

Our logarithmic brain



Ask most adults what number is halfway between 1 and 9 and they'll answer somewhere between 4 and 5, whereas if you ask a young child they are more likely to say 3. This is because our brains naturally think in sequences of proportions – i.e., logarithmically. But what exactly are logarithms, and how do they affect the way our minds perceive and process information?

What are logarithms?

In maths, a logarithm is a way of expressing how many times a number needs to be multiplied by itself to reach another number. For example, the logarithm base 10 of 100 is 2, because 10 needs to be multiplied by itself twice (10×10) to get 100. Logarithmic scales and functions are commonly used in various scientific fields and real-life situations where the range of values can span several orders of magnitude, making it easier to represent and analyze the data.

It seems that the way we think about numbers and the way that we perceive numbers and quantities – such as weights or distances – is more naturally logarithmic than the linear system we learn in school.

A mental number line is an internal, mental representation of numbers that our brains use to organize and understand numerical information. It's like an imaginary number line in our minds, where we visualize numbers in a spatial arrangement, typically with smaller numbers on the left and larger numbers on the right (in cultures with left-to-right

reading and writing systems). This mental number line helps us perform arithmetic operations, make estimations, compare numbers, and process numerical information in general.

The mental number line is not always linear; as mentioned earlier, it can be logarithmic, especially in young children or people from certain cultures. In a logarithmic mental number line, the distance between smaller numbers is perceived as larger than the distance between larger numbers, reflecting the proportional nature of logarithmic thinking. As we grow and are exposed to formal education and linear numeric systems, our mental number line tends to shift towards a more linear representation, though some logarithmic tendencies may still persist.

Here are some examples of how our brains use logarithms:

1. The Weber-Fechner Law

One of the most well-known examples of logarithmic perception is the Weber-Fechner Law. This law states that the perceived change in a stimulus is proportional to the initial intensity of the stimulus. For instance, if you're holding a 1-kilogram weight in one hand and then pick up another 1-kilogram weight with the other hand, you'll feel a significant increase in heaviness. However, if you're already holding a 20-kilogram weight and then add a 1-kilogram weight, the perceived increase in heaviness will be much smaller, even though the actual increase is the same.

Or, to give a different example: If you only have a dollar, and you are given a second dollar, that's a bigger difference to you than if you have 100 dollars and you are given a dollar. The proportional change is larger between the change of 1 to 2 than 100 to 101.

This phenomenon suggests that our perception of stimuli is not linear but follows a logarithmic pattern.

When estimating quantities or comparing numbers, people often make judgments based on relative differences (proportions) rather than absolute differences. This can lead to errors in estimation, as people may perceive a smaller difference between larger numbers (e.g., between 1000 and 1100) than between smaller numbers (e.g., between 100 and 200), even though the absolute difference is the same.

2. Sound Perception

Our perception of sound intensity is another example of logarithmic processing. The decibel scale, which measures the loudness of sound, is a logarithmic scale. This means that an increase of 10 decibels corresponds to a tenfold increase in sound intensity. Our ears perceive these changes in intensity proportionally, allowing us to detect both very soft and very loud sounds.

3. Visual Perception

Our visual system also works logarithmically, particularly when it comes to light intensity perception. The human eye can perceive an enormous range of light intensities, from dim starlight to bright sunlight. The retina's response to light follows a logarithmic function, enabling us to adjust to different light levels quickly and efficiently.

Why do our brains and nervous systems count and perceive things logarithmically?

One reason is that logarithmic processing allows for more efficient use of our cognitive resources. By focusing on proportional differences rather than absolute differences, our brains can handle a wide range of stimuli and experiences without getting overwhelmed. This is particularly important

for our senses, which must process and interpret vast amounts of information from the environment every second.

Another reason is that logarithmic processing is an adaptive mechanism that has evolved to help us navigate and make sense of the world around us. In nature, many phenomena follow logarithmic patterns, such as the distribution of resources, the growth of populations, and the intensity of natural hazards. By thinking and perceiving logarithmically, our brains are better equipped to understand these phenomena and make accurate predictions and decisions based on them.

Furthermore, logarithmic processing can also help us make quick judgments and estimations in situations where precise calculations are not possible or necessary. For example, when comparing the loudness of two sounds or the brightness of two lights, our brains can quickly determine which one is more intense based on the proportional difference, without needing to calculate the exact intensity levels.

The ability to think logarithmically also has implications for education and learning. Traditional educational methods often focus on linear thinking and arithmetic, which may not always align with the natural logarithmic tendencies of our brains. Incorporating logarithmic concepts and activities into learning experiences could help students develop a more intuitive understanding of numbers, proportions, and the relationships between them.

In conclusion, our brains work logarithmically rather than linearly in various domains of perception and cognition. This logarithmic processing allows us to perceive and process a wide range of stimuli and experiences more efficiently, helping us navigate and make sense of the world around us. Understanding the role of logarithms in human cognition and perception can provide valuable insights into how we think, learn, and make decisions, and may even offer new avenues for enhancing education and cognitive training.