Pacing through History: Vignettes to Inform, Refresh and Motivate

Deborah V. Dawson
Division of Biostatistics and Research Design, College of Dentistry, University of Iowa, 801 Newton Rd, Iowa City, IA 52246

Abstract
The liberal use of quotes, anecdotes and illustrations from the history of statistics can serve to enhance statistical presentation, particularly when the expertise of the audience is not mathematical. Such materials can help set the stage when introducing a new topic, and leaven the lecture material – providing a breather after particularly intense exposition or otherwise assisting with pacing of the presentation. They can make the course material more approachable, and place it in context, emphasizing the relevance of the material to the research area to which it will be applied. And while such vignettes can inspire and motivate, they can also serve as cautionary tales – an important function in its own right! Well-chosen stories serve to connect statistical inquiry to the greater scientific endeavor – and may even humanize the practitioners – or the lecturer! This presentation will provide examples illustrating all of these functions, as well as resources for instructors. We will draw from the lives of a wide range of statisticians, but also consider a gambler, a brewery employee, a Faustian bargain, an African explorer, the Lady with the Lamp, and a lady drinking tea.

Key Words: statistics education, history of statistics, biostatistics education, pedagogy

1. Introduction

Why use quotations, anecdotes, and illustrations from the history of statistics in our lectures? Such materials can help set the stage, and motivate the topic. They can make the material more approachable, particularly for the non-statistical audience. A good story is welcomed by anyone, and the judicious use of biographical information can assist the student in relating to the historical figure – and to the topic at hand.

Possibly one of the most helpful uses of historical material is in pacing – it can provide a welcome, useful breather for the students after a demanding stretch of didactic presentation. At the same time, well-developed and well-presented background information can help to put the topic in context, and assure the non-statistician of the relevance of the information.

Historical anecdotes are also an important source of cautionary tales – a colorful tale at a safe remove in time will be nonthreatening – but will often stick in the memory, along with its caveats. Finally, historical vignettes may serve to humanize the statistical practitioner – and perhaps even the lecturer! More importantly, they are vehicles for teaching our students that statistics, like other branches of the sciences, is a living, breathing discipline,

constantly in evolution and development. It is important that our students, many of whom will become researchers themselves, understand that techniques are superseded over time, as someone "builds a better mousetrap" – and that if they are to use and/or understand statistical methodology most effectively, their understanding of it will need to grow along with it!

This presentation will focus on a few historical figures: a gambler, a brewery employee, a lady with a lamp and a lady drinking tea, an African explorer, and a lover of German culture – and even a fictitious partner in a Faustian bargain! Along the way, sources and references for historical enrichment to statistical presentations will be provided.

2. The Chancing Origins of Probability

2.1 Gambling and Gamblers

> *"It is remarkable that a science which began with the consideration of games of chance should have become the most important object of human knowledge."*
>
> - *Pierre Simon Laplace*

As noted by Laplace, the development of modern probability, which took place in the 17th century through the joint efforts of Blaise Pascal and Pierre de Fermat, did indeed have its start in considerations of problems associated with gambling. It began with Antoine Gombaud, the Chevalier de Meré, a nobleman and enthusiastic gambler, who posed to Pascal a problem related to the odds of a particular result involved in a popular dice game. Pascal brought Fermat into the discussion, and, as charmingly told by E.T. Bell in his book *Men of Mathematics* (1986), from this correspondence between Pascal and Fermat was created the modern theory of probability. Bell may perhaps be forgiven his less than inclusive title – the book, first published in 1937, does include a portrait of Sonja Kowalewski, and its graceful, occasionally pithy, commentary is always entertaining. Furthermore, at the front of the book is a treasure of wonderful mathematical quotations.

2.2 More on the Founders

Many interesting details about these two men are given by Bell (1986). Blaise Pascal, despite ill health, not only was a founder of probability theory, but made many other contributions during his relatively short life (he died at 39). Some students are gratified to learn of his philosophical and religious writings, others that he invented the first calculating machine at the age of 18– but dental residents appear to be more taken with his invention of the syringe.

