

The Career of a Methodology

Ratio Scaling of Psychological Magnitude.

In Honor of the Memory of S. S. Stevens. STANLEY J. BOLANOWSKI, JR., and GEORGE A. GESCHIEDER, Eds. Erlbaum, Hillsdale, NJ, 1991. xvi, 324 pp., illus. \$49.95. From a conference, Syracuse, NY, July 1989.

Progress in psychology, as in other disciplines, proceeds in an uneven fashion, with periods of rapid growth spurred sometimes by new ideas but more often by new methods and the data they generate. During the 1950s and 1960s the Harvard psychologist S. S. Stevens (1906–1973) developed a set of techniques for the study of the intensity of sensations that quite transformed that field of study. The present volume presents the proceedings of a conference held in 1989 in honor of Stevens's achievements.

For many years it had been believed that the strength of sensations was nonlinearly related to the intensity of the stimuli that produced them, but the nature of that nonlinearity was largely a matter of speculation. In the mid-19th century it was proposed, in what came to be called Fechner's law, that sensation was logarithmically related to stimulus intensity, but little evidence could be produced to support that or any alternative view, because no methods more powerful than simple categorizing had been developed to estimate the magnitude of sensations. Everyone knew, for example, that the loudness of a tone grew as sound pressure was increased, and it was also apparent that it grew more slowly than the energy of the signal, but what was the exact form of the function?

It was Stevens who discovered that listeners could describe the loudness of signals presented for judgment with greater precision than was implied by simple categories such as "soft," "loud," and "very loud." Rather than limit his subjects to such insensitive categories, Stevens encouraged them to pick values on a continuous scale, such as number, and discovered that they had little hesitation in making fine distinctions with their numerical judgments and that those judgments consistently followed a power function in relation to the tones presented. This power law was subsequently confirmed for dozens of different perceptual continua, ranging from such straightforward cases as brightness, heaviness, and sweetness to such unusual instances as the apparent intensity of coffee odor, the perceived intensity of electric shock applied to the fingertips, and the felt roughness of sandpaper. In each case, the judged magnitude of the sensation grew as a power function of the stimulus intensity, confirming the generality of the power law. Even more provocative was

Stevens's discovery that the exponent for this power relation varied substantially among the various continua he studied. Though the judgments of some sensations (such as loudness) grew more slowly than did the strength of the signal, in other cases (such as electric shock) subjects reported their sensations growing as the square or even the cube of the stimulus strength.

Prior to Stevens's pioneering work, students of sensory systems had largely confined their psychological investigations to the study of very weak signals, and measures of detectability were relied upon almost exclusively. With the advent of Stevens's new methods it became possible to study the whole range of sensory experience, from the very faint to the painfully strong, and there followed an outpouring of new and useful information about the function of the various sensory systems. Much of what we now know about the perception of taste, smell, pain, skin pressure, and effort was learned by means of Stevens's techniques and variants of them. And the already large body of knowledge about hearing and vision has been increased in important and surprising ways because of these methods. As an unexpected dividend, these methods have proved readily applicable to a wide variety of perceptual continua in which the sensory components are multidimensional, such as size and distance, and even to subjective judgments where there is no simple metric for the associated physical correlate, such as the intensity of stage fright, phobic fear, and seriousness of criminal acts. Like the methods developed by B. F. Skinner (a colleague of Stevens's, for many years with a laboratory in the same building), techniques developed by Stevens in connection with problems in basic science have proved suitable for application to a host of practical questions in everyday life.

But, perhaps inevitably, following Stevens's death, the pace of new discovery has slowed considerably, and much of the work that continues to be done with his methods has more to do with the nature of these methods, the problems and biases that afflict them, and the variations of them that may succeed in avoiding those difficulties. (If it hasn't already been done, it might be useful to construct an index of productivity for scientific methods: the ratio of new published knowledge resulting from the use of a given method to the amount of published research about the method itself. As the ratio drops toward and even below unity, as seems to be the case for Stevens's scaling methods, it may be cause for concern.) It was therefore a timely and appropriate idea to bring together 20 experts in the field for a retrospective look at Stevens's techniques and an assessment of their present value.

I cannot say that the results of this assessment are very encouraging. Though a few of the participants had new and interesting findings to report, many could only provide reviews of past successes, and the theoretical and methodological papers provide a glimpse into the very considerable conflict about the best ways to address the serious problems that have surfaced in recent years. And, I think, the gravity of these problems may have been underestimated in a group of largely like-minded participants. A useful concluding chapter by the editors provides an interesting summary of the main issues raised in the individual papers as well as a final general discussion, but there remains much uncertainty about what lies ahead. The history of science yields many examples of new, and for a while productive, methods that were eventually abandoned. In psychology, the once-popular memory drum and its computerized successors have disappeared. On the other hand, tests of mental abilities, having run the gauntlet of searching criticism, have emerged in substantially new form and promise to play a continuing role in the study of human intellectual capacity. Whether Stevens's ingenious methods will undergo a comparable rejuvenation and stimulate a renewed flow of important knowledge about human perception remains to be seen. The interested reader can find in the present volume an account of some obstacles to that goal and some ideas about how to overcome them.

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Before and After Phage

The Emergence of Bacterial Genetics. THOMAS D. BROCK. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1990. xxii, 346 pp., illus. \$55.

Bacterial genetics is a field that grew out of studies of bacteria and bacterial viruses prior to 1940 and then began a meteoric rise to its prominent place in the history of molecular genetics owing to seminal work carried out principally in the 1940s and 1950s. Although books have been written about various parts of this story, until now no single treatise has covered the emergence of bacterial genetics in its entirety.

Thomas Brock's *The Emergence of Bacterial Genetics* will be regarded as the definitive treatment of the history of the science behind the development of bacterial genetics as we know it today. It is as remarkable for its completeness as for its deft interweaving