# twin research and human genetics

The official journal of the International Society for Twin Studies and the Human Genetics Society of Australasia

Covering all areas of

human genetics

with an emphasis on

twin studies, genetic

epidemiology, psychiatric

and behavioral genetics,

and research on

multiple births in the

fields of epidemiology,

genetics, endocrinology,

fetal pathology, obstetrics

and pediatrics.

Volume



Number



August 2018

# **Editor**

Nicholas G. Martin

# **SPECIAL ISSUE**

The Legacy of Irving I. Gottesman (29/12/1930–29/06/2016)

**Guest Editor** 

Nancy L. Segal



# twin research and human genetics



The official journal of the International Society for Twin Studies and the Human Genetics Society of Australasia

Twin Research and Human Genetics is the official journal of the International Society for Twin Studies and, as such, is the successor journal to Acta Geneticae Medicae et Gemellologiae, which was founded in 1952 by Luigi Gedda. He edited it until its cessation in 1998, with Paolo Parisi as Acting Editor and then Executive Editor from 1968 to 1992. Acta became the official journal of ISTS when the society was established in 1974. The subtitle Twin Research was adopted in 1979. It was published by The Mendel Institute in Rome, except for the years 1979 to 1983, when it was published jointly with Alan R. Liss in New York.

Twin Research itself was founded in 1998 by Robert Derom, who edited it in 1998 and 1999. It has been edited by Nick Martin since 2000. It was published by Stockton Press (which became part of Nature Publishing Group) from 1998 to 2000, by Australian Academic Press from 2001 to 2012, and by Cambridge University Press since 2012.

The title *Twin Research and Human Genetics* was adopted from the beginning of Volume 8 in 2005 and is a translation of *Acta Geneticae Medicae et Gemellologiae*, Luigi Gedda's original title.

In 2008, *Twin Research and Human Genetics* was also adopted as the official journal of the Human Genetics Society of Australasia.

#### **Editor**

Nicholas G. Martin. Brisbane

## **Associate Editors**

CLINICAL GENETICS
Petra Zwijnenburg, Amsterdam

BEHAVIOR GENETICS

Dorret Boomsma, Amsterdam

**EPIGENETICS** 

Jeff Craig, Melbourne

TWIN REGISTRIES

Yoon-Mi Hur, Jeonnam, South Korea

COMPLEX DISEASES

Jaakko Kaprio, Helsinki

ENDOCRINOLOGY

Cornelis Lambalk, Amsterdam

**HUMAN GENETICS** 

Jozef Gecz, Adelaide

**NEWS & VIEWS** 

Nancy Segal, Fullerton, CA

FETAL MEDICINE

Asma Khalil, London

PSYCHIATRIC GENETICS

Wendy Slutske, Columbia, MO

SOCIAL SCIENCES

Levente Littvay, Budapest

STATISTICAL MODELING

Michael Neale, Richmond, VA

# **Book Review Editor**

Dorret Boomsma, *Amsterdam* di.boomsma@psy.vu.nl

# **Editorial Board**

Isaac Blickstein, Rehovot

Charles Boklage, Greenville

Andreas Busjahn, Berlin

Michèle Carlier, Marseille

Kaare Christensen. Odense

Catherine Derom, Leuven

Lindon Eaves, Richmond, Virginia

David Evans, Bristol

Johan Fellman, Helsinki

Jack Goldberg, Seattle

Judith Hall, Vancouver

lennifer Harris, Oslo

Yoko Imaizumi, Suita City

Kirsten Kyvik, Odense Barbara Luke, Miami

Nancy Pedersen, Stockholm

Daniel Pérusse, Montréal

Robert Plomin, London

Danielle Posthuma. Amsterdam

Shaun Purcell, Boston

Roger Short, Melbourne

Tim Spector, London

Antonia Stazi, Rome

Martine Thomis, Leuven

Karen Thorpe, *Brisbane* Mark Umstad, *Melbourne* 

# **Subscription Rates 2018**

Individual subscriptions to *Twin Research and Human Genetics* as members of the International Society for Twin Studies (ISTS) and the Human Genetics Society of Australasia (HGSA):

For those members who wish to receive a printed copy, an additional fee of AUD120 may be paid.

ISTS membership application or renewal can be made online at https://genepi.qimr. edu.au/ists/ists.cgi Alternatively, the Word document is available upon inquiry from ISTS@qimrberghofer.edu.au

INSTITUTIONAL SUBSCRIPTION RATES

This journal is published 6 times per year. The institutional rates (excluding VAT) are:

Only
Australia 842 AUD
N America 746 USD
UK and ROW 481 GBP

Electronic

EU subscribers (outside the UK) who are not registered for VAT should add VAT at their country's rate. VAT registered subscribers should provide their VAT registration number. Prices include delivery by air when appropriate. Japanese prices for institutions are available from Kinokuniya Company Ltd, P.O. Box 55, Chitose, Tokyo 156, Japan.