Fermat, as a King's Councillor in Toulouse, was a busy civil lawyer in public service – yet was immensely productive, contributing to number theory, analytic geometry, calculus – and probability theory. Bell calls him the "Prince of Amateurs". Interestingly, only one mathematical essay of his was published during his lifetime, and that anonymously. He is perhaps most famous for his Last Theorem, an assertion he scrawled in the margin of his copy of Diophantus' *Arithmetica*, along with the claim that he had discovered a marvelous proof that could not be contained in that narrow space. This assertion was to torture mathematicians for centuries, until in 1997, over three hundred years after Fermat's death, it was generally accepted that Andrew Wiles had indeed proved Fermat's Last Theorem. This enduring conundrum so captured the public imagination that it passed into our

literature. In Arthur Porges' short story "The Devil and Simon Flagg" a mathematician initiates a Faustian bargain with the Devil - that the Devil cannot produce a proof of Fermat's Last Theorem within twenty-four hours. This short story, originally published in the *Magazine of Fantasy and Science Fiction* in 1954, also appears in *Fantasia Mathematica* by Clifton Fadiman (1958).

3. Some Statistical Suggestions

3.1 Surprising Supporters, including a Lady

Those familiar with the website of the American Statistical Association will know that the lives of many prominent historical personages intersected with the discipline of statistics, and that, in fact, Alexander Graham Bell, Andrew Carnegie, and Martin Van Buren were all members of the society (https://www.grantforward.com/sponsor/detail/american-statistical-association-271). Another member was the celebrated nursing pioneer, Florence Nightingale, whose tireless efforts in tending wounded soldiers during the Crimean War won her the sobriquet "The Lady with the Lamp." However romantic that image may be, it was Nightingale's abilities as a superb administrator – and an accomplished statistician – that permitted her to succeed so brilliantly in advancing the field of nursing by using applied statistics to influence policy, as discussed by Rehmeyer (2008).

3.2 Yet Another Lady

Sir Ronald Aylmer Fisher made outstanding contributions to the development of the statistical discipline, in methodology, design, and statistical genetics, as detailed by Bos (1978). Many wonderful stories are associated with his career, but one of the most charming is the story related by David Salsburg in his book entitled *The Lady Tasting Tea: How Statistics Revolutionized Science in the Twentieth Century* (2002). The title story, one of many historical vignettes, describes an episode during Fisher's early days at the Rothamsted Experimental Station, where his offer of a cup of tea, already poured, to Dr. Muriel Bristol was declined because she preferred to have the milk poured into the cup first. Fisher's skepticism resulting in a trial of the lady's ability to detect milk poured in before vs. after the tea, and the result was not only the formulation of what we know as Fisher's exact test, but the beginning of Fisher's sustained and productive efforts in the design of experiments. Lehman (2011) provides further discussions of Fisher's contributions to the development of modern statistical thought. Below is a favorite quotation, a salutary warning, from Fisher's presidential address to the First Indian Statistical Congress, published in *Sankhya* in 1938 (page 17):

To consult the statistician after an experiment is finished is often merely to ask him to conduct a post mortem examination. He can perhaps say what the experiment died of.

- *Sir Ronald Aylmer Fisher*

3.3 Let's Hear It for Beer

The story of William Sealy Gosset, the mathematician who discovered the t distribution while working for the Guinness brewery, is too well known to dwell on here. Because of the company policy prohibiting publication – his discovery would have been essentially considered proprietary information – Gosset published his results under the pseudonym "Student" – the standard utilization of the "t" appears to have originated with Fisher.

However, this story never fails to get a strong reaction from the students, and so it is mentioned here.

4. The Genetic Origins of Biometry

4.1 The Growth of a New Discipline

It is perhaps not widely appreciated that the development of the discipline of biometry was closely associated with nineteenth century interests in quantitative genetics. It was in fact an interest in genetics that inspired the work of the two men most closely associated with the founding of the discipline of biometry -- Francis Galton and Karl Pearson – as well as their close collaborator, the biologist Walter Weldon, who was part of these seminal efforts.

