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Words help people form mathematical concepts (w/ Video)



February 7, 2011

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University of Chicago researchers tested deaf people in Nicaragua who communicate with a self-developed signing system to see if they understood the value of numbers. (iStockphoto.com)

(PhysOrg.com) -- Language may play an important role in learning the meanings of numbers, scholars at the University of

Chicago report.

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A study based on research on deaf people in Nicaragua who never learned formal [sign language](#) showed that people who communicate using self-developed gestures, called homesigns, were unable to comprehend the value of numbers greater than three because they had not learned a [language](#) containing symbols used for counting.

By contrast, deaf people who acquire conventional sign [language](#) as children can learn the meaning of large numbers. Researchers believe this is because conventional sign language, like spoken languages, imparts a counting routine early in childhood.

The study illustrates the complexity of learning the symbolic relationships embedded in language, including seemingly simple numerical concepts. The work may help researchers learn more about how language shapes the way children learn early mathematical concepts, and how that crucial process can go awry in the preschool years.

"It's not just the vocabulary words that matter, but understanding the relationships that underlie the words—the fact that 'eight' is one more than 'seven' and one less than 'nine.' Without having a set of number words to guide them, deaf homesigners in the study failed to understand that numbers build on each other in value," said Susan Goldin-Meadow, the Bearsdley Ruml Distinguished Service Professor in Psychology at the University.

Here the subject is instructed to make the number of chips she lays out equal to the number of knocks she feels on her hand; the test demonstrated she could not understand the value of numbers above 3.

The findings are reported in the paper, "Number Without a Language Model," published in the current issue of the *Proceedings of the National Academy of Sciences*. The lead author is University researcher Elizabet Spaepen, a 2008 Ph.D. graduate in psychology who did field work in Nicaragua as part of the study.

Inability to think rather than communicate about numbers

Scholars have previously found that people in isolated cultures do not learn the value of large numbers when they are not part of the local language. Two groups studied in the Amazon, for instance, do not have words for numbers greater than five and are unable to match two rows of checkers containing more than five items. Their local culture does not require the use of exact large numbers, which could explain the Amazonians' difficulty with them.

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However, most Nicaraguans do use exact numbers in everyday monetary transactions. Although the deaf homesigners in the UChicago study understood the relative worth of different currency items, they apparently had an incomplete understanding of their numerical values because they had never been taught number words, Spaepen said.

For the study, scholars gave homesigners a series of tasks to determine how well they could recognize money. They were shown 10-unit and 20-unit bills and asked which had more value. When asked if nine 10-unit coins had more or less value than a 100-unit bill, each of the homesigners was able to determine the money's relative value.

"The coins and bills used in Nicaraguan currency vary in size and color according to value, which give clues to their value, even if the user has no knowledge of numbers," Spaepen said. The deaf homesigners could

learn about currency based on its color and shape without fully understanding its numerical value.

To see if the homesigners could express numerical value outside of the context of money, the scholars showed them animated videos in which numbers were an important part of the plot. They then asked the deaf individuals to retell the video to a friend or relative using homesigns. As the numbers grew, the homesigners became increasingly less able to produce an accurate gesture for the number with their fingers.

They were then shown cards with different numbers of items on them, and asked to give a gesture that represented the number of items. The homesigners were accurate only up to the number 3. In addition, they had difficulty making a second row of checkers match a target row when there were more than three checkers in the target, despite the fact that this task did not require any comprehension or production of [number gestures](#). Their difficulty in understanding large numbers therefore did not stem from an inability to communicate about large numbers, but rather from an inability to think about them, the researchers concluded.

Researchers performed the tests on hearing, unschooled Nicaraguans, as well as deaf individuals trained in American Sign Language. Both groups outperformed the Nicaraguan homesigners in the study.

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I am certain that our ability as humans to make sense of our environment in terms of numbers is almost entirely due to the limitations of language. ie improve language to improve or develop our understanding of universe in numerical terms

Interesting idea. So you're suggesting that an explanation based on words can inform us and lead to a precise mathematical model? I completely agree. I fear that the "math only" physics being done today, that cannot even be explained in words, bears little hope of correctly describing reality. There are just too many mathematical models to try. It seems better to start with a picture of how things work and then choose the mathematical model based on that...

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The value of a number.

I don't know what the above statement is stating.

Was the original research paper translated?

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So you're suggesting that an explanation based on words can inform us and lead to a precise mathematical model? I completely agree.

I completely disagree. Words and prose are wholly inadequate, imprecise and ambiguous when dealing with scientific models. This is why numbers, mathematics and logic work so well - they have precise meanings and rules which removes bias and subjectivity.

I completely agree. I fear that the "math only" physics being done today, that cannot even be explained in words, bears little hope of correctly describing reality.

It's the only way forward. When dealing with complex systems oftentimes words and even human imagination are too limited to make any progress. We are so fortunate to have mathematics in our armory to help us shed light in otherwise inaccessible realms.

It seems better to start with a picture of how things work and then choose the mathematical model based on that

I'm afraid, that is totally backwards!

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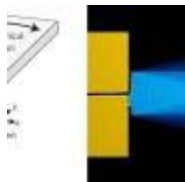
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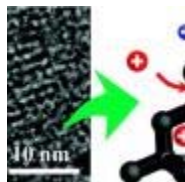
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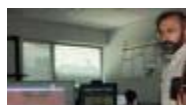
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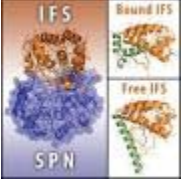
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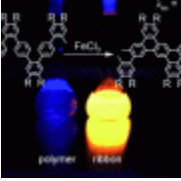
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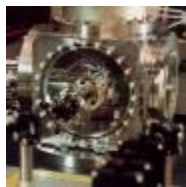
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