THE CONCEPT OF PROBABILITY IN PSYCHOLOGICAL EXPERIMENTS

THEORY AND DECISION LIBRARY

AN INTERNATIONAL SERIES
IN THE PHILOSOPHY AND METHODOLOGY OF THE
SOCIAL AND BEHAVIORAL SCIENCES

Editors:

GERALD EBERLEIN, *University of Saarland*
WERNER LEINFELLNER, *University of Nebraska*

Editorial Advisory Board:

K. BORCH, *Norwegian Schools of Economics and Business Administration*

M. BUNGE, *McGill University*

J. S. COLEMAN, *University of Chicago*

W. KROEBER-RIEL, *University of Saarland*

A. C. MICHALOS, *University of Guelph*

A. RAPOPORT, *University of Toronto*

A. SEN, *University of London*

W. STEGMÜLLER, *University of Munich*

K. SZANIAWSKI, *University of Warsaw*

L. TONDL, *Prague*

VOLUME 8

THE CONCEPT OF PROBABILITY IN PSYCHOLOGICAL EXPERIMENTS

Edited by

CARL-AXEL S. STAËL VON HOLSTEIN
Stanford Research Institute

D. REIDEL PUBLISHING COMPANY

DORDRECHT-HOLLAND/BOSTON-U.S.A.

Library of Congress Catalog Card Number 74-83873

ISBN-13: 978-94-010-2290-3 e-ISBN-13: 978-94-010-2288-0
DOI: 10.1007/978-94-010-2288-0

Published by D. Reidel Publishing Company,
P.O. Box 17, Dordrecht, Holland

Sold and distributed in the U.S.A., Canada and Mexico
by D. Reidel Publishing Company, Inc.
306 Dartmouth Street, Boston,
Mass. 02116, U.S.A.

All Rights Reserved

Copyright © 1974 by D. Reidel Publishing Company, Dordrecht, Holland
and copyrightholders as specified on appropriate pages within

Softcover reprint of the hardcover 1st edition 1974

No part of this book may be reproduced in any form, by print, photoprint, microfilm,
or any other means, without written permission from the publisher

CONTENTS

INTRODUCTION	VII
ACKNOWLEDGEMENTS	XI
BRUNO DE FINETTI / The Value of Studying Subjective Evaluations of Probability	1
BRUNO DE FINETTI / The True Subjective Probability Problem	15
DANIEL KAHNEMAN and AMOS TVERSKY / Subjective Probability: A Judgment of Representativeness	25
THOMAS S. WALLSTEN / The Psychological Concept of Subjective Probability: A Measurement-Theoretic View	49
GERARD DE ZEEUW and WILLEM A. WAGENAAR / Are Subjective Probabilities Probabilities?	73
ROBERT L. WINKLER and ALLAN H. MURPHY / On the Generalizability of Experimental Results	103
ROBERT L. WINKLER / Statistical Analysis: Theory Versus Practice	127
A SELECTED BIBLIOGRAPHY	141
AUTHOR INDEX	147
SUBJECT INDEX	151

INTRODUCTION

1. BACKGROUND

The last twenty-five years have seen a large amount of psychological research in the area of behavioral decision theory. It followed the major breakthrough of decision theory that came with von Neumann and Morgenstern's *Theory of Games and Economic Behavior* in 1944. The key concepts are probability as a measure of uncertainty and utility as a measure of value and risk. The theory prescribes, given some behavioral axioms, that alternatives should be ranked in accordance with their expected utilities.

Psychologists became interested in studying how people's decision behavior agreed with what was prescribed by the theory. Three broad areas for research developed, i.e., research relating to each of the two concepts of probability and utility, and research relating to the interaction of the two in decision situations.

The papers in this book have been selected to illustrate various aspects of how the concept of probability has been used in psychological experimentation. The early experiments were generated, as mentioned above, by an interest among psychologists to see how people evaluate uncertainty and quantify it in probabilistic terms. Many of these experiments set out to evaluate subjects' estimates of relative frequencies; these were situations where one had access to 'objective' answers. In the 1960's psychologists changed the focus of their studies to how people revise probabilistic judgments when they receive new information. In recent years there has been a growing interest in the cognitive processes by which people express their judgment in probabilistic terms. This means that the research aims at answering "*how* do people evaluate uncertainty" rather than "*how well* do people evaluate uncertainty".

The major part of experiments in probability encoding by psychologists has thus been generated by an interest in testing whether the normative decision theory is also descriptive of people's behavior in uncertain

situations. However, there is also a class of experiments that has been generated from learning theory. 'Probability learning' really means the learning, by observing a long sequence of trials, of the relative frequency of an event that is generated by a simple stochastic process. This has been used as an area of application for testing various hypotheses of statistical learning theory.

Experiments in probability encoding have not been restricted to psychologists. There have also been statisticians and decision theorists who have been addressing the questions of how to find an efficient procedure for quantifying judgment in practical situations and how to measure the quality of probabilistic forecasts. The research takes the normative theory as given and tries to make it operational for real problems. This has lead to experimentation that has been more focused on practical situations, as contrasted to the well-controlled but oversimplified practical situations favored by psychologists.

The personalistic view of the probability concept has been a major determinant of the explosive interest in experimentation around the probability concept. According to this view, a probability represents a degree of belief and is therefore associated with the person making a probabilistic statement. It was well developed forty years ago by, for instance, Ramsey and de Finetti, but did not attract much attention before the publication in 1954 of Savage's book *The Foundation of Statistics*. This book and subsequent publications by statisticians and psychologists presented an interpretation of the probability concept that inspired psychological experimentation. This is only natural since the interpretation focuses on personal judgment, in contrast to the classical frequentistic interpretation, which views probability as a property of an object or a process and therefore cannot be expected to invite much psychological research.

2. CONTENTS

The purpose of the book is to illustrate questions relating to the use of probabilities in psychological experiments. The topics range from the philosophical how the interpretation of the probability concept affects or should affect the choice of experiment, to the practical whether the results from a laboratory experiment can be extrapolated to real-world problems.

Half the authors are psychologists and half are mathematicians or statisticians (in a broad sense). Philosophers, psychologists and decision theorists should all find something of interest here and quite possibly new angles on their work. That is, the book may serve as an introduction for mathematicians and philosophers to the kind of behavioral research concerned with the probability concept that has been performed in the last twenty years. The book also contains contributions that concern the fundamental bases for the choice and design of psychological experiments, and thus should also be of interest to psychologists.

The book begins with two contributions by de Finetti. The first paper expounds the subjective (personal) interpretation of probability and discusses why it is valuable to study how people form probabilistic judgments. The second paper was originally presented at a conference as a discussion of some psychological experiments. It extends the first paper in that it argues why some typical experiments do not agree with a subjective interpretation and also suggests areas that would be more relevant for experimentation.

Kahneman and Tversky have been concerned with the processes by which people formulate judgments about uncertain quantities. They argue that people rely on a limited number of heuristic principles by which the complex task of assigning a probability is reduced to simpler judgmental operations. This book includes a paper of theirs on representativeness, which is a heuristic that comes into play in most practical situations.

Wallsten discusses the probability concept on the basis of empirical implications of axiom systems for measurement. He concludes that few, if any, current theories of subjective probability are satisfactory because human behavior does not seem to be consistent with these theories. Simultaneous conjoint measurement is presented as a possible solution for a theory concerning behavioral aspects of uncertainty.

The contribution by de Zeeuw and Wagenaar discusses whether it is admissible to identify actual behavior with a probabilistic model that describes the behavior reasonably well. This is often implicitly assumed and leads to a confusion problem. Behavior in uncertain situations may be based on computational structures but these need not be probabilistic in nature. Research to identify such structures is discussed, in particular with respect to the confusion aspect.

ACKNOWLEDGEMENTS

The paper by Kahneman and Tversky is a slightly abridged version of a paper published in *Cognitive Psychology* **3** (1972), 430–454. Much of the material in the paper by Winkler and Murphy appeared as ‘Experiments in the Laboratory and the Real World’, in *Organizational Behavior and Human Performance* **10** (1973), 252–270. I am grateful to Academic Press, Inc., for their permission to include the two papers in this book.

I would also like to thank David Krantz, Amnon Rapoport, and Paul Slovic for valuable assistance as referees.

ACKNOWLEDGEMENTS

The paper by Kahneman and Tversky is a slightly abridged version of a paper published in *Cognitive Psychology* **3** (1972), 430–454. Much of the material in the paper by Winkler and Murphy appeared as ‘Experiments in the Laboratory and the Real World’, in *Organizational Behavior and Human Performance* **10** (1973), 252–270. I am grateful to Academic Press, Inc., for their permission to include the two papers in this book.

I would also like to thank David Krantz, Amnon Rapoport, and Paul Slovic for valuable assistance as referees.