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Frontiers of Mathematical Psychology: Essays in Honor of Clyde Coombs

Edited by Donald R. Brown and J. E. Keith Smith. New York: Springer-Verlag, 1991. 202 pp. Paper, $35.00.

Titles can be seductive. "Frontiers" seems to promise that mastery of the volume will provide one with a good sense of what is current in that field. Certainly *Frontiers of Mathematical Psychology* is easily mastered by any experimental or cognitive psychologist, but he or she will learn little about contemporary mathematical psychology. Just leafing through the volume provides a warning hint, at least to the trained eye: Very little mathematics is in evidence. A more careful perusal uncovers little that is new in mathematical modeling, although much of the empirical work described in the book has been stimulated by one model or another. If these are the frontiers, they are largely empirical, not mathematical.

Mathematical psychology has two central aspects plus a strong interplay with parts of experimental psychology. One aspect is the development of applicable mathematics designed for the peculiarities of our science, analogous to the development since the seventeenth century of mathematical analysis for physics and, in this century, of combinatorial analysis for dealing with aspects of finite physical and computational structures. The second is the modeling of specific psychological phenomena.

Mathematics applicable to psychology encompasses a number of areas. One is special topics in probability and statistics motivated by our problems. Recent examples include general attempts to devise stochastic methods to use response times in distinguishing various underlying processing networks (Link, 1992; Luce, 1986; Schweickert & Townsend, 1989; Townsend & Ashby, 1983; Townsend & Schweichert, 1989) and multinomial modeling as an alternative to analysis of variance in analyzing commonly used designs in cognitive psychology (Batchelder & Riefer, 1990). A second is seen in most of the span of the journal *Psychometrika*—factor analysis, multidimensional scaling, classification, and various latent attribute models. These are schemes, applicable to fairly broad ranges of experiments and observations, that seek out the structure in bodies of data. This was an area to which the late Clyde Coombs, whose memory this book honors, devoted much effort (e.g., his 1964 *A Theory of Data*). A third broad area encompasses the various axiomatic representation theories. These include measurement structures, some developments concerning the classical geometric axiomatizations, called synthetic, leading to representations as analytic geometries, and the recent attempts to axiomatize geometries using primitives more appropriate to the behavioral sciences than lines and points (Falmagne, Koppen, Villano, Doignon, & Johannesen, 1990; Krantz, Luce, Suppes, & Tversky, 1971; Luce, Krantz, Suppes, & Tversky, 1990; Narens, 1985; Suppes, Krantz, Luce, & Tversky, 1989). Still another topic of applicable mathematics concerns properties of various kinds of networks suggested by neural systems, among them connectionist models (Grossberg, 1982; McClelland, Rumelhardt, & PDP Research Group, 1986), that are of interest to neuroscientists, psychologists, and computer scientists focused on artificial intelligence. Contributions to this area appear only rarely in psychological journals or at psychological meetings, usually being reported at neuroscience and specialized conferences.

The dividing line between applicable mathematics and models of specific phenomena surely can be very fuzzy. Should the various breeds of stochastic learning models of the 1950s and 1960s have been thought of as specific or general? Norman (1972) clearly thought general, but many of the papers were certainly specific. Which type is a theory for aptitude testing? My pragmatic test is to ask where most such papers are usually published: in a clearly methodological journal or a more substantive one? Scientists working in vision or audition are of necessity, to some degree, mathematical psychologists, but with few exceptions their models—often quite mathematically subtle—are found in specialty journals or in major psychological journals such as *Psychological Review, Psychological Bulletin,* and *Perception & Psychophysics.* It is rare, but not unheard of, for such articles to appear in the *Journal of Mathematical Psychology, Psychometrika,* or the *British Journal of Mathematical and Statistical Psychology.* Likewise, there is a huge modeling literature having to do with judgment and decision making, some of it quite mathematical, which mostly appears in interdisciplinary specialized journals appealing to subgroups of psychologists, economists, management theorists, and decision analysts. Very little, if any, is found in the general methodological journals.

