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CLYDE HAMILTON COOMBS

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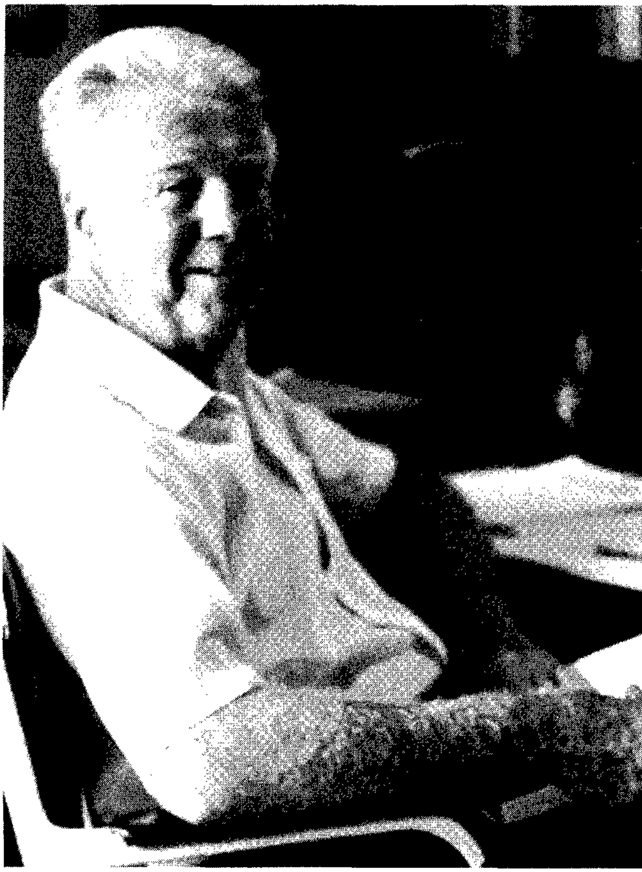
A Biographical Memoir by

AMOS TVERSKY

Biographical Memoir



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Clyde H. Coombs

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BY AMOS TVERSKY

CLYDE COOMBS will be remembered by his fellow psychologists and other social scientists for his seminal contributions to the analysis of qualitative measurement and multidimensional scaling, and for his innovative models of conflict and choice. Clyde will be remembered by his students and friends as an inspiring teacher and colleague, who stimulated and enriched the lives of those who were fortunate enough to know him. Clyde was endowed with enormous energy, genuine curiosity, and a deep commitment to research and testing. Research, for Clyde, was an exciting adventure in the realm of new ideas, and teaching provided him with an opportunity to share ideas with his students and to convey his contagious enthusiasm, as well as his personal warmth and unfailing sense of humor. Although Clyde was primarily a theoretician who developed mathematical structures for describing cognitive processes, he was also a gifted experimentalist who introduced several elegant and innovative designs and an ingenious data analyst who contributed some powerful and parsimonious methods for the analysis of psychological data. Indeed, much of Coombs' work may be characterized as an attempt to discover and articulate the formal structures that are hidden in psychological data.

Coombs' major contribution consists of his creative analysis of the qualitative structures that arise from similarity and preference data, and the insightful applications of this analysis to many psychological problems. In an early paper entitled "A Theory of Psychological Scaling" that appeared in 1952, Coombs developed his central ideas about qualitative measurement that served as the basis for the ideal point model and the unfolding technique. Coombs realized, as did other psychometricians, that the measurement of psychological attributes cannot be carried out using the standard logic of physical measurement that is based, in one form or another, on the concatenation of objects and is carried out by the counting of units.

