Oxford NCRM Summer School

Introduction to Using Molecular Genetic Data in the Social Sciences

June 26-30, 2017

Nuffield College, Oxford, United Kingdom

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WELCOME TO OXFORD!

Welcome to the NCRM (National Centre for Research Methods), ESRC (Economic and Social Research Council, UK)-funded Oxford Summer School 'Introduction to using molecular genetic data in the social sciences', hosted by the Department of Sociology, University of Oxford and Nuffield College, Oxford.

Within the last decade there has been an explosion in the amount of data that includes both social science and molecular genetic information. The UK – and organizations such as the ESRC – have been frontrunners in funding the collection of this type of data with large samples such as the UK Biobank, Understanding Society and many other longitudinal data sources (e.g., ALSPAC, 1958 Birth Cohort, ELSA). The majority of these datasets are also open-access allowing researchers to relatively easily access them. Although expensive data infrastructures for large biosocial data are available, they remain underutilized and yet to be exploited by social scientists.

For the first time in history social scientists can uncover whether there is a genetic and biological component to many of the behaviours that have until now only largely been attributed to social factors. Increasing studies demonstrate that there is a genetic component to core social science topics such as educational attainment (Rietveld et al. 2013; Okbay et al. 2016), fertility behaviour (Barban et al. 2016; Mills & Tropf 2015; Tropf et al. 2015) and wellbeing (Okbay et al. 2016) and a myriad of 'complex' behavioural health and psychological outcomes.

Knowledge from social scientists about how to properly use this data to answer pertinent research questions and statistical tools to accommodate social science problems remains underdeveloped. This is often due to a lack of introductory training in the field. Our NCRM/ESRC SOCGEN project and this summer school attempts to overcome this problem and initiate a new generation of scientists to the exciting new field of sociogenomics. The aim is an introductory course aimed at first-time applied researchers.

This course will equip you with a unique insight into the emerging topic of sociogenomics and the most cutting-edge methodological techniques in this area of research. The focus will be on understanding the key substantive research questions in this area, an overview of data, hands-on computer exercises of how to work with genetic data, and an introduction into the most current methodological techniques used in the field. The course is aimed at a very introductory level for first time applied researchers in the field.

We would like to particularly Jane Greig for her excellent and incredible skills in the excellent organization of this event.

On behalf of all co-organizers,
Melinda Mills, University of Oxford and Nuffield College

NCRM/ESRC SOCGEN PROJECT: COMBINING SOCIAL SCIENCE AND MOLECULAR GENETIC RESEARCH TO EXAMINE INEQUALITY AND THE LIFE COURSE

This summer school and funding for our SOCGEN project has been provided by the UK's Economic and Social Research Council within the National Centre for Research Methods.

A primary objective of this project is to bring together substantive social science researchers in the field of inequality and the life course with expertise in statistics, biodemography, and quantitative molecular genetics to develop innovative learning resources, statistical models and packages to address the specific shortcomings in this substantive area of research. Developing accessible teaching resources and tailored statistical models and packages will allow UK social scientists to become trendsetting pioneers in answering new biosocial research questions. This will allow us to convey how insights from molecular genetic data and research can be integrated into life course (and social science) research.

The key research questions to be answered in this project are:

- To what extent can genetic data be informative about an individual's life course behaviour?
- Which statistical methods can be developed to examine the smaller effects that need to be detected in Gene X Environment (GxE) analyses, where the socio-environment interacts with or moderate genetic effects?
- Which statistical tools and packages can be developed to deal with central analytical problems faced by life course researchers engaging in sociogenomic analyses? How can we introduce Bayesian models that accommodate longitudinal covariates and measurement error in both covariates and their outcomes? How can cope with multiple correlated covariates?
- Can recent models from molecular genetics (GCTA - genome-wide complex trait analysis) be validated and adapted to deal with substantive life course research?
- How can biological, genetic and medical research benefit from insights from the life course and social science research?

People

Melinda Mills (PI, Department of Sociology & Nuffield College, University of Oxford)
David Steinsaltz (Co-I, Department of Statistics, University of Oxford)
Nicola Barban (Co-I, Department of Sociology & Nuffield College, University of Oxford)
Felix Tropf (Co-I, Department of Sociology & Nuffield College, University of Oxford)
Maria Christodoulou (Postdoctoral Researcher, Department of Statistics, University of Oxford)
Stine Møllegaard (Postdoctoral Researcher, Department of Sociology, University of Oxford)

PRACTICAL INFORMATION

SUMMER SCHOOL LOCATION

The entire Summer School will take place in the Large Lecture Room at Nuffield College (please see map on next page), which is located at 1 New Road in the centre of Oxford. All lectures and computer labs will be held in that room.

