

# Research Report 2007–2008



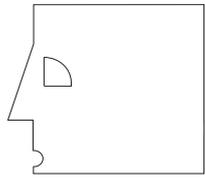
The Max Planck Institute for Human Development, founded in 1963, is a multidisciplinary research establishment dedicated to the study of human development and education. Its inquiries are broadly defined, and concentrate on the evolutionary, social, historical, and institutional contexts of human development. The disciplines of education, psychology, and history reflect the current directors' backgrounds, but the Institute's scholarly spectrum is enriched by the work of colleagues from such fields as behavioral developmental neuroscience, sociology of education, mathematics, economics, computer science, evolutionary biology, and the humanities.

The Institute for Human Development is one of about 80 research facilities financed by the Max Planck Society for the Advancement of Science (Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V.), the core support for which is provided by the Federal Republic of Germany and its 16 states.

Max-Planck-Institut für Bildungsforschung  
Max Planck Institute for Human Development



MAX-PLANCK-GESELLSCHAFT



# Research Report 2007–2008





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# Introduction







## Introduction

The Max Planck Institute for Human Development is a multidisciplinary research institution dedicated to the study of human development and education. Its inquiries encompass evolutionary, historical, social, and institutional contexts of individual human development from infancy to old age. The disciplines of education, history, and psychology, which reflect the current directors' backgrounds, are enriched by the work of colleagues from computer science, behavioral neuroscience, economics, evolutionary biology, mathematics, sociology, and the humanities.

The Institute is one of about 80 research facilities financed by the Max Planck Society for the Advancement of Science (Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V.), the core support for which is provided by the Federal Republic of Germany and its 16 states. The total permanent staff at the Institute is 108, including 34 researchers, supplemented by a varying number of pre-doctoral, postdoctoral, and affiliate researchers and visiting fellows.

### Research Centers

Research into processes of human development is conducted primarily from the theoretical vantage points offered by models of bounded rationality and risk behavior, institutionalized learning, lifespan psychology, life-course sociology, and, as of 2008, cultural history.

In the 2007–2008 period, research at the Institute was primarily organized in four research centers:

**The Center for Adaptive Behavior and Cognition** (Director: Gerd Gigerenzer) investigates human rationality, in particular decision making and risk perception in an uncertain world. Current research focuses on (1) bounded rationality, that is, the simple heuristics—cognitive, emotional, and behavioral—that laypeople and experts use to make decisions under constraints of limited time and knowledge; (2) social intelligence in cooperation and competition; and (3) risk understanding and uncertainty management in everyday life, including applications in medicine, law, and education. Each of these research areas emphasizes the evolutionary foundations of behavior and cognition, in particular their domain specificity and functional adaptiveness (pp. 29–65).

### The Center for Educational Research

(Director: Jürgen Baumert) examines learning and development from an institutional point of view. Educational settings, such as schools, offer a variety of developmental opportunities, but, at the same time, exclude others. The impact of such settings is investigated from three perspectives: (1) the long-term consequences of schools' opportunity structures on individual development in terms of cognitive competencies as well as motivational and social resources; (2) international comparison of the outcomes of schooling in the fields of reading comprehension, mathematics and science literacy; and (3) improvement of learning and instruction in terms of the cognitive activation of students, mainly in science and mathematics (pp. 67–121).

### The Center for the History of Emotions

(Director: Ute Frevert), opened in January 2008, examines human emotions. The research rests on the assumption that emotions—feelings and their expressions—are shaped by culture and learnt in social contexts. A central objective is to trace and analyze the changing norms and rules of feeling. Geographically, the Center's scope includes both Western and Eastern societies (Europe, North America, and South Asia). Special attention is paid to institutions that have a strong impact on human behavior, such as the family, law, religion, the military, and the state (pp. 123–163).

### The Center for Lifespan Psychology

(Director: Ulman Lindenberger) has helped to establish lifespan psychology as a distinct conceptual approach within developmental psychology. Work at the Center is guided by three propositions: (1) to study lifespan changes in behavior as interactions among

maturation, learning, and senescence; (2) to develop theories and methods that integrate empirical evidence across domains of functioning, timescales, as well as behavioral and neuronal levels of analysis; and (3) to identify mechanisms of development by exploring age-graded differences in plasticity. While the Center continues to pay special attention to the age periods of late adulthood and old age, which offer unique opportunities for innovation, both in theory and practice, it also intensified its interest in early periods of ontogeny, including infancy and early childhood (pp. 165–223).

In June 2008, **Gert G. Wagner**, professor at the Technical University Berlin and Head of the **German Socio-Economic Panel Study (SOEP)**, was appointed **Max Planck Fellow** at the Institute. The Max Planck Society established the fellow program to further strengthen research cooperation between its institutes and neighboring universities or other research institutions. Cooperation with Gert G. Wagner has allowed researchers at the Institute to link their experimental work, such as cognitive interventions, to longitudinal observations from the SOEP to investigate selectivity and maintenance of training effects. In addition, innovative survey technology, such as mobile-phone based cognitive testing in real-life settings, has been explored and validated. The Institute also houses an **Independent Junior Research Group on the Neurocognition of Decision Making** (Head: Hauke R. Heekeren). Using a combination of psychophysical methods, functional and structural neuroimaging, modeling, and pharmacological intervention, this group investigates mechanisms of decision making in the human brain (pp. 225–249).

An important collaborative effort involving three of the four Centers at the Institute as well as universities in Berlin and the United States is the **International Max Planck Research School "The Life Course: Evolutionary and Ontogenetic Dynamics (LIFE)"**, which is currently co-chaired by Ulman Lindenberger, Berlin, Patricia Reuter-Lorenz, University of Michigan, and John R. Nesselrode, University of Virginia. The University of Zurich joined the Life Research School in

October 2008. This interdisciplinary graduate program brings together doctoral students from the United States and Germany but also from many other countries (pp. 21–26).

In 2008, the Max Planck Society established the **Max Planck Research Network on Cognition (Maxnet Cognition)**. Its substantive focus is on the behavioral science, the behavioral neuroscience, and the computer science of cognition. The main goal of the Network is to foster research cooperation between institutes and across sections of the Max Planck Society on a small number of particularly important research topics in the field of cognition that profit from an interdisciplinary approach. The Steering Committee of the Network consists of Peter Hagoort (MPI for Psycholinguistics, Nijmegen), Ulman Lindenberger (MPI for Human Development, Berlin), and Arno Villringer (MPI for Human Cognitive and Brain Science, Leipzig). The administration of the Network is located at this Institute (p. 27).

#### **Governance of the Institute**

The Institute is governed by a Board of Directors, currently consisting of the four members of the Institute who are Fellows (Wissenschaftliche Mitglieder) of the Max Planck Society (Jürgen Baumert, Ute Frevert, Gerd Gigerenzer, and Ulman Lindenberger).

The Board is augmented by one member from the Institute's research staff (Margrit Pernau) and the Head of Administration (Olaf von Maydell). On a rotational basis, one of the directors is elected by the Board to serve as Managing Director, usually for a period of 2 years.

Several in-house committees, composed of representatives elected by the entire research staff or by appointment, advise the Board of Directors on matters of scientific research and policy. One of the major institute-wide committees is the Scientific Staff Committee (Mitarbeiterausschuss), which is elected by all researchers.

The **International Board of Scientific Advisors** offers an important source of external review and advice to both the directors and the scientific staff on matters of research at the Institute. Members are selected from an

international circle of distinguished researchers and appointed by the President of the Max Planck Society. They meet biannually to discuss completed, ongoing, and future research projects at the Institute. A list of the current members can be found on the front matter of this report.

Finally, it is worth noting that the Institute building underwent major renovations from March 2008 until March 2009. During this period, people working at the Institute were relocated to a nearby building. Despite numerous restrictions and shortcomings at the interim site, the Institute has been able to maintain its productivity and further expand its research activities. In mid-march 2009, everyone moved back into the renovated building, featuring improved facilities, fresh colors, and a beautiful garden. The Institute will host an exhibit honoring the architects of the Institute building, Hermann Fehling and Daniel Gogel, in fall 2009.

Berlin, April 2009

### **Organization of the Annual Report**

This research report is organized in the following manner:

- The presentation of each research center begins with an introductory overview summarizing its program.
- The introduction is followed by descriptions of the center's research areas and selected projects along with a list of scientific publications.
- The supportive activities of the service units—library and computing services—are described in a special section at the end of the report (pp. 251–257).
- The appendix provides information on the research colloquia held at the Institute, the visiting scholars, and the cooperation of the Institute's scientific staff with projects outside the Institute. It also includes an index of the scientific staff and their research interests (pp. 258–283).

For the Board of Directors:  
Ulman Lindenberger

# Highlights



## Honors and Awards 2007–2008

**Adrien Barton** Zusätzliches Leistungsstipendium der Studienstiftung des Abgeordnetenhauses von Berlin.

**Jürgen Baumert** Vice-President of the Max Planck Society for the Advancement of Science (MPG). Appointed Chair of the Advisory Council for the new Joint Commission of the Federal and Länder governments on Monitoring the Performance of the German Education System in International Comparison, Educational Reporting, and Joint Recommendations.

**Ute Frevert** accepted the offer as Honorary Professor of History at the Free University Berlin. As of 2008, she is the Managing Director of the "Geschichte und Gesellschaft" journal, Board Member of the "Schülerwettbewerb Deutsche Geschichte," Hamburg, and Member of the "Berlin-Brandenburgische Akademie der Wissenschaften." Since 2007, she is Member of the Board of Trustees at the "Zentrum für Zeithistorische Forschung," Potsdam, and Member of the Supervisory Board at Jacobs University in Bremen.

