

OXFORD

BEHAVIORAL METHODS IN
**CONSCIOUSNESS
RESEARCH**



EDITED BY
MORTEN OVERGAARD

Behavioral methods in consciousness research

Behavioral methods in consciousness research

Edited by

Morten Overgaard

OXFORD
UNIVERSITY PRESS

OXFORD

UNIVERSITY PRESS

Great Clarendon Street, Oxford, OX2 6DP,
United Kingdom

Oxford University Press is a department of the University of Oxford.
It furthers the University's objective of excellence in research, scholarship,
and education by publishing worldwide. Oxford is a registered trade mark of
Oxford University Press in the UK and in certain other countries

© Oxford University Press 2015

© iStockPhoto.com

The moral rights of the author have been asserted

First Edition published in 2015

Impression: 1

All rights reserved. No part of this publication may be reproduced, stored in
a retrieval system, or transmitted, in any form or by any means, without the
prior permission in writing of Oxford University Press, or as expressly permitted
by law, by licence or under terms agreed with the appropriate reprographics
rights organization. Enquiries concerning reproduction outside the scope of the
above should be sent to the Rights Department, Oxford University Press, at the
address above

You must not circulate this work in any other form
and you must impose this same condition on any acquirer

Published in the United States of America by Oxford University Press
198 Madison Avenue, New York, NY 10016, United States of America

British Library Cataloguing in Publication Data

Data available

Library of Congress Control Number: 2014958222

ISBN 978-0-19-968889-0

Printed and bound by
CPI Group (UK) Ltd, Croydon, CR0 4YY

Oxford University Press makes no representation, express or implied, that the
drug dosages in this book are correct. Readers must therefore always check
the product information and clinical procedures with the most up-to-date
published product information and data sheets provided by the manufacturers
and the most recent codes of conduct and safety regulations. The authors and
the publishers do not accept responsibility or legal liability for any errors in the
text or for the misuse or misapplication of material in this work. Except where
otherwise stated, drug dosages and recommendations are for the non-pregnant
adult who is not breast-feeding

Links to third party websites are provided by Oxford in good faith and
for information only. Oxford disclaims any responsibility for the materials
contained in any third party website referenced in this work.

Contents

Contributors *vii*

Part 1 **Introduction**

- 1** Consciousness research methods: the empirical “hard problem” 3
Morten Overgaard
- 2** The challenge of measuring consciousness 7
Morten Overgaard
- 3** How can we measure awareness? An overview of current methods 21
Bert Timmermans and Axel Cleeremans

Part 2 **Experimental paradigms**

- 4** Unmasking the pitfalls of the masking method in consciousness research 49
Talis Bachmann
- 5** A behavioral method to manipulate metacognitive awareness independent of stimulus awareness 77
Amanda Song, Ai Koizumi, and Hakwan C. Lau
- 6** Inferences about consciousness using subjective reports of confidence 87
Maxine T. Sherman, Adam B. Barrett, and Ryota Kanai
- 7** Direct and indirect measures of statistical learning 107
Arnaud Destrebecqz, Ana Franco, Julie Bertels, and Vinciane Gaillard
- 8** Binocular rivalry and other forms of visual bistability 121
Jan Brascamp

Part 3 **Measures of consciousness**

- 9** Intentional binding: a measure of agency 145
Mads Jensen, Steven Di Costa, and Patrick Haggard
- 10** Measuring consciousness with confidence ratings 159
Elisabeth Norman and Mark C. Price
- 11** Using the perceptual awareness scale (PAS) 181
Kristian Sandberg and Morten Overgaard

Part 4 **Analysis and statistics**

- 12** How Bayesian statistics are needed to determine whether mental states are unconscious 199

Zoltan Dienes

- 13** Handling the p —and how real evidence goes beyond p -values 221

Kim Mouridsen

Part 5 **Metachapter**

- 14** Variability, convergence, and dimensions of consciousness 249

Colin Klein and Jakob Hohwy

Index 265

Contributors

Professor Talis Bachmann

University of Tartu,
Näituse 20
50409 Tartu, Estonia

Dr Adam B. Barrett

Sackler Centre for Consciousness
Science and Department of Informatics,
University of Sussex, Brighton, UK

