What happens when you can't count past four?

Brian Butterworth asks whether you can do maths without words for big numbers

'Some Americans I have spoken with (who were otherwise of quick and rational parts enough) could not, as we do, by any means count to 1,000; nor had any distinct idea of that number," wrote the English philosopher John Locke in 1690.

He was referring to the Tououpinambos, a tribe from the Brazilian jungle, whose language lacked names for numbers above five. Locke's point was that number names "conduce to well-reckoning" by enabling us to keep in mind distinct numbers, and can be helpful in learning to count and to calculate, but they are not necessary for the possession of numerical ideas.

Two recent studies of Amazonian Indians reported in the journal Science, take a crucially different view. These studies, far from maintaining that number words are convenient, propose they are actually necessary.

The theory that language shapes thought is sometimes called the Whorf hypothesis, after the anthropologist Benjamin Lee Whorf. Berinmo, a stone-age tribe in New Guinea, does not put a linguistic boundary between blue and green but does have a boundary between "nol" and "wor" within what we would call green. Research by Jules Davidoff, Ian Davies and Debi Roberson showed that the Berinmo categorise blue and green together but nol and wor separately, whereas we do the opposite - see blue and green as separate colours, but nol and wor as variants of the same colour.

So if categorising objects by colour can be shaped by colour vocabulary, why shouldn't categorising the number of objects? The idea advanced in the two studies of Amazonian Indian tribes support a strong Whorfian view that number vocabulary is necessary for categorising the world numerically. The idea being tested in the Amazon is that humans, and many other species, are born with two "core" systems of number that do not depend on language at all. The first is a small number system related to the fact that we can recognise the exact number of objects up to three or four without counting. We use a second system to deal with numbers larger than four, but it only works with approximations. To get the ideas of larger numbers, of exactly five, exactly six, and so on, you need to be able to count, and to count, you need the counting words.

The Pirahã, a tribe of 150 people who live by the banks of a remote tributary of the Amazon, studied by Columbia linguist Peter Gordon, have words for one and two, and for few and many. That's all. Even the words for one and two are not used consistently. So the question is, do they have the idea of exact numbers above three?

Not having much of number vocabulary, and no numeral symbols, such as one, two, three, their arithmetical skills could not be tested in the way we would test even fiveyear-olds in Britain. Instead, Gordon used a matching task. He would lay out up to eight objects in front of him on a table, and the Pirahã participant's task was to place the same number of objects in order on the table. Even when the objects were placed in a line, accuracy dropped off dramatically after three objects.

The Mundurukú, another remote tribe, studied by a French team led by Pierre Pica and Stanislas Dehaene, only have words for numbers up to five. Pica and colleagues showed that the Munduruku could compare large sets of dots and add them together approximately. However, when it came to exact subtraction, they were much worse.

Mundurukú participants saw on a computer screen dots dropping into a bucket, with some dots falling through the bottom. They had to calculate exactly how many were left. The answer was always zero, one or two, and they had to select the correct answer. They were quite good, but not perfect, when the initial numbers dots going in and falling out were five or fewer, the limit of their vocabulary, but many of them were doing little better than guessing when the numbers were more than five, even though the answers were always zero, one or two. Pica and colleagues concluded that "language plays a special role in the emergence of exact arithmetic during child development".

Tribal societies in the Amazon differ in many ways from a numerate society like ours. The Pirahã are essentially hunter-gatherers who rarely trade, and the Munduruku also have little need for counting in their everyday lives. It is therefore very difficult to tell whether it is only the difference in the number vocabularies that hold the key to their unusual performance on exact number tasks. It could be lack of practice at using the ideas of number themselves, in counting or calculating. Pica and colleagues seem to recognise this, since even in the range of their vocabulary, the Munduruku are approximate - "ebadipdip" is typically used for four, but also used for three, five and six. The words alone are not enough, they conclude. The number names need to be used to do counting, and some conception of what it is to count must co-exist with the vocabulary.

So maybe Locke was right. Counting can exist without number names, but is greatly helped by them.

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