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SIGNIFICANT DIFFERENCES
The Construction of Knowledge, Objectivity, and Dominance

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Synopsis — The scientific method is a tool for the construction and justification of dominance in the world. The invention of statistics was a major methodological advance in the descriptive sciences causing a shift from descriptive analysis to mathematical analysis. The new methodological techniques were invented by men who were interested in explaining the inheritance of traits in order to support their political ideology of natural human superiority and inferiority. The statistical techniques transformed the scientific method and resulted in a process that constructs knowledge and establishes "significant differences" between the dominant group as the norm and the subordinate group as the "Other." The five steps in the process that integrates domination into the scientific method and results in the scientific construction the Other are: (a) Naming, (b) Quantification, (c) Statistical Analysis, (d) Reification, and (e) Objectification.

> Some people hate the very name statistics, but I find them full of beauty and interest. Whenever they are not brutalized, but delicately handled by the higher methods, and are warily interpreted, their power of dealing with complicated phenomena is extraordinary. They are the only tools by which an opening can be cut through the formidable thicket of difficulties that bars the path of those who pursue the Science of man. (*Natural Inheritance*, Francis Galton, 1889)

The scientific method is a tool for the construction and justification of dominance and exploitation in the world. It also enables the creation of replicable information and explanations of the natural and social world. Recognizing these dual functions is crucial to understanding how the scientific method is used to provide increasingly broad and in-depth understandings of the world and to explain and create stratifications within the world.

Although sexist, racist, heterosexist, and classist biases in language, interpretation, and representation have been uncovered by scholars studying gender, race, class, and sexual identity, the scientific method remains the citadel of scientific authority. Science, as an institution, remains secure in its power and authority as long as the scientific method is without culpability in politics. The need for a feminist critique of the scientific method is stated by Evelyn Hammonds (1990):

> Feminist critics have articulated a sophisticated argument about the inscription of gender in the language and norms of scientific practice, but they have been less successful in demonstrating, at least to the satisfaction of practicing scientists, how the scientific method, especially in the "exact" sciences, is itself inscribed by gender. Above all, we have yet to demonstrate how the scientific method can provide successful representations of the physical world while at the same time inscribing social structures of domination and control in its institutional, conceptual, and methodological core. (p. 181)

The politics of domination are integrated into the scientific method and used as a social and political agent for those in power. Specifically, the invention of statistics, while being a major methodological advance in the descriptive sciences was, and is, used to create and support political dynamics of domination and

exploitation. Statistical methods were invented over the last 100 years to support politically motivated science. The focus of this paper is on how these methods are used in a process that constructs knowledge in a way that legitimizes paradigms of domination.[1]

STATISTICAL METHODS AND THE POLITICS OF DOMINATION

Positivist views of science argue that an objective scientific method is powerful enough to eliminate social and political subjectivity. Feminists argue there is no objectivity disassociated from the social and economic politics of the inventors or users of specific scientific methods. Even methods of mathematical analysis are intertwined with politics. Statistical analysis is an intrinsic part of the scientific method and used by every discipline in the natural and social sciences. The journal *Science* listed the development of the chi-square statistical test as one of 20 important scientific breakthroughs of the 20th century (Barnard, 1992, p. 1).

Statistics is defined as: "a scientific discipline concerned with the collection, analysis and interpretation of data obtained from observation or experiment" (Plackett & Barnard, 1990, p. 4); "the mathematics of experiment" (Mather, 1972, p. 9); "the language of science" (Atkinson & Fienberg, 1985, p. vii); "the branch of scientific method which deals with the data obtained by counting or measuring the properties of populations of natural phenomena" (Kendall, 1948, p. 2); "an indispensable tool in all branches of human endeavor from scientific research and complex decision making to regulation of our daily lives" (Rao, 1983, p. 35); and "a practical discipline for understanding the indeterministic world that we live in and for solving the real problems in society from agriculture, through meteorology to zoology — from A to Z!" (Barnett, 1983, p. 7).