Dr Julie Bertels

Consciousness, Cognition and
Computation Group (CO3)
Center for Research in Cognition
& Neurosciences (CRCN)
ULB Institute of Neurosciences (UNI)
Université Libre de Bruxelles
50 av. Franklin Roosevelt CP 191
1050 Brussels, Belgium

Dr Jan Brascamp

Utrecht University,
Willem C. Van Unnikgebouw,
Heidelberglaan 2, Room 16.22,
Utrecht, The Netherlands

Professor Axel Cleeremans

Consciousness, Cognition
and Computation Group (CO3)
Center for Research in Cognition
& Neurosciences (CRCN)
ULB Neuroscience Institute (UNI)
Université Libre de Bruxelles
50 av. Franklin Roosevelt CP 191
1050 Brussels, Belgium

**Associate Professor Arnaud
Destrebecqz**

Consciousness, Cognition
and Computation Group (CO3)
Center for Research in Cognition
& Neurosciences (CRCN)
ULB Institute of Neurosciences (UNI)
Université Libre de Bruxelles
50 av. Franklin Roosevelt CP 191
1050 Brussels, Belgium

Professor Zoltan Dienes

Sackler Centre for Consciousness
Science and School of
Psychology,
University of Sussex,
Falmer, UK

Mr Steven Di Costa

Institute of Cognitive Neuroscience,
University College London
Alexandra House,
17 Queen Square,
London, UK

Dr Ana Franco

Unité de Recherche en Neurosciences
Cognitives (Unescog)
Center for Research in Cognition
& Neurosciences (CRCN)
ULB Institute of Neurosciences (UNI)
Université Libre de Bruxelles
50 av. Franklin Roosevelt CP 191
1050 Brussels, Belgium

Dr Vinciane Gaillard

Consciousness, Cognition
and Computation Group (CO3)
Center for Research in Cognition
& Neurosciences (CRCN)
ULB Institute of Neurosciences (UNI)
Université Libre de Bruxelles
50 av. Franklin Roosevelt CP 191
1050 Brussels, Belgium

Professor Patrick Haggard

Institute of Cognitive Neuroscience,
University College London
Alexandra House,
17 Queen Square,
London, UK

Professor Jakob Hohwy

Cognition & Philosophy Lab,
Monash University,
Melbourne, Australia

Mads Jensen

Cognitive Neuroscience Research
Unit (CNRU) CFIN, MindLab
Dept. of Clinical Medicine
Aarhus University
Aarhus, Denmark

Dr Ryota Kanai

Sackler Centre for Consciousness
Science and School of Psychology,
University of Sussex,
Brighton, UK

Dr Colin Klein

Department of Philosophy,
Macquarie University,
Sydney, Australia

Dr Ai Koizumi

Psychology Department,
Columbia University,
1190 Amsterdam Avenue,
New York, USA

University of Tokyo,
Tokyo, Japan

Professor Hakwan C. Lau

Psychology Department,
UCLA
11620 Mayfield Avenue,
Los Angeles, USA

Associate Professor Kim Mouridsen

Department of Clinical Medicine,
Center for Functionally Integrative
Neuroscience,
Nørrebrogade 44 NBG/10G,
Room 10G-5-36,
Aarhus, Denmark

Associate Professor Elisabeth Norman

Faculty of Psychology,
University of Bergen,
Christies gate 12,
5015 Bergen,
Norway

Professor Morten Overgaard

Cognitive Neuroscience Research
Unit (CNRU) CFIN, MindLab
Dept. of Clinical Medicine
Aarhus University
Aarhus, Denmark

Dept. of Communication and Psychology
Aalborg University
Aalborg, Denmark

Associate Professor Mark C. Price

Faculty of Psychology,
University of Bergen,
Christies gate 12,
5015 Bergen,
Norway

Dr Kristian Sandberg

Cognitive Neuroscience Research Unit
(CNRU), Hammel Neurorehabilitation
Centre and University Research Clinic
Aarhus University
Aarhus, Denmark

Maxine T. Sherman

Sackler Centre for Consciousness Science
and School of Psychology,
University of Sussex,
Brighton, UK

Amanda Song

Cognitive Science Department,
University of California, San Diego, US

Assistant Professor Bert Timmermans

School of Psychology,
University of Aberdeen,
William Guild Building,
King's College,
Aberdeen, UK

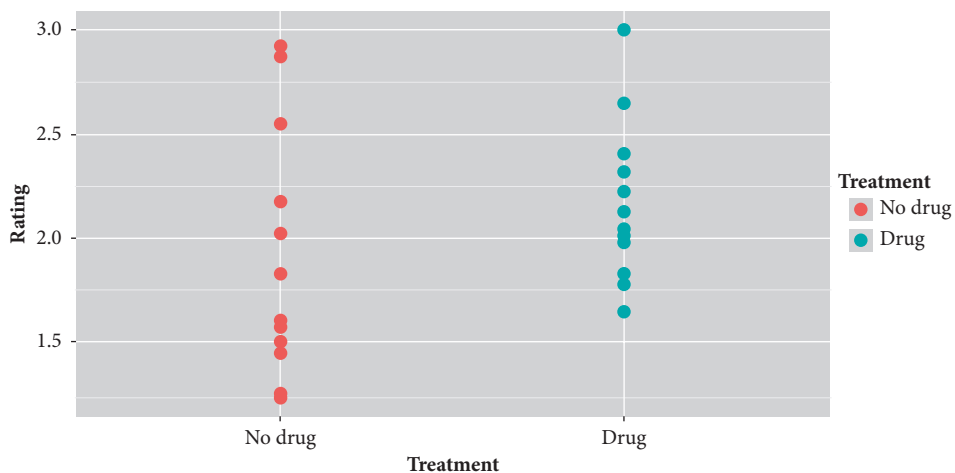


Plate 1 Average rating data (perceptual awareness scale) in the word presentation experiment with and without administration of a dopamine agonist. (See Fig. 13.1)

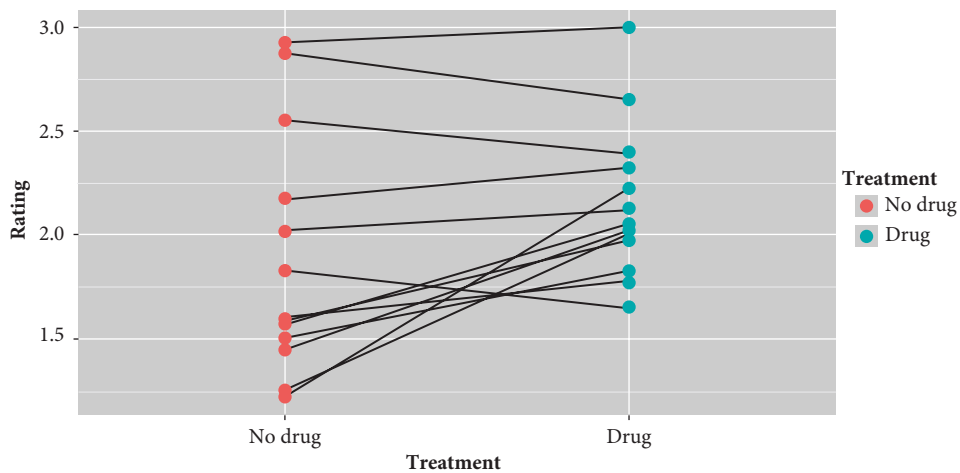


Plate 2 Data from Plate 1 with lines indicating that the same subjects were observed in the two groups. Compared to Plate 1 we see a clearer trend towards higher ratings with the dopamine agonist. (See Fig. 13.2)

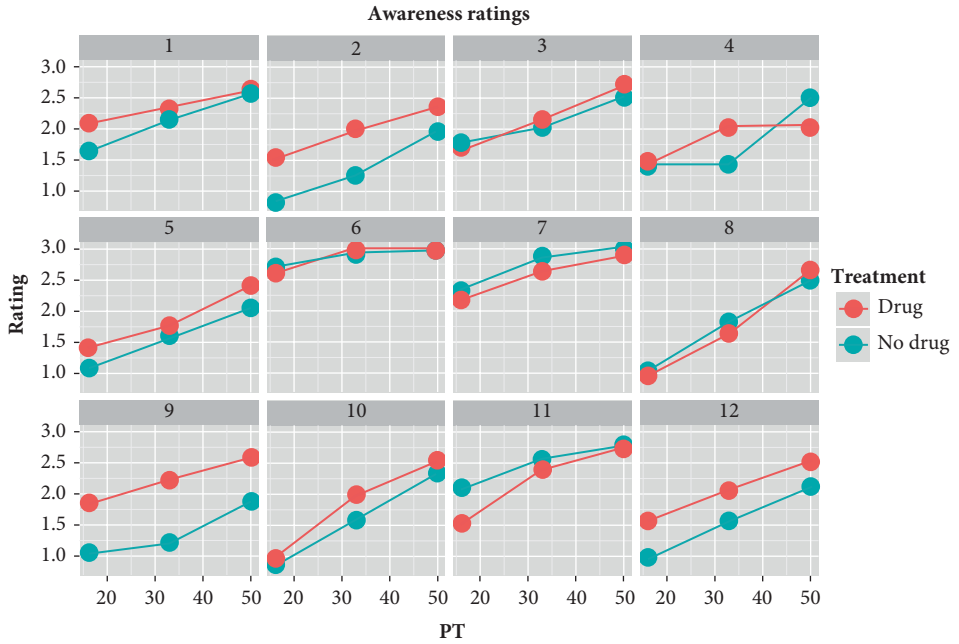


Plate 3 Average PAS ratings at three different stimulus durations for each subject with and without the dopamine agonist. (See Fig. 13.3)

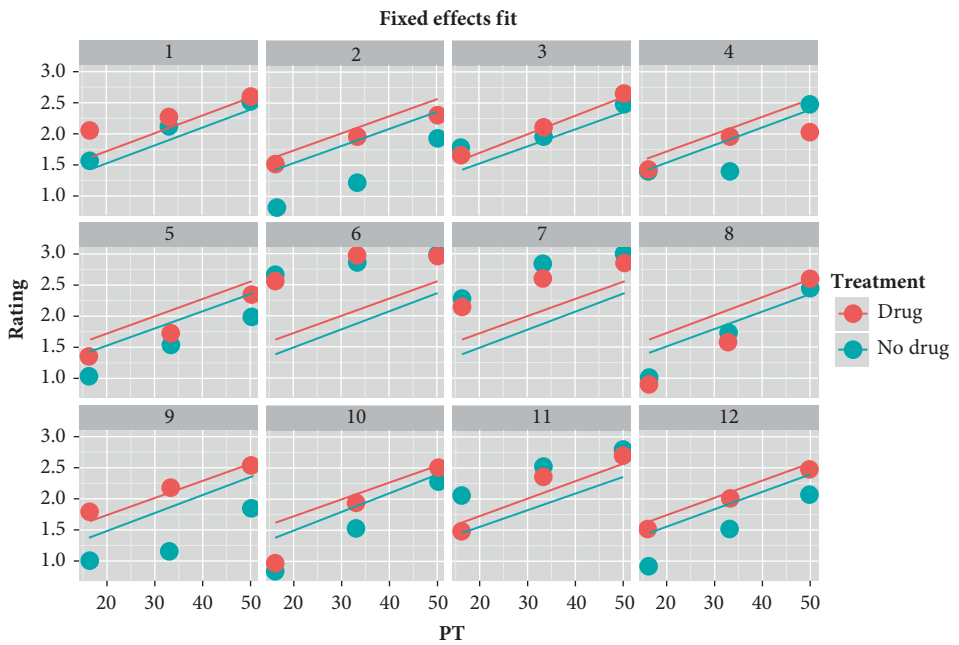


Plate 4 Fixed effects analysis suggests an increase in PAS rating with dopamine agonist, but the model provides a poor fit in most subjects. It estimates the same effect across all subjects. (See Fig. 13.4)

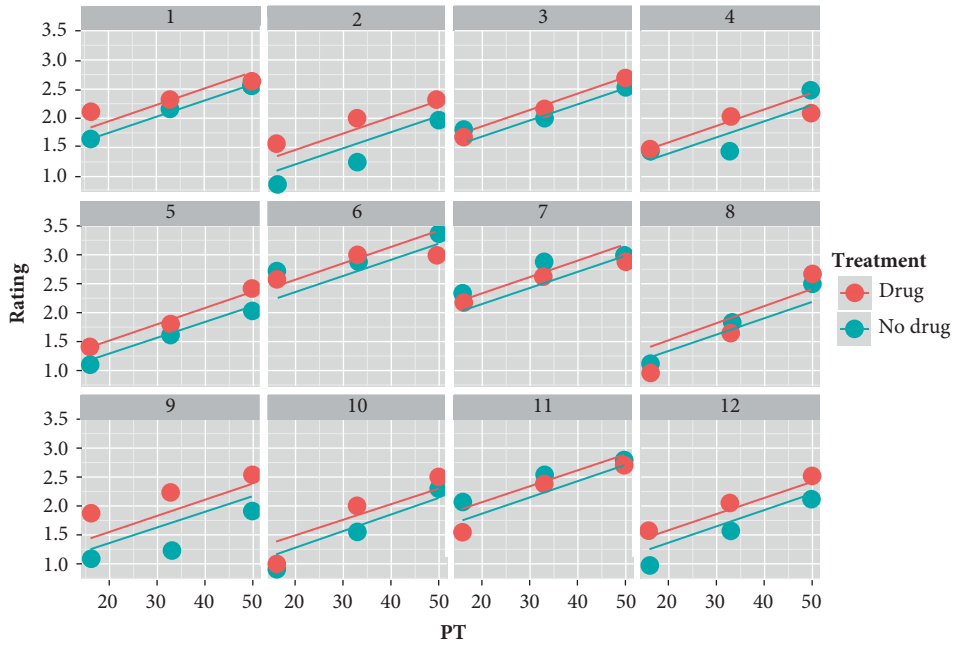


Plate 5 The random effects or mixed model produces an individual fit to each subject and provides a more accurate fit to the individuals than the fixed effects model. Note that this comes at the cost of only one additional parameter in the model (the variance component corresponding to subject variation). (See Fig. 13.5)

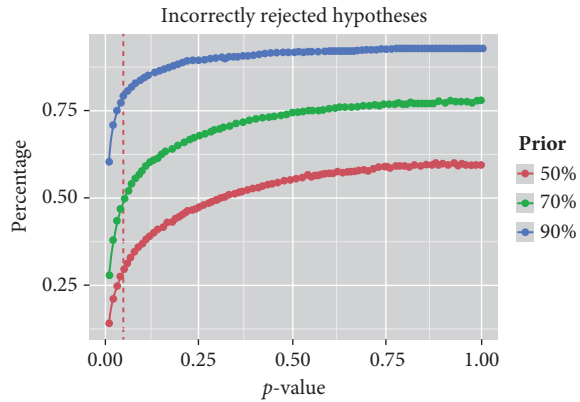


Plate 6 Fraction of incorrectly rejected null hypotheses when the prior probability that the null is true is 50, 70, or 90%. The dashed vertical line illustrates the fraction of incorrect rejections that occurs if the alpha level is fixed at the typical 5%. (See Fig. 13.6)

