SOCIOLOGICAL RESEARCH IN RELIGION: STATISTICAL CONSIDERATIONS

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Abstract

The application of quantitative research has diminished in recent years in favor of qualitative research. This article present a history of statistics, suggests the applicability of statistics to religion related research, and recommends websites for initial data collection, as a way to diffuse student anxiety in the application of quantitative research. The discipline of Statistics developed in the 20th century; Pearson, Edgeworth, Yule, Gosset, and Fisher were prime movers in the development of the language and procedures of statistics. Ronald Aylmer Fisher contributed more to the theory and practice of mathematical statistics than anyone else. The academic discipline of statistics in the United States was fostered at Iowa State University under the direction of George W. Snedecor and the electronic digital computer was invented on the campus of Iowa State University by John Vincent Atanasoff and Clifford E. Berry. A.C. Elliott and Associates of TexaSoft Company applied the electronic digital computer to solve mathematical formulas of several statistical procedures. A number of organizations dedicated to the study of religion and related issues were listed. Wave III of the Baylor Religion Survey was recently released. The statistical revolution has become so widely used that its unspoken history has become part of the popular culture of the Western world.

Introduction

Fewer graduate students favor quantitative research, and the few quantitative research projects available demonstrated lower quality than expected for graduate research (Scourfield, 2008, Shaw, 2007). Some of the lower quality quantitative research was attributed to poor instruction or lack of rigor. More significantly, student perceptions about statistics were a contributing factor to the lack of quantitative research and to student attrition in doctoral programs (Baloglu, 2003; Walsh & Ugumba-Agwunobi, 2001; Onwuegbuzie, 1999, 2003, 2004; Pan & Tang, 2004, 2005).

The majority of 1,274 articles published between 1935 and 2005 in *The American Journal of Sociology* and the *American Sociological Review* were quantitative (Hunter &

Leahey, 2008). The relevance of quantitative research to sociological research was the ability to create an essential relationship between empirical observations and mathematical expressions of quantitative relationships. Overcoming student anxieties related to statistics was essential for doctoral program completion and a continuing ability to contribute high quality research. The sociology of religion appeared to be an exception, since the field has maintained a desirable balance between quantitative and qualitative research (Wuthnow, 2008). Smith (2011) called for an improvement in the quality of quantitative articles and cautioned against a mindless devotion to statistics.

Following are three thoughts about the challenge of quantitative research that may be helpful. First, when one did not understand the history and development of a discipline, it was difficult to appreciate its purpose. Second, it was often difficult for students to determine how interdisciplinary research applied statistics. Third, researchers are frequently unable to obtain useful data for meaningful research projects while studying a topic. This article proposes that understanding the history of statistics, the applicability of statistics to religion related research, and recommended websites for initial data could significantly diffuse student anxiety.   Such a background could promote interest in high quality quantitative research in the sociological integration of religion and society.

History

Statistics developed in the 20th century as the mathematical tool for analyzing experimental and observational data. Statistical analysis emerged in many scientific disciplines as indispensable for drawing reliable conclusions from empirical findings. The foundation of mathematical statistics was laid between 1890 and 1930; the principle families of procedures for analyzing numerical data were established during the same period. Karl Pearson (1857-1936), Francis Ysidro Edgeworth (1845-1926), George Udny Yule (1871-1951), William Sealy Gosset (1876-1937), and Ronald Aylmer Fisher (1890-1962), all from England, were among the leaders in the development of statistics. "The invention of statistics was the recognition of distinct and widely applicable set of procedures based on mathematical probability for studying mass phenomena" (Porter, 1986, p. 3).