There is some recognition among statisticians, mathematicians, and philosophers that statistics is a socially constructed method. They ask: Is it an "exact science" or a "social product" (Bibby, 1983, p. 239)? Are statistical methods "discovered" or "invented" (Tankard, 1984, p. 138)? There is a tension between statistics as an exact science, defined as "objective, rigorous, culture-free, [and] technique oriented" and statistics as a social product which is "produced as the outcome of human responses to a wide variety of conflict-laden situations" (Bibby, 1983, p. 239). Although some statisticians and a few scientists are aware of the limitations of the methods and urge caution in their use, the social construction of statistics is often obscured or forgotten by emphasizing "technique."

> There remains an insidious force within [statistics] which pushes relentlessly towards *technique*. The tendency is enhanced by the fact that "statistics as social product" remains an amorphous and ill-formulated concept: this is seen as a weakness in a world where precision is a sign of strength. (Bibby, 1983, p. 244)

It is impossible to separate the process of invention, discovery, and science. Efforts to distinguish between discovery and invention or between fact and theory are efforts to disassociate science from its subjective context. The artificial distinction enhances the illusion of objectivity in science, but once the social, political, or economic history is reconnected, the subjectivity becomes apparent.[2]

The statistical methods developed by scientists cannot be separated from the social, political, and economic forces that motivate the research. The early inventors of statistics were motivated to invent mathematical tools to measure and *improve* the human race. They were not interested in statistics itself as a scientific method; they were looking for a way to describe and prove their political ideology of human superiority and inferiority. The tests that comprise the foundation of statistical analysis were invented to provide authoritative support for the paradigms of domination and exploitation created by social, political, and economic forces. That does not make the mathematics incorrect, or nullify knowledge that has been gained by the use of statistical analysis, but it does raise questions about the objectivity of the methods. It places the invention of the scientific method deeply within a social, political, and economic context.

Many of the early inventors of the early statistical methods had interests similar to other nineteenth century scientists who were greatly interested in measuring and categorizing racial and ethnic differences, especially as they revealed perceived mental abilities. In their pursuit of race science they invented tools and

methods to measure the variables of interest. For example, to measure physical differences, especially skull shape and size, among races, ethnic groups, and sexes the scientists invented calipers, cephalometers, craniometers, craniophores, craniostats, and parietal goniometers (Stepan, 1990, p. 43). They also invented experimental techniques and methods of data analysis. These statistical inventions created new scientific methods which enabled the scientists to construct knowledge in new ways, all of which reinforced their social, political, and economic ideologies.

For centuries the principles of probability have been investigated and descriptive statistics used by science and nation states to compile information, but what today is called statistical analysis had its beginnings in the work of Sir Francis Galton, wealthy cousin of Charles Darwin. Galton's goal was the mathematization of the laws of heredity. Influenced by Charles Darwin's *Origin of Species*, he drew upon the mathematics of probability to search for the relationship among physical traits and mental ability between parents and their children that would lead to the discovery of natural laws of inheritance (Cowan, 1972a, 1972b; Kevles, 1985). Abraham de Moivre's normal curve became a basic tool in Galton's investigation of physical and mental anthropological measurements and invention of statistical methods for measuring heredity (Tankard, 1984, pp. 23, 48). By studying the mathematical relationship among physical and mental traits Galton invented a measurement of "co-relation." Today this measure of co-relation between two variables is called the correlation coefficient. Galton also invented a measurement of "reversion" to describe the mathematical stability of physical traits in a population when measured intergenerationally. Today that statistical method is known as regression analysis.

With his invention of these techniques Galton transformed the concept of heredity as it was known. Prior to his work the investigation of inheritance focused on finding the mechanism or "force" of heredity, however, with the invention of correlation and regression, heredity became a relationship between generations that could be studied by measuring physical and mental traits (Cowan, 1972a).

Galton, today, known as the founder of biostatistics, biometrics, and behavior genetics, made the previously descriptive science of biology accessible to mathematical analysis. In the hierarchical world of science, this transformed biology into a *real* science.

> Measurement has long been considered a hallmark of science properly practiced, and once a new discipline has developed a mathematical discourse, it has almost immediately laid claim, at least in the language of its most enthusiastic disciples, to the significant status — science! (Woolf, 1961, p. 3)

Galton is also known as the founder of eugenics — the science of improving the human race through encouraging reproduction of the most capable and discouraging reproduction of the least capable. He planned that the mathematical principles of heredity, once discovered, would form the basis for a political moral reformation of society which would lead to the improvement of the human race. Eugenics was the single motivator for Galton's work. Karl Pearson, Galton's biographer, and protégé wrote, "We can see that his researches in heredity, in anthropometry, in psychometry and statistics were no independent studies, they were all auxiliary to his main object — the improvement of the race of man" (Tankard, 1984, p. 40). Galton wrote about the power of men to mold the future of the human race by the selection of progenitors on the basis of intelligence.

