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The Lady Tasting Tea Paper
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# The Lady Tasting Tea

The Lady Tasting Tea not only takes the reader through the progression of statistics, but also the history of the world during the time period; the brilliant minds associated with the breakthroughs in this mathematical realm; the people of the era affected by the different applications of this progressing science; and, last but not least, the various philosophical questions, answered and unanswered, inextricable from the study of statistics.

The story begins in Cambridge, England in the 1920s in the simple setting of a garden tea party. A woman claiming she can tell the difference between tea poured into milk and milk poured into tea introduces this story, and then we jump back into the 1890s, when the statistics revolution grows roots. The story progresses from Pearson's early work through World War I, The Depression and New Deal, World War II, and the Russian Revolution, and we learn of the different characters (Gosset aka "Student", Fisher, Neyman), scientific journals and books (*Biometrika*, *Statistical Methods for Research Workers*), and experiments of importance to the field that come into play. The reader is given example after example of statistical applications during the different time periods, from brewing Guinness in Ireland, to cracking German codes during wartime, to attempting to locate buried landmines in Japan, a failed attempt, which, according to the author, in part led to the atomic bombing.

The statistical portion of the story is entirely qualitative, I do not recall a single number or equation. The author says the book was not written for the mathematically educated (which becomes evident, for example on pg. 69, "Remember high school algebra? If $x$ equals the value in drachmas, then…"), and, indeed, the individual theorems and methods are not enumerated. But I am not convinced I would have understood the mathematical language or the statistical operations the author describes if I did not have some exposure to the subject. The book ends in the present time with some provoking questions about who will be the next great statistician and what will be discovered that could overthrow the current statistical theories.

Much to my surprise I enjoyed <u>The Lady Tasting Tea</u>, probably because it had all the qualities of a good book. It did not belabor the statistical history, but included interesting world history, characters, and anecdotes. The book was at times touching, funny, educational, and enthralling. Not only did Salsburg include interesting content, his writing was entertaining and rarely dry, quite impressive in a book subtitled "How Statistics Revolutionized Science in the Twentieth Century".

One of my favorite pleasing subtleties of the writing in the book is the footnotes. The author does not just use them to cite published works or authors, but includes them as part of the story, filling in the back story or history of a particular time period or tidbit. For example, Salsburg uses his footnotes for everything from telling the reader how "Student"'s ratio transformed from the variable "z" to "t", to how Pearson identified the head of Oliver Cromwell after it sat on a pike above Westminster Abbey for several years after his dictatorship. Another of Salsburg's writing styles I appreciated is his use of parenthetical "reminders". A plethora of names, publications, and studies are mentioned

throughout the book, and the author is aware of this and has included, for the benefit of the reader, some refreshers when referencing a previous, perhaps obscure, name. For example, on page 220 Salsburg mentions Henri Lebesgue and immediately reminds us in parentheses "recall the Lebesgue whose work Jerzy Neyman had admired but who was so rude to young Neyman whey they met".

Salsburg wrote about statistics and statisticians with surprising humanity and wit. There were many good quotes scattered throughout the book, and each time I came across one I appreciated this book more and more and forgot I was reading about statistics. One of my favorite lines is from the chapter discussing how hard Fisher was objecting to the statistics showing smoking caused cancer: "It became the conventional wisdom that he was playing the role of a crotchety old man who did not want to relinquish his beloved pipe." This, to me, is just good writing, no matter if its in a history book or a novel.

This book also included the human side of these brilliant men and women, not just their work and contributions to the field of statistics. We learned of the feud between Fisher and Pearson, and of Fisher's attacks on Neyman's work. The latter was really brought to life in the story of Fisher attending a presentation by Neyman in France and how Neyman prepared himself for tough questions from Fisher only to find Fisher could not speak French. The humanity is also evident in the sad story of Chester Bliss who invented probit analysis yet sat alone with no lunch date; the touching story of how Jerzy Neyman, after being rudely dismissed by his idol Henri Lebesgue, made it a point to be genuine and courteous to all his students and colleagues from thereafter; and the comical anecdote of how George Snedecor thought he was in Iowa City when he was actually in

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Ames and therefore stayed and taught at Iowa State instead of University of Iowa where he was originally headed.

The different historical and mathematical details of statistics are quite interesting, at least the ones the author selected for this book. These trivia-worthy facts include how Florence Nightingale used statistics and invented the pie chart to convince the British army to allow her to supply nursing care to the soldiers; how technology and its own revolution played a part in the progression of statistics, from "calculators" (an army of young women grinding through tedious calculations), to the "Millionaire", a hand-cranked calculator, to the first desk computer, screaming "BRAAAAAK" as it plugged away; and how the lingo in statistics was shaped by public opinion on word choice, such as "significant", "chaos", and "bias".