**Mirta Galesic** was awarded a research grant by the Foundation for Informed Medical Decision Making, Boston, MA; the grant will be used for the research project "Helping People With Low Numeracy Understand Medical Information."

**Gerd Gigerenzer** was awarded the Fellow status of the Association for Psychological Science (APS) for distinguished contributions to Psychological Science 2008; the APS has invited him to give a William James Distinguished Lecture in Psychological Science next year in Chicago. He received the Honorary Doctorate from the University of Basel; he was honored for his research on bounded rationality and social intelligence, decision making, as well as risk behavior and communication. His new book "Gut Feelings" was shortlisted for the Royal Society's Science Book Prize, the world's most prestigious award for science writing. "Gut Feelings" was selected as Book of the Year in Business by the Swiss weekly magazine "Handelszeitung." For the same book, Dr. Gigerenzer was also honored for the Science Book of the Year by the German monthly science magazine "Bild der Wissenschaft."

**Ilonka Hardy** was offered a professorship for Early Science Education at the University of Münster.

**Hauke R. Heekeren** was offered a full professorship (W3) for the Psychology of Emotions at the Free University Berlin.

**Lothar Krappmann** was reelected for a consecutive 4-years' term as one of the 18 Members of the United Nations' Committee on the Rights of the Child; the Committee is elected by the General Assembly of the 193 signatory states of the Convention on the Rights of the Child.

**Shu-Chen Li** was appointed as Honorary Professor of Psychology at the Free University Berlin. She was offered a W3 full professorship from University Konstanz (offer declined for personal reasons).

**Ulman Lindenberger** has been elected as DFG Review Board Member in the field of Developmental and Educational Psychology. He has been invited to spend a year as a visiting fellow at the Stanford Center for Advanced Study in the Behavioral Sciences (2009–2010).

**Oliver Lüdtke** accepted the offer for a full professorship (W3) for Educational Psychology at the University of Tübingen. He was offered a full professorship (W3) for Empirical Research in Teaching and Instruction at the Saarland University.

**Shabnam Mousavi** received a 2-year award from the University of Chicago; she is now a Member of the first Defining Wisdom Project.

**Angela Neumeyer-Gromen** Doctoral thesis award 2008 of the Westphalian University Society Bielefeld: "Historical Cohort Study About Diesel Motor Emissions and Lung Cancer Mortality in Potash Mining—Second Follow-Up and Validation Study."

**Margrit Pernau** has received the Habilitation Prize of the Association of German Historians; the 6,000 Euro prize has been awarded to her for her book "Bürger mit Turban, Muslime in Delhi im 19. Jahrhundert." Since 2008, she is Member of the Advisory Board of "Concepta" (Interna-

tional Research School in Conceptual History and Political Thought) and elected Member of the Board of Editors of "Geschichte und Gesellschaft—Journal of Historical Social Sciences."

**Jörg Rieskamp** has accepted the offer for a professor position for Economic Psychology at the University of Basel, starting September 2008.

**Ulrich Trautwein** accepted the offer for a full professorship (W3) for Educational Science at the University of Tübingen. He was appointed as Honorary Professor of Psychology at the Free University Berlin. He was offered a full professorship for Educational Research at the University of Fribourg (Switzerland) and for Educational Science at the University of Erfurt. He was awarded the CORECHED-Preis 2009: Preis der Schweizerischen Koordinationsstelle Bildungsforschung (together with Franz Baeriswyl, Christian Wandeler and Karin Oswald for an article in the Zeitschrift für Erziehungswissenschaft).

**Gert G. Wagner** has been elected as the Chairman of the German Council for Social and Economic Data for 2009; the Council's main purpose is to advise in the development of the German data infrastructure for empirical research in the social and economic sciences; this includes to increase access to microdata and to sustainably improve data quality.

#### Early Career Awards

**Markus Bahnemann** Travel Award for the 13th Annual Meeting of the Organization for Human Brain Mapping, Chicago, USA.

**Yvonne Brehmer** received the Otto Hahn Medal 2007 for her doctoral dissertation and has the opportunity to set up an Otto Hahn Group. She received the prize FLARE (Future Leaders of Aging Research); the program offers her a longer research visit at the MPIB next year; she will investigate age differences in memory function together with the LIP team.

**Agnieszka Zofia Burzynska** received a Travel Award for the Pathogenesis and Mechanisms of White Matter Injury Workshop, Krakow.

**Edward T. Cokely** Best Student Poster Award, 2nd Runner-Up at the 28th Annual Meeting of the Society for Judgment and Decision Making.

**Isabel Dziobek** Travel Award for the 4th International Meeting for Autism Research, Seattle, USA; travel award for the 13th Annual Meeting of the Organization for Human Brain Mapping, Chicago, USA. She received a Dissertation Award from the University of Bielefeld.

**Wolfgang Gaissmaier** received the Otto Hahn Medal 2008 for his doctoral dissertation.

**Bettina von Helversen** received the Otto Hahn Medal 2008 for her doctoral dissertation.

**Nicole Husemann** received the Otto Hahn Medal 2007 for her doctoral dissertation.

**Kathrin Jonkmann** received the Student Research Excellence Award of the EARLI "Motivation and Emotion" Special Interest Group.

**Jennifer Kirchner** received a Travel Award for the 1st Scientific Meeting for Autism Spectrum Conditions (WTAS), Frankfurt.

**Lea Katharina Krugel** Travel Award for the 14th Annual Meeting of the Organization for Human Brain Mapping, Melbourne, Australia.

**Kai Maaz** Junior Research Award in Sociology of Education, German Sociological Association.

**Julian N. Marewski** Reimar-Lüst-Stipendium der MPG.

**Paula Parpart** Best Student Poster Award, Honorable Mention to Paula Parpart (supervisor and co-author Edward T. Cokely) at the Second Biennial Symposium on Personality and Social Psychology for "Individual Differences and the Use of Fluency in Judgment: Paradoxical Evidence of Reflective Heuristic Processing."

**Antje Rauers** received the Best Poster Prize of the German Psychological Association, Section for Developmental Psychology.

**Camilla Rjosk** received the Marie-Schlei Award of the Free University Berlin for her diploma thesis.

**Christina Scheibe** Travel Award for the 13th Annual Meeting of the Organization for Human Brain Mapping, Chicago, USA.

**Benjamin Scheibehenne** Best Student Poster Award, 1st Runner-Up at the 28th Annual Meeting of the Society for Judgment and Decision Making.

**Yee Lee Shing** Humboldt Research Fellowship for Postdoctoral Researcher. She received the Otto Hahn Medal 2008 for her doctoral dissertation.

**Yi-Miau Tsai** received the Student Research Excellence Award of the EARLI "Motivation and Emotion" Special Interest Group.

## Where Have Our Researchers Gone? New Positions 2007–2008

### Researchers

**Yvonne Anders (Grabbe)** 2008, Federal Ministry of Family, Affairs, Senior Citizens, Women and Youth, Scientific Advisor

**Nathan Berg** 2007, University of Texas at Dallas, Associate Professor

**Ilonca Hardy** 2008, University of Frankfurt, Full Professor for Educational Science

**John M. C. Hutchinson** 2007, Senckenberg Museum für Naturkunde Görlitz, Research Assistant

**Stefan Krauss** 2007, University of Kassel, Assistant Professor

**Oliver Lüdtke** 2008, University of Tübingen, Full Professor for Educational Psychology

**Jörg Rieskamp** 2008, University of Basel, Professor position for Economic Psychology

**Ulrich Trautwein** 2008, University of Tübingen, Full Professor for Educational Science

### Postdoctoral Research Fellows

**Markus Bauer** 2008, University College London, Postdoctoral Researcher

**Christian Chicherio** 2008, University of Geneva, Maître d'Enseignement et de Recherche, suppléant

**Natalie C. Ebner** 2007, Yale University, Postdoctoral Fellow

**Sandra Fronz** 2007, Pennsylvania State University, Lecturer and Child Therapist, in training

**Erin Furtak** 2008, University of Colorado, Boulder, Assistant Professor

**Denis Gerstorff** 2007, Pennsylvania State University, Assistant Professor of Human Development

**Bettina von Helversen** 2008, University of Basel, Research Scientist

**Dana Kotter-Grühn** 2008, North Carolina State University, Postdoctoral Research Associate

**Jutta Mata** 2008, Technical University Lisbon, Postdoctoral Researcher

**Shabnam Mousavi** 2008, Virginia Tech

**Jing Quian** 2007, Columbia University of New York, Fellowship in Primary Pediatric Psychopharmacology (PPP)

**Susanne Scheibe** 2007, Stanford University, Postdoctoral Research Fellow

**Benjamin Scheibehenne** 2008, Indiana University, Bloomington, Postdoctoral Researcher

### Predocctoral Research Fellows

**Markus Bahnemann** 2008, Charité University Medicine Berlin, First-Year Resident

**Linan Diao** 2008, MPI for Economics, Jena, Predocctoral Research Fellow

**Andrea G. Eckhardt (Müller)** 2007, German Youth Institute (DJI), Munich

**Oliver Huxhold** 2007, The German Centre of Gerontology (DZA), Research Assistant

**Michaela Köller** 2008, Institute for Education and Socio-Economic Research and Consulting, Research Assistant

**Lea Katharina Krugel** 2008, Charité University Medicine Berlin, Medical Intern

**Thomas Mell** 2008, Charité University Medicine Berlin, Department of Psychiatry, Resident Physician

**Katja Mériau** 2008, Gesellschaft für Technische Zusammenarbeit, Project Assistant

**Kristin Prehn** 2008, University of Rostock, Postdoctoral Researcher





# External Cooperation

## Teaching and Academic Degrees

The Institute has always considered its cooperation with universities as very important, especially by participating in teaching activities. Researchers from our Institute teach courses at three universities in Berlin and at the University of Potsdam as well as at many other universities in Germany and abroad.

