

Hiding the world with (bad) measurement

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Measurement, as it is defined in science and engineering, means comparison to some standard. This standard is arbitrary, but is usually the subject of political negotiation, as was the original [Treaty of the Meter](#), which defined the standard meter as one ten millionth of the distance from the North Pole to the equator on a meridian that passed through Paris. The realization of this standard was widely understood to be inaccurate, but the arbitrary nature of any standard made the actual relationship of the standard meter to the size of the earth unimportant. 30 copies of the standard were made, and, on May 20, 1875, the treaty was signed by 20 countries.

While it is commonplace to note that reality is socially constructed, few generally understand that the Treaty of the Meter was the fundamental step in the process of constructing the concept of space as we understand it today. Using the method of comparison to the standard, we are able to say that the diameter of the sun is 1.4 million kilometers, the diameter of the moon 3476 kilometers, the diameter of a US quarter 24.26 millimeters, and a US nickel 21.21 millimeters. We can say that the sun is 6.6^{10} larger than a nickel, about 66 billion times larger.

In the social sciences, business, marketing and advertising research, however, the idea of measurement as comparison to some standard has never been widely understood, or put into practice. Practitioners instead typically use categorical scales of the type developed by [Rensis Likert](#) in 1932 to measure attitudes and beliefs¹. On the face of it, the social reality that can be constructed out of five points scales is very crude, allowing for at maximum a ratio of five to one (i.e., something could be, at most five times larger than something else) compared to the 66 billion to one ratio of the sun to a nickel. But in practice, the distortion is even worse. Consider the following experiment:

Twenty four undergraduate students were randomly divided into three groups. Each answered four questions. Each question was collected before the next was administered. The questions were:

- How large is the sun?
- How large is the moon?
- How large is a quarter?
- How large is a nickel?

The questions were administered in this order:

¹ There are philosophical and historical reasons why the commitment to categorical scaling methods was made, none of which bear scrutiny today, but most of today's practitioners use them solely because they've been used for years, clients will accept them, they are recommended in introductory textbooks, and they require very little effort to write.

Group 1	Group 2	Group 3
Moon	Sun	Nickel
Sun	Moon	Quarter
Nickel	Nickel	Moon
Quarter	Quarter	Sun

Responses were:

- 1 very small
- 2 small
- 3 neither large nor small
- 4 large
- 5 very large

Table 1 shows the results:

Table 1: Estimated size of four objects in three conditions

	Group 1	Group 2	Group 3
Moon	3.38 ± 1.41	$4.00 \pm .93$	3.88 ± 1.25
Sun	4.25 ± 1.16	4.25 ± 1.04	$4.13 \pm .99$
Nickel	$2.13 \pm .64$	$2.25 \pm .71$	$2.50 \pm .53$
Quarter	$2.13 \pm .64$	$2.38 \pm .52$	$3.25 \pm .71$

Although the actual ratio of the size of the sun to the size of a nickel is about 66 billion to one, and the maximum theoretical ratio possible in a five point scale is five, the actual ratios measured in the experiment are shown in table two:

Table 2: Estimated ratios of four objects in three conditions

	Group		
	1	2	3
Moon/Sun	$.80 \pm 1.82$	$.94 \pm 1.40$	$.94 \pm 1.59$
Moon/Nickel	2.0 ± 1.72	1.89 ± 1.07	1.65 ± 1.36
Sun/quarter	2.0 ± 1.32	1.79 ± 1.16	1.27 ± 1.21
Nickel/quarter	1.0 ± 1.17	$.95 \pm .88$	$.77 \pm .89$

The largest ratio actually measured in Table 2 is 2.0, showing respondents estimated the Moon to be twice the size of a nickel, and the Sun to be twice as large as a quarter. Respondents report that the moon is between 80 and 94% of the size of the sun, and one group reports the sun is only 27% larger than a quarter. Moreover, the errors of estimate are so large that, if standard 90 or 95 percent confidence intervals are used, we would conclude that these subjects show no significant differences in size between the Sun, the Moon, a quarter and a nickel.

The point of this exercise is not to show the low level of education of the typical undergraduate. These students may not know that the Sun is 66 billion times larger than a nickel, but they do know that it is vastly larger. The form of the scale, however, *prevents them from expressing this knowledge*².

² This extreme imprecision is endemic in marketing and advertising research. Vehicle quality, for example, is measured in number of defects per 1000 vehicles, but the nature of the defect is ignored. Overall evaluations of vehicles are made on a [five-point scale](#). In the day-to-day politics of big business, uncertainty and obfuscation can be a great tactical advantage.