Probability theory and error theory were precursors to the principle accomplishments of mathematical statistics. Error theory, known today as the normal distribution, suggested that measurement of a physical quantity was never made with perfect accuracy; there was always some error or uncertainty. When experimental results were reported, they were accompanied by an estimate of the experimental error, called the uncertainty. This uncertainty indicated how reliable the experimenter believed the results to be. The analysis of error became a method of studying the causes of variation rather than for measuring it. (Scuro, 2011)

Probability was the number of outcomes favorable to an event, divided by the total number of outcomes, where all outcomes were equally likely. Probability theory

was the area of mathematics that provided insight into phenomena that depended on chance or uncertainty. Glimmerings of probability theory were seen in the investigations into games of chance by Gerolamo Cardano [1501-1576], Pierre de Fermat [1601-1665], and Blaise Pascal [1623-1662] in the 16th and 17th centuries. (Porter, 1986)

Through the first third of the 20th century, the eighteenth century works of Jakob or James Bernoulli (1654-1705) and Abraham De Moivre (1667-1754) were viewed as the nearly definitive treatises of probability theory. In 1933 Andrey Nikolayevich Kolmogorov published a succinct volume entitled *Foundations of Probability Theory.* (Steele, 2011) Kolmogorov suggested that finding the probability of an event was like finding the area of an irregular shape. He adapted the newly emerging mathematics of measure theory to the calculations of probability. Kolmogorov combined the notion of sample space and measure theory and presented his axiom system for probability theory. The sample space of an experiment or random trial was the set of all possible outcomes. A measure on a set was a systematic way to assign to each suitable subset a number, intuitively interpreted as the size of the subset. A measure was a generalization of the concepts of length, area, volume. With these tools, Kolmogorov identified a small set of axioms upon which he constructed the probability theory. (as reported by Salsburg, 2001)

Stigler (1999) suggested that mathematical statistics began in 1933; the discipline of mathematical statistics was born as a separate field of study with techniques unique to the field. Kolmogorov's (1956) publication of *Foundations of Probability Theory*, the appointment of Ronald Fisher to replace Karl Pearson as Galton Professor at London's University College, and the publication of a series of statistical papers by Jerzy Neyman (1894-1981) and Egon Pearson (1895-1980) were contributing factors to designating 1933 as the date for the birth of mathematical statistics as a discipline. Neyman, born in Russia, was appointed professor at the University of California at Berkeley and Pearson, son of Karl Pearson, was Professor at London's University College. Fisher was later eclipsed mathematically by the next generation represented by Neyman/Pearson; they in turn were eclipsed by Harald Cramer (1893-1985), professor at the University of Stockholm, Sweden.

Some consider Karl Pearson, whose name is attached to the Pearson Product Moment of Correlation, as founder of the 20th century science of statistics. Pearson was appointed to the Chair of Applied Mathematics at University College in London in 1885. In July 1900 Pearson made a most significant contribution to statistics with the publication of the Chi-Square Test. Pearson's initial fame came from work on skew curves. In 1893 he coined the term *standard deviation;* he defined the correlation coefficient mathematically in 1896. Pearson wrote *The Grammar of Science* (1892) and with Francis Galton founded the statistical journal *Biometrika* in 1901, which he edited from its inception until 1936. (Porter, 1986)

Francis Ysidro Edgeworth influenced theoretical statistics significantly, yet he remains one of the least known major figures in the history of statistics. After graduating from the University of Oxford in 1869, Edgeworth undertook a program of self-study in mathematics that was equal to a university program at that time. From 1883 to 1893 Edgeworth published nearly 40 notes and articles, one book, and many reviews dealing with probability and statistics. After 1894 Edgeworth published nearly 60 articles, 27 of which dealt with the generalized law of error, known today as normal distribution. (Stigler, 1999)

George Udny Yule was a student of Karl Pearson and contributed to regression and correlation theory, distribution theory, and stochastic processes. Yule made fundamental contributions to the theory of statistics of regression and correlation; a great deal of Yule's contribution to statistics was in the stimulus he gave to students and in discussion with his colleagues. Yule wrote *Introduction to the Theory of Statistics* (1937), which ran to 14 editions. (Johnson & Kotz, 1997)