In the years 2007–2008, more than 100 courses were taught by scientific staff members—directors, research scientists, postdoctoral as well as predoctoral fellows—of the Institute.

In addition, Institute members were supported in completing their academic degrees in cooperation with the universities in Berlin and elsewhere. In the years 2007–2008, 5 habilitations and 22 doctoral dissertations were completed by research staff members of the Institute.

All degrees are listed in the Appendix.



Exhibition in the Institute's entrance hall. Sculptures by Özgür Emeklier

## International Max Planck Research School The Life Course: Evolutionary and Ontogenetic Dynamics (LIFE)



International Max Planck  
Research School  
on the Life Course

This graduate program on the Life Course is part of the Max Planck Society's framework of International Max Planck Research Schools (IMPRS). It was established in 2002 as a collaboration between the Max Planck Institute for Human Development, Berlin, the Humboldt University Berlin, the Free University Berlin, and the University of Michigan, Ann Arbor. The University of Virginia, Charlottesville, joined in October 2004, and the University of Zurich followed suit in October 2008.

The goal of the Research School is advanced research training in the study of human behavior and institutional systems over evolutionary and ontogenetic (life cycle) time. LIFE takes an integrative and interdisciplinary approach to understanding human development in a changing world, connecting evolutionary, ontogenetic, historical, and institutional perspectives. A major aspect of this program is its internationality. On the one hand, this is achieved by recruiting students from all over the world (e.g., Peru, Portugal, Malaysia, etc.). On the other hand, the four LIFE sites in three countries (Germany, USA, Switzerland) secure true international exchange by collaborating closely in the training of the fellows (see below).

The target groups of the Research School are post-diploma or post-master's graduate students who intend to pursue a doctorate in one of the relevant disciplines (biology, psychology, neuroscience, sociology, anthropology, educational science). As a collaborative Research School, LIFE offers students a unique educational experience: Discipline-based training in the study of the life course/life cycle that is enriched by interdisciplinary and international perspectives.

The training program involves seminars at the participating institutions, a series of Fall and

Spring Academies, and collaborative supervision of research training. It also includes opportunities for research abroad at a cooperating institution. Ten fellows (five from Berlin and five from the University of Virginia) have made use of this in 2007 and 2008.

The strong interlocking components are two annual weeklong academies in which fellows and faculty from each site participate. During the reporting period, four such academies took place. The LIFE Spring Academy 2007 was organized by the MPI for Human Development at the Harnack-Haus in Berlin, the Fall Academy 2007 took place at the University of Michigan. In 2008, the Spring Academy was held at the University of Virginia, and the Fall Academy took place in Berlin again and was organized by the MPI. Generally, the average number of participants including faculty was about 60. The teaching faculty consisted of faculty members from Ann Arbor, Berlin, Charlottesville, and, most recently, from Zurich, as well as several guests from other institutions. The next Academy is scheduled to take place in Zurich in May 2009. After a very positive evaluation of LIFE in 2006, funding by the Max Planck Society was granted to the IMPRS for another five-year period until 2013.

### Co-chairs

Ulman Lindenberger (MPI for Human Development), Jacquelynn S. Eccles (University of Michigan, from January 2002 to May 2008), Alexandra M. Freund (University of Zurich, since October 2008), John R. Nesselrode (University of Virginia), Patricia A. Reuter-Lorenz (University of Michigan, since June 2008)

### Coordinators

Julia A. M. Delius (MPI for Human Development, August 2008 to January 2009, during Imke Kruse's maternity leave), Imke Kruse (MPI for Human Development), Deanna Maiola (University of Michigan), Juanita L. Geer (University of Virginia)

In total, 77 faculty (Berlin: 28; Michigan: 26; Virginia: 14; Zurich: 9) and 58 fellows (Berlin: 23; Michigan: 13; Virginia: 16; Zurich: 6) were involved at the end of 2008. In addition, 25 fellows (Berlin: 15; Michigan: 7; Virginia: 3) completed their dissertation during the reporting period.

Over the last years, fellows from all over the world have joined the program on the following annual schedule:

2006: 23 (Berlin: 11; Michigan: 4; Virginia: 8)

2007: 12 (Berlin: 8; Michigan: 4)

2008: 25 (Berlin: 5; Michigan: 5; Virginia: 8; Zurich: 7)

[www.imprs-life.mpg.de](http://www.imprs-life.mpg.de)

In addition to the Academies, each participating university offers special courses reflecting the special profile of its graduate programs and selects a subset of fellows for the added specialization provided by LIFE. The Berlin approach is to offer weekly seminars at the MPI for Human Development, taught throughout the academic year by a varying team of faculty from the three Berlin institutions.

Topics of the Berlin LIFE seminars in 2007 and 2008 were:

- *Research Methods*  
Ulman Lindenberger, Markus Bauer, Martin Brunner, Hauke R. Heekeren, Shu-Chen Li, Lael J. Schooler, & Timo von Oertzen (MPI), Michael Eid & Arthur M. Jacobs (Free University), Florian Schmiedek (Humboldt University), Paolo Ghisletta (University of Geneva), Gert G. Wagner (Deutsches Institut für Wirtschaftsforschung, DIW), Nilam Ram (Penn State University)
- *Theoretical and Methodological Approaches to the Study of the Life Cycle: Interdisciplinary Perspectives*  
Ulman Lindenberger, Jürgen Baumert, Gerd Gigerenzer, Rui Mata, Michaela Riediger, Lael J. Schooler, Jeffrey R. Stevens, & Ulrich Trautwein (MPI), Gert G. Wagner (DIW), Clemens Tesch-Römer (Deutsches Zentrum für Altersfragen)
- *Emotion, Sensorimotor Functions, and Cognition: A Lifespan Perspective*  
Ulman Lindenberger, Martin Lövdén, Michaela Riediger, Sabine Schaefer, & Ulrich Trautwein (MPI), Sabine Hunnius (Nijmegen Institute for Cognition and Information), Peter Zimmermann (University of Dortmund), Ute Kunzmann (International University Bremen), Eugenio Parise & Stefanie Höhl (Laboratory for Infant Development, Leipzig), Hermann Müller (Saarland University), Christopher Hertzog (Georgia Institute of Technology), Evelyn Bertin (University of Zurich), Naftali Raz (Wayne State University)
- *Methods in Research on Human Development*  
Gerd Gigerenzer & Ulman Lindenberger (MPI), Steven M. Boker (University of Virginia), Denis Gerstorff, Peter Molenaar, & Nilam Ram (Penn State University), Christopher Hertzog (Georgia Institute of Technology)
- *The ACT-R Cognitive Architecture: How the Mind's "Gears Clank and How the Pistons Go"*  
Lael J. Schooler (MPI) & Guests: Shu-Chen Li & Yee Lee Shing (MPI)

**Life Faculty  
2007/2008  
(as of December  
2008)**

**MPI for Human Development**

*Jürgen Baumert*, Educational Science  
*Gerd Gigerenzer*, Psychology  
*Hauke R. Heekeren*, Neuroscience (since 2008)

*Shu-Chen Li*, Psychology  
*Ulman Lindenberger*, Psychology  
*Michaela Riediger*, Psychology (since 2008)  
*Lael J. Schooler*, Psychology  
*Ulrich Trautwein*, Educational Science

**Free University Berlin**

*Michael Eid*, Psychology  
*Arthur M. Jacobs*, Psychology  
*Martin Kohli*, Sociology (currently European University Institute, Florence)  
*Hans Merckens*, Educational Science

*Herbert Scheithauer*, Psychology  
*Ralf Schwarzer*, Psychology & Health  
*Clemens Tesch-Römer*, Psychology & Gerontology

**Humboldt University Berlin**

*Jens B. Asendorpf*, Psychology  
*Hans Bertram*, Sociology  
*Jaap Denissen*, Psychology (since 2007)  
*Peter A. Frensch*, Psychology  
*Peter Hammerstein*, Biology  
*Olaf Köller*, Psychology & Education  
*Rainer H. Lehmann*, Educational Science  
*Florian Schmiedek*, Psychology (since 2007)  
*Arno Villringer*, Psychology  
*Oliver Wilhelm*, Psychology & Education

**Other Institutions Affiliated With LIFE  
Berlin**

*Gerd Kempermann*, Neuroscience, Center for Regenerative Therapies Dresden  
*C. Katharina Spieß*, Economics, Deutsches Institut für Wirtschaftsforschung & Free University Berlin  
*Gert G. Wagner*, Economics, Deutsches Institut für Wirtschaftsforschung & MPI for Human Development

**University of Michigan**

*Toni C. Antonucci*, Psychology  
*Don Brown*, Psychology  
*Kai S. Cortina*, Psychology & Education  
*Jacquelynne S. Eccles*, Psychology & Education  
*Robin S. Edelstein*, Psychology (since 2008)  
*Richard Gonzalez*, Psychology  
*L. Rowell Huesmann*, Psychology & Communication Studies  
*James S. Jackson*, Social Psychology  
*Daniel Keating*, Psychology  
*Shinobu Kitayama*, Psychology  
*Daniel Kruger*, Psychology & Public Health  
*Bobbi S. Low*, Evolutionary & Behavioral Ecology  
*Cindy Lustig*, Psychology (since 2007)  
*Kevin F. Miller*, Psychology & Education  
*Maria Muzik*, Psychiatry  
*Randolph M. Nesse*, Psychology & Psychiatry  
*Sheryl Olson*, Psychology  
*Thad Polk*, Psychology  
*Patricia A. Reuter-Lorenz*, Cognitive Psychology & Neuroscience  
*Arnold Sameroff*, Psychology  
*John Schulenberg*, Psychology  
*Rachael Seidler*, Psychology & Kinesiology  
*Jacqui Smith*, Psychology  
*Abigail Stewart*, Psychology  
*Twila Tardif*, Psychology  
*Henry M. Wellman*, Psychology

**University of Virginia**

*Steven M. Boker*, Cognitive & Quantitative Psychology  
*Gerald L. Clore*, Social Psychology  
*Judy DeLoache*, Developmental Psychology  
*Chad Dodson*, Cognitive Psychology  
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Lively discussion among  
fellows and faculty dur-  
ing the LIFE Fall Academy  
2008.

