Weber's Law

(from http://www.cis.rit.edu/people/faculty/montag/vandplite/pages/chap_3/ch3p1.html)

E. H. Weber, in 1834, had the following insight:

The number in this example are made up; your values may vary in practice.

If you lift up and hold a weight of 2.0 kg, you will notice that it takes some effort. If you add to this weight another 0.05 kg and lift, you may not notice any difference between the apparent or subjective weight between the 2.0 kg and the 2.1 kg weights. If you keep adding weight, you may find that you will only notice the difference when the additional weight is equal to 0.2 kg. The increment threshold for detecting the difference from a 2.0 kg weight is 0.2 kg. The just noticeable difference (jnd) is 0.2 kg.

Now start with a 5.0 kg weight. If you add weight to this, you will find that the just noticeable difference is 0.5 kg. It takes 0.5 kg added to the 5.0 kg weight for you to notice an apparent difference.

For the weight of magnitude, I, of 2.0 kg, the increment threshold for detecting a difference was a ΔI (pronounced, delta I) of 0.2 kg.

For the weight of magnitude, $I = 5.0$ kg, the increment threshold $\Delta I = 0.5$ kg.

The ratio of $\Delta I/I$ for both instances ($0.2/2.0 = 0.5/5.0 = 0.1$) is the same. This is **Weber's Law.**

Weber's Law states that the ratio of the increment threshold to the background intensity is a constant. So when you are in a noisy environment you must shout to be heard while a whisper works in a quiet room. And when you measure increment thresholds on various intensity backgrounds, the thresholds increase in proportion to the background.

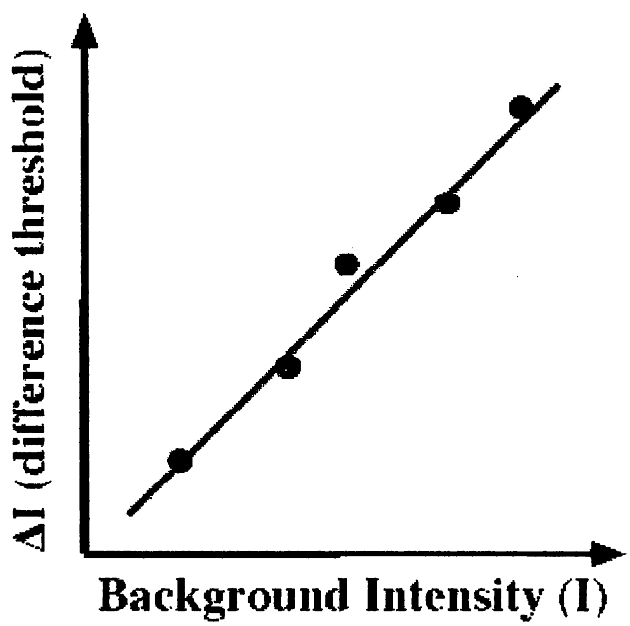
$$\frac{\Delta I}{I} = K$$

The Weber fraction

The fraction $\Delta I/I$ is known as the Weber fraction (aka Fechner fraction). If we rearrange the equation to $\Delta I=IK$, you can see that Weber's Law predicts a linear relationship between the increment threshold and the background intensity. Below is a plot of some hypothetical data showing Weber's Law. The slope of the line is the Weber fraction.

A TVI plot Threshold Versus Intensity

sometimes called a TVR plot for thresholds
for detecting light (threshold versus radiance).



Weber's Law is not always true, but it is good as a baseline to compare performance and as a rule-of-thumb.

On a plot of $\log(\Delta I)$ vs $\log I$, the slope of the resulting line is one if Weber's Law holds. A modified version of Weber's law is as follows:

$$\frac{\Delta I}{I+a} = K$$

where *a* is a constant, usually small that represents a baseline level of activity that must be surpassed. Here is real data from Aguilar and Stiles (1954) plotting increment thresholds.