REGISTRATION DESK

On the morning of the first day we will have a Registration Desk located outside of the Large Lecture Room, where all pre-registered participants may pick up their material and name badge.

REGISTRATION FEE INCLUDES

- Admission to the entire summer school and all sessions
- Welcome Drinks reception at Nuffield College on Monday, June 26 at 6.30 pm
- Welcome three course High Table conference dinner on Monday, June 26 at 7.00 pm (sharp) at Nuffield College
- Coffee, tea and snacks served during the morning and afternoon breaks
- Lunch served each day in the College
- Social Excursion and Boat Trip to and from 'The Perch' on Wednesday, June 28
- Conference Dinner at 'The Perch' on Wednesday, June 28
- Teaching material
-

SOCIAL EVENTS

There will be a welcome drinks reception (6.30 pm) and High Table conference dinner (7 pm sharp) at Nuffield College on Monday, June 26, 2017.

Students are also invited to join a boat trip excursion on the River Thames on Wednesday, June 28, which will travel to the infamous 17th Century Perch restaurant. http://the-perch.co.uk/

INTERNET ACCESS

Wireless internet can be obtained using the Oxford Wireless LAN (OWL). A username and password for OWL are included in your pack. By signing you, you will have signed your agreement to the OWL license if you choose to use it. "Eduroam" is also available in many locations across Oxford.

ACCOMODATION

We have reserved a limited number of rooms at Balliol College from Sunday, June 25th to Friday, June 30th. Rooms are priced at £53.50 per person per night inclusive of VAT and breakfast. Bookings can be made directly with the Balliol Conference and Events Manager, Jacqueline Gills by email. Please attach in the email a completed version of the form (found on our website: http://www.oxfordsociogenetics.com/visiting-oxford/) with your payment details.

If you are interested in finding private accommodation, there are several hotels in walking distance from the Nuffield College. Book early as most hotels are relatively small and fill up quickly.

GETTING TO OXFORD

Oxford has an excellent bus connection to London and its two main airports. There is a bus from London very frequently throughout the hour (X90 and Oxford Tube) and from Heathrow/Gatwick two to three times an hour (Airline bus). You can also take the train from London Paddington or Birmingham International Airport. London Stansted Airport and Luton Airport have a direct bus connection and train connections via London. Links to all of these sites are available on our conference webpage:
http://www.oxfordsociogenetics.com/visiting-oxford/

GETTING AROUND OXFORD

Most destinations in Oxford are close enough to walk to. However, Oxford also provides excellent bus services for getting around. For more information, please see here: https://www.oxford.gov.uk/info/20012/parking_and_travel/495/public_transport.

INFORMATION ABOUT OXFORD

Oxford is a tourist destination and known for its beauty but also diverse range of cafes, pubs and restaurants and many cultural events.

For more information on the history and culture of both Oxford city, and its university, as well as advice on planning your stay, please visit the University's Visiting Oxford webpages.

You also may wish to visit the Oxford Visitor Information Centre's Experience Oxfordshire website.

Oxford's Daily Info website contains further information.

The Oxford Visitor Information Centre is located at 15-16 Broad Street, and is open from 9.30am – 5.30pm on Saturday and Sunday, and from 10am - 4pm on Sunday. The Ashmolean Museum on Beaumont Street houses world class art and historical exhibits and charges no entrance fee (open 10am – 6pm on Friday and Sunday, 10am – 5pm on Saturday). Blackwells bookshop, including the famous underground Norrington room, can be found on Broad Street.

RESTAURANTS

There are many restaurants in Oxford city center and in particular in George Street as well as the Oxford Castle Quarter, both of which are literally on either side of Nuffield College.

