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THE NUMBERS | THE NUMBERS

# Grasping Giant Numbers Is Far From Second Nature

Shaky numerical literacy can undermine our sense of issues like the federal budget that deal in millions and billions


President Donald Trump's preliminary 2018 budget would trim $2.7 billion from $1.068 trillion in discretionary spending. Is that a lot, or not? Many people can't grasp the huge numbers involved. **PHOTO:** J. SCOTT APPLEWHITE/ASSOCIATED PRESS

*By*

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Here's a brainteaser. Take a sheet of paper, and draw a line with the endpoints 0 and 1 billion. Then place a tick mark on the line where 1 million should appear.

A typical person will place the mark too close to the middle. But that's where 500 million should go.

"About 40% to 50% of the people tested get it terribly wrong, and when they get it terribly wrong, they get it terribly wrong pretty much all of the time," said David Landy, a cognitive scientist at Indiana University who studies mathematical perception and numerical reasoning.

Big numbers befuddle us, and our lack of comprehension compromises our ability to judge information about government budgets, scientific findings, the economy and other topics that convey meaning with abstract figures, like millions, billions and trillions.

We understand how to count that high. We just have trouble conceiving what the figures mean. Yet humongous numbers pepper the news, and as citizens, we are asked to make sense of the material.

The president's 2018 preliminary budget, for example, proposes to cut $2.7 billion from $1.068 trillion in discretionary spending.

Is that a lot or a little? As a group, we're pretty bad at figuring it out, especially when multiple scales are involved.

"Inside millions, you're comfortable," Dr. Landy said. "You think it's 250 vs. 500 and, oh, and it's in millions. But if it's 500 million vs. 2 billion, it crosses scales. Suddenly, you have to calculate."


To visualize where 1 million should go in the number-line test, imagine a meter stick with each of its 1,000 millimeters representing a million units. At that scale, the tick mark for 1 million would align with the first millimeter. The final millimeter would represent 1 billion.

Placing 1 trillion at the appropriate spot would require extending the line to the length of a kilometer, with a trillion falling at the end.

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Or think of it in terms of time, like Richard Panek, a professor at Goddard College in Vermont and a Guggenheim fellow in science writing. There are 1 million seconds in roughly 11½ days. There are 1 billion seconds in around 31 years. And there are 1 trillion seconds in around 31,000 years.

Someone who doesn't grasp these differences in magnitude is also likely to be clueless when it comes to assessing the impact of chopping $2.7 billion from a $1.068 trillion budget. It's less than 1% of the total—the proverbial rounding error.

"We assume all these things are very natural, but they are highly abstract," said Daniel Ansari, an investigator at the Numerical Cognition Laboratory at Western University in Ontario. "We can't really perceive a million or a billion."

To address that conundrum, two researchers at Microsoft set out to develop a framework to help people relate mind-blowingly large numbers to everyday references.

"Our phrase was 'normalizing the news,'" said Jake M. Hofman, who conducted the research with Daniel G. Goldstein and Pablo J. Barrio. "The basic idea was that we could provide extra information around a number."

The study grew out of a brainstorming session when Dr. Hofman observed that most people didn't know whether numbers in advertisements or news are big or small.

"Everybody started nodding," Dr. Goldstein said.

They developed a set of 10 templates that use ratios, ranks and unit changes to make large numbers easier to understand. Each template includes an attribute, a scaling factor and a reference.

"One of my favorite examples is an article that talked about a conservation group that reclaimed about 100 million acres of land across the Earth," Dr. Goldstein said. "We've given a quiz to people and asked how big do you think that is? People have no idea. It turns out it's California in terms of size."

In the conservation example, 1.15 times was the scaling factor and California the reference.

Microsoft has incorporated the strategy into its search engine Bing. Now, when someone in the U.S. searches for the size of a country, Bing provides the area along with the name of a state that

is similar in area.

“The goal is to not just have an answer,” Dr. Hofman said. “It’s to have an answer that is helpful to a human.”

And as goals go, that’s big.

**Please email** Jo.McGinty@wsj.com with examples of published numbers that would be easier to understand with added perspective.

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