> The power of man over animal life, in producing whatever form he pleases, is enormously great. It would seem as though the physical structure of future generations was almost as plastic as clay, under the control of the breeder's will. It is my desire to show . . . that mental abilities are equally under control. (Cowan, 1972b, p. 511)

Galton thought that traits such as character, disposition, energy, intellect, and physical power were quantitative and determined solely by heredity. These various "natural qualities" or "talents" comprised the social worth of a person. Galton ranked the categories of people in the British social structure. They were, starting at the bottom, the "criminals, semicriminals, loafers, and some others," followed by the "very poor persons who subsist on casual earnings, many of whom are inevitably poor from shiftlessness, idleness or drink," next were

"those supported by intermittent earnings — they are a hard-working people, but have a very bad character for improvidence and shiftlessness," then came the "mediocre class" of ordinary respectable workers. After these classes came those of higher worth, the "better paid artisans and foremen," followed by the "lower middle class of shopkeepers, clerks and subordinate professional men, who as a rule are hard-working, energetic and sober." The last and highest class were the entrepreneurs and the professionals who had "the brains of our nation" (MacKenzie, 1981, p. 16). Galton never questioned the class hierarchy within British society. He just invented statistical methods in his attempt to prove the biological basis for its existence.

In his book, *Hereditary Genius*, Galton (Tankard, 1984, p. 47) describes an early IQ scale for the "classification of men according to their natural gifts," and speculated on how it could be used to measure the mental capacity of different races. He concluded that Negroes were two grades below whites in intellectual abilities. Galton also concluded that female traits were defects with no adequate adapive purpose.

Galton's work, both eugenic and statistical, attracted followers. Karl Pearson later wrote of the influence of Galton's work on their life and work:

> For some of us Galton's new calculus . . . enabled us to reach real knowledge . . . in many branches of inquiry where opinion only had hitherto held sway. It relieved us from the old superstition that where causal relationships could not be traced, there exact or mathematical inquiry was impossible. We saw the field of scientific, or quantitative, study carried into organic phenomena and embracing all the things of the mind. It was for us the dawn of a new day. (Cowan, 1972b, p. 525)

Karl Pearson, as Galton's protègè, finished the work Galton started on correlation and used his findings to prove that heredity had greater control over physical and mental traits than did the environment. In a study meant to resolve the nature–nurture debate he measured physical characteristics such as eye color, hair color, and head length on school children who were brothers and sisters, and had the teachers evaluate the children on mental characteristics, such as introspection, assertiveness, conscientiousness, and general intelligence. Pearson found similar correlations among the siblings in both the physical and mental characteristics. From these findings he concluded that because physical traits were not affected by the environment, and the correlations for the mental traits were the same as the physical traits, the mental traits were equally influenced by heredity. This meant that the influence of the environment must be small as compared to heredity (Tankard, 1984, p. 78).

Pearson is known in the history of statistics as the inventor of the standard product-moment expression of the coefficient of correlation and a large part of the theory of multiple correlation and regression. He is best known as the inventor of the chi-square statistical test for comparing the fit of observed data to the normal curve or normal distribution expected in a population sample. The chi-square test has been described as "a powerful new weapon in the hands of one who sought to do battle with the myths of a dogmatic world" (Peters, 1987, p. 105). Pearson wanted to make the biological sciences as mathematical as the science of physics. In his book, *The Grammar of Science*, he states that the essence of science is its method, and no areas of human experience are inaccessible to study by this method (Barnard, 1992, p. 4).