TAXIS

Taxis are located at the Oxford Railway Station and Gloucester Green Coach (Bus) Station and St. Giles in the City Centre. Taxi numbers: ABC Radio Taxis - 01865 242424; 001 Taxis – 01865240000; Oxford Cars – 01865 406080

USEFUL CONTACT NUMBERS

Department of Sociology: +44 (0)1865 281 740

Balliol College: +44 (0)1865 277777

Nuffield College: +44 (0)1865 278 500

Emergency numbers:

Police, Ambulance, Fire: 999

NHS Direct: http://www.nhsdirect.nhs.uk/ or 0845 4647

MEET THE INSTRUCTORS

The programme consists of morning lectures by top scholars in the emerging field of 'sociogenomics', including Dalton Conley (Princeton), Ben Domingue (Stanford), Melinda Mills (Oxford), David Steinsaltz (Oxford), Meena Kumari (Essex), Cecilia Lindgren (Oxford). Afternoon lectures consist of hands-on computer lab training by Oxford-based researchers Nicola Barban, Felix Tropf, Charles Rahal, Melissa Smart (Essex), and Yanchun Bao (Essex).

Dalton Conley is the Henry Putnam University Professor of Sociology at Princeton University

His current work applies econometric methods for causal inference–namely, a natural experiment framework–to genome-wide data available in social surveys to model gene-by-environment interaction effects. Examples in this vein include deploying the Vietnam draft lottery, twin differences in birth weight, exogenous job loss (such as plant closure), and sibling differences in genotype (polygenic scores) to questions of health, development and socioeconomic attainment across the life course. He is also interested in mapping the genetic architecture of phenotypic plasticity, interrogating the assumptions underlying models for heritability, and characterizing social and genetic sorting as distinct processes.

Ben Domingue is Assistant Professor, Stanford Graduate School of Education, Stanford University

Ben Domingue has two areas of active research. The first focuses on statewide standardized test scores and their uses, particularly how test scores are used in statistical models that evaluate the effectiveness of teachers and schools. On a technical level, he also is interested in the extent to which test scores and the data from which they are drawn demonstrate certain desirable properties. The second area of research focuses on the integration of genetic data into social science research. In particular, he is interested in understanding the genetic architecture of educational attainment and the way in which schools can and do moderate the association between genes and educational attainment.

Melinda Mills is Nuffield Professor of Sociology at the University of Oxford and Nuffield College and Editor-in-Chief of the European Sociological Review

She is currently working on the area of combining a social science and molecular genetic approach to the study of behavioural outcomes, with a focus on human fertility, socioeconomic differentials and the labour market. She is the PI of the ERC SOCIOGENOME project and the ESRC NCRM SOCGEN project. Her work includes a genome-wide association study of human reproductive behaviour, genes, environment and educational attainment, genetic overlap in traits, assortative mating on the internet, the impact of labour market uncertainty and schedules. She recently published books on non-standard work schedules and survival and event history analysis in R.

Meena Kumari is Professor of Biological and Social Epidemiology at ISER, University of Essex

Her research interests include: the biological pathways by which the social environment and health are linked over the lifecourse and the use of genetic epidemiology to inform understanding of the causal influence of environmentally modifiable risk factors. She is a leading expert in biomarkers and genetics, and has worked to apply insights from these areas to better understand ageing, cardiovascular disease, and health inequalities using the Whitehall II cohort study of British civil servants and the English Longitudinal Study of Ageing. She continues to lead research on the social-biological interface and genetic epidemiology as an investigator for Understanding Society.

Cecilia Lindgren is Associate Professor and Senior Group Leader at the Big Data Institute, Nuffield Department of Medicine

Her research seeks to advance understanding of the mechanisms involved in obesity and the regulation of differential central fat accumulation in the belief that an appreciation of these mechanisms will complement advances in understanding of overall energy balance. By applying a range of genetic and genomic approaches, she aims to identify genetic variants influencing regional fat distribution, and to illuminate some of the biological pathways involved. Recent publications examine sexual dimorphism in genetic loci linked to body fat distribution, BMI, body shape, and analyses on trans-ethnic and trans-ancestry studies.

David Steinsaltz is Associate Professor in the Department of Statistics, University of Oxford, and Tutor in Statistics at Worcester College

His interests are in stochastic processes, biodemography, mathematical biology, random dynamical systems, survival analysis, Bayesian statistics. His work forms part of a loosely organised international collaborative effort, including laboratory biologists, field biologists, demographers, economists, statisticians, mathematicians, working to bring modern mathematical and statistical technology to bear on the major theoretical problems of ageing: Why do organisms senesce (i.e., deteriorate in physiological function as they age)? Why do some organisms apparently not senesce? Why do organisms show the patterns of age-related change that they do, and how is this linked to other characteristics of their life course?