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Table 1  
Dissertations Completed (2007–2008)

<i>Fellow</i>	<i>Dissertation title</i>	<i>Institution</i>	<i>Discipline</i>	<i>Current position</i>
Joaquin Anguera	Contributions of Spatial Working Memory to Visuomotor Adaptation	UM	Psychology	University of California, San Francisco
Helen Baykara-Krumme	Parent-Adult Child Relationships in Later Life: A Comparative Study on Migrant and Non-Migrant Families in Germany	FU	Sociology	Chemnitz University of Technology
Michael Becker	Kognitive Leistungsentwicklung in differenziellen Lernumwelten: Effekte des gegliederten Sekundarschulsystems in Deutschland	FU	Educational Science	MPI for Human Development
Tobias Bothe-Hutschenreuter	Accounting for Individual Differences in Financial Old-Age Provision Through Maximum Behavior, Typical Response, and Life Data	HU	Psychology	Kienbaum Consultants, Düsseldorf
Marie Burrage	How Closely Are You Reading That? Students' Interpretations of Research Findings	UM	Psychology	City University of New York
Jessica Garrett	Motivation in the Transition to Adulthood	UM	Psychology	Ohio State University
Bettina von Helversen	Quantitative Estimation From Multiple Cues: Test and Application of a New Cognitive Model	MPI/HU	Psychology	University of Basel, Switzerland
Oliver Huxhold	Processing Fluctuations in Postural Control: Relations to Adult Age and Fluctuations in Cognition	MPI/FU	Psychology	German Center of Gerontology
Justin Jager	The Impact of Social Status on Levels of Psychological Well-Being: A Dynamic Developmental Approach	UM	Psychology	University of Michigan
Dana Kotter-Grühn	Development and Functionality of Life Longings: The Case of Involuntary Childlessness	MPI/FU	Psychology	North Carolina State University
Poldi Kuhl	Family Matters: A Longitudinal Study on Within-Family Associations Between Family Context and Adjustment in Adolescence	FU	Educational Science	Berlin-Brandenburg Institute for School Quality
Cristine Legare	The Development of Causal Explanatory Reasoning	UM	Psychology	The University of Texas at Austin
Vanessa LoBue	Detection of Threat in Infants and Young Children	UVa	Psychology	University of Virginia
Jamie Mangold	The Effects of Prenatal Sodium Restriction on Plasticity and Development of Gustatory Brainstem Anatomy and Taste-Related Behavior	UVa	Neuroscience	University of Virginia
Jutta Mata	Healthy Food Choice: How Environment and Cognition Determine What We Eat	MPI/HU	Psychology	Stanford University
Emily Messersmith	Longitudinal Correlates of Changing Educational Expectations During the Transition to Adulthood	UM	Psychology	University of North Carolina at Chapel Hill
Andrea G. Müller	Barriers to Reaching Proficiency in School-Related Language Among Second Language Learners	MPI/FU	Educational Science	German Youth Institute
Lars Penke	Approaches to an Evolutionary Personality Psychology: The Case of Sociosexuality	HU	Psychology	The University of Edinburgh
Tabea Reuter	Self-Regulation of Health Behavior Change: A Developmental and Dynamic Perspective	FU	Psychology	Free University Berlin
Dennis Rüdiger	On the Generation and Function of Conscious Sequence Knowledge	HU	Psychology	Berlin Brandenburg Academy of Sciences and Humanities

Table 1 (continued)  
Dissertations Completed (2007–2008)

<i>Fellow</i>	<i>Dissertation title</i>	<i>Institution</i>	<i>Discipline</i>	<i>Current position</i>
Besangie Sellars	A Longitudinal View of Sex Role Development: Demographic Differences and the Influence of Social Relations	UM	Psychology	University of Pittsburgh
Yee Lee Shing	Dynamics of Episodic Memory: Interaction Between Associative and Strategic Components	MPI/HU	Psychology	MPI for Human Development
Yi-Miau Tsai	Motivation in Context: Intraindividual Variability in Day-To-Day Classroom Learning	MPI/HU	Educational Science	University of Michigan
Lijuan (Peggy) Wang	Generalized Mixed Models With Mixture Links for Multivariate Zero-Inflated Count Data	UVa	Psychology	University of Notre Dame
Markus Werkle-Bergner	Age Differences in Episodic Memory and Visual Perception Across the Lifespan: Insights Into Dynamic Structure-Function Relations From Behavioral and Electrophysiological Investigations	MPI/HU	Psychology	MPI for Human Development



Participants from all four LIFE sites during the LIFE Fall Academy 2008 at the Magnus-Haus in Berlin.

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## Maxnet Cognition Max Planck Research Network on Cognition



THE MAX PLANCK SOCIETY

In 2008, the Max Planck Society established the **Max Planck Research Network on Cognition (Maxnet Cognition)**. The substantive focus of Maxnet Cognition is on the behavioral science, the behavioral neuroscience, and the computer science of cognition, broadly defined, with an emphasis on one or more of the following: human cognitive performance, functional brain circuitry, and computational algorithms. The Network is open to all institutes of the Max Planck Society and also includes cooperation partners from other research institutions. The Innovation Fund of the Max Planck Society has funded the Network for an initial period of 5 years.

The primary goals of Maxnet Cognition are to:

(a) increase cooperation and improve coordination between institutes and across sections; (b) promote research on cognition by providing a more cohesive representation of cognitive research issues and identifying future research directions; (c) foster cross-disciplinary insights and collaboration; and (d) signal the strong and sustained commitment of the Max Planck Society to the topic of cognition.

The activities of Maxnet Cognition fall into three broad categories:

– Topical workshops and mini-conferences by at least two different institutes on themes of common interest. The objectives of these meetings will be to: (a) nurture interdisciplinary and multilevel discourse; (b) present research on cognition broadly but also in-depth; (c) advance theories and new methodologies/paradigms; (d) open up new lines of inquiry into the study of cognition; and (e) plan collaborative research to be conducted at the home institutions.

– Collaborative research projects between at least two different institutes, typically with a postdoctoral fellow as the principal investigator and at least two Network members, and generally initiated as a result of a workshop.

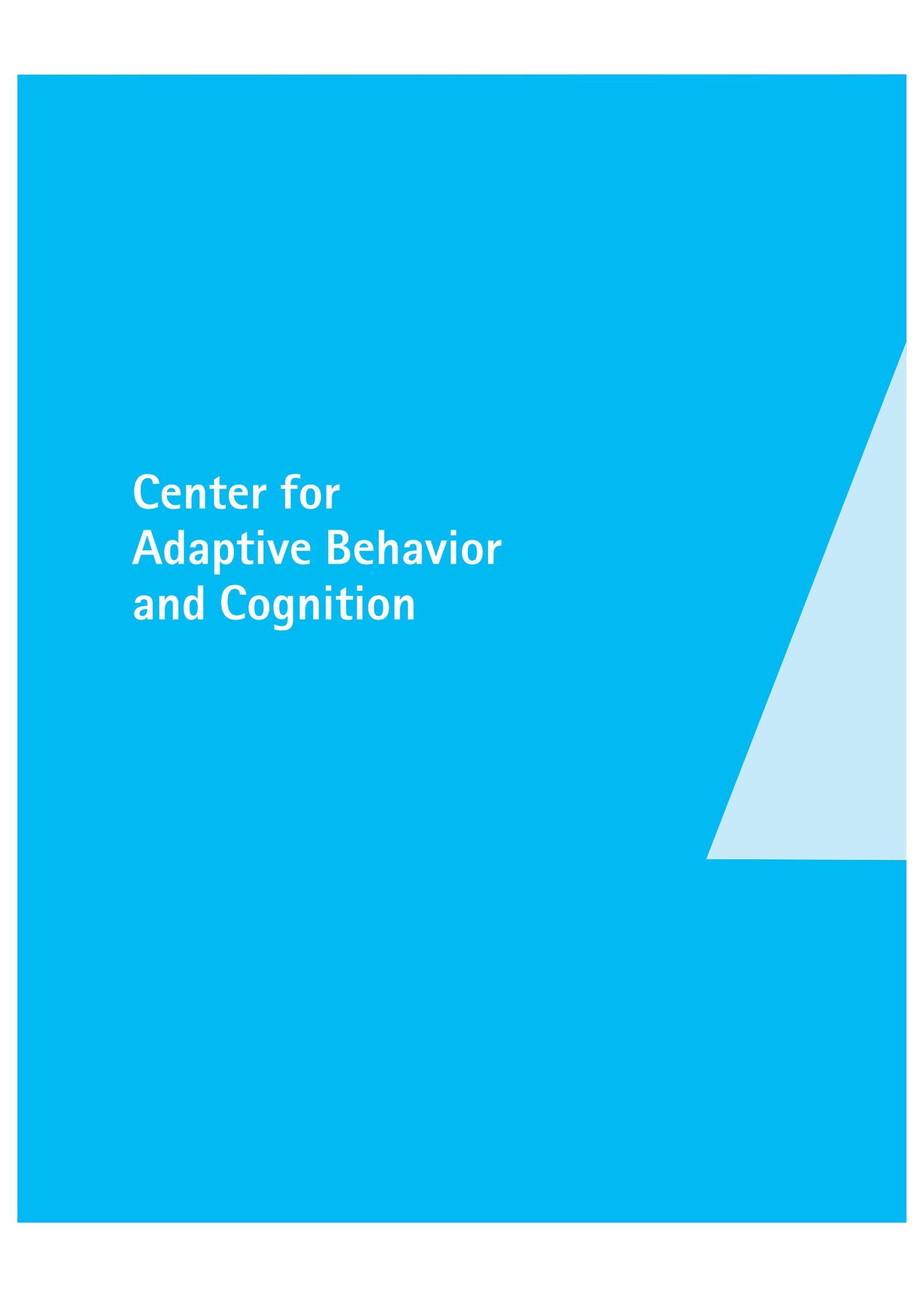
– Public Max Planck Society forums on “hot topics” in the field of cognition to promote the visibility of Max Planck Society research on cognition, both nationally and internationally.