Pearson's motivation, like Galton's, was the investigation of heredity and evolution as based on eugenic principles for the biological improvement of the human race. Pearson is attributed with taking Galton's ideas and turning them into a new science (MacKenzie, 1981, p. 88). Commenting on Pearson's mathematical papers, his son Egon Sharpe Pearson said:

> The main purpose of all this work was the development and application of statistical methods for the study of problems of heredity and evolution; it would certainly be wrong to think of the Pearson of this period as concerned with the development of statistical theory for its own sake. (Tankard, 1984, p. 69)

Pearson was an ardent supporter of eugenics and a socialist reformer. Although he was opposed to a society stratified by wealth, he

was not an egalitarian. He thought education and culture determined the value of a person in society. In his view, the group that should have the highest standing and power in society was the professional middle class. He was quite concerned that the "lower" classes of people not become too powerful. Pearson thought that natural selection had to be replaced by artificial selection to ensure that the "unfit" did not out breed the "fit" in a socialist nation (MacKenzie, 1981, p. 84).

Pearson's politics and scientific studies lead him to write papers opposing Jewish immigration into Britain (Tankard, 1984, p. 62). According to Fredrick Henry Osborn, an American eugencist, "Pearson shares the blame . . . for making possible the dreadful misuse of the word eugenics in Hitler's propaganda" (Tankard, 1984, p. 62).

The quantitative methods invented by Galton and Pearson added the power and authority of numbers to their science and ideology. Galton's work, followed by Pearson's, made heredity accessible to mathematical scientific study.

> Galton developed a definition for heredity which was limited and operationally meaningful, a definition which could be researched. In so doing Galton managed to bring order where there had been chaos; he managed, in short, to simplify a situation which previously had been hopelessly complex. (Cowan, 1972a, p. 403)

Eugenics motivated the invention of statistical techniques and the science that emerged. The newly defined science of heredity enabled scientists to scientifically investigate the conceptual dualism of nature and nurture. For Galton and the other eugenicists, all was nature. The politics of domination and exploitation of the time were inscribed into the methods and the science.

> Eugenic doctrine was antiurban at a time when fear of the cities was becoming rampant. It was racist at a time when the conflicts between the races were becoming everywhere apparent; in the United States and in the British Empire, at home and abroad. Most significantly, eugenic doctrine congratulated Anglo-Saxons on the superiority of their civilization at a time when they were beginning to feel insecure about their role in the world. (Cowan, 1977, p. 201)

Galton and Pearson's goal to transform the study of heredity and evolution was successful. Their statistical techniques, correlation, regression, and the chi-square test, introduced quantitative methods to the descriptive sciences which enabled scientists to construct knowledge in a way that had never been done before. In the next phase of invention of statistical methods, the new techniques furthered the social construction of knowledge and added the social construction of objectivity.

William Gosset contributed to statistical methods by inventing the *t*-test. He worked as a brewer for the Guinness Brewery his entire life, although he kept in close contact with the other inventors of statistical methods by correspondence and he spent 1 year studying in the Galton Laboratory at The University of London with Karl Pearson. Guinness Brewery would allow Gosset to publish his work only if he used a pseudonym and if none of the brewery's data appeared in the papers. Therefore, all of Gosset's papers were published under the pseudonym of "Student" — explaining why for years this statistical test was known as the *Student t*-test.

Gosset's work represents a shift in the invention of statistics. Up until then the work in statistics focused on studying relationships among variables by methods of correlation. Gosset introduced the problems of experimental control and the significance of differences. His statistical methods were invented in response to the needs of the brewery. He needed to know the accuracy and reliability of results derived from small sample sizes. The *t*-test enabled him to determine if differences ascribed to experimental results could reliably be due to experimental treatment, not chance. Gosset published his invention of the *t*-test in 1908, but the other biometricians of the time were more interested in studying traits in large human populations, so the *t*-test went unused for years.

Ronald A. Fisher extended the concept of a test of significance. Fisher's work greatly influenced the areas of statistical methods, experimental design, and genetics. He is the inventor of the statistical method analysis of variance. Similar to Galton and Pearson before him, eugenics was central to Fisher's career.

Natural and artificial selection featured strongly in his work on theoretical genetics and in agricultural experimentation. This scientific focus is consistent with his social support for eugenics. He favored use of scientific selection to mold the population of the future. Fisher said, "Biometrics can effect a slow but sure improvement in the mental and physical status of the population; it can ensure a constant supply to meet the growing demand for men of high ability" (MacKenzie, 1981, p. 190).