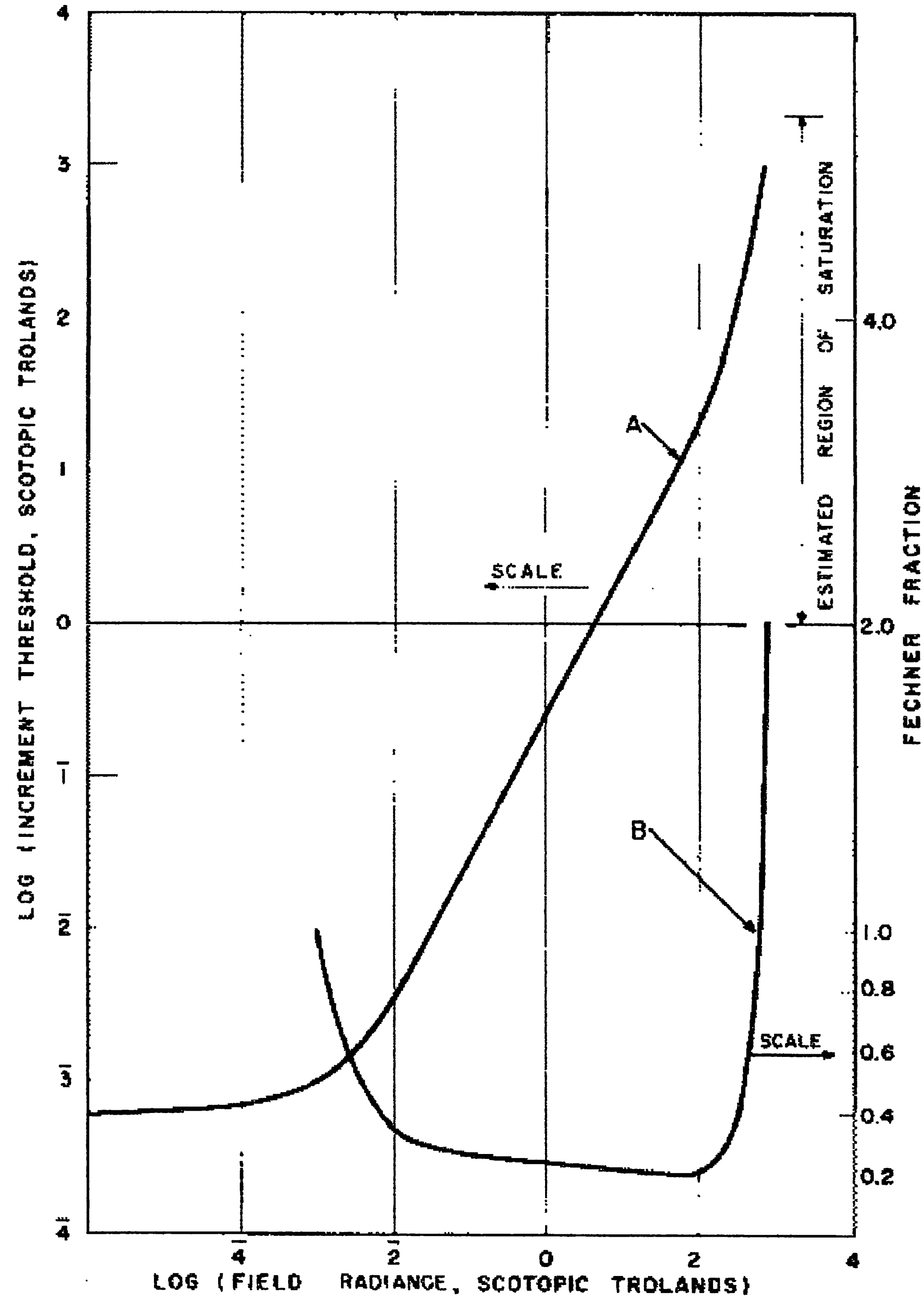


Fig. 1(7.5). Approach to saturation of rod mechanism in 9° extrafoveal vision by rapid rise in increment threshold. *Curve A*: log (increment threshold); *Curve B*: ratio (increment threshold/field radiance). (Aguilar and Stiles, 1954).

Each curve plots the same data in a different way using the two y-axes. See if you can interpret the data? Where is Weber's law approximately true?