In early 2009, a first workshop was held, exploring potential research collaborations in the field of genetics and cognition. A second workshop on face perception in social context is planned for summer 2009.

### Steering Committee

Peter Hagoort (MPI for Psycholinguistics, Nijmegen)  
Ulman Lindenberger (MPI for Human Development, Berlin)  
Arno Villringer (MPI for Human Cognitive and Brain Sciences, Leipzig)





**Center for  
Adaptive Behavior  
and Cognition**

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## Introductory Overview

The Center for Adaptive Behavior and Cognition (ABC) investigates reasoning and decision making under uncertainty at the levels of both individuals and social groups. The research group consists of psychologists, mathematicians, computer scientists, evolutionary biologists, economists, and researchers from other fields. Using a range of methodologies, such as experimental methods, computer simulation, and mathematical analysis, we cooperate in solving the same problems. The ABC program combines a strong theoretical focus with practical applications, that is, the research group both develops specific models and explores their applications. Applications range from helping physicians and patients understand the statistical evidence arising from medical research; helping courts, administrators, and legislators understand the importance of heuristic thinking in the law; and improving teaching practices in statistical education by introducing transparent representation formats. The theoretical focus is on rationality and can be, albeit artificially, divided into three aspects: bounded, ecological, and social rationality.

### Bounded Rationality

Models of bounded rationality attempt to answer the question of how people with limited time, knowledge, money, and other scarce resources make decisions. This program is an alternative to the dominant optimization paradigm in cognitive science, economics, and behavioral biology that poses the question of how Laplacean superintelligences or near omniscient beings would behave. We study the proximal mechanisms of bounded rationality, that is, the adaptive heuristics that enable quick and frugal decisions under uncertainty. This collection of heuristics and their building blocks is what we call the adaptive toolbox.

### Ecological Rationality

Models of ecological rationality describe the structure and representation of information in actual environments and their match with mental strategies, such as boundedly rational heuristics. To the degree that such a match exists, heuristics need not trade accuracy for speed and frugality: Investing less effort can also improve accuracy. The simultaneous focus on the mind and its environment, past and present, puts research on decision making under uncertainty into an evolutionary and ecological framework, a framework that is missing in most theories of reasoning, both descriptive and normative. In short, we study the adaptation of mental and social strategies to real-world environments rather than compare human judgments to the laws of logic and probability theory.

### Social Rationality

Social rationality is a variant of ecological rationality, one for which the environment is social rather than physical or technical. Models of social rationality describe the structure of social environments and their match with boundedly rational strategies that people might use. There is a variety of goals and heuristics unique to social environments. That is, in addition to the goals that define ecological rationality—to make fast, frugal, and fairly accurate decisions—social rationality is concerned with goals, such as choosing an option that one can defend with argument or moral justification, or that can create a consensus. To a much greater extent than the cognitive focus of most research on bounded rationality, socially adaptive heuristics include emotions and social norms that can act as heuristic principles for decision making.

## Bounded Rationality

Humans and animals must make inferences about unknown features of their world under constraints of limited time, knowledge, and computational capacities. We do not conceive bounded rationality as optimization under constraints nor do we think of bounded rationality as the study of how people fail to meet normative ideals. Rather, bounded rationality is the key to understanding how people make decisions without utilities and probabilities. Bounded rationality consists of simple step-by-step rules that function well under the constraints of limited search, knowledge, and time—whether an optimal procedure is available or not. Just as a mechanic will pull out specific wrenches, pliers, and gap gauges to maintain an engine rather than just hit everything with a hammer, different domains of thought require different specialized tools. The notion of a toolbox full of unique single-function devices lacks the beauty of Leibniz’s dream of a single all-purpose inferential power tool. Instead, it evokes the abilities of a craftsman, who can provide serviceable solutions to almost any problem with just what is at hand.

### The Adaptive Toolbox

This repertoire of specialized cognitive mechanisms, which include fast and frugal heuristics, are shaped by evolution, learning, and culture for specific domains of inference and reasoning. We call this collection of mechanisms the “adaptive toolbox.” We clarify the concept of an adaptive toolbox as follows:

- It refers to a specific group of rules or heuristics rather than to a general-purpose decision-making algorithm.
- These heuristics are fast, frugal, and computationally cheap rather than consistent, coherent, and general.
- These heuristics are adapted to particular environments, past or present, physical or social.
- The heuristics in the adaptive toolbox are orchestrated by some mechanism reflecting the importance of conflicting motivations and goals.

### Fast and Frugal Heuristics

Fast and frugal heuristics generally consist of three building blocks: simple rules for guiding search for information (in memory or in the environment), for stopping search, and for decision making. They are effective when they exploit the structure of the information in the environment. That is, their rationality is a form of “ecological rationality” rather than one of consistency and coherence. We continue to explore fast and frugal heuristics and their importance in diverse disciplines, such as biology, economics, and cognitive psychol-

ogy. In addition, we have applied our basic research in the areas of consumer behavior, medicine, and the law. In what follows, we describe some major developments in the understanding of the adaptive toolbox in the past two years.

### The Mapping Heuristic: Quantitative Estimation the Fast and Frugal Way

How do people make quantitative estimations, such as estimating the selling price of a car? People typically rely on cues, information that is probabilistically related to the quantity being estimated. For instance, to estimate the selling price of a car, they could use information, such as the car’s manufacturer, age, mileage, or general condition. Traditionally, linear regression models have been employed to capture the estimation process. These models assume that people weigh and integrate all available cues (attributes) to estimate a quantity. However, these models have been criticized as psychologically unrealistic. Adopting the approach of simple heuristics, von Helversen and Rieskamp (2008) developed a new cognitive theory—the mapping heuristic—for quantitative estimation. Assuming the availability of multiple binary cues, the estimation process is decomposed into a categorization phase and an estimation phase. First, objects are categorized by counting all the positive cue values the object has. Then, the heuristic estimates the object’s size by using the typical (median) size within the category of objects with the same number of positive cues. This estimation strategy implies

that all cues are weighted equally, avoiding the need to weight cues by their importance. Von Helversen and Rieskamp (2008) compared the mapping heuristic with a regression model in various experimental studies. Their findings showed that the mapping heuristic predicted participants' estimations well. For example, if the criterion quantity is a multiplicative function of the cues, the mapping heuristic predicted participant's behavior more accurately than the regression model. Only when the criterion quantities were determined by a linear function was the mapping heuristic less accurate than the linear regression model. Overall, the success of the mapping heuristic

shows that simpler strategies can rival and exceed the ability of linear regression to describe human judgments. Furthermore, it has become clear that the cognitive processes used in quantitative estimation will often depend on the characteristics of the environment, highlighting the importance of studying the ecological rationality of cognitive processes for estimation.