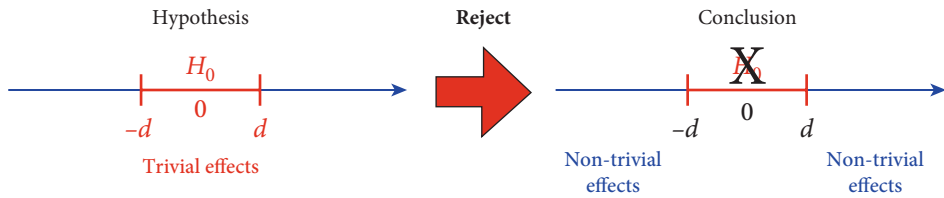


Plate 7 By extending the usual null hypothesis of zero effect to the hypothesis that the effect is numerically less than d we avoid declaring the significance when magnitude of the effect is scientifically negligible but p -value for the point null hypothesis nevertheless is below 5%. (See Fig. 13.7)

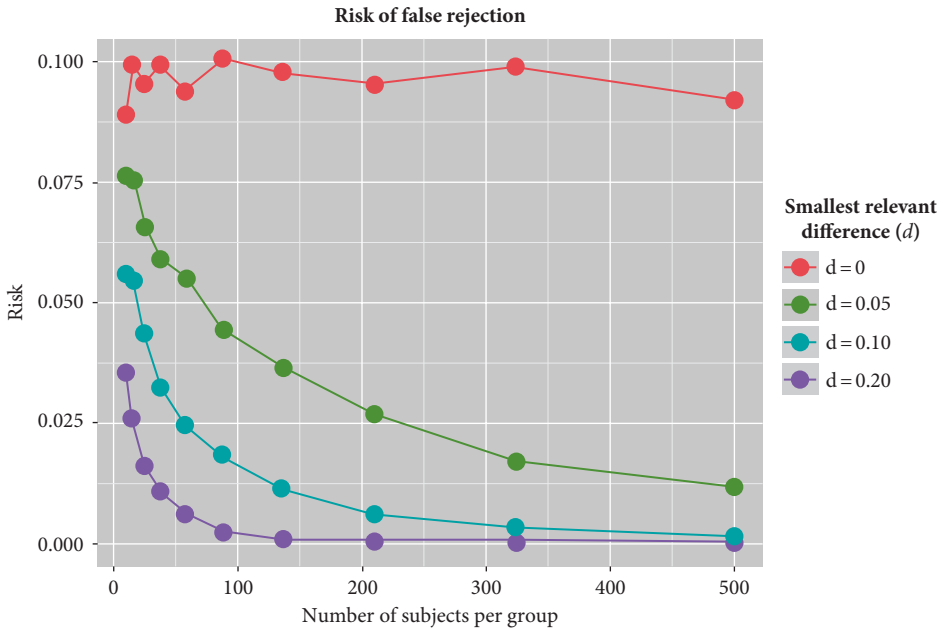


Plate 8 Risk of falsely rejecting different null hypotheses in a simulated experiment with zero effect. The usual point null is rejected in just under 10% of cases, which is about double the alpha-level (5%), demonstrating that the risk of a false positive is not the usual 5% when the researcher has the possibility to choose between two outcomes (and does not correct for multiple comparisons). Testing the presence of non-zero effects leads to lower risks (however, the appropriate strategy is to correct p -values for multiple comparisons). (See Fig. 13.8)

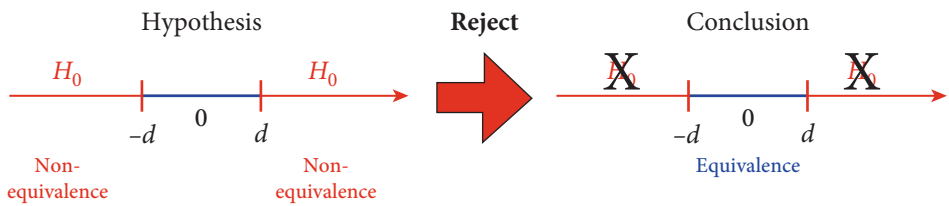


Plate 9 Equivalence tests assume that an effect is numerically larger than some d , then rejects this assumption if p -value is low. Hence equivalence can be concluded and the risk of a false rejection is bounded by the alpha-level (which may be the usual 5%). (See Fig. 13.9)