Fisher's new methods quantified Gosset's statistical differences. A question that arose in determining the reliability and repeatability of experimental results was to what degree could the findings be relied upon. Fisher invented a statistical test that determined significance levels for experimental results. He explained it this way:

> The evidence would have reached a point which may be called the verge of significance; for it is convenient to draw the line at about the level at which we can say "Either there is something in the treatment or a coincidence has occurred such as does not occur more than once in twenty trials." This level, which we call the 5 percent point, would be indicated, though very roughly, by the greatest chance deviation observed in twenty successive trials. Personally, [I] prefer to set a low standard of significance at the 5 percent point, and ignore entirely all results which fail to reach this level. (Cochran, 1976, p. 13)

Fisher's arbitrary decision to set the point of significance at the 5% level still holds today in drawing conclusions from experimental results. Gosset and Fisher invented ways to quantify the significance of experimental results and findings of "differences." These tests are essential to the scientific method. When data is analyzed by statistical methods, the reporting of significance levels is required.

The establishment of a way to determine differences between variables and the quantification of the significance of the differences marked the addition of a quantitative determination of objectivity to experimental results. From now on, variables could be quantified, tested for significant differences, and declared to be objective findings of the scientific method by adding the authority of level of significance. Once variables are compared and found to be *significantly different*, the results acquire the authority of *fact*, *truth*, or *objective information*.

Fisher introduced another experimental design concept — the null hypothesis. The null hypothesis is the assumption in statistical methods that there is no significant difference between two variables (or experimental treatments, whatever is being measured). If statistically significant differences can be found between the variables, then the null hypothesis can be rejected. If significant differences are not found, the null hypothesis cannot be rejected. In research laboratory practice, this is a negative result, a failed experiment. Findings of significant differences are the positive or successful results in research. Experiments are designed to look for differences. Fisher said, "Every experiment may be said to exist only in order to give the facts a chance of disproving the null hypothesis" (Tankard, 1984, p. 127).

Scientific methods of experimental design and statistical methods objectively measure and determine differences. Determinations of differences and their explanation are considered to be progress, to have advanced scientific knowledge. No such procedure is used for measuring and confirming sameness. Sameness is not much of a question in science. Experimental findings of sameness (no significant differences) are usually not publishable.

The above described statistical methods make up a central part of the scientific method. The men who invented them were either influenced or motivated by political ideology. Their goal was the explanation of social, political, and economic inequalities among people by differences in heredity. They envisioned a future society where artificial selection of people to reproduce would replace natural selection.

With the use of the new statistical techniques, the construction of knowledge in biological sciences, such as heredity and evolution, shifted from descriptive analysis to mathematical analysis. The use of these apparently more sophisticated and authoritative techniques enabled the men to transform the study, reporting, and analysis of the sciences. They used the new techniques to construct scientific knowledge to conform to their political ideology of eugenics. By cloaking their ideas with mathematics and "objective" analysis that qualified

their ideas as the leading science of the times, they were able to explain, justify, and enact the social, political, and economic oppressions and exploitations of the time.

These statistical techniques became part of the basic scientific method in designing experiments and analyzing results. The statistical methods of determining and quantifying differences became a standard methodological technique in science.

STATISTICS, KNOWLEDGE AND DOMINATION

A fundamental principle in the implementation of domination and exploitation is the construction of the dominant group as the norm and the subordinate group as the Other. For science to serve the powerful, its methods must play a supporting role. Statistical methods were invented as a way of knowing by men motivated by eugenic politics. It continues to serve as a tool for analysis and validation of experimental results, from which the findings can be declared to be objective. Statistical analysis serves in the verification and establishment of "significant differences," by "objectively" determining whether populations (or samples of populations) are the same or different. Any people politically, socially, and/or economically outside the dominant group are identified and studied by the biological, psychological, and social sciences. Scientific investigation has great implications for groups who are socially and politically defined as Other, such as women, lesbians, gay men, African-Americans, Latinos, the old, the poor, the disabled. Once difference between groups has been established as fact by the authority of objective "neutral" science, the powerful can act, all the while believing in and justifying their actions because of the proof supplied by scientific methods. While enabling investigation in every field of study, statistical analysis has also aided in the social construction of dominance by giving scientific authority to the construction of reified categories which lead to the objectification of oppressed, subjugated groups.

I have constructed a five-step process for the scientific construction of the Other: (a) Naming, (b) Quantification, (c) Statistical analysis, (d) Reification, and (e) Objectification. This five-step description is not a linear process; it is circular and interactive, with each step legitimating and reinforcing the previous and following steps.