Nicola Barban is a Nuffield Research fellow and a Senior Research Associate in the Department of Sociology, University of Oxford

He works as a member of Mills' ERC Consolidator Grant project "SOCIOGENOME: Unravelling the genetic influences of reproductive behaviour and gene-environment interaction" and co-PI of the NCRM SOCGEN project. His research interests

include sociogenetics, life course analysis, gene-environment interactions in fertility research, immigrant assimilation, social interactions and fertility, and statistical methods for demographic research.

Felix Tropf is Postdoctoral Research Fellow in sociogenomics at Nuffield College and the Department of Sociology, University of Oxford

He works as a member of Mills' ERC Consolidator Grant project "SOCIOGENOME: Unravelling the genetic influences of reproductive behaviour and gene-environment interaction" and co-PI of the NCRM SOCGEN project. For his Master thesis on sex-differences in elderly care, the German Society for Demography (DGD) honoured him with the Allianz-Newcomer award 2012. From 2011 to 2015, he was appointed as doctoral researcher and lecturer at the ICS Graduate School, University of Groningen.

Charles Rahal is a Postdoctoral Researcher Computational Sociology, Department of Sociology and Nuffield College.

He works with M. Mills, C. Lindgren & K. Zondervan on the Wellcome Trust Project on multidisciplinary approaches to studying human fertility, with skills in the areas of computational sociology and econometric modelling. He completed his PhD in computational econometrics working in the areas of spatial econometrics, dimensional reduction, high dimensional forecasting and software development. His current work focuses on using 'Big Data' and machine learning algorithms to apply to broader social science problems (particularly using Python, R, SQL and MongoDB). His expertise is in the creation and development of complex datasets from unstructured sources.

Melissa Smart is a Senior Research Officer in Genetics at the Institute for Social and Economic Research, University of Essex

She has a Bsc in Biology and MSc in Cancer Genetics and PhD in Biomedical Genetics. She is a Senior Research Officer in Genetics at ISER, interested in complex human disease and the biological pathways by which disease can develop over the life course. She is also interested in the interplay with genetics and epigenetic with the environment.

Yanchun Bao is a Senior Research Officer at the Institute for Social and Economic Research, University of Essex

She is working on the Understanding Society Biomarker Project at ISER. Her interests are mendelian randomisation, causal, several and longitudinal analysis, Hidden Markov Modelling and covariance modelling.

Stine Møllegaard is a Postdoctoral Research Fellow in sociogenomics at Nuffield College and the Department of Sociology, University of Oxford since June 2016

She is working as part of the ESRC NCRM SOCGEN project on the integration of genetic data into social sciences funded from the National Centre for Research Methods. Her research focuses on the role of nature and nurture in social science research, mechanisms generating inequality in educational outcomes, and intergenerational transmission in the family. In her Phd work she investigated the role of cultural capital and behavioral problems in educational inequality, as well as multigenerational effects of family resources, and the effects of prenatal nurture.

Maria Christodoulou is a Postdoctoral Research Fellow at the Department of Statistics, University of Oxford

She is working as part of the ESRC NCRM SOCGEN project on the integration of genetic data into social sciences funded from the National Centre for Research Methods. Her current research focuses on the development of models for survival analysis of genetic data. Prior to this she completed her PhD in Evolutionary Biology at the University of Reading where she focused on combining morphometrics with machine learning to aid botanical identification. Her research interests include mathematical biology, machine learning, taxonomy and evolution, and botany.

