Book Review


It is a curious fact that although everyone recognizes that psychological experience possesses a time dimension, psychology has virtually ignored this fact, judging by the choice of experimental designs and analytical tools. Certainly these tools, such as ARIMA, MANOVA, factor analysis, have achieved a very high level of sophistication, including the introduction of methods for dealing with inherent nonlinearities among the dependent variables. Nevertheless, the models constructed are static, frozen in time, mere snapshots of our psychological world.

Recognition of the importance of the time dimension has come relatively late to psychology, essentially within the past twenty years. Spurred by its success in the physical sciences, researchers began to apply ideas emanating from the study of dynamics, particularly nonlinear dynamics, to problems relevant to psychology, such as the structure of the electroencephalogram, the structure of psychological development, and the dynamics of organizations. Most researchers worked in isolation, but were given a boost ten years ago with the formation of the Society for Chaos Theory in Psychology & Life Sciences, which brought these researchers together into a common forum for the dissemination of their work and ideas and in particular, their methods.

Scientific research advances on the shoulders of its methodologies, and it is critical for its researchers to have up to date and detailed descriptions of these methodologies in order for the field to grow. Sadly, the teaching of quantitative methods in the standard psychology curriculum is limited to static statistical methodologies, without much exposure to other branches of mathematics and almost certainly without exposure to dynamical systems theory in any form.

To be fair, the lack may be due in part to the relative absence of accessible textbooks. To my knowledge there are only two: A Visual Introduction to
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Dynamical Systems Theory for Psychology by F. Abraham, R. Abraham, and C.D. Shaw (1990), and Understanding Nonlinear Dynamics by D. Kaplan and L. Glass (1995). Although these two books provide an excellent introduction to the mathematics underlying dynamical systems approaches, they have little detailed information about the related methods that are to be applied to the analysis of real experimental data. Thus the average psychological researcher is forced to attempt to master the vast and technically challenging literature available in the mathematics, physics, and engineering journals. At least that has been the case until now. Finally, however, researchers have at their disposal an accessible, thorough and comprehensive handbook of nonlinear dynamical systems methods, specifically oriented towards applications in psychology.

In ten chapters, Heath surveys all of the most important areas being applied in current research. The range is truly impressive, as is the adherence to examples based either on real psychological experiments or on simulations motivated by psychological questions. Examples include the tracking of anxiety ratings during forty sessions of psychotherapy, the analysis of temporal correlations in time series of response times in a line length discrimination experiment, the analysis of interkeypress data from an extended typing study, the analysis of a two channel tracking task, the analysis of handwriting velocity, the analysis of time series of EEG and ECG signals, and neural network simulations. In almost every case, the examples are based upon real data, which lends an important air of credibility as well as relevance to the text.

The first two chapters cover fairly standard approaches to the linear analysis of time series data using ARIMA, autocorrelation, power spectrum, and, in the case of nonstationary time series, adaptive Kalman filtering.

Nonlinearity is introduced in Chapters 3 and 4 in the context of the creation of system identification models using transfer functions to relate stimulus and response. In Chapter 3, Heath compares and contrasts linear and nonlinear approaches using the method of nonlinear system identification developed by Marmarelis and Marmarelis in 1978. In Chapter 4, Heath presents a generalization of this approach that includes a learning component based upon a gradient decent minimization procedure, in order to obtain an improved fit between model and data.

These first four chapters take what might be described as a systems theory approach to data analysis, since these methods find their origins in the systems literature. The discussion of nonlinear dynamical systems methods properly begins in Chapter 5 and extends through to Chapter 8.

Chapter 5 concerns itself with the graphical representation of data, beginning with the phase space, indisputably the heart of nonlinear dynamical systems methods. This chapter is notable for its extensive discussion of