Naming

All scientific investigation is conceptualized from a social, political, and economic context. What is worthy of measure and analysis is that which has economic, political, social, or aesthetic value to the dominant group — the people with economic, social, and political power. What is measured is often important to the maintenance of the present structure and balance of power. In the scientific method the first step is to name and define the variables to be studied and analyzed. Naming and defining of variables is an essential element in the construction of knowledge and consequential domination and exploitation. Once something is named it is made visible and real. Concepts can be constructed around it which are then used to explain experience and observations.

In addition, the variables measured and the attributes assessed by the variables depend on what *can* be measured. A brief look at the history of the scientific study of women reveals that when skull size could be measured, the science of craniometry constructed theories of intelligence (Gould, 1981). When sex hormones could be measured, the science of endocrinology constructed theories of femininity and masculinity (Oudshoorn & van den Wijngarrd, 1991). When brain laterialization could be measured, the science of neurobiology constructed theories of verbal and visuospatial ability (Bleier, 1987). Not surprising, considering men's domination and women's subjugation, women were always found objectively to be inferior to men. Variables are not assessed without social history and meaning attached to them. The reason the variables come to the attention of scientists is by the social, political, or economic value or meaning attached to them. Often times variables are measured because new techniques have been invented to measure them .

Helping to strengthen the naming is the use of metaphor and analogies. Metaphors and analogies are used to construct scientific theories which link systems of oppression. For example, in the 1800s women were demonstrated to lack intelligence because they were more like the "lower" races, while Other races were proven to be inferior because they were like women. The metaphors "functioned as the

science itself — that without them the science did not exist" (Stepan, 1990, p. 30). The theories, constructed from the analogies, were then tested by assessing variables that could be measured — like skull size.

In constructing knowledge, variables can always be found to measure. New variables are "discovered" and named as new techniques are invented which enable them to be measured. This is a process by which new information and understandings of the world are made. In and of itself, this is not a problem, but when social, political, and economic forces influence the naming and construction of variables, the result is the scientific construction of ideas which support the perspective and power of the dominant class.

Quantification

Once variables have been named the next step is quantitative measurement. Quantification creates the scientific illusion that subjectivity and politics have been transcended. Numbers, in and of themselves, proclaim objectivity. The power and authority of the scientific method established by statistical analysis is based on the idea that numbers are the ultimate expression of objectivity. Numbers are used to construct meanings to present views and support theories. When the perceived objectivity of numbers is added to ideas, the value and power of the ideas are enhanced.

As the social and political value of quantification increases, what can be expressed in numbers also takes on a greater meaning. Once something is expressed in numbers it quickly lends itself to further mathematical analysis: the more complicated, the more prestigious. If concepts and theories can be expressed in numbers, the ideas themselves take on greater objectivity and authority. This esteemed value is socially constructed. Thomas Kuhn states:

> Both as an ex-physicist and as an historian of physical science, I feel sure that, for at least a century and a half, quantitative methods have indeed been central to the development of the fields I study. On the other hand, I feel equally convinced that our most prevalent notions about the function of measurement and about the source of its special efficacy are derived largely from myth. (Kuhn, 1961, p. 31)

In addition, the serial nature of numbers easily allows the ranking of measurements and the creation of hierarchical relationships. Differences can be quickly determined and evaluated by statistical methods. As stated in one statistics text, "Virtually any kind of difference can be tested for statistical significance. The only requirement is that the data be expressed numerically" (Phillips, 1982, p. 133).

Quantification is seen as an important step in the scientific evaluation of observations. As variables are quantified they take on greater authority and lend themselves to further mathematical evaluation.

Statistical analysis — Difference and objectivity

The creation of difference is essential for the social construction of the Other. The scientific method makes that difference appear to be just the facts. The inventor or user of these methods appears to be powerless to influence or control the outcome. The distancing of the observer and the observed creates the illusion of objectivity, from which the "facts" emerge from the proper implementation of the scientific method. As stated in one statistics text, "Statistical analysis must aim at making the data tell their own story in such a way that their true value and degree of trustworthiness may be accurately assessed" (Mather, 1972, p. 12).