### Individual Differences in the Use of the Recognition Heuristic

Goldstein and Gigerenzer (2002) proposed the recognition heuristic, a strategy that uses recognition to make inferences about

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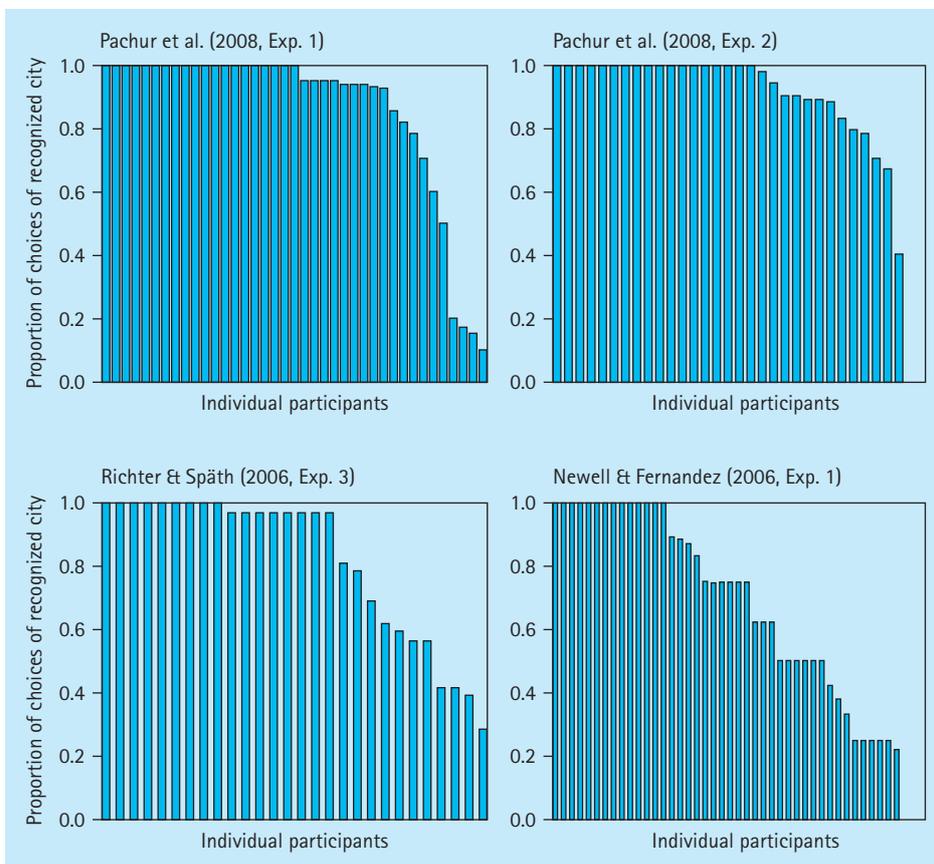


Figure 1. Regardless of contradicting cues, a large proportion of subjects consistently rely on the recognition heuristic. These four plots show the distribution of individual proportions of choices for which the recognized city was chosen. In the upper row, the result of two experiments by Pachur et al. (2008) show that, even when most additional cues suggest that the recognized city was small, the majority of subjects consistently follow the recognition heuristic. The bottom row shows a reanalysis of two experiments originally interpreted at the aggregate level, and used to suggest a lack of adherence to the recognition heuristic. However, when interpreted at the individual level, the responses of many subjects were found to be consistent with the recognition heuristic, despite the presence of conflicting cues.

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Pachur, T., Bröder, A., & Marewski, J. N. (2008). The recognition heuristic in memory-based inference: Is recognition a non-compensatory cue? *Journal of Behavioral Decision Making*, 21, 183–210.

Rieskamp, J., & Hoffrage, U. (2008). Inferences under time pressure: How opportunity costs affect strategy selection. *Acta Psychologica*, 127, 258–276.

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the environment. For two-alternative choice tasks, where one has to decide which of two objects scores higher on a criterion, the heuristic can be stated as follows:

*If you recognize one object but not the other, then infer that the recognized object scores higher on the criterion.*

The recognition heuristic piggybacks on recognition, a highly efficient cognitive ability, and exploits environmental regularities, namely, that recognition in natural environments is often systematic rather than random. In such environments, the recognition heuristic is ecologically rational, exemplifying Herbert Simon's vision of rationality as being shaped by two blades, one being the mind, the other being the environment. There has been continued progress in demonstrating the predictive power of the recognition heuristic in, for instance, soccer (Pachur & Biele, 2007) and tennis (Scheibehenne & Bröder, 2007). In addition, we have further explored its cognitive foundations, focusing on when people choose the recognized alternative and when they do not. Importantly, the recognition heuristic assumes a noncompensatory use of recognition: Even when a person could rely on knowledge about an alternative's attributes (e.g., facts about a carmaker) to complement recognition, when the heuristic is used to make inferences about that alternative, these cues are ignored. Yet, in situations of conflict, individual differences arise.

For instance, Richter and Späth (2006) ran a series of studies and—observing that fewer decisions were consistent with the recognition heuristic when knowledge that contradicted recognition were available—concluded that there was no evidence of a noncompensatory use of recognition. In contrast, Pachur, Bröder, and Marewski (2008) found strong individual differences in the use of recognition (Figure 1). Whereas approximately half of the participants chose the recognized object regardless of conflicting knowledge, the remaining participants were influenced by the additional knowledge. Furthermore, a reanalysis of Richter and Späth's data showed that the majority of participants in fact consistently followed the recognition heuristic even in the presence of conflict-

ing evidence, whereas others switched to different (unknown) strategies (Gigerenzer & Brighton, 2009).

## How Time Pressure Influences Strategy Selection

Do the inference strategies people select depend on time pressure? Rieskamp and Hoffrage (2008) addressed this question in a study in which participants made inferences after having searched for information on a computerized information board. In a series of experiments, time pressure was induced indirectly by imposing opportunity costs for being slow, a form of time pressure that is common in daily life but that has rarely been examined in the literature, or directly by limiting the time for each choice. Regardless of how time pressure was induced, under high time pressure, the inferences participants made could be best predicted with a simple fast and frugal heuristic, whereas under low time pressure, a weighted linear model that integrates all available information predicted their inferences best. These results show that people select strategies adaptively depending on characteristics of the situation.

## The Aging Decision Maker: Individual Differences in Strategy Use Induced by Limited Cognitive Resources

Rieskamp and Hoffrage (2008) argued that people rely on simple heuristics when they lack the time to execute a complex information-intensive strategy. Analogously, Mata, Schooler, and Rieskamp (2007) examined whether individuals with limited cognitive resources might rely more frequently on a simple heuristic in comparison to individuals with more cognitive resources. Two populations that differ in their cognitive resources are the elderly and young adults. Therefore, one might predict that the elderly use simple heuristics more frequently than young adults. This prediction was tested by Mata et al. (2007). In their experiment, participants made decisions in an environment that favored the use of information-intensive strategies and in an environment favoring the use of simple information-frugal strategies. The

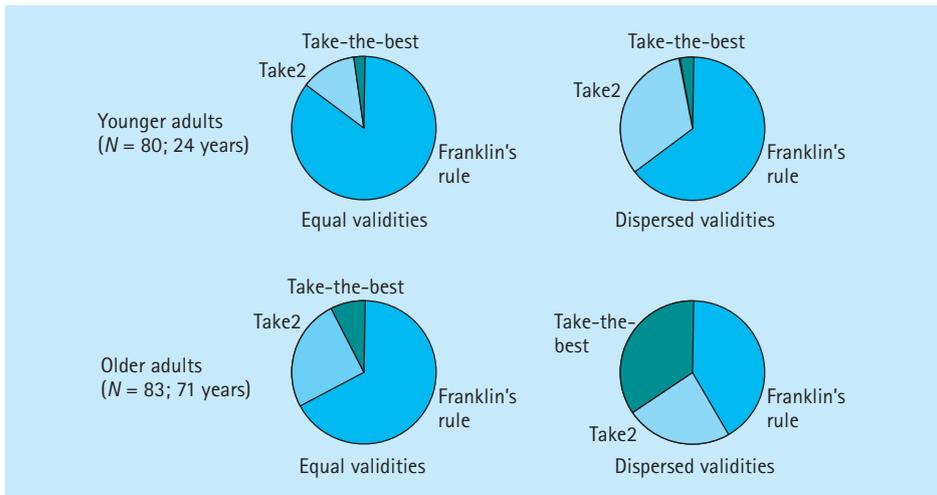


Figure 2. Older subjects use strategies adaptively: Mata et al. (2007) conducted an experiment in which the participants had to infer which of two diamonds was more expensive. When making their inferences, participants were able to look up attributes (e.g., size, cut) about each diamond. In the equal validities condition, the attributes were equally predictive of price. In the dispersed validities condition, some attributes were more predictive than others. Using simple heuristics, Take2 and take-the-best, would yield the higher payoff in the dispersed validities condition. Franklin's Rule, which weights the attribute values based on how well they predict, would yield the higher payoff in the equal validities environment. Participants were classified according to which strategy or heuristic described their decisions best. In general, the older participants had a stronger preference for selecting a simple heuristic than the younger participants. Moreover, both younger and older participants were sensitive to the environment characteristics; that is, they were more likely to use the simple heuristics in the dispersed validities environment.

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results (shown in Figure 2) indicated that both younger and older adults seem to be adaptive decision makers, adjusting their information search and strategy selection as a function of environment structure. Crucially, however, old adults tended to look up less information and relied more on simpler less cognitively demanding strategies compared to young adults. In accordance with the idea that age-related cognitive decline leads to reliance on simpler strategies, measures of fluid intelligence explained age-related differences in information search and strategy selection.

#### How the Misperception of Randomness Facilitates the Detection of Patterns

"Clarice, does this random scattering of sites seem overdone to you? Doesn't it seem desperately random? Random past all possible convenience? Does it suggest to you the elaborations of a bad liar?" (Harris, T. [1988]. *The Silence of the lambs* [p. 293]. New York: St. Martin's Press).  
In Thomas Harris' "The Silence of the Lambs," the imprisoned cannibal Dr. Hannibal Lecter

helps FBI agent Starling hunt a serial killer. The killer tries to hide his whereabouts among seemingly random crime scenes, but by trying too hard to give the impression of randomness, he unintentionally helps agent Starling discover an important pattern which ultimately results in his location being revealed. This example illustrates that people have trouble mimicking randomness, and that they are very good in detecting patterns. Both may be two sides of the same coin: The well-documented misperception of randomness may facilitate the detection of patterns. Sometimes, however, people detect patterns where there are none.