How, then, can we quantify psychological attributes, such as similarity or preference? The traditional psychometric approach, applied by Spearman and Thurstone to the measurement of intellectual abilities, employs factor analysis and similar statistical techniques to construct abstract dimensions from observed intercorrelations among variables, such as test scores. An alternative approach, developed by Thurstone for the measurement of attitude and preference, posits an underlying probabilistic process whose location parameters, estimated from choice probabilities, are interpreted as psychological scale values. Coombs was not fully satisfied with either the correlational or the probabilistic approach to psychological measurement because they introduced strong, and largely unverifiable, assumptions. Instead, he approached the problem of psychological measurement from a purely ordinal perspective that does not presuppose a numerical structure. In this respect, Coombs' work pioneered the development of multidimensional scaling and axiomatic measurement theory, while Thurstone's work was the precursor of the modern theory of signal detection.

Coombs began his analysis with a classification of empirical relational structures based on (i) whether the observed relation is binary (e.g., *x* is brighter than *y*) or quaternary (e.g., *w* and *x* are closer than *y* and *z*), and (ii) whether the data refer to objects from one set (e.g., stimuli) or to objects from two distinct sets (e.g., individuals and stimuli). The two dichotomies yielded four kinds of structures that Coombs called preferential choice data, single stimulus data, stimulus comparison data, and similarities data. This classification scheme was used by Coombs to exhibit the distinctive features of different data structures that can nevertheless be embedded within a unified system.

The central elements in Coombs' system are the ideal point model for similarity and preference, the ordered metric scale derived from these data, and the unfolding technique for constructing this scale. Coombs' system, therefore, has three major components: a psychological model of choice, a measurement structure implied by the model, and a scaling technique for recovering the underlying structure. In the ideal point model, both individuals and stimuli are represented as points in some multidimensional space. The dimensionality of the space depends on the nature of the stimuli: rectangles are two-dimensional; paintings can have many dimensions. Each individual is represented in the space by an ideal point that corresponds to the most preferred position of that individual. According to this model, a person prefers option *A* over option *B* if and only if *A* is closer to *B* to his or her ideal point. Thus, voters order political candidates, or consumers order products, by the distances from their ideal points. This model does not restrict the representation of the options, and it allows different individuals to have radically different preference orderings. The force of the model stems from the assumption that all individuals and stimuli reside in a common space, which constrains the set of permissible preference orderings.

Coombs noted that the preference orders generated by different individuals convey a great deal of information about the structure of the common space—even when the number of alternatives is relatively small as is often the case in many applications. These data give rise to what Coombs called an order metric scale, which consists of a partial ordering of the distances between stimuli. This scale represents a new type in the classification of scales introduced by Stevens; it lies between the purely ordinal scale obtained by a simple ordering of stimulus points and the stronger interval scale that requires a complete ordering of all interpoint distances.

Coombs and his students applied this model to a wide variety of choice problems, varying from marketing to politics and from risk to psychophysics. The unidimensional case illustrates the power of the model. Consider, for example, a group of voters who rank-order each of several candidates for office, and suppose the candidates differ along a single left–right dimension. Because the ideal points of all the voters lie on the same left–right dimension, the permissible orderings of the candidates are constrained. Clearly, an individual whose ideal point is to the left of all candidates will order them from left to right, whereas an individual whose ideal point lies to the right of all candidates will order them from right to left. An individual whose ideal point lies near the middle of the scale, however, will prefer the candidates in the center to those who lie on either extreme. This model can accommodate many, but not all, preference orders. In particular, it prohibits any ordering in which both left and right candidates are preferred to those in the center. Such an ordering is excluded in the unidimensional case because there is no point on the line that is closer to both the left and the right than to the center. The preference orders that are compatible with the unidimensional ideal point model, therefore, are those generated by single-peaked utility functions over the left–right dimension. A single-peaked utility function is an ordinal scale of preference that reaches its maximum somewhere along the dimension and falls off monotonically in either direction. This notion, which generalizes the standard notion of a monotone utility function, played a central role in Coombs' research on choice and conflict. The significance of Coombs' analysis stems from the fact that it provides a method for discovering an underlying common dimension, if one exists, even when there is no *a priori* (e.g., left to right) ordering of the points. Thus, Coombs' model generalizes the psychometric notion of a unidimensional ensemble of items (e.g., test questions or attitude statements) developed by his longtime friend Louis Guttman.