A professional employee of the Guinness brewery, William Sealy Gosset invented small sample statistics. Gosset studied with Karl Pearson during 1906-1907; in 1908 he derived a sample distribution that incorporated the error of the mean and the standard deviation, which later became known as the t-statistic. The paper was published under the name *Student* in *Biometrika* and was later popularized by Ronald Fisher. (William Sealey Gosset, 2011)

Ronald Aylmer Fisher contributed more to the theory and practice of mathematical statistics than anyone else. He coined the name of many statistical procedures and was a major developer of many statistical concepts. Fisher's most significant contributions were the development of the Analysis of Variance procedure and the integration of statistics with experimental design (David, 2011). Included among the concepts that he coined and/or developed were: Analysis of Variance, Ancillary Statistics Bayesian Inference, Covariance, Confounding Variables, Consistency, Degrees of Freedom, Factorial Design, Fiducial Inference, Level of Significance, Likelihood, Maximum Likelihood, Null Hypothesis, Randomization, Randomized Experimentation, Randomized Blocks, Sampling Distribution, Statistics, Sufficient Statistics, Test of Significance, and Variance (see Glossary).

Fisher set down applied ideas of statistics in *Statistical Methods for Research Workers*, first published in 1925, which reached 14 editions and was translated into six foreign languages. Much of the book is devoted to showing how to calculate p-values; Fisher developed most of the significance testing methods now in general use. Fisher's summa on experimental design, *The Design of Experiments*, was published in 1935. (as reported by Salsburg, 2001)

George W. Snedecor (1881-1974) taught a first, formal statistics course at Iowa State College in 1915. Snedecor was teaching mathematics at Iowa State University in 1919 when Fisher's first papers on agricultural experiments began to appear. With no

background in probability theory, Snedecor studied Fisher's papers and reviewed the work of Pearson, Student, Edgeworth, and others. Snedecor founded a statistical laboratory at Iowa State and the first academic department of statistics in the United States. Fisher visited and lectured on statistics at Iowa State during the summers of 1931 and 1936. The Statistical Laboratory and Department of Statistics at Iowa State was one of the most important centers of statistical research in the world. Snedecor wrote a textbook in the 1930s, finally published in 1940, entitled *Statistical Methods Applied to Agriculture and Biology.* The book was a preeminent text in the field and helped popularize Fisher's work. (Salsburg, 2001)

Gertrude Cox (1900-1978), who received the first master's degree in statistics at Iowa State in 1931 and taught statistics at Iowa State, was interested in Fisher's experimental design and taught the first courses in experimental design at Iowa State University. Her mimeographed notes were later published as *Experimental Designs* (1950). (as reported by Johnson & Kotz, 1997)

John Vincent Atanasoff (1903-1995) invented the electronic digital computer, the Atanasoff-Berry Computer. The computer was built by John Vincent Atanasoff and Clifford E. Berry (1918-1963) on the campus of Iowa State University during 1937 to 1942; the electronic digital computer incorporated several major innovations in computing including the use of binary arithmetic, regenerative memory, parallel processing, and separation of memory and computing functions. (Iowa State University College of Liberal Arts and Sciences Department of Computer Science, 2011)

Application

A.C. Elliott and Associates of TexaSoft Company applied the electronic digital computer to solve mathematical formulas of several statistical procedures through the development of the WINKS Statistical Data Analysis software. WINKS (Windows KWIKSTAT) makes statistical data analysis understandable and easy to perform. Output contains explanatory information such as hypothesis tested and suggestions for interpretation. Basic analyses available in WINKS include Descriptive Statistics and Graphs; calculation of p-values, t-Tests, and Analysis of Variance (ANOVA); paired and repeated measures; non-parametric analyses including Mann-Whitney, Kruskal-Wallis, and Friedman's procedures; Chi-Square procedures including Goodness of Fit and Test for Independence; and Regression and Correlation. WINKS can import files from other programs such as Excel. WINKS is an award-winning statistics program with thousands of users in over 65 countries. (Elliott, 2011)

For research related to the integration of religion and social science, statistics is a valuable tool for examining trends, demographic features, and attitudes. Not all research must solve a specific problem; research can provide insight into social attitudes and issues (Williams, 2003).

