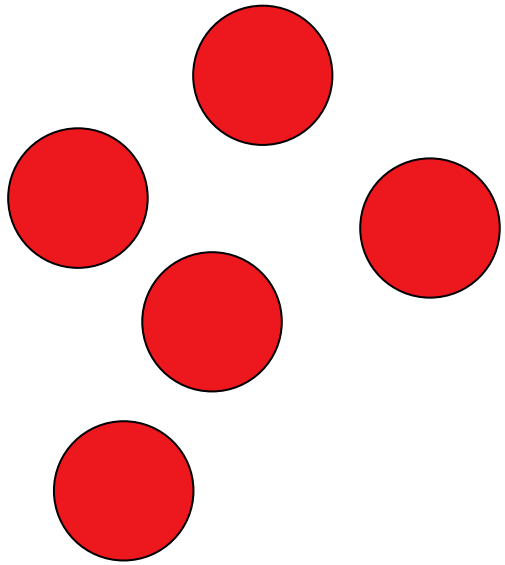
Numeral identification

When a young child learns the name of a numeral it sows the idea that *a symbol can stand for a whole word*.

At the most basic level, numeral identification is a form of shape recognition. This means that numeral identification can develop at a different rate to number knowledge. Numerals have a consistent shape, numerically equivalent sets do not.

Linking quantity and number

There are occasions when we know how many without counting.



Early quantitative reasoning

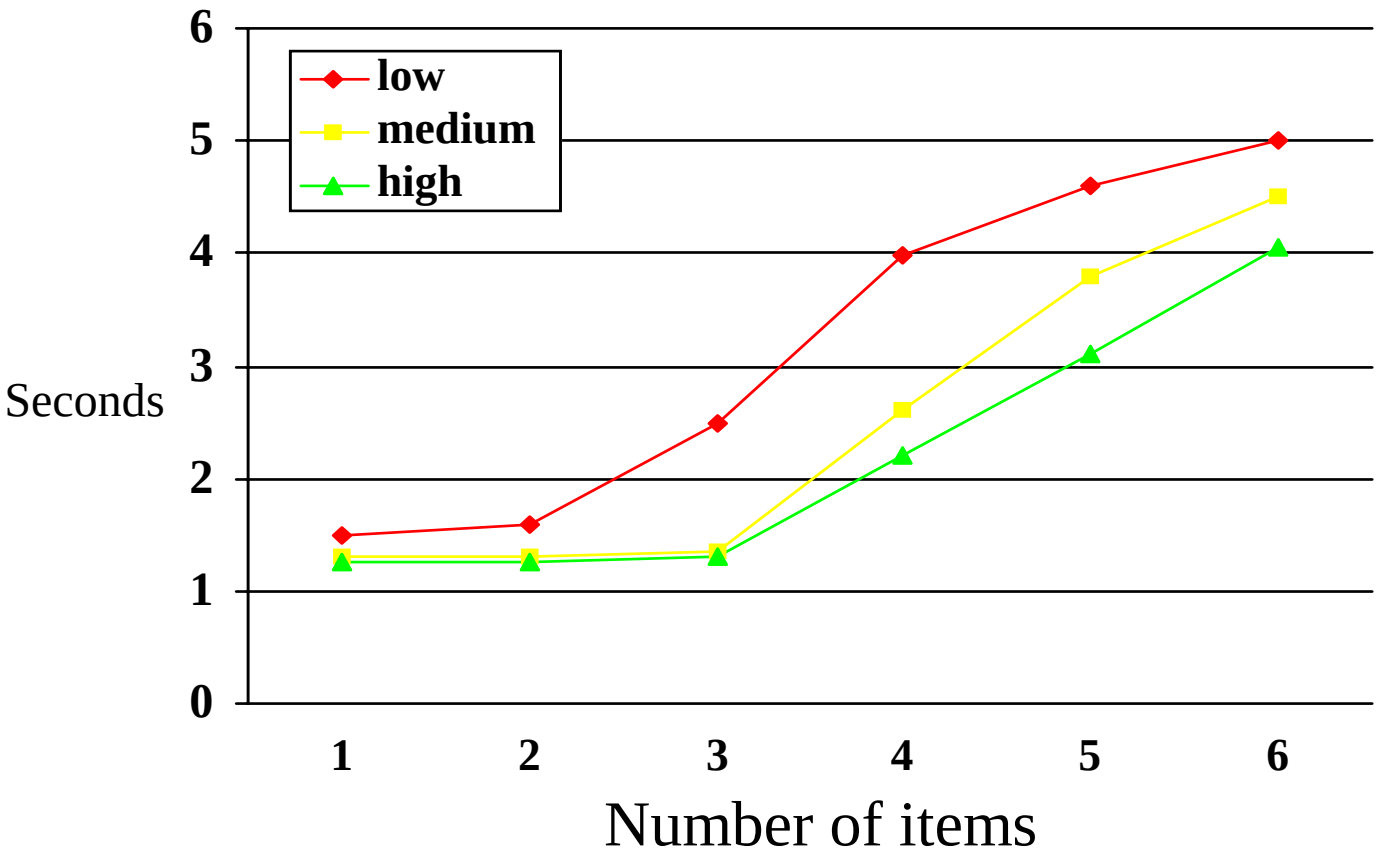
Subitising

The direct and rapid perceptual apprehension of the numerosity of a group.

From the Latin “to arrive suddenly”.

(Kaufman, Lord, Reese, & Volkmann, 1949)

Response times for different groups



N=256

Canadian (K-2)

Looking back

There are several indications that infants perceive quantities in terms of amount rather than number.

It takes several years for children to coordinate pointing, counting, partitioning and the count to cardinal transition.

Looking back

Developing the idea of number as standing for a completed count can develop independently from being able to identify numerals.

Working with number as a “breakable chain” is important in operating on number (e.g. addition and subtraction).

The difficulty of the *teens* (in English) should not be under estimated in developing a robust understanding of number.