In dealing with attributes such as money or pain, it is natural to assume that everyone will prefers more to less, or less to more. In such cases, the utility scale is a monotone function of the attribute in question. For such attributes, such as temperature, risk, or conservatism, we normally prefer intermediate levels over extreme ones, and different people prefer different levels. This state of affairs gives rise to the single-peaked preference functions, which Coombs investigated both theoretically and empirically. Many years later, Coombs discovered an explicit statement of this idea in an eighteenth-century book by Joseph Priestley, the discoverer of oxygen, who discussed the flow of pleasure and pain associated with variation in temperature. Although the significance of single-peaked preference functions has been recognized by several scholars since Priestley, Coombs made two distinct contributions in connection to this concept.

First, he analyzed the qualitative structure that lies behind this representation and showed how to recover the underlying dimension (e.g., right–left) from individuals' preference orders, when the ordering of the stimuli is not known in advance. He also showed that some of the metric properties of the dimension (i.e., the ordering of intervals) can also be inferred from the data, using the unfolding algorithm. Second, Coombs did not accept the presence of single-peaked preferences as a blind fact to be treated as a primitive concept. Instead, he attempted to derive it from more basic principles of hedonic experience. He proposed that nontrivial choices involve a conflict between the upside and the downside, or between the benefit and the cost. To understand the making of decisions, therefore, we must understand the principles that govern the resolution of this basic conflict. Coombs proposed two such principles: "One is that good things satiate and the other is that bad things escalate" (Coombs, 1983, p. 21). With George Avrunin, Coombs formalized these assumptions and showed how the satiation of good and the escalation of bad give rise to single-peaked preference functions. These assumptions also served as a basis for their systematic analysis of the various types of conflict (e.g., approach–approach, approach–avoidance), which was summarized in *The Structure of Conflict,* Coombs' last monograph, which was published after his death.

Coombs's contribution to the analysis of preference, however, is not limited to the investigation of its formal structure and its psychological underpinnings. Coombs applied these notions to a wide array of psychological problems, ranging from judgments of the severity of crimes to the pattern of citation in psychological journals, and from preferences concerning family composition to the problems of risk perception and risk preferences, to which he devoted much of his research.

Coombs did not view expected utility theory as an adequate descriptive model, and throughout his career he developed alternative accounts of risky choice, and tested them in many experiments. Coombs departed from the traditional analysis of risk in two important respects. First, he distinguished clearly between the perception and the preference for risk and explored their interrelations, using the newly developed methods of conjoint measurement. He investigated the parameters that control the perceived riskiness of options and concluded that it is determined primarily by the undesirable outcomes and their likelihood, rather than by the desirability of a risky prospect can be decomposed into two components: its expected actuarial value and the value of the risk it entails. Contrary to the classical assumption of risk aversion according to which all people minimize the risk component, Coombs argued that different individuals have different ideal levels of risk at the same level of expected value, and that people choose between gambles in order to achieve the level of risk they desire.

The ideal point model is very typical of Coombs' style and character. On the one hand, he was fiercely individualistic and committed to the idea that people are entitled to their own views, tastes, and beliefs. At the same time, he held strong beliefs and uncompromising views on scientific and personal conduct. The ideal point model reconciles the tension between individual freedom and global order. Individuals are allowed to have different ideal points and different preferences, yet they must all coexist in a common space that imposes some higher-order constraints, which are needed to ensure the coherence of the system.