Statistical analysis and the scientific method take on the appearance of being detached from any social, political, or economic forces. The data or numbers are perceived as telling the story, not the researcher or theorist. Also, increasingly complex techniques within statistical analysis give the impression of being more sophisticated "truth finders." Most techniques of data analysis enable a decontextualized practice of science. "Exploratory data analysis is dangerously empiricist — it risks encouraging the notion that knowledge somehow 'arises out of the data,' it downplays prior knowledge and the role of theory" (Bibby, 1983, p. 279).

In data analysis, following the implementation of every statistical method is the test of significance. In experimental research this is the determiner of success or failure of an experiment and whether knowledge has been added to the field. The elevation of this test to this status has been referred to as "the canonization of tests of significance." The test of sig-

nificance is the adjudicator for the value of experimental findings, of whether a significant truth has been discovered. "The only purpose of the experiment seems to be to test significance, and thereby the problem is considered solved" (Hamaker, 1982, p. 665).

Statistical analysis becomes a powerful tool in constructing the Other. A premise for domination and exploitation of an oppressed group is that the Other is *not* the same as the dominant group. Domination and exploitation would be impossible to sustain if difference was not created and maintained. Difference is equally important for statistical analysis. "Variation of individuals in a measurable characteristic is a basic condition for statistical analysis and theory. If uniformity prevailed there would be no need for statistical methods" (Cox, 1992, p. xxvii).

Statistical analysis serves as a process through which measures of variables can be transformed into objective facts and knowledge. The findings of significant differences validates constructed ideas about differences between populations. If differences are proven by scientific methodology, then scientific proof exists that the Other is *not* the same as the norm. These findings hold great political power in constructing theories to explain the differences, and the eventual inferences that are drawn. Oppressor classes can feel secure in their social, political, and economic domination, and subjugated classes internalize their oppression as the fact that they really are different.

Reification — Interpretation and ranking of difference

Reification is the transformation of abstract concepts into concrete entities. It is the next step in constructing the Other from scientifically collected and analyzed data. In this step variables that are measured are constructed into entities and given meaning. Whatever difference has been found and analyzed to be "significant" is interpreted to further knowledge, verify or disprove theories and validate and reinforce social, political, and economic structures. The process of science produces information and meanings which are used to make decisions and formulate further study.

Stephan Jay Gould (1981, p. 24) has described the process of reification in the scientific construction of "intelligence." The "wonderfully complex and multifaceted set of human capabilities" were reified into the entity known as intelligence, which was then further reified into a single number known as the intelligence quotient or IQ score. The reified entity was then measured and analyzed among men and women, whites and Other races, with the scientifically objective results confirming that the dominant group was more "intelligent."

The reified differences and meanings further the construction of the Other. Differences are assigned value which legitimizes and promotes domination and exploitation. Identities based on these differences are created. Rationales for stratifications are argued. The Other is made.

Robyn Rowland (1988) has described the social construction of women's identity by the reification of difference:

> I argue that men have created an identity for women, based in biology, which is intended to reinforce difference and to tie women to a "natural" position in such a way as to make woman the negative or Other. Through patriarchy men direct and try to impose this self on woman for the purpose of controlling her and maintaining woman as a serving class for men. (p. 2)

After naming, quantifying, and analyzing the variables, they are ranked. Complex and abstract qualities are reified into single entities to be ranked in a hierarchy of social, political, and economic value. Sex, skin color, age, sexual identity, culture, and economic class, once reified into meaningful social and political entities by the powerful, become determinants of power and privilege or powerlessness and exploitation. "Reification is not just an illusion to the reified: it is also their reality" (MacKinnon, 1982, p. 542).

In the reification step the differences measured in a variable are given meaning according to the theory being tested. Differences in variables such as skull size and sex hormones are reified into determinants of abilities and behaviors on which social, political, and economic domination can be justified.

Objectification

In objectification, the last step of the scientific construction of the Other, the full social,

political, and economic implications of the integration of the politics of dominance and the scientific method are revealed. Objectification is the process of turning a subjective entity into an object. The quality of objectivity, so highly valued in scientific methodology, is shown to be closely related, if not the same thing, as the process of turning an entity into a thing, an object — the defining quality of the Other.