Probability matching, a classic choice anomaly, could be a further consequence of hunting for patterns. In a typical experiment, people have to predict which of two events, with different probabilities of occurring, will take place. For example, event  $E1$  could occur with a probability of  $p(E1) = .67$ , while event  $E2$  occurs with  $p(E2) = 1 - p(E1) = .33$ . Given that the sequence of events is random, the best strategy would be always to predict the more

### Key Reference

Gaissmaier, W., & Schooler, L. J. (2008). The smart potential behind probability matching. *Cognition*, 109, 416-422.

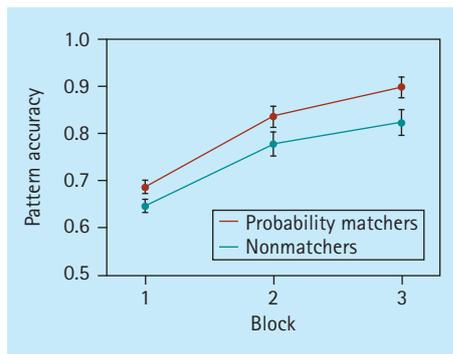


Figure 3. Are probability matchers irrational? A smart strategy underlies this classic choice anomaly: When a systematic pattern is present, probability matchers outperform everyone else. Mean accuracy when systematic sequence pattern is present ( $\pm$  standard error of the mean) for probability matchers and nonmatchers as classified by their tendency to probability match in the absence of a systematic pattern. The data is depicted for three blocks of trials (adapted from Gaissmaier & Schooler, 2008).

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frequent event,  $E1$ . This strategy is called maximizing and would yield an average accuracy of 67%. However, probability matching is often observed, which means predicting the events in proportion to their probability of occurrence. In the example, this would mean predicting  $E1$  in 67% of the trials and  $E2$  in 33% of the trials. Probability matching is considered suboptimal because it would yield an accuracy of only 55.78% on average ( $67\% \times 67\% + 33\% \times 33\%$ ). Does this mean that people are not smart enough to solve this simple task? Not necessarily. Rather, one could say that people are too smart. They do not believe that consistently predicting  $E1$  is the best policy, but try to improve their accuracy by looking for other patterns in the sequence. Any plausible pattern a person might try tends to match the probabilities, which is why searching for patterns leads to probability matching at the outcome level.

Supporting the hypothesis that probability matching is the result of pattern searching, Gaissmaier and Schooler (2008) showed that those people who fall prey to the probability matching choice anomaly, looking irrational in the absence of patterns, were better in detecting patterns when they were there to be found. This finding, shown in Figure 3, illustrates how important it is to consider the structure of the environment when evaluating behavior. From this perspective, pattern search is not a suboptimal policy. Outside casinos and psychology laboratories, there are few natural environments where one can safely assume that events occur at random. Thus, suboptimal probability matching in these few cases could well be a price worth paying for being better at detecting patterns in everyday settings.

## Ecological Rationality

The structure of the environment will often play a crucial role in determining the performance of cognitive processes for reasoning and decision making. The study of ecological rationality examines this relationship by considering the structural properties of natural environments, precise quantitative models of heuristics and other cognitive models, and how the two interact to yield functional outcomes, such as fast, frugal, and accurate inferences about the world. We employ a variety of methods to examine these issues, including computer simulation and mathematical analysis. Our recent research has led to considerable advances in our understanding of the interplay between environmental conditions and heuristic performance.

### Fast and Frugal Trees

In everyday cognition, categorization tasks typically involve limits on time and the availability of information. These decision-making problems often have significant consequences, need to be made under pressure, and involve high stakes. Models of categorization, and professional decision making more generally, have been studied in fields spanning biology, education, engineering, law, and medicine. For example, a patient who is rushed to the hospital with intense chest pain has to be categorized quickly and accurately as being at a high or low risk of suffering from ischemic heart disease. Can heuristics rival the accuracy of the decisions made using the standard methods found in fields such as medicine and engineering? If so, under which ecological conditions are simple heuristics likely to perform well in comparison?

Categorization methods used in engineering applications typically integrate all available cues, compute sophisticated statistical measures of similarity and informativeness, and consider potentially complex dependencies between cues. Fast and frugal trees, in contrast, process cues sequentially and use simple descriptive statistics that ignore cue dependencies. A fast and frugal tree of depth  $n$  is unbalanced and has only  $n + 1$  exits, whereas a full binary decision tree of depth  $n$  is balanced and has  $2^n$  exits. When using a fast and frugal tree, cues are considered in sequence, and the final categorization decision can be made at any point during this process. A fast and frugal tree for the heart disease problem is shown in Figure 4.

For 30 real-world problems, Martignon, Katsikopoulos, and Woike (2008) compared the performance of fast and frugal trees

with the performance of two commonly used categorization methods: classification and regression trees (CART), and logistic regression (LR). Two kinds of fast and frugal tree were considered, both of which ignore cue dependencies, but differ in how they order cues. The accuracy of all four methods was evaluated in four settings: data fitting and three measures of predictive accuracy. In the data fitting case, all data was used to estimate the parameters of each method, and the models were then evaluated on their ability to describe this data accurately. For the case of predictive accuracy, each method had access to 15%, 50%, and 90% of the objects in the data set, and their parameters were fitted to data samples of these sizes. The models were then evaluated on their ability to make correct categorization decisions for novel objects from the same data set, those which were not

### Key Reference

Martignon, L., Katsikopoulos, K. V., & Woike, J. K. (2008). Categorization with limited resources: A family of simple heuristics. *Journal of Mathematical Psychology*, 52, 352–361.

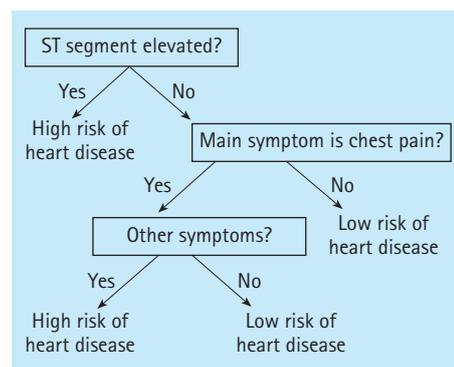


Figure 4. A fast and frugal tree for categorizing patients as having a high or low risk of heart disease. Rather than requiring consideration of all three pieces of information, a fast and frugal tree can lead to a decision being made at any point during the sequential consideration of this information.

Source. Green, L., & Mehr, D. R. (1997). What alters physicians' decisions to admit to the coronary care unit? *Journal of Family Practice*, 45, 219–226.

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Brighton, H., & Gigerenzer, G. (2008). Bayesian brains and cognitive mechanisms: Harmony or dissonance? In N. Chater & M. Oaksford (Eds.), *The probabilistic mind: Prospects for Bayesian cognitive science* (pp. 189–208). New York: Oxford University Press.

used to estimate the parameters of the models. Put simply, fitting refers to describing the past, while prediction refers to the tougher test of second-guessing the future. The results of this study are shown in Figure 5, which illustrates that the performance of each method depends in large part on the environmental conditions, such as the amount of data available. In the data fitting case, where all data is available, the more sophisticated methods, such as classification and regression trees and logistic regression, are more accurate. In the prediction case, which considers more realistic settings in which small amounts of data are available (15% prediction), the fast and frugal trees were almost as accurate as the more complex methods. However, the fast and frugal trees were more robust in the sense of losing less of their accuracy when moving from the fitting problem to the prediction problem. Given that fast and frugal trees also require less time, information, and computation than the more computationally complex methods, they represent a particularly attractive option when categorization decisions need to be made quickly and with limited resources. This

first example shows how the performance of heuristics and other decision rules will depend on environmental conditions, such as sample size. But can we understand this dependence in more detail?

### The Bias-Variance Dilemma in Inductive Inference

How and when can fast and frugal heuristics achieve higher predictive accuracy than linear regression, classification and regression trees, and several other resource-intensive statistical methods? In previous work, we have shown how the simple heuristic take-the-best can often outperform such methods. Take-the-best models the process of inferring which of two options scores higher on some criterion of interest, such as price. These findings, which surprised many experts, were made when evaluating the performance of several methods on real-world problems. Previously, we have shown how mathematical analyses can go some way to explaining these results and provide pointers to the precise environment conditions under which they will occur. More recently, however, we have taken a statistical approach to the problem of understanding when and why heuristics work. Brighton and Gigerenzer (2008) examined the ecological rationality of take-the-best using a statistical decomposition of prediction error into bias and variance. For illustrative purposes, consider the problem of finding a predictive pattern for the mean daily temperature in London. Figure 6 plots temperature data for the year 2000 as well as showing two polynomial models (one of degree 3 and one of degree 12) superimposed on this data. These two models attempt to capture a systematic predictive pattern in the data. In general, the more parameters a model has, the better the fit to the data it can achieve. However, there is a point at which using too many parameters begins to damage the predictive accuracy of a model. This point is illustrated in Figure 7, which plots the error in both fitting and predicting temperature data for polynomial models, ranging from degree 1 to 12. A model with an intermediate number of parameters (in this case, a degree 4 polynomial with 5 parameters) predicts best. The reason why