BIOGRAPHY

Clyde Hamilton Coombs was born in New Jersey on July 22, 1912, but he spent most of his early life in California, where he developed a lifelong love of outdoor activities, particularly camping, tennis, and swimming. His first two college years were spent at Santa Barbara State, where he studied mathematics and engineering in preparation for a military career that he intended to pursue largely because his father, who died before Coombs was born, had been in the Navy. A course in psychology, however, opened up an exciting new world for Clyde and convinced him to change direction. Coombs stopped his college education for a year to read psychology and physiology, and continued his education at the University of California at Berkeley, where he majored in psychology. He was strongly influenced by Wagner Brown, Edward C. Tolman, Robert Tryon, and Nathan Shock. His preference for hard science led him to pursue courses in chemistry and biology, aiming to study psychological problems from a physiological perspective. He completed a master's thesis on adaptation of the galvanic skin response, and he planned to do a dissertation on olfaction.

The second event that changed Coombs' academic course was the appearance of L. L. Thurstone's *Vectors of the Mind,* which first introduced Coombs to the new field of mathematical psychology. One of his teachers at Berkeley, Robert Tryon, formed a small group that went through Thurstone's book chapter by chapter. Coombs was very impressed with the possibilities of using mathematical models to study psychological processes, and he wrote to Thurstone, who offered Coombs a research assistantship at the University of Chicago. In 1937 Coombs went to Chicago and began a new phase in his intellectual development. Thurstone had created in Chicago a stimulating intellectual environment, full of fervor and excitement. The weekly seminars in Thurstone's home generated intense discussions of basic scientific and methodological problems. Coombs followed Thurstone's example and, for more than thirty years, he ran a weekly seminar in his home in Ann Arbor that became a major forum for the discussion of new, exciting ideas in measurement, scaling, and decision research.

At Chicago Coombs studied mathematical biophysics with Nicholas Rashevsky, who provided him with a different perspective on mathematical modelling. Coombs also met a graduate student in demography, Lolagene Convis, who later became his wife. Clyde and Lolagene Coombs had two children, Steven and Douglas. As a graduate student, Coombs was asked to teach an elementary course in social psychology, a field with which he was not acquainted. Approaching this task with his characteristic enthusiasm, Clyde put an enormous amount of effort into preparing the course, which made him appreciate both the significance of social psychology and the difficulty of applying the scientific method to the complicated problem of interpersonal relations. Much of his work in the following years dealt with the attempt to use formal models and deductive reasoning to illuminate complex psychological processes. This is the theme of his 1983 book *Psychology and Mathematics.*

After receiving his Ph.D. in 1940, Coombs became a personnel research psychologist for the U.S. War Department. Over the next six years, he rose to the rank of major and designed a separation counseling program for demobilized G.I.s that won him the Legion of Merit. In 1947, Coombs returned to academic life, joining the psychology department of the University of Michigan in Ann Arbor under the inspired chairmanship of Donald Marquis, who encouraged a broad-based department and was very supportive of interdisciplinary approaches and innovative research. At the invitation of Samuel Stauffer, director of the Laboratory of Social Relations, Coombs spent the academic year 1948–49 with Paul Lazarfeld and Fred Mosteller at Harvard University, where he began to develop his "ideal point" model and unfolding technique.

Upon his return to Michigan in 1949, Coombs began developing a mathematical psychology program that became noted for the quality of its staff, research, and students. Coombs initiated an interdisciplinary seminar that attracted people from philosophy, mathematics, economics, political science, sociology, and psychology—all interested in the development of a mathematical social science. In the summer of 1952, Coombs and R. M. Thrall, of the mathematics department, received a grant from the Ford Foundation for a summer institute on interdisciplinary approaches to measurement and decision making. The result of the summer institute, held in Santa Monica, was a book edited by Thrall, Coombs, and Davis entitled *Decision Processes,* which played an important role in shaping the emerging field of behavioral decision research and mathematical psychology.