The final feature of the area are experiments motivated by the models.

Although I do not class this as at the center of what I mean by "mathematical psychology," I do not intend to suggest that it is either a small or unimportant activity—quite the contrary. Rather, I maintain that from the perspective of mathematical psychology, experimental tests form a partial partner in the sense that they are often of as much interest to the substantive subfield itself as to model builders.

In this last judgment, I may be betting on a losing horse judging by the book under review and by some of the contributions at recent meetings of the Society for Mathematical Psychology, although not those of the European Mathematical Psychology Group. Still, the journals themselves tell us something. Table 1 provides my somewhat subjective counts of articles in these three categories, plus an additional one that may become increasingly important, in recent volumes of the three major methodological journals as well as in *Frontiers*. To be sure, this book is based on a very small and special sample of people—some of those associated one way or another with Coombs—but presumably it was intended to be representative. Unfortunately, it is not.

To understand more fully what is encompassed by the book, I take up the individual chapters—there are only seven in addition to an introduction, which is a reprint of a sensitive memorial piece prepared by Amos Tversky (in press).

The first main chapter, by David H. Krantz, is mostly expository. I list it as ½ applicable mathematics because it gives a succinct indication of some of the simpler measurement representations (see Krantz et al., 1971) and their relations to aspects of scaling; little is said of the work of the past decade (see Luce et al., 1990). The remainder discusses applications of measurement approaches to three distinct substantive problems. The first recounts Krantz's 1970s axiomatic contribution—a brilliant success story—to our understanding of the three-dimensional vector space of color mixtures (a full treatment is given in Suppes et al., 1989, chap. 15). He next examines "the myth of utility," describing briefly the classical approach using choice as a primitive, where additive conjoint measurement is, more or less directly, the fundamental tool of analysis. Krantz cites many of the empirical and

Table 1. Classification of articles in *Frontiers of Mathematical Psychology* and in several relevant journals

Category	*Frontiers*	*JMP* 1990–91	*Psyk* 1990	*BJMSP* 1990–91
Applicable math	½	22	40	38
Specific models	1½	12	0	5
Experimental tests	5	1	0	0
Algorithms	0	0	4	0

Note. JMP, Journal of Mathematical Psychology; Psyk, Psychometrika; BJMSP, British Journal of Mathematical and Statistical Psychology.

normative questions that have been raised against this modeling strategy. He suggests that "some fairly powerful alternative formalism needs to be invented, in which one evaluates potential actions taking account of likely goal changes as well as likely outcomes" (p. 38). In fact, such work is underway, but not in this volume. Surprisingly, he does not mention the early, but still interesting, contributions of Coombs to this topic. Finally, Krantz sketches some new ideas that he and collaborators are developing that involve applying additive conjoint measurement to the study of inferences. This looks potentially interesting, although as described it seems in a very early stage of development.

The last chapter, by J. E. Keith Smith, offers a very specific model for the speed-accuracy tradeoff that exists when one makes a rapid limb movement toward a specific location, such as a finger moving to touch an object. Elaborating on earlier ideas, he develops predictions from the model when the movement is partitioned into several submovements of increasing refinement until the finger is within some range of the target location. This is an appropriate, if highly specific, example of its genre. Unfortunately, it fails as a model of exposition; I, at least, found obscure the arguments leading to the key equations. Once stated, the model is fit to two existing data sets with mixed success. The idea of submovements, as many as four, seems plausible, but the details of the underlying distributions clearly need revision.

The remaining five chapters are fairly loosely coupled to modeling, being primarily empirical in nature. I take them up in order. Robyn M. Dawes, whose contributions are as always insightful and rich in illuminating real-world examples, summarizes a number of classical ideas and results about social dilemmas which have attracted a good deal of attention since the arrival of game theory in the middle of the century. He attributes certain weaknesses to many of the empirical studies, in particular inadequate experimental manipulation. Dawes then summarizes several experiments that he and his collaborators have published elsewhere aimed at understanding how various factors affect how groups deal with the dilemma. The effects are large. In time, they should feed back into the modeling of such dilemmas, but no new model is proposed.