Data Sources

Dartmouth College Library, Emory University Libraries, Hartford Institute for Religion Research, Lifeway Research, and Baylor Institute for Studies in Religion, to name a few, are ongoing programs/resources for religion and religion/society research. Gallup, Pew Research Center, and Roper Public Opinion Archives provide information on issues, attitudes, and trends shaping America and the world (see Appendix).

Baylor Institute for Studies in Religion recently released the findings from Wave III of the Baylor Religion Survey, an extensive survey of religious practices, attitudes, beliefs, and values of the American public. The findings focused on health and religiosity, entrepreneurship/work and religion, and religion and cultural issues, such as politics and same-sex marriage. (see http://www.baylor.edu/newsclips/index.php?id=85125)

Wave I of the Baylor Religion Survey was completed in 2006; Wave II in 2008. In Wave III 1,714 adults randomly chosen from across America answered more than 300 items designed by Baylor faculty and administered by Gallup in the fall of 2010. The survey was supported by the National Science Foundation and the John M. Templeton Foundation.

From the vantage of the second decade of the 21st century, the statistical revolution in science stands triumphant. The statistical revolution has become so widely used that its unspoken history has become part of the popular culture of the Western world.

GLOSSARY

Analysis of Variance is a statistical test applied to compare the means of two or more groups and to eliminate sampling fluctuations as an alternative explanation for observed differences in group means. (Elmore and Woelke, 1996)

Ancillary Statistics are statistics whose distributions do not depend on the model parameters; in conjunction with other statistics, typically the maximum likelihood estimate, they provide valuable information about the parameters of interest. (Ghosh, Reid, & Fraser, 2011)

Bayesian Inference allows one to model uncertainty about outcomes of interest by combining common-sense knowledge and observational evidence. (Basics of Bayesian Inference and Belief Networks, 2011)

Covariance is a measure of how much two variables change together. Variance is a special case of the covariance when two variables are identical. (Free Online Dictionary, 2011)

Confounding Variable is an extraneous variable in a statistical or research model that should have been experimentally controlled but was not. (Free Online Dictionary, 2011)

Consistency does not contain a contradiction. (Free Online Dictionary, 2011)

Degree of Freedom references the number of values in a final calculation of a statistic that are free to vary. (Free Online Dictionary, 2011)

Factorial Design is an experiment whose design consists of two or more factors, each with discrete possible values or levels, and whose experimental units take on all possible combinations of these levels across all such factors. Such an experiment allows studying the effect of each factor on the response variable and the effects of interactions between factors on the response variable. (Free Online Dictionary, 2011)

Fiducial Inference is a form of interval estimation. (Free Online Dictionary, 2011)

Level of Significance is the probability of a false rejection of the null hypothesis in a statistical test. Also called *significance level*. (American Heritage Dictionary, 2011)

Likelihood is usually a synonym for *probability*; the probability of some observed outcomes given a set of parameter values is referred to as the likelihood of the set of parameter values given the observed outcomes. (Free Online Dictionary, 2011)

Maximum Likelihood is a popular statistical method used for fitting a statistical model to data and providing estimates for the model's parameters. (Free Online Dictionary, 2011)

Null Hypothesis involves formulating and testing hypotheses, assertions that are falsifiable using a test of observed data. The null hypothesis typically proposes a general or default position, such as that there is no relationship between two measured phenomena or that a potential treatment has no effect. (Free Online Dictionary, 2011)

Pivotal Quantity is a function of observations and unobservable parameters whose probability distribution does not depend on unknown parameters. If it is a statistic, then it is known as an ancillary statistic. (Free Online Dictionary, 2011)