While Coombs was developing and refining his theoretical ideas, he also carried out an innovative experimental program. A particularly insightful study that revealed some of the stochastic characteristics of choice behavior was conducted while Coombs was a Fulbright fellow at the University of Amsterdam in 1955–56. This experiment, which involved choice between various shades of gray, demonstrated elegantly the need to incorporate ideal points (in this case concepts of a perfect gray) into the measurement of sensation. The next sabbatical year, spent at the Center for Advanced Study in the Behavioral Sciences in Palo Alto in 1960–61, gave Coombs the opportunity to put together many of the ideas he had developed over the years. The logical interrelations among the various data-collection procedures and data-analytic techniques were explored in detail in Coombs' major book on scaling, *A Theory of Data,* which was published in 1964. Back at Michigan, Clyde continued to teach and train a new generation of mathematical psychologists. He took enormous pride in his students and followed their intellectual development throughout the years. His lively and exciting course on mathematical psychology attracted many students, who convinced him to write an elementary graduate text based on this course. This book, coauthored with former students Robyn Dawes and Amos Tversky, appeared in 1970, and it has been translated into six foreign languages.

Lolagene Coombs' research on fertility problems and gender preferences in Asia provided Coombs with a new domain for his scaling methods. Working together, Lo and Clyde utilized conjoint measurement and unfolding theory to develop scales for measuring people's preferences for family size and gender composition. These scales, and the models from which they derived, were applied and tested in many countries. Their research showed that despite the large variations among cultures, people's preferences in all countries are better described in terms of ideal points for the number of children and for the balance between genders than in terms of specific ideal points for the number of boys and the number of girls.

Much of Coombs's work on choice was concerned, directly or indirectly, with the question of conflict. How do people reconcile incompatible goals and inconsistent objectives, and how do they trade off risks against benefits? Shortly before his retirement, Coombs turned his attention and energy to this fundamental problem. In collaboration with George Avrunin, he explored the origin of the single-peaked preference function that played such a central role in his work and analyzed the structure of both intrapersonal conflict and interpersonal conflict from this perspective. This work culminated in a book entitled *Structure* *of Conflict*, which brought together many of the major themes from Coombs' work. With an impeccable sense of timing, Coombs was able to complete the revisions of the manuscript and send it to the publisher a day before his unexpected death.

Coombs' retirement from the University of Michigan did not slow him down in the least. With his characteristic exuberance and zest for life, he continued to pursue his research on the structure of conflict and to teach at the universities of Hamburg, Calgary, and Santa Barbara. The flexible "retirement" schedule permitted him and Lo to travel to far places, such as the Galápagos and the Amazon, to play tennis, to go camping in Idaho, and to continue his activity in the French Wine Club that had amply supplied his table for many years. The Coombses spent more time at their second homes in Vermont and Florida, but Clyde always carried his portable computer from one setting to another, and that allowed him to continue the work he enjoyed so much. Until the very last day, he remained an active outdoorsman, a witty conversationalist, and a gracious host.

Clyde was a creative scientist, an inspiring teacher, and a beloved friend. But perhaps his most precious gift was his ability to enjoy life—people, research, scenery, and art—and to make others' lives richer and more enjoyable. In a field populated by models, Clyde provided the best model of all: himself.

He will be remembered and missed.

HONORS AND RECOGNITIONS

For many years, Clyde Coombs chaired the Mathematical Psychology Program at the University of Michigan. He served on numerous review committees for the National Science Foundation, the National Institutes of Health, the Canadian Research Council, and the Deutsche Forschungsgemeinschaft. He was president of the Psychometric Society (1955–56) and of the Division of Measurement and Evaluation of the American Psychological Association (1958–59), and he was the first head of the Society for Mathematical Psychology (1977–78). He was an honorary fellow of the American Statistical Association (since 1959), and he was elected to the American Academy of Arts and Sciences (1977) and to the National Academy of Sciences (1982). He received an honorary doctorate from the University of Leiden, The Netherlands, in 1975, and was awarded the Distinguished Scientific Contribution Award of the American Psychological Association in 1985.

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