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Where Do Babies Come From?

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Synopsis

According to European folklore, popularized by a fairy tale, storks are responsible for bringing babies to new parents. This probably came from observation in certain European countries, such as Norway, Netherlands or Germany, that storks nesting on the roofs of households were believed to bring good luck, as the possibility of new births. People love stories, but correlation simply means that there is a relationship between two factors that tells nothing about the direction of said relationship, if any. Another possibility is simple coincidence. Let us say that it's possible that one factor causes another. It's also possible that the inverse occurs. And maybe both are being caused by a third. The main point is that there is a fundamental confusion between correlation and causality. A correlation doesn't prove a cause by itself. During these times of abundant fake news, it is necessary to warn folks of the fallacy of mistaking correlation for causation.

Keywords: statistics; correlation; sex education; fake news

1. Once Upon a Time

Children's questions about how babies come into the world can cause discomfort and apprehension to parents and families. This question, recurring among children, has several answers [9]. One of the most interesting involves white storks (*Ciconia ciconia*) bringing babies on the top of a sheet for the joy of dads and moms. What few people know is that this question has a profound mathematical explanation.

The stork myth has existed for a long time. In ancient Egypt, the soul was usually symbolized by a stork. In Greece, storks were sacred due to Hera, the protective goddess of pregnant and lactating women. The fable that storks bring babies seems to have originated in Northern Europe some centuries ago and was immortalized in the short story "The Storks" ("Storkene", published in 1839 [1] by the Danish writer and poet Hans Christian Andersen (1805–1875).

Storks are migratory birds that usually cross Europe in large amounts. When mating, they usually seek sheltered and warm places, such as roofs and chimney homes. Big houses can represent huge families, and anyone could jump to conclusions about the association between families, storks and babies.

2. Tales from the Bed: The Baby and the Stork

Just as well, anyone could make estimates of how many children were born into a family just by counting the nests or even the number of storks on the roofs of Northern European houses. In fact, this was done, among others, by the German ornithologist Ernst Paul Theodor Schüz (1901- 1991), who did important experimental studies on bird migration and population dynamics, especially on white storks [17, 18]. More relevant information could be obtained from statistical tables of the annual number of babies born published by Dr. Karl Erich Schumann (1898–1985, German physicist), Director in the Statistical Office of the Dresden City, and Professor Dr. Maximilian Meyer (1876–1951), Director of the Statistical Office of the Nuremberg City. Their results were published by the German bookseller and publisher Gustav Adolf Fischer (1878–1946), nephew and adoptive son of Gustav Paul Dankert Fischer (1845–1910), founder of the Gustav Fischer Verlag (see [10]-[16]).

The Danish civil engineer Lars Christian Pallesen (b. 1947) surveyed the number of storks and baby births in the German city of Oldenburg between 1930 and 1936 based on the data above. He collected the data while doing his master's and doctoral studies in statistics at the University of Wisconsin-Madison in the 1970s. The result was published in the well-known book *Statistics for Experimenters* [2] by the statisticians George Edward Pelham Box (1919–2013, British), John Stuart Hunter (b. 1923, American) and William Gordon Hunter (1937–1986, American) in 1978, see the scatter plot in Figure 1. These scholars were also affiliated with the same university, and worked with data reported by Pallesen. What is curious about the data is that an increase was observed in the number of storks in the same period when the German population increased.

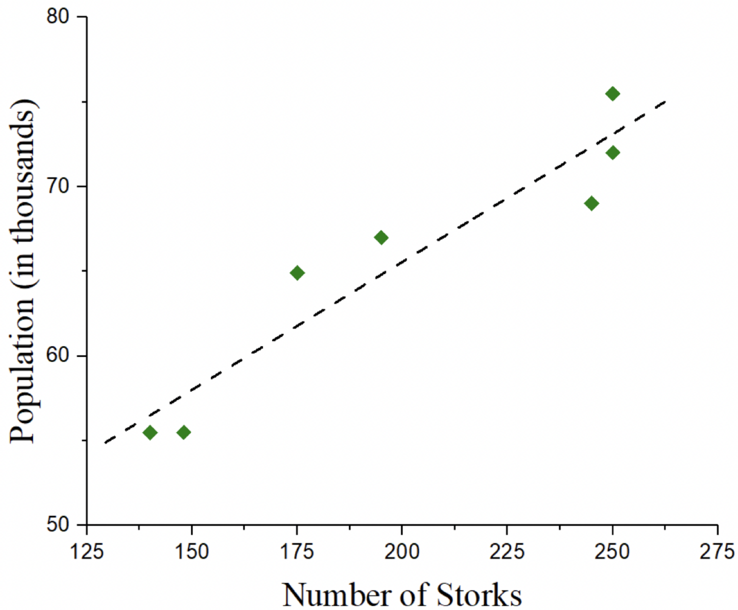

Figure 1: Correlation between the number of storks versus the population of Oldemburg, Germany, between 1930 and 1936, published in [2].

3. Real Tales of Real Storks

Given the data presented above, in statistical terms, it can only be said that there is a positive correlation between the number of storks and the population of Oldenburg city. The population increased due to baby births year by year, while the number of storks grew. However, this association does not prove that one caused the other.

To illustrate people's tendency to link causality to correlation, Steven David Levitt (b. 1967, American economist) and Stephen Joseph Dubner (b. 1963, American journalist) illustrated with the following story: a snake bites a person, who screams with pain and dies. The snakebite must have killed this person [6]. Most of the time such reasoning is correct, but the main reason in this scenario was the venom injected by the snake, and not the bite itself. Often, correlation doesn't prove causation because there are several ways in which two variables can be correlated. For example, X can cause Y; or Y can cause X; or it may be that some other Z factor (the *tertium quid* or literally the "third what" in Latin) that is causing both X and Y, or one of them.

This term comes from the Greek *triton ti* (τριτον τι), a sentence used by the Athenian philosopher Plato (c.428–c.347 BCE) in his dialogue *Sophist* from around 360 BCE about a particular situation where a snake (X) caused a death (Y) due to its venom (Z).

Some authors have presented new data and discussions involving storks and babies over the years. For example, in a very short letter published in the renowned *Nature* magazine, with only one paragraph and a graphic, the German physician and biochemist Helmut Sies (b. 1942) showed data on the decrease in the number of stork couples between 1965 and 1980, following by same downward trend in the number of babies in West Germany for same period [19], see Figure 2. According to Höfer *et al.* [5] the reduction in the number of storks in Germany can be explained by the presence of, for example, electrical wires, noise, traffic, and pollution, as shown below.

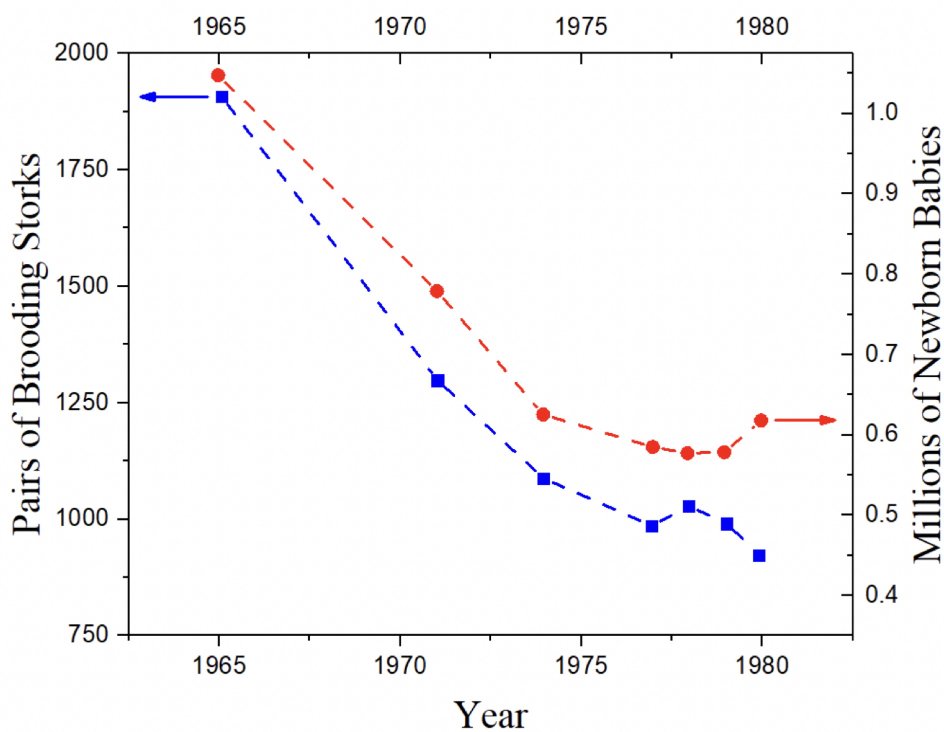

Figure 2: Correlation between the pairs of brooding storks versus millions of newborn babies in West Germany between 1965 and 1980, as presented in [19].

The English physicist and writer Robert Andrew James Matthews (b. 1959) showed data on the number of pairs of storks, number of babies, area of each country and birth rates from seventeen European countries covering the period from 1980 to 1990 [7]. He affirmed that, although the occurrence of a statistically significant degree of correlation cannot be taken to infer causation, its absence would establish evidence against a simple relationship. By means of statistical tools, a combined analysis of such four variables provided a non-trivial example of correlation result which is highly statistically significant and causally nonsensical [7]. One solution to this problem was proposed by the German economist Steffen Wirth (b. 1965): observing the same data, Wirth concluded that there would be a statistical significance result if one considers just fifteen of the seventeen countries analyzed [21]. He noted that the two countries excluded could be considered extreme cases that caused problems using standard calculations.

More than a decade after Sies' publication, Thomas Höfer (b. 1967, German biophysicist), Hildegard Przyrembel (b. 1942, German pediatrician) and Silvia Verleger (now Höfer, b. 1956, German writer) observed that the number of storks and the birth rates declined from 1971 to 1985 in Lower Saxony, Germany. After that, a steady increase in the number of deliveries occurred up to 1995, in parallel to the number of stork pairs, which increased from 1985 to 1993 and reached a plateau afterwards. Also, a nearly constant number of out-of-hospital deliveries from 1991 to 1999 in Berlin, Germany, was associated with an unchanged stork population, but again without statistical significance. They conclude with a warning on how studies based on popular belief and unsubstantiated theory, seconded by low quality references, and supported by coincidental statistical association, could lead to apparent scientific endorsement [5].[1]

4. Correlation is not Causation

Historically, correlation is measured by a construct credited to Karl Pearson (1857–1936, English mathematician) [8] and his mentor, Sir Francis Galton (1822–1911, English polymath) [4]. In this perspective, correlation is a measure of the relationship between two variables.

[1] For examples of spurious correlations, see *Spurious Correlations*, at `https://www.tylervigen.com/spurious-correlations`, last accessed on January 31, 2023.

Two variables can be positively correlated, which may mean that the longer a person reads, the greater the understanding of the subject among storks and babies. There may also be no correlation, for example, if the understanding of the subject remains the same regardless of the time spent reading this text. There may also be a negative correlation, which means that the more a person reads this text, the less they will understand about the subject involving babies and storks.

In statistics (following Pearson's analysis [8]), given two variables, X_i and Y_i, each one corresponding to n data, and their means, $\bar{X}$ and $\bar{Y}$, the correlation coefficient r is defined as follows:

$$r = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}}.$$

From this definition it is possible to note that, the correlation coefficient is the covariance of two variables X and Y divided by the product of their standard deviations [3].

In other words, correlation is a measure of the strength of the relationship between two variables, such as the number of newborn babies and the number of storks over years. This word is made of *co-* (a Latin prefix meaning "together"), and *relation* (from Latin *relātus*, originally meaning narration). A correlation is positive when the values increase together and negative when one value decreases as the other increases.

A perfect positive correlation is assumed to be linear; when one variable increases, the other also increases by a comparable quantity, resulting in a coefficient r of $+1$. However, this does not mean that the variation in one variable causes the other to change, only that their changes coincide. On the other hand, a perfect negative correlation is assumed to be linear in a slightly different way; if one variable increases, the other decreases by a comparable amount, resulting in a coefficient of -1. A zero correlation implies that the values don't seem linked at all, or there is no linear relationship between the variables. According to Levitt and Dubner [6] correlation is nothing more than a statistical term that indicates whether two variables move together.[2]

[2] On the other hand, the daily web comic `xkcd` teaches us that "[c]orrelation doesn't imply causation, but it does waggle its eyebrows suggestiely and gesture furtively while mouthing 'look over there'." See https://xkcd.com/552/.

5. Final Words

Statisticians and mathematicians know that correlation does not imply causation. Still, many conspiracy theories, misconceptions and fake news are based on fallacious arguments that involve spurious correlations. An association between two factors does not prove that one caused the other. In other words, it is not automatically the case that just because there are coincidences there is something that one can prove.

Although most people will not be led to assume that the observed increases in the number of storks has promoted the observed increases in the local human population, researchers and scientists, too, may make these kinds of errors in other contexts. All sorts of examples can be found in newspapers today.

It is not always easy to find flaws in the assumptions of causality, especially when it seems to make a lot of sense or even when it pleases a popular belief. Mere coincidences can occur, as in the case of storks and babies, as it is not possible to assume that the increase in the number of storks X has caused an increase in a population Y. In this particular case, the correlation between storks and babies occurs simply because each of these factors is associated with a third factor, time, that was defined in 1979 by the Brazilian singer, poet and writer Caetano Emanuel Viana Teles Veloso (b. 1942) as "a destinies' composer" [20].

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