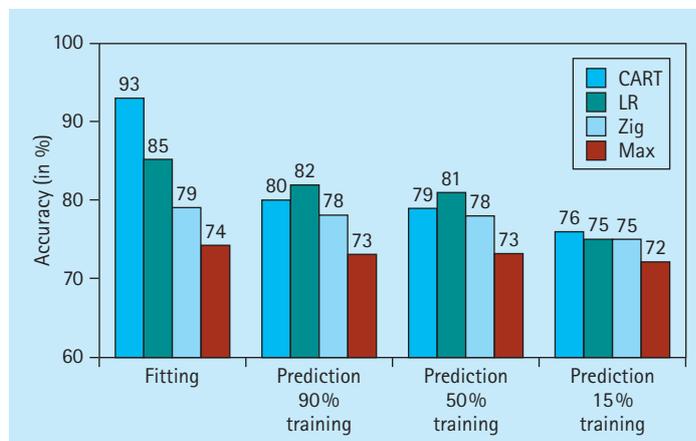


Figure 5. A comparison of the predictive accuracies of two kinds of fast and frugal tree, with two standard and more resource intensive methods: classification and regression trees (CART) and logistic regression (LR). Two kinds of fast and frugal tree, Max and Zig, were tested. Max considers cues in decreasing order of their validity. Zig is similar, but alternates between using left and right exits at each level of the tree. The results reported are the mean accuracies achieved by each method over 30 real-world data sets. For example, one data set considers the problem of deciding where a postoperative recovery patient should be sent next, using cues such as body temperature and blood pressure.

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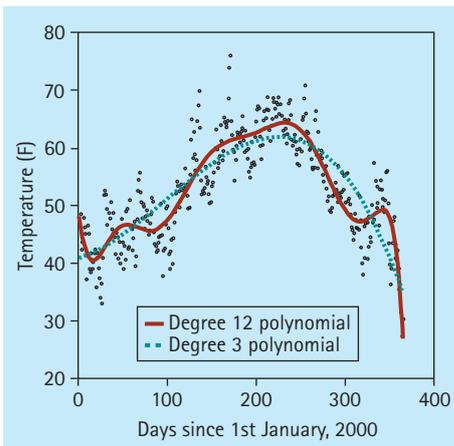


Figure 6. When fitting data, complex models are more accurate. For example, consider London's mean daily temperature on each day of 2000: Two polynomial models attempting to capture a systematic pattern (one of degree 3, the other degree 12) are superimposed on this data. The models were fitted to the data using the least squares method.

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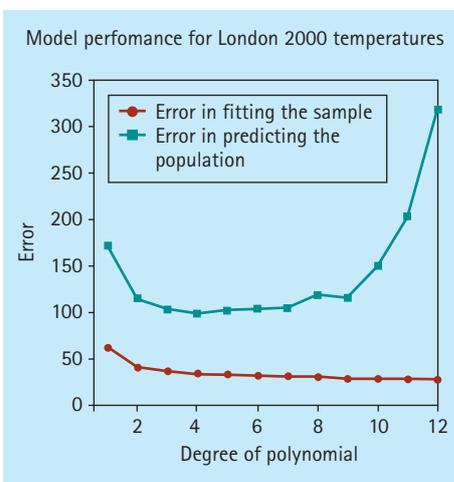


Figure 7. When predicting data in an uncertain world, complex models are often less accurate: As the degree of the polynomial model increases, the more parameters it has, and the lower the error it incurs when fitting samples of observations of London's mean daily temperature (circles). For the same models and samples, the error in predicting the temperature (squares) follows a U-shaped pattern: Too many parameters damage the predictive ability of the model, and the best predicting model is of degree 4. Models of degree 5 and higher become unstable and suffer from high variance. Notice that a degree 2 polynomial model (which is biased) incurs less prediction error than a degree 10 polynomial model (which is unbiased). It achieves this by incurring low variance in error.

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this occurs can be explained by considering the statistical problem known as the bias-variance dilemma. Here, bias and variance, along with noise, additively contribute to the total prediction error as follows:

$$\text{Total error} = (\text{bias})^2 + \text{variance} + \text{noise}.$$

The bias of a method is its error when given an infinitely large sample of observations with which to estimate its parameters. The variance is the additional error this method incurs when only a finite sample of observations are available, and reflects how sensitive the method is to the particular content of samples.

Returning to our temperature example, polynomial models of degree 1 to degree 3 suffer from bias: They lack the flexibility to adequately describe what is systematic in the data. Overly complex models, those of degree 5 and higher, have zero bias, but suffer from

high variance: They become unstable, model noise and accidental patterns in the data, and predict poorly. In exactly the same way, heuristics and other cognitive models of decision making suffer from bias and variance. Brighton and Gigerenzer (2008) used this fact to show that heuristics outperform alternative approaches exclusively as a result of reducing variance. This means that heuristics are often more stable in the face of noise and small samples. In the inaugural issue of the *Cognitive Science Society's* new journal, *Topics in Cognitive Science*, Gigerenzer and Brighton (2009) use these findings to make a general point: Minds rely on heuristics in order to combat the uncertainty arising from limited observations of our world. Although heuristics can suffer from bias, they can also have very low variance, and this allows them to outperform more resource intensive

#### Key Reference

Gigerenzer, G., & Brighton, H. (2009). Homo heuristics: Why biased minds make better inferences. *Topics in Cognitive Science*, 1, 107–143.

### Key Reference

Katsikopoulos, K. V., & Gigerenzer, G. (2008). One reason decision making: Modeling violations of expected utility theory. *Journal of Risk and Uncertainty*, 37, 35–56.

unbiased methods. Statistical bias can be a positive force in an uncertain world. These first two examples of our recent research into ecological rationality have a prescriptive flavor. That is, they help answer the question of what heuristics people should use in order to increase their accuracy. Taking a prescriptive stance was possible because the tasks we considered had a correct answer (e.g., a patient either suffers from heart disease or not). Importantly, the approach to studying the predictions of a method in relation to the environment also proves insightful for tasks where there is no correct answer. In this next example of our recent research, we examine the descriptive question: What heuristics do people use?

### A Novel Approach to Explaining Violations of Expected Utility Theory

Expected utility theory has been the dominant theory in the social and behavioral sciences for explaining how people make choices under risk. In a risky choice, choosing an option does not always lead to the same outcome. For example, a participant may be asked to choose between the following two options. The first option is a gamble where there is a 50% chance of receiving 1,000 Euro and a 50% chance of receiving nothing. In the second option, 500 Euro is received with certainty. Expected utility theory tells us that, for each option, people add the worth or utility of each possible outcome, weighted by its probability, to calculate the expected utility of the option. Then, so the theory goes,

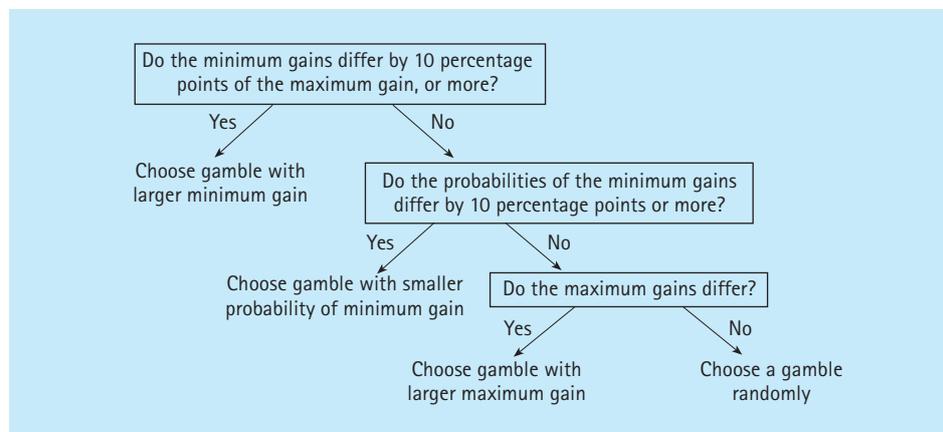
people choose the option with the highest expected utility.

In the choice between a sure gain of 500 Euro and a fifty-fifty chance of 1,000 Euro or nothing, most of us choose the sure gain of 500 Euro. In this case, we are risk averse. Expected utility theory predicts that a person's attitude toward risk does not change as the outcomes or probabilities change. But people are not risk averse when the gambles involve losses. For example, very few people choose a sure loss of 500 Euro over a gamble in which there is a 50% chance of losing 1,000 Euro and a 50% chance of losing nothing. That is, people are risk averse for gains and risk seeking for losses. But this view conflicts with the fact that people buy lottery tickets (i.e., are risk seeking for gains) while, at the same time, buy insurance (i.e., they are risk avoiding for losses). That is, when the probability of the gain is relatively small (e.g.,  $\leq 5\%$ , as in lotteries) people are risk seeking; also, when the probability of the loss is relatively small (again  $\leq 5\%$ ), people are risk averse (and buy insurance). This pattern of behavior is called the four-fold pattern of risk attitude. This four-fold pattern is not predicted by expected utility theory.

The four-fold pattern is an empirical puzzle that needs to be modeled quantitatively and accounted for theoretically. If one wishes to stay within the expected utility approach, it has to be assumed that the probabilities entering the utility calculation are weighted. Furthermore, in order to account for the four-fold pattern, it has to be assumed that

Figure 8. Conflict resolution without trade-offs. The priority heuristic for a choice between two gambles when all outcomes are gains. This simple heuristic implies the Allias paradox, the four-fold pattern, and other violations of expected utility theory (Katsikopoulos & Gigerenzