# NEURAL NETWORKS AND PSYCHOPATHOLOGY

## Connectionist models in practice and research

Research on connectionist models is one of the most exciting areas in cognitive science, and neural network models of psychopathology have immediate theoretical and empirical appeal. This volume aims to bring clinicians and computer modellers into closer contact, recognizing that clinical science often lacks an adequate theoretical framework for integrating neurobiological and psychological data, while neural networks, which have been tremendously successful in modelling a range of important psychological phenomena, have focused less on models of psychopathology.

The contributors to this pioneering book review theoretical, historical and clinical issues, including the contribution of neural network models to diagnosis, pharmacotherapy and psychotherapy. Models are presented for a range of disorders, including schizophrenia, obsessive–compulsive disorder, dissociative phenomena, autism and Alzheimer's disease.

This book will appeal to a broad audience. On the one hand, it will be read with interest by psychiatrists, psychologists and other clinicians and researchers in psychopathology. On the other, it will appeal to those working in cognitive science and artificial intelligence, and particularly those interested in neural network or connectionist models.

DAN J. STEIN is Director of the MRC Research Unit on Anxiety and Stress Disorders in the Department of Psychiatry, University of Stellenbosch, South Africa.

JACQUES LUDIK is Senior Lecturer in the Department of Computer Science, University of Stellenbosch, South Africa.

# NEURAL NETWORKS AND PSYCHOPATHOLOGY

## Connectionist models in practice and research

DAN J. STEIN

Department of Psychiatry
University of Stellenbosch

JACQUES LUDIK

Department of Computer Science
University of Stellenbosch

CAMBRIDGE UNIVERSITY PRESS

PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
The Pitt Building, Trumpington Street, Cambridge CB2 1RP, United Kingdom
CAMBRIDGE UNIVERSITY PRESS
The Edinburgh Building, Cambridge CB2 2RU, UK http://www.cup.cam.ac.uk
40 West 20th Street, New York, NY 10011-4211, USA http://www.cup.org
10 Stamford Road, Oakleigh, Melbourne 3166, Australia



First published 1998

Printed in the United Kingdom at the University Press, Cambridge

Typeset in Times [KW]

*A catalogue record for this book is available from the British Library*

*Library of Congress Cataloguing in Publication data*

Neural networks and psychopathology : connectionist models in practice
and research/ [edited by] Dan J. Stein, Jacques Ludik.
p. cm.
Includes index.
ISBN 0 521 57163 4 (hardback)
1. Psychology, Pathological–Computer simulation. 2. Neural
networks (Neurobiology). 3. Cognitive psychology. 4. Neural
networks (Computer science). I. Stein, Dan J. II. Ludik, Jacques,
1960–
[DNLM: 1. Mental Disorders–physiopathology. 2. Neural Networks
(Computer) 3. Mental Disorders–diagnosis. 4. Mental Disorders–
therapy. 5. Psychopathology–methods. WM 140 N494 1998]
RC455.2.D38N48 1998
616.89–dc21
DNLM/DLC
for Library of Congress 98-5826 CIP

ISBN 0 521 57163 4 hardback

For our families, with thanks for their support.
D.J.S.
J.L.

# Contents

# Contributors

German E. Berrios
*Department of Psychiatry, University of Cambridge, Addenbrooke's Hospital, Cambridge CB2 2QQ, UK*

Franz Caspar
*Institute of Psychology, University of Bern, Muesmattstrasse 45, 3000 Bern 9, and Psychiatric Hospital Sanatorium Kilchberg, Switzerland*

Eric Y. H. Chen
*Department of Psychiatry, University of Hong Kong, Hong Kong*

Ira L. Cohen
*Division of Behavioral Assessment and Research, Institute for Basic Research in Developmental Disabilities, 1050 Forest Hill Road, Staten Island, NY 10314-6399, USA*

David V. Forrest
*New York State Psychiatric Institute, 722 W. 168th Street, New York, NY 10032, USA*

Michael E. Hasselmo
*Department of Psychology, Harvard University, 33 Kirkland Street, Cambridge, MA 02138, USA*

David Hestenes
*Arizona State University, Tempe, AZ 85287, USA*

Dan Lloyd
*Department of Philosophy, Trinity College, 300 Summit Street, Hartford, CT 06106, USA*

Jacques Ludik
*Department of Computer Science, University of Stellenbosch, PO Box 19063, Tygerberg 7505, South Africa*

S. B. G. Park
*University Department of Psychiatry, Duncan Macmillan House, Porchester Road, Nottingham NG3 6AA, UK*

John H. Poole
*San Francisco Veterans Administration Medical Center – 116C, 4150 Clement Street, San Francisco, CA 94121, USA*

Manfred Spitzer
*Universitätsklinikum Ulm, Abteilung Psychiatrie 111, Leimgrubenweg 12–14, 89075 Ulm, Germany*

Dan J. Stein
*Department of Psychiatry, University of Stellenbosch, PO Box 19063, Tygerberg 7505, South Africa*

Sophia Vinogradov
*San Francisco Veterans Administration Medical Center – 116C, 4150 Clement Street, San Francisco, CA 94121, USA*

Gene V. Wallenstein
*Department of Psychology, Harvard University, 33 Kirkland Street, Cambridge, MA 02138, USA*

Jason Willis-Shore
*San Francisco Veterans Administration Medical Center – 116C, 4150 Clement Street, San Francisco, CA 94121, USA*

# Preface

This volume of essays on neural networks and psychopathology is aimed at an unusually diverse audience. On the one hand, we hope that the volume will be read by psychiatrists, psychologists, and other clinicians and researchers interested in psychopathology and its treatment. On the other hand, we hope that it will be read by those who work in the fields of cognitive science and artificial intelligence, and particularly those interested in neural network or connectionist models.

We believe that it is timely for clinicians and computational modellers to be in closer contact. While recent decades have seen dramatic advances in pharmacological and psychological treatments of psychiatric disorders, clinical science often lacks an adequate theoretical framework for integrating neurobiological and psychological data. Conversely, while neural networks have been tremendously successful in modelling a range of important psychological phenomena and in analysing data from a wide range of other sciences, less work has focused on connectionist models of psychopathology.

Neural network models of psychopathology have immediate theoretical and empirical appeal. They are theoretically interesting because they seem to incorporate neurobiological and psychological data in a seamless model of the way in which representational processes emerge from assemblies of neuron-like processing elements. They are empirically useful because they have been able to allow rigorous and elegant simulations of such uniquely human phenomena as pattern recognition, categorization, and learning; simulations that have in turn led to new insights into the phenomena under study.

In aiming at a diverse audience, contributors to this volume have had to tread a fine line between ensuring that their chapters are not only relevant to clinical practice and research, but also tackle basic questions

about how the brain–mind works and about how best this can be operationalized using computational models. Any such pioneering attempt to straddle two such different camps runs the risk of drawing criticism from some clinicians who find that computational models are too removed from clinical experience, or from some cognitivists who find clinical phenomena abstruse.

However, we believe that our contributors have succeeded remarkably in reaching out to all members of the intended audience. An introductory chapter by Stein and Ludik introduces the concept of neural networks and considers some of the potentials and pitfalls of using connectionist models to investigate psychopathology. In a second background chapter, Spitzer provides important historical context, outlining the long use of neural networks in clinical theory. For example, in his abandoned 'Project for a scientific psychology', Freud drew on the neuroscience of his day to develop an approach that is in many ways reminiscent of current connectionism.

Other contributions in Part one of the volume show how neural network models may have value in several different arenas of clinical practice and research. These range from diagnosis (Chen and Berrios) to pharmacotherapy (Park) and psychotherapy (Caspar). Hestenes concludes this part of the volume with an overview of the implications of neural network theory for approaching the neurobiology of clinical disorders.

In the second part of the volume, contributors develop models of a range of different clinical disorders. These include examples from the psychotic, anxiety, dissociative, and cognitive psychiatric disorders. Specifically, models are provided for schizophrenia (Chen and Berrios; Vinogradov and colleagues), obsessive–compulsive disorder (Ludik and Stein), dissociative phenomena (Lloyd), autism (Cohen), and Alzheimer's disease (Wallenstein and Hasselmo).

Finally, Forrest, who has long been working at the interface of neural networks and psychiatry, provides an epilogue and a vision for the future.

We hope that this brief outline of the volume sufficiently whets the appetite of both clinicians and connectionists to pursue the exciting interchange between these fields more fully. Ultimately, we look forward to the development of a strong field of cognitive clinical science, in which computational models inform clinical practice and research, and in which clinical data provide an important impetus for work in connectionism.

It is left only for us to add a few brief words of thanks. First, to each of the contributors for their generous participation in this volume. Second, to our publisher director, Dr Richard Barling, who provided sound advice throughout the project. Third, to the many colleagues who have supported our work, particularly Professor Robin Emsley, Head of the Department of Psychiatry at the University of Stellenbosch. And finally, to our wives and families, who have always been supportive and encouraging of our academic lives.

*Dan J. Stein*
*Jacques Ludik*