# Orders and subscription enquiries should be addressed to:

Cambridge University Press, Journals Fulfillment Department, UPH, Shaftesbury Road, Cambridge CB2 8BS, UK

# Orders from N America should be addressed to:

Cambridge University Press, 1 Liberty Plaza, Floor 20, New York, NY 10006, USA

Twin Research and Human Genetics and all other Cambridge Journals can be found at cambridge.org/core

# **ISTS Website**

www.ists.qimr.edu.au

# Indexing/Abstracting

This journal is indexed in the following databases: MEDLINE/PubMed, EMBASE/Excerpta Medica, PsycINFO, Science Citation Index®, Journal Citation Reports/Science Edition, Science Citation Index Expanded® (available as the ISI Web of Science®), Current Contents®/Clinical Medicine, Current Contents®/Life Sciences

# E-mail Address for Manuscript Submission

See inside back cover for author instructions.

#### **Editorial Office**

Nicholas G. Martin Editor

Twin Research and Human Genetics
QIMR Berghofer Institute of Medical Research
Brisbane QId 4029 Australia
E-mail: ISTS@qimrberghofer.edu.au

https://doi.org/10.1017/thg.2018.42 Published online by Cambridge University Press

# twin research and human genetics

Volume 21 Number 4

#### August 2018

The official journal of the International Society for Twin Studies and the Human Genetics Society of Australasia

Covering all areas of

human genetics

with an emphasis on

twin studies, genetic

epidemiology, psychiatric

and behavioral genetics,

and research on

multiple births in the

fields of epidemiology,

genetics, endocrinology,

fetal pathology, obstetrics

and pediatrics.

Twin Research and Human Genetics is published six times annually and issued to all financial ordinary, institutional and student members of ISTS and HGSA.

Copyright in all articles rests with authors. A limited set of permanent copyright permission licences has been granted by authors to the publisher to allow publication in this journal. Rights in the reproduction and distribution of the published articles as visual facsimiles of this published edition by either mechanical or digital means is controlled by the publisher and any distributions by CAL for copying of an author's work are due to the publisher in the first instance. All other rights in the words contained in this edition are controlled by the authors. Authors are therefore free to adapt and/or republish the words making up their own articles either online or in print.

Published by Cambridge University Press on behalf of Australian Academic Press Pty Ltd. and the International Society of Twin Studies. Cambridge University Press, The Edinburgh Building Shaftesbury Road Cambridge CB2 8RU, UK www.journals.cambridge.org.uk

#### **Articles**

Symposium in Honor of Irving I. Gottesman (December 29, 1930–June 29, 2016)  Nancy L. Segal	281
Gene–Environment Correlations Affecting Children's Early Rule-Breaking and Aggressive Play Behaviors Lisabeth F. DiLalla and David L. DiLalla	285
From Genes to Behavior Through Sex Hormones and Socialization: The Example of Gender Development Sheri A. Berenbaum and Adriene M. Beltz	289
Twins Reared Apart and Twins in Families: The Findings Behind the Fascination  Nancy L. Segal, Yesika S. Montoya and Erika N. Becker	295
Rereading 'Biogenetics of Race and Class' 50 Years Later Eric Turkheimer	302
Mapping Risk from Genes to Behavior: The Enduring and Evolving Influence of Irving Gottesman's Endophenotype Concept Danielle M. Dick	306
Understanding Mechanisms of Genetic Risk for Adolescent Internalizing and Externalizing Problems: The Mediating Role of Parenting and Personality  Jinni Su, Sally I-Chun Kuo, Kathleen K. Bucholz, Howard J. Edenberg, John R. Kramer,	310
Marc Schuckit and Danielle M. Dick  Irving I. Gottesman's Collaboration in Psychiatric Genetics Research in	322
Denmark Kaare Christensen and Aksel Bertelsen	
Closing Remarks—A Twin Research Legacy Nancy L. Segal	324
N 10 10	

# **News, Views and Comments**

Human Dizygotic Twinning: Evolutionary-Based Explanations/Twin Research Reviews: Conjoined Twins in a Triplet Pregnancy; Double Embryo Transfer; Health Anxiety; Delayed Delivery of the Second Twin/In the Media: Digital Marketing Twins; Bereaved Twin at March for Our Lives; Exchange of Places; Football Players Reunite as Patriots Nancy L. Segal

## **Book Review**

Institute, Brisbane, Australia

Accidental Brothers: The Story of Twins Exchanged at Birth and the
Power of Nature and Nurture
Reviewed by Michelle K. Lupton, Genetic Epidemiology, QIMR Berghofer Medical Research

325