Objectivity is seen as crucial to the process of science. Objectivity is what is supposed to prevent social and political subjectivity from skewing scientific results. One part of the construction of objectivity thought to be needed for the proper conduct of science is the distancing of the object of study from the scientist. Feminist scholars have noted that the objectification of a person or group is the starting point for violence against the person or group (Barry, 1979, p. 253). It has been further noted that the distance created by objectivity is "perhaps roughly the same distance necessary for pain's infliction" (Baldwin, 1992, p. 50).

Connecting the objectivity of the scientific method with social/political objectification, or identifying them as the same thing, forms the final link in the integration of the politics of domination with the scientific method. MacKinnon (1982) states, "Objectivity is the methodological stance of which objectification is the social process. It unites act with word, construction with expression, perception with enforcement, myth with reality" (p. 541).

Another way in which the politics of domination through science ensures the continuing stratification of power is the institutional discrimination against the Others. The exclusion or invisibility of women, Other races, the poor, the disabled, and gays and lesbians from participation in science ensures that their status as objects is maintained.

CONCLUSION

This interactive five-step process of the scientific construction of the Other reveals the integration in form and function of the politics of domination with the scientific method. "Statistics is a part of the technology of power in a modern state" (Kapadia, 1983, p. 170). Statistical analysis, as part of the scientific method, serves the powerful by constructing knowledge and meaning; it is a way of knowing and controlling the world.

More and more scholars of gender, race, and sexual identity are analyzing how these identity classifications are used to construct social reality. Biological determinism has long been shown to be sexism, racism, and heterosexism at work under the guise of science. The objectivity of science has long been suspect or rejected. The outcomes of scientific study on Other groups are frequently observed to be reinforcement for politics of domination. The continuing social stratifications by gender, race, class, sexual identity has led Sandra Harding (1991) to ask, "Is it possible that *more* scientific, medical, and technological research in societies stratified by race, class and gender actually *increases* social stratification?" (p. 36). If the scientific method is deeply implicated in constructing differences, then more research on differences leads to more reification of differences and more objectification of the Other.

The use of the statistical analysis in the scientific construction of Other goes beyond research in the natural sciences; it also includes all of the social sciences. The predominant research method in the social sciences is the use of statistical analysis to study people and society (Tankard, 1984, p. 1). For example, in analyzing her research on the homeless, Anne Pugh (1990) observed that "statistics contribute to the formation of a new ideology or stereotyping" (p. 108).

The continual reification of differences that occur in the natural and social sciences insures that the paradigms of domination and exploitation will never change. The only changes may be the variables. The resurgence of the women's movement in the last 25 years has generated much scientific research on gender and gender differences, but have the findings brought about more than incremental progress for women? I am reminded of the words of Audre Lorde (1984), "The master's tools will never dismantle the master's house. They may allow us temporarily to beat him at his own game, but they will never enable us to bring about genuine change" (p. 112). This thought raises a question about the value of continuing to measure and analyze differences between dominant and subordinate groups, no matter the good intentions of the researcher. At least it indicates the need for further thought on the use of the scientific method as a tool for social, political, or economic change. As MacKinnon (1983) states, "The equality of women to men will not

be scientifically provable until it is no longer necessary to do so" (p. 639).

The scientific method is as deeply implicated in the social construction of paradigms of domination and exploitation as any other institution in society. The invention of statistics was politically motivated and statistical methods are part of a process that scientifically constructs the identity of the Other — an essential step in justifying domination and exploitation. The integration of these politics of domination into the scientific method means, not only, that the scientific method is not objective, but that the scientific method itself is an agent for those with social, political, and economic power.

ENDNOTES

1. The history of statistics can generally be divided into three areas: the history of probability, the history of state collection of data, and the history of statistical methods. My analysis focuses only on the later. Western nation states started collecting statistics for political purposes in the mid-19th century. However, one of the earliest uses of a statistical test involved sex. In the early 1700s John Arbuthnot counted the number of males and females born in London from 1629 to 1710 and observed that more males were born than females in every year. He computed the probability of this happening if there was an equal likelihood of male and female births. After calculating the probability of this occurence, he rejected the possibility of a greater number of births of males being due to chance and concluded that the consistent pattern of greater male births proved the existence and action of God (Hacking, 1965, p. 77).
2. To emphasize the social constructedness of scientific methods I use the term *invention* when describing the evolution of statistical methodology.

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