Current Biology, Vol. 14, R927–R928, November 9, 2004, ©2004 Elsevier Ltd. All rights reserved. DOI 10.1016/j.cub.2004.10.016

Language: Life without Numbers

Dispatch

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If your language did not have words for numbers, would you be able to think about numeric quantities? An Amazonian culture where number words are limited to one, two and many has provided new insights to the interaction between thought and language.

Lev Vygotsky [1] wrote in a 1934 essay that "the relation of thought to word is not a thing but a process, a continual movement back and forth from thought to word and from word to thought." This reciprocal interchange between thought and language is central to our ability to communicate as scientists. While many agree that there must be an interaction between the thoughts that we have and the language we speak (Figure 1), there is considerable variation in the literature regarding whether language or thought is the decisive factor.

Many contemporary psychologists express the view that thought drives language [2–4]. One version of this view is that thought precedes language. Everyone is born with a set of universal concepts that are independent of language, and these concepts give meaning to the words that they hear [5]. An alternative view is that language shapes thought. This view, referred to as linguistic relativity, implies that speakers of different languages are guided by the grammar of their language to organize experiences differently [6–8]. Cross-linguistic comparisons show that languages vary in how they categorize color, space, time and number [2,9–12]. Linguistic relativity would suggest that these differences influence the way one categorizes the world, and that speakers of different languages think about the world differently.

Peter Gordon [12] has now reported data that support a strong version of linguistic relativity. Gordon describes a culture whose number words consist of approximately one, approximately two and many. The people who speak this language show poor discrimination between any numeric quantities larger than 3. The evidence comes from a culture named the Pirahã who live in Brazil but reject assimilation to the mainstream Brazilian culture (Figure 2). Gordon used a variety of number tasks that ranged from the relatively easy/concrete to difficult/abstract. An example of the former was a matching task using everyday objects; the participants were presented with an array of AA batteries and had to recreate the array on their side of a table with their own set of batteries. One of the more difficult tasks was drawing a single line for each battery displayed on the other side of the table (the Pirahã culture does not draw or use writing, so this task was extremely demanding for the participants).

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Figure 1. Numbers are in integral part of our culture. It is hard to imagine what it would be like not to have number symbols.

The results reported by Gordon [12] indicate that the Pirahã were generally accurate up to quantities of 2 or 3, but their performance deteriorated from 4 to 10. Even with a task where the participant was highly motivated, for example where there was a reward for remembering the difference between 3 and 4, the results were just at the chance level. It is noteworthy that performance for the larger numbers was not random; the answers increased as the overall number increased, suggesting that their answers were a rough approximate of the correct number.

This report [12] of the Pirahã number ability coincides with recent theories about number abilities. There is a dual model that suggests there are different signatures for small and large number abilities [11,13–15]. The small number ability allows detection of up to 3 objects quickly and accurately without counting them. The large number ability allows approximation of large quantities; however, the amount of error is proportional to the set size. For example, the ability to discriminate 8 from 16 is equivalent to discriminating 16 from 32 because the ratio, 1:2, is the same in both cases. The dual model number sense is evident in human infants as well as many non-human species. Gordon's discoveries are important for what they reveal about the human number concepts. The Pirahã culture provides a sample of the broad range in human number abilities. Could this be a view of our innate number ability when it is not elaborated by written number and word?

The description of the Pirahã's number ability [12] is similar to many historic examples of other cultures. There has been speculation that the transition between cultures that have an approximate number system, like the Pirahã, and symbolic number systems, such as English, appears to involve a stage where the approximate number system is elaborated by a one-to-one correspondence of body parts with the enumerated objects. Many of the tasks Gordon [12] used on the

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Figure 2. A Pirahã tribesman performing the matching task [12]. Photograph courtesy of Peter Gordon. See text for details.

Pirahã required making a one-to-one mapping between the objects they were manipulating and the batteries displayed on table. It is clear from the results that the Pirahã do not use body parts for enumeration. Making the transition beyond the finite set of body parts to potentially infinite numerosities seems to require an abstract symbol system. Historic examples reveal that written language and abstract number systems seem to coincide in many cultures. The Pirahã provide a rare example of a culture without the use of one-to-one mappings or a symbolic number system.

Gordon [12] has provided the scientific community with an excellent study that helps fuel the debate on thought and language. The data are presented as evidence in favor of a strong version of linguistic relativism, because the absence of discrete number words in the Pirahã language appears to preclude the ability to conceptualize large numerosities. Seminal papers often raise as many questions as they answer, and this one begs the question of whether the language or culture is responsible for the absence of discrete number words. It is not clear, however, how one could separate the relative influences of language and culture. Many opportunities and challenges remain in understanding our number system and how it relates to thought and language. It is clear that the number abilities of the Pirahã are different from our symbolic number system. Future studies may clarify whether these differences are a matter of degree or of a qualitatively different system. Until then, we have some exceptional new data to contemplate.

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