

A LINE ON LIFE

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Two Plus Two Equals Four, But Not Always

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Believe it or not, sometimes $2 + 2$ does not equal 4. It depends on what type of measurement scale you are using. There are four types of **measurement scales** – nominal, ordinal, interval, and ratio. Only in the last two categories does $2 + 2 = 4$. Let me explain.

All the **nominal scale** does is **name** or **classify**. Each number merely represents a category or individual. For example, numbers on baseball or football uniforms are only nominal. Having the number "1" on your uniform does not necessarily mean you are "*numero uno*" (the best) in your sport. Social security numbers are also nominal. All they do is name or classify the individual.

The **ordinal scale** has all the qualities of the nominal scale plus the ability to **rank** objects according to some attribute. If you ranked all the members of a group according to height, "1" would be the tallest, "2" the second tallest and so on. However, the intervals between these rankings are *not necessarily equal*. If the tallest people were 5'11", 5'8" and 5'7", respectively, the interval between the first two ranks would be 3 inches, while the interval between the last two is only 1 inch. Ranking in various sports and beauty contests are also only ordinal scales.

An **interval scale** combines the qualities of the previous scales with **equal intervals**. The best example would be a *centigrade (Celsius) thermometer*. The change in heat between 0°C and 10°C is the same as between 10°C and 20°C . But watch out! 20°C is *not twice* as hot as 10°C ! Why? Interval scales have **arbitrary zeros** (just because we decided to call it zero), rather than absolute (true) zeros. At 0°C water freezes, but that does not mean that there is no heat.

In contrast, the **ratio scale** has all the qualities of the previous scales plus an **absolute (true) zero**, as with a *Kelvin thermometer*. At 0°K , theoretically there is *no heat*. You have *nothing* of what you are measuring, therefore the zero is true or absolute. However, $0^{\circ}\text{K} = -273^{\circ}\text{C}$. Since one degree indicates the same heat change in both scales, we can see what happens when we compare them.

$$\begin{aligned}20^{\circ}\text{C} &= 293^{\circ}\text{K} \\10^{\circ}\text{C} &= 283^{\circ}\text{K} \\0^{\circ}\text{C} &= 273^{\circ}\text{K} \\-273^{\circ}\text{C} &= 0^{\circ}\text{K}\end{aligned}$$

Thus 20°C is not twice as hot as 10°C ! Although this may seem confusing, it becomes very clear when you switch to the Kelvin scale – 293°K definitely does not even look like it is twice as hot as 283°K . Only with a ratio scale – with a true zero – can you correctly use the concept of multiples. Length, height, and weight are ratio scales. Therefore, you can correctly say that "*A yard is three times longer than a foot*" or "*A 200-pound man weighs twice as much as a 100-pound woman*."

If you are having some trouble understanding this, it is probably because most of you have only used ratio scales in school. Mathematics courses typically deal only with scales that have true zeros and equal intervals.

How does this relate to psychology? Most *psychological tests are only ordinal* measures! Let's say that three different people score 60, 40 and 20 on a test of extraversion (having outgoing personality traits).

Because it is an ordinal scale we can correctly say that 60 is the most extraverted (rank #1), 40 is the second most, and 20 is the third most or least extraverted.

Notice that the difference between 60 and 40 is 20, and the difference between 40 and 20 is also 20. However, a 20-point difference in one part of the scale may not have the same meaning as a 20-point difference in another part of the scale. Thus the same difference of 20 points may not reflect the same underlying difference in extraversion, because we don't know if the intervals are equal. It is not an interval scale.

Likewise, even though $20 \times 2 = 40$ and $20 \times 3 = 60$, we cannot correctly say that the person with a score of 60 has three times the extraversion as the person with 20 or that the person with a score of 40 has twice as much. We cannot compare scores in terms of multiples, because the scale has *no true or absolute zero*. It is not a ratio scale.

Again, most psychological tests – and almost all tests used in our schools (including mine) – are *only ordinal* measures. These tests allow ranking of people according to various attributes — personality traits or knowledge in specific subject areas. However, if someone gets a score twice as great as yours, it does not mean that person knows twice as much as you do.