It was also very interesting to read about how statistical terminology and methods we are using in class came about historically, such as the t-test, the retrospective study, and the p-value. The author does not hide attempt to hide the fact that statistics are not perfect, and that there are still unanswered questions. On page 165, a chapter entitled "Unsolved Problems" points out the exact two questions we have asked in class this semester: "If the data have a known parametric distribution, like the normal distribution, how badly will the analysis go wrong if we use nonparametric methods?" and "If the data do not quite fit a parametric model, how far off from that model must the data be before the nonparametric methods are the better ones to use?". The answers the author discusses in the book are vague at best, and it is very interesting to see that the same questions we struggle with as statistics amateurs trouble these brilliant professors, too. The last chapter of the book explores more in depth the questions of how statistics fit in the real world and

if people actually understand these statistical numbers.  No real answers are given, possibilities are just bantered about.  I think the ending is quite appropriate, challenging the reader to think of who may be the next great statistician, what they may come up with, and how it could change current perspectives.  Because, as Professor Shirley has taught us, "oh, what a fuzzy world we live in".

I think that Salsburg put together a great and very readable book of the history of statistics and their various applications over time.  His wife deserves a lot of credit for her insistence on writing the book for the layman (as stated in the author's dedication) and therefore opening it to a much wider audience.  Overall I enjoyed <u>The Lady Tasting Tea</u>, and thought it was a well-written book as well as an informative history lesson.

My roommate is a biology major, and as I am an engineering major and know very little about biology, I have been picking her brain since I started toxicology, my first biology-related course since 7.012 freshman year.  When Professor Shirley pointed out in class that geneticists rarely look to environmental factors and only consider familial relationships when studying diseases, I asked my roommate if this was true in her experience.  She informed me that she did in fact consider environmental factors in her genetics class.  When reading <u>The Lady Tasting Tea</u> I stopped and asked her if she knew about the chi-square test, and she said yes, they used it all the time in genetics.  I never knew biology encompassed so much math and statistics!  I found this overlap interesting, the study of genetics and this statistical method, and decided to examine it more closely.

Geneticists use the chi-square test to rule out hypotheses on how many genes a certain phenotype is caused by. You start with a specific hypothesis with a certain expectation and then apply this test to the real experimental results. The test will give the probability of obtaining the results under the hypothesis.

The following is an example my roommate was kind enough to dig out of her 7.03 notes and show me. Studying 16 flies in the $F_2$, 14 of which are not paralyzed and 2 of which are paralyzed, we hypothesize two genes are the cause of paralysis in flies, and therefore expect 15 non-paralyzed flies and 1 paralyzed fly. Running these numbers through the chi-square test gets an answer of 1.067, and using the degrees of freedom as the number of classes minus one, in this case 1, we look at the table and find that $0.05 < p < 0.5$. The convention is that $p < 0.05$ is significant enough to reject the hypothesis, and therefore in this example the hypothesis cannot be ruled out.

The next example examines 64 $F_2$ flies and 12 of them are paralyzed. For the same hypothesis of two gene causation, 4 flies would be paralyzed. The chi-square test with these numbers returns an answer of 17.1, so again with 1 degree of freedom, the table yields a $p < 0.005$. In this case the hypothesis can be rejected. This is due to what we have studied in class, that increasing sample size emphasizes the effects seen.

One more example is to use the same data as in the last example, except to test the hypothesis of one gene, which would be expected to produce 16 paralyzed flies from 64 $F_2$ flies. The chi-square answer from this data is 1.33, and with 1 degree of freedom, the chart yields $0.05 < p < 0.5$. Therefore, this hypothesis of one gene still holds and cannot be ruled out.

After initially learning of this specific use, determining number of genes causing a certain phenotype, of the chi-square test in genetics, I went on to Pubmed.com to find what other uses the chi-square test played in genetics. Many, many journal articles made use of the chi-square test, for a whole variety of reasons. Some examples I found include: a study that used the chi square method to disprove a hypothesis that post-streptococcal reactive arthritis was a variant of acute rheumatic fever. A study had found this hypothesis was true in white Americans, but this study ("Lack of association between the HLA-DRB1 locus and post-streptococcal reactive arthritis and acute rheumatic fever in Italian children." Simonini G, et. Al, Semin Arthritis Rheum. 2004 Oct;34(2):553-8.) of Italian children did not confirm this association; chi square tests also helped determine modest associations between polymorphisms and grafting acute rejections ("Donor genomics influence graft events: the effect of donor polymorphisms on acute rejection and chronic allograft nephropathy." Hoffmann S, et al. Kidney Int. 2004 Oct;66(4):1686-93.); another study used the chi squared test to compare the genetic and environmental factors causing children who abused alcohol to act out; and another study utilized the chi square test to compare psychopathology among juvenile sex-offenders and their non-sex offending delinquent peers.

It appears that geneticists use the chi square test in many different applications; all they need is a hypothesis and then a study with results. The chi square test can compare percentages of people, genes, or characteristics, and therefore is quite useful in this field of study for eliminating hypotheses. Although chi square tests are useful for ruling out certain hypotheses, as we have seen in The Lady Tasting Tea and in class, this, and other statistical methods cannot definitively identify true or correct hypotheses or statements.