Randomization in the design of experiments involves randomly allocating the experimental units across the treatment groups. (Free Online Dictionary, 2011)

Randomized Experimentation reduces bias by equalizing factors or independent variables that have not been accounted for in the experimental design. (Free Online Dictionary, 2011)

Randomized Blocks is an experimental design in which the various treatments are reproduced in each of the blocks and are randomly assigned to the units within the blocks, permitting unbiased estimates of error to be made. (Free Online Dictionary, 2011)

Sampling Distribution is a distribution of the estimates that can be made by each of all possible samples of a fixed size that could be taken from a universe. (Free Online Dictionary, 2011)

Statistic is an estimate or piece of data, concerning some parameter, obtained from a sampling. (Free Online Dictionary, 2011)

Sufficient Statistics is the property possessed by a statistic with respect to a parameter, "when no other statistic which can be calculated from the same sample provides any additional information as to the value of the parameter" The distributions of samples drawn are independent of the underlying parameter(s) the statistic is sufficient for. Both the statistic and the underlying parameter can be vectors. (Free Online Dictionary, 2011)

Test of Significance is a test of a hypothetical population property against a sample property where an acceptance interval is used as the rule for rejection. (Free Online Dictionary, 2011)

Variance is a measure of how far a set of numbers are spread from each other. It is one of several descriptors of a probability distribution, describing how far the numbers lie from the mean (expected value). (Free Online Dictionary, 2011)

Appendix

RESEARCH INFORMATION RESOURCES
Integration of Society and Religion

American Academy of Religion: AAR is the world's largest association of scholars of religion. The Academy promotes research, publishing, and teaching about religion in academia.
http://www.religionsource.org/Contents/ResourcesStatistics.aspx

Association of Religion Data Archives: Provides quality data and statistics on US and International Religion. http://www.thearda.com/

Baylor Institute for Studies in Religion: The Baylor Institute for Studies of Religion (ISR) initiates, supports, and conducts research on religion, involving scholars and projects spanning the intellectual spectrum: history, psychology, sociology, economics, anthropology, political science, epidemiology, theology, and religious studies. The Institute extends to all religions, everywhere, and throughout history, and embraces the study of religious effects on such things as prosocial behavior, family life, population health, economic development, and social conflict. http://www.isreligion.org/programs-research/surveys-of-religion/

Bureau of Justice Statistics: The mission of the bureau is to collect, analyze, publish, and disseminate information on crime, criminal offenders, victims of crime, and the operation of justice systems at all levels of government.
http://www.bjs.gov/index.cfm?ty=daa

Dartmouth College Library (Religion) Resources: A listing of many resources related to religion.
http://researchguides.dartmouth.edu/content.php?pid=5919&sid=69391

Emory University Libraries: Resources for the study of society related to religious belief and practice or to the social-scientific study of communities of faith.
http://guides.theology.library.emory.edu/content.php?pid=93833&sid=741260
FedStats provides access to the full range of official statistical information produced by the Federal Government. With convenient searching and linking capabilities to more than 100 agencies that provide data and trend information on such topics as economic and population trends, crime, education, health care, aviation safety, energy use, farm production and more. http://www.fedstats.gov/

Gallup provides research on what people around the world think and feel. Gallup's 2,000 professionals deliver services at client organizations, through the Web, at Gallup University's campuses, and in more than 40 offices around the world. http://www.gallup.com/home.aspx

Hartford Institute for Religion Research: The Institute gathers reliable information about what is happening in religious life today. http://hirr.hartsem.edu/research/fastfacts/fast_facts.html

Lifeway Research: LifeWay Research assists and equips church leaders with insight and advice that will lead to greater levels of church health and effectiveness. http://www.lifeway.com/LifeWay-Research/c/N-1z13wgl

Pew Research Center, Washington, DC: The Pew Research Center is a nonpartisan fact tank that provides information on the issues, attitudes and trends shaping America and the world. It does not take positions on policy issues. http://pewresearch.org/