Francis Galton, who has been called "the last of the gentlemen scientists," was a renowned African explorer, geographer, scientist and proponent of eugenics (the science of hereditary improvement by selective reproduction). It was a problem in fitting mixtures of normal distributions as part of a collaboration with Weldon that led to consultation with Karl Pearson and the beginning of many years of fruitful collaboration among the three men. Pearson, Galton's pupil, collaborator, and biographer, is probably best known to the quantitative world as a statistical pioneer and founder of *Biometrika*. The extensive scientific inquiries of these two men, fired by an intense interest in heredity and eugenics, culminated in the birth of a new science -- and in a profusion of new statistical methodology, including such techniques as regression and correlation.

4.2 The African Explorer

Francis Galton's early fame grew out of his efforts as an African explorer, often under the auspices of the Royal Geographical Society. In 1855, he published the first edition of *"The Art of Travel; or, Shifts and Contrivances Available in Wild Countries"* (2017) in which he instructed the reader on such matters as how to swim with a horse and how to meet the charge of an enraged beast. Its readability is attested to by the fact that it is still in print; it is full of pithy passages to enliven lectures.

Galton was to go on to contribute to a wide range of scientific topics, including meteorology. Here we see a pattern that would be repeated throughout his long and productive life: Galton was adept at seeing how techniques from one area of inquiry could be adapted to another. One of the notable outcomes of Galton's explorations were maps, including contour maps where areas of similar elevation were connected. He applied similar methods to areas of similar barometric pressure – and discovered the "anticyclone," currently called the "high" in modern meteorological terminology. Galton also created the first weather map published in the Times of London – on April 1, 1875.

Francis Galton went on to contribute to psychology, twin studies, fingerprinting and numerous other areas. But it was his interest in genetics that culminated in the development of biometry. In looking for a model organism, his first cousin, the esteemed evolutionist Charles Darwin, suggested he work with garden peas. In applying methods similar to those he employed in cartography and meteorology, working with both outcomes from garden peas and measurements of human parents and children, Galton conceptualized both correlation and regression. More detail may be found in the works of Bulmer (2003), Forrest (1974), Gillham (2001), and his protégée Karl Pearson (1914, 1924, 193). Kevles (1985) particularly addresses the involvement with eugenics, a term that was coined by Galton.

4.3 The Lover of Things German

Karl Pearson, lover of things German, was so enamored of German thought and culture that he changed the spelling of his name from "Carl" to "Karl." If Galton provided insight and intuition, it was Pearson's mathematical prowess that put many of Galton's seminal conceptualizations on a first mathematical footing, with correlation and regression being two outstanding examples. Pearson's contribution to statistical science, recounted by Walker (1958) in commemoration of the 100th anniversary of Pearson's birth, are prodigious. They include the development of such widely used techniques as the Pearsonian chi-square, multiple correlation, and multiple regression. Pearson also worked in physics, and put forward a number of concepts that would be familiar to a devotee of Einstein's work. They did indeed influence the work of Einstein, who selected Pearson's *The Grammar of Science* (2007) as the first book to be read at Einstein's Olympia Academy study club, a private group to discuss books on physics and philosophy founded by Einstein in 1902. Pearson's work *The History of Statistics in the 17th and 18th Centuries against the Changing Background of Intellectual, Scientific and Religious Thought* (1978) is another good resource for the statistical lecturer.

4.4 The Biologist Who Rolled the Dice

Walter Frank Raphael Weldon, the third member of the founding triumvirate, is much less well known to the statistical community, perhaps partly because he was basically a biologist and partly because of his relatively early death. However, he was most dedicated to the biometric cause, and in fact rolled a set of 12 dice 26,306 times, creating a data base used in Pearson's pioneering work in chi-square analysis. The story of Weldon's dice was revisited by Kemp and Kemp (1991) and also discussed by Labby (2009).

5. Other Resources

Other reference works that may be of interest to the statistical lecturer are the collections of Clifton Fadiman: *Fantasia Mathematics* (1958) and *The Mathematical Magpie* (1981). Hacking's book on the history of probability, *The Emergence of Probability: A Philosophical Study of Early Ideas about Probability, Induction and Statistical Inference*, (2006), is another good resource. Stigler (1986, 1999) has written extensively on the history of statistics, and has also used the historical approach to expound on the foundational ideas of statistics in *The Seven Pillars of Statistical Wisdom* (2016). A recent (2017) book by Salsburg addresses "errors, blunders, and lies" and describes how statistical methods have been used to identify falsification of data.

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