	Monday 26th June	Tuesday 27th June	Wednesday 28th June	Thursday 29th June	Friday 30th June
8:15	Coffee & Tea and Registration				
8.45 - 9.00		Coffee & Tea	Coffee & Tea	Coffee & Tea	Coffee & Tea
9.00 - 10.30	**Dalton Conley:** How genetics can inform sociological questions	**David Steinsaltz:** Statistical Foundations for Genetics	**Ben Domingue:** Polygenic scores & Mendelian Randomization in social science research	**Melinda Mills** An introduction to GWAS (genome-wide association study), population stratification and LD-score regression	**Melinda Mills:** Gene x Environment interaction: A review
10.30 - 11.00					
11.00 - 12.30	**Dalton Conley**: Estimating Heritability: An Overview	**Ben Domingue:** An introduction to polygenic scores	**Felix Tropf:** Heritability studies in social science research	**Meena Kumari:** How do biomarkers and genetics contribute to understanding society?	**Cecilia Lindgren,** Expect the unexpected: exploring and utilizing the UK Biobank for obesity and reproductive health research
12.30 -13.30					
13.30 - 15.00	*Computer Session 1* **Charles Rahal and Felix Tropf** An introduction to the command line	*Computer session 3* **Nicola Barban, Melinda Mills, Stine Møllegaard:** Descriptive Statistics, Quality Control and Association Analysis	*Computer session 5* **Felix Tropf and Maria Christodoulou:** Heritability estimates using GCTA	*Computer session 6* **Yanchun Bao & Melissa Smart:** Understanding Society overview	*Computer session 8* **Nicola Barban and Felix Tropf** GxE interaction using polygenic scores and general Q&A for computer sessions
15.00-15.30					
15:30 – 17:15	*Computer session 2* **Felix Tropf and Charles Rahal** Introduction to genetic data and programmes, focus on PLINK	*Computer session 4* **Nicola Barban, Melinda Mills, Stine Møllegaard:** Calculation and use of ploygenic scores	Prepare for boat trip – arrived at Folly Bridge Boat House at 16:45	*Computer session 7* **Nicola Barban and Felix Tropf** Working with Association Results	**Melinda Mills:** Ethics, sociogenomics and general discussion
18:30 – 19:00 19:00	Welcome Drinks Welcome Conference High Table Dinner Nuffield College		17.00 Boat trip and Perch. Boat leaves Perch at 8:15 to return to Oxford		

SUMMER SCHOOL SCHEDULE

DAY 1, MONDAY 26 JUNE

8:15	Coffee and Tea and Registration
8:45-9:15	Welcome and introductions, Melinda Mills
9:15-10:30	How genetics can inform sociological questions, Dalton Conley
10:30-11:00AM	Coffee/Tea with pastries/cookies/fruit
11:00-12:30	Estimating Heritability: An Overview, Dalton Conley
12:30-13:30	Lunch
13:30-15:00	*Computer Session 1:* An introduction to the command line (Charles Rahal, Felix Tropf)
15:00-15:30	Coffee/Tea with cookies/fruit
15:30-17:15	*Computer Session 2:* Introduction to genetic data and programmes, focus on PLINK (Felix Tropf, Charles Rahal)
18.30	Welcome Drinks, Nuffield College
19:00	Welcome Conference High Table Dinner Nuffield College

DAY 2, TUESDAY 27 JUNE

8:45	Coffee and Tea
9:00-10:30AM	Statistical Foundations for Genetics, David Steinsaltz
10:30-11:00AM	Coffee/Tea with pastries/cookies/fruit
11:00-12:30	An introduction to polygenic scores, Ben Domingue
12:30-13:30	Lunch at Nuffield
13:30-15:00	*Computer session 3*: Descriptive Statistics, Quality Control and Association Analysis (Nicola Barban, Melinda Mills, Stine Møllegaard)
15:00-15:30	Coffee/Tea with cookies/fruit
15:30-17:15	*Computer session 4*: Calculation and use of polygenic scores, (Nicola Barban, Melinda Mills, Stine Møllegaard)

DAY 3, WEDNESDAY 28 JUNE

8:45	Coffee and Tea
9:00-10:30AM	Polygenic scores and Mendelian Randomization in social science research, Ben Domingue
10:30-11:00AM	Coffee/Tea with pastries/cookies/fruit
11:00-12:30	Heritability studies in social science research, Felix Tropf
12:30-13:30	Lunch at Nuffield
13:30-15:00	*Computer Session 5*: Heritability estimates using GCTA (Felix Tropf, Maria Christodoulou)
15:00	Prepare for boat trip
16.45	Arrive Boat, Folly Bridge House (aprox. 15 minute walk from Balliol College or 20 minute walk from Nuffield College).

Boat leaves at **5pm sharp** from Folly Bridge to travel to The Perch for Dinner.

Dinner at The Perch (boat leaves at 8.15pm promptly to take you back to Folly Bridge)

DAY 4, THURSDAY 29 JUNE

8:45	Coffee and Tea
9:00-10:30AM	An introduction to GWAS (genome-wide association study), population stratification and LD-score regression, Melinda Mills
10:30-11:00AM	Coffee/Tea with pastries/cookies/fruit
11:00-12:30	How do biomarkers and genetics contribute to understanding society?, Meena Kumari
12:30-13:30	Lunch at Nuffield
13:30-15:00	*Computer session 6:* An introduction to Mendelian Randomisation, Melissa Smart and Yanchun Bao
15:00-15:30	Coffee/Tea with cookies/fruit
15:30-17:15	*Computer session 7:* Working with Association Results (Nicola Barban, Felix Tropf)

DAY 5, FRIDAY 30 JUNE

8:45	Coffee and Tea
9:00-10:30AM	Gene x Environment interaction: A review, Melinda Mills
10:30-11:00AM	Coffee/Tea with pastries/cookies/fruit
11:00-12:30	Expect the unexpected: exploring and utilizing the UKBiobank for obesity and reproductive health research, Cecilia Lindgren
12:30-13:30	Lunch at Nuffield
13:30-15:00	*Computer session 8:* GxE interaction using polygenic scores and general Q&A for computer sessions (Felix Tropf, Nicola Barban)
15:00-15:30	Coffee/Tea with cookies/fruit
15:30-17:15	Ethics, sociogenomics and general discussion, Melinda Mills

READING LIST

DAY 1

INTRODUCTION TO SOCIOGENOMICS

Conley, D. & J. Fletcher. 2017. *The Genome Factor: What the Social Genomics Revolution Reveals about Ourselves, Our History and the Future*. Princeton University Press.

Plomin R, Owen MJ, McGuffin P. 1994. The genetic basis of complex human behaviors. *Science* 264(5166):1733–39

Conely, D. (2016). "Socio-Genomic Research Using Genome-Wide Molecular Data," Annual Review of Sociology, 42: 275-99.

Boardman JD, Domingue BW, Fletcher JM. 2012. How social and genetic factors predict friendship networks., PNAS 109(43):17377–81.

Conley D. 2009. The promise and challenges of incorporating genetic data into longitudinal social science surveys and research. Biodemography Soc. Biol. 55(2):238–51

Domingue BW, Fletcher J, Conley D, Boardman JD. 2014. Genetic and educational assortative mating among US adults. PNAS 111(22):7996–8000.

Courtiol, A., F.C. Tropf & M.C.Mills (2016) When genes and environment disagree: making sense of trends in recent human evolution, Proceedings of the National Academy of Science PNAS, 113(26): 7693-769

HERITABILITY

Falconer, D, and T Mackay. (1996). "Continuous Variation." Introduction to Quantitative Genetics, 4th ed. Harlow, Essex: LongmanGroup Ltd, 101-107.

Polderman, T.J.C., Benyamin, B, de Leeuw, C.A, Sullivan, P.F. et al. (2015). "Meta-analysis of the heritability of human traits based on fifty years of twin studies," Nature Genetics, 47.

Domingue, B. W., Wedow, R., Conley, D., McQueen, M., Hoffmann, T. J., & Boardman, J. D. (2016). Genome-wide estimates of heritability for social demographic outcomes. Biodemography and social biology, 62(1), 1-18.

Mills, M. & F. Tropf (2015). The biodemography of fertility: A review and future research frontiers, Kölner Zeitschrift für Soziologie und Sozialpsychologie, 67(1): 397-424. DOI: 10.1007/s11577-015-0319-4.

DAY 2

STATISTICAL FOUNDATIONS FOR GENETICS

A short introduction: "Statistics 101"—A Primer for the Genetics of Complex Human Disease

Tutorials of an introduction to linear models for those who require it:

http://www.bodowinter.com/tutorial/bw_LME_tutorial1.pdf

http://www.bodowinter.com/tutorial/bw_LME_tutorial2.pdf

Goeman, Jelle J., and Aldo Solari. "Multiple hypothesis testing in genomics." Statistics in Medicine 33.11 (2014): 1946-1978. http://onlinelibrary.wiley.com/doi/10.1002/sim.6082/full

POLYGENIC SCORES

Ware, E. B., Schmitz, L. L., Faul, J. D., Gard, A., Mitchell, C., Smith, J. A., ... & Kardia, S. L. (2017). Heterogeneity in polygenic scores for common human traits. bioRxiv, 106062.