Roper Public Opinion Archives: The Roper Center for Public Opinion Research is one of the world's leading archives of social science data, specializing in data from surveys of public opinion. The data held by the Roper Center range from the 1930s, when survey research was in its infancy, to the present. Most of the data are from the United States, but over 50 nations are represented. http://www.ropercenter.uconn.edu/

U.S. Census Bureau: The Census Bureau serves as the leading source of quality data about the nation's people and economy. http://www.census.gov/

WORKS CITED

American Heritage Dictionary. (2011). Retrieved on August 9, 2011 from
        http://www.answers. com/topic/statistical-significance

Basics of Bayesian Inference and Belief Networks. (2011). Retrieved on August 9, 2011
        from
        http://research.microsoft.com/enus/um/redmond/groups/adapt/msbnx/msbnx/ba
        sics_of_bayesian_inference.htm

Baylor News Clip. (2011). Retrieved on September 24, 2011 from
        http://www.baylor.edu/ newsclips/index.php?id=85125

Cochran, W.G. & Cox, G.M. (1950). *Experimental designs.* New York, NY: John Wiley&
        Sons.

David. H.A. (2011). History of statistics in the classroom. Retrieved on August 13, 2011
        from http://www.stat.auckland.ac.nz/~iase/publications/jsm/03.davidpap.pdf

Elliott, A.C. (2011). WINKS *statistical data analysis: User's guide*, (7th ed.). Cedar Hill, TX:
        TexaSoft.

Fisher, R.A. (1925). *Statistical methods for research workers.* Edinburgh, Scotland: Oliver &
        Boyd.

Fisher, R.A. (1935). *The design of experiments.* New York: NY: MacMillan.

Free Online Dictionary. (2011). Retrieved on August 9, 2011 from
        http://encyclopedia2.thefreedictionary.com/

Ghosh, M., Reid, N., & Fraser. (2011). *Ancillary statistics: A review.* Retrieved on August
        9, 2011 from http://www.utstat.toronto.edu/dfraser/documents/237.pdf

Iowa State University College of Liberal Arts and Sciences Department of Computer
        Science. (2011). Retrieved on August 13, 2011 from
        http://www.cs.iastate.edu/jva/jva-archive.shtml

Johnson, N.L. & Kotz, S. (Eds.). (1997). *Leading personalities in statistical sciences: From the
        seventeenth century to the present.* New York: NY: John Wiley & Sons.

Kolmogorov, A. N. (1956). *Foundations of the theory of probability*, (2nd ed.). New York:
        Chelsea.

Pearson, K. (1892). *The grammar of science.* London: A. & C. Black.

Porter, T.M. (1986). *The rise of statistical thinking 1820-1900.* Princeton, NJ: Princeton
        University Press.

Salsburg, D. (2001). Lady tasting teach: How statistics revolutionized science in the
        twentieth century. New York, NY: Henry Holt.

Scuro, S.R. (April, 2004). Introduction to error theory, VP-218 04/04. Retrieved on
        August 9, 2011 from http://physics.uwyo.edu/~adrian/p1220-
        Fall2010/Error_Theory.pdf

Snedecor, G.W. (1940). *Statistical methods applied to agriculture and biology.* Ames, IA:
        Iowa State University Press.

Steele, J.M. (2011). Probability theory. Contract no: BAP098M-RG-15-Med. Retrieved on August 9, 2011 from
http://wwwstat.wharton.upenn.edu/~steele/Publications/PDF/PT.pdf

Stigler, S.M. (1999). *Statistics on the table: The history of statistical concepts and methods.* Cambridge, MA: Harvard University Press.

William Sealey Gosset. (2011). Retrieved on August 8, 2011 from
Http://www.morris.umn.edu/
~sungurea/introstat/history/w98/gusset.html

Yule, G.U. (1911). *An introduction to the theory of statistics.* London: Charles Griffin.