Gordon G. Bechtel says of his contribution that it "adds the notions of item reactivity and item distribution to Coombs' formulation . . . [and] it leads to an aggregate item response theory . . . which sets the benchmark for estimating and assessing the unidimensionality of a set of items purportedly measuring a given construct" (p. 80). So in a sense, this is a new mathematical wrinkle, but the main portion of the paper is given over to applying the revised model to some existing survey data on consumer confidence and demand. He concludes that one of the standard items used to assess consumer demand could usefully be partitioned into several subscales.

William M. Goldstein and Jane Beattie address the general issue of the concept of the relative importance of distinct factors in decision making. They describe some of the suggestions that have been made for assessing the concept, and point out how each suffers from either confoundings with other concepts, extreme model dependence, or both. The main focus of their chapter is two experiments intended to demonstrate that relative importance of factors is a real concept that can be manipulated experimentally, greatly affecting the responses of subjects. They conclude that it is a concept of significance to decision theorists, one that must be incorporated into their models, but they make no suggestions about how this is to be done.

Homogeneous geometric models are widely used in psychology, especially in the scaling literature (e.g., factor analysis and multidimensional scaling). As Richard J. Gerrig, Laurence T. Maloney, and Amos Tversky observe, if this class of geometries is correct, then the angles between inferred dimensions should be independent of where in the space the dimensions are evaluated. Three experiments are reported in detail. Invariance of angles is sustained in data on size of rectangles but fails dramatically for judgments about personality traits and emotional states. Presumably, homogeneous models are going to have to be replaced by nonhomogeneous ones, which is the same conclusion that vision scientists have drawn from entirely different data about the geometry of perceptual space (see Suppes et al., 1989, pp. 147–152).

Finally, Gary H. McClelland and William D. Schulze focus experimentally on the sizeable discrepancy between what a person is willing to pay for an object and what he or she is willing to accept for it when it is owned. They first attempt to account for the behavior in terms of prospect theory (Kahneman & Tversky, 1979) but conclude that it cannot be done using a fixed status quo. Ultimately, their conclusion is that the magnitude of the discrepancy is controlled by how the problem is framed and so how the person feels about the loss of the object when it is sold. No explicit model is proposed.

The volume ends abruptly with neither a summary chapter nor an index.

So, we have seven largely expository and, for five, empirical contributions that are held together primarily by the closeness of the authors to the highly revered Clyde Coombs, not by their representing the latest or best work in mathematical psychology. "Frontiers" it is not. Why is it not sufficient for an honorific volume to be titled as such, in this case by its subtitle?

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Witness for the Defense: The Accused, the Eyewitness, and the Expert Who Puts Memory on Trial

By Elizabeth Loftus and Katherine Ketcham. New York: St. Martin's Press, 1991. xiv + 288 pp. Cloth, $19.95.

Eyewitness memory is one of the areas of experimental psychology that is often cited as a useful application, and at the same time criticized as a topic about which psychologists should never be allowed to testify. *Witness for the Defense* is clearly meant as a contribution to this argument, though of a kind to which scientists are little accustomed: romanticization of Elizabeth Loftus's experiences as an expert witness. The book is written for a very large audience, and therefore it lacks the style that typifies scientific literature. But it is exactly this feature that opens up the discussion to those people involved in the legal system—judges, lawyers, and jury members.

Witness for the Defense convinces by its narrative, rightly or wrongly. In the courtroom, as I will argue later, story value is more important than scientific argument. If this book, through its direct approach and emotional appeal, is going to convince trial courts about the value of expert testimony on memory problems, its importance cannot be overestimated.

After a summary exposition of some research on memory, *Witness for the Defense* tells the stories of eight criminal trials in which memory problems played a decisive role. One theme in the stories is how science helped to resolve some of the problems facing the courts. An even more important