Chatterjee N, Wheeler B, Sampson J, Hartge P, Chanock SJ, Park JH. 2013. Projecting the performance of risk prediction based on polygenic analyses of genome-wide association studies. Nature Genetics, 45(4):400–5.

Dudbridge F. 2013. Power and predictive accuracy of polygenic risk scores. PLOS Genet. 9(3):e1003348

Vilhjálmsson, B.J., Yang J., Finucane, H.K., Gusev, A. et al. 2015 . Modeling linkage disequilibrium increases accuracy of polygenic risk scores. The American Journal of Human Genetics 97(4): 576-592.

Daetwyler, H.D., Villaneuva, B., and Woolliams, J.A. 2008 . "Accuracy of Predicting the Genetic Risk of Disease Using a Genome-Wide Approach," PLoS One 3(10).

Wray, N.R., Yang, J., Hayes, B.J, Price, A.L. et al. 2013. "Pitfalls of predicting complex traits from SNPs," Nature Reviews Genetics,14.

DAY 3

APPLICATION OF POLYGENIC SCORES IN SOCIAL SCIENCE RESEARCH

Belsky, D. W., & Israel, S. (2014). Integrating genetics and social science: Genetic risk scores. Biodemography and social biology, 60(2), 137-155.

Belsky, D. W., Moffitt, T. E., Baker, T. B., Biddle, A. K., Evans, J. P., Harrington, H., ... & Poulton, R. (2013). Polygenic risk and the developmental progression to heavy, persistent smoking and nicotine dependence: evidence from a 4-decade longitudinal study. JAMA psychiatry, 70(5), 534-542.

MENDELIAN RANDOMIZATION

Lawlor, D. A., Harbord, R. M., Sterne, J. A., Timpson, N., & Davey Smith, G. (2008). Mendelian randomization: using genes as instruments for making causal inferences in epidemiology. Statistics in medicine, 27(8), 1133-1163.

Burgess, S., Timpson, N. J., Ebrahim, S., & Smith, G. D. (2015). Mendelian randomization: where are we now and where are we going? International Journal of Epidemiology 379-388. doi: 10.1093/ije/dyv10

DAY 4

GENETIC WIDE ASSOCIATION STUDIES (GWAS) – focus on social science outcomes

Fertility behaviour

Barban, N.……M.C. Mills (October 31 2016). "Genome-wide analysis identifies 12 loci influencing human reproductive behavior," *Nature Genetics*, Dec;48(12):1462-1472.

For our Frequently Asked Questions, which provides a more accessible introduction see: http://www.sociogenome.com/data/NG2016FAQ/

For film about this research:
see: http://www.youtube.com/watch?feature=player_embedded&v=PWSfWSb5KwE

Additional sociogenomic research on fertility

Tropf, F. C., Mills, M., Barban, N., Stulp, G., and H. Snieder (2015) Human fertility, molecular genetics and natural selection in modern societies, PLoS ONE, DOI: 10.1371/journal.pone.0126821

Mehta, D.,…..M.C. Mills, N.R Way, S.Hong Lee. (2016). Evidence for genetic overlap between schizophrenia and age at first birth in women. JAMA PSYCHIATRY, 73(3):193-194. doi:10.1001/jamapsychiatry.2015.2964.

Verweij, R.M., M. Mills, F.C. Tropf et al. (2017). Sexual dimorphism in the genetic influence on human childlessness, European Journal of Human Genetics (forthcoming).

Briley, D., F.C. Tropf, M.C.Mills (2017). "What explains the heritability of completed fertility? Evidence from Two large Twin Studies," Behaviour Genetics, 47(1): 36-51.

Tropf, F. C.,Barban, N., M. Mills, Snieder, H. & J. Mandemakers (2015) Genetic influence on age at first birth of female twins born in the UK, 1919-68, Population Studies, pp. 129-145

Educational Attainment

Rietveld, C. A., Medland, S.E., Derringer, J., Yang ,J. et al. (2013). "GWAS of 126,559 individuals identifies genetic variants associated with educational attainment," *Science*, 340(6139).

For an accessible explanation of this article, see the FAQ:
http://ssgac.org/documents/FAQsRietveldetal2013Science.pdf

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For an accessible explanation of this article, see the FAQ: https://www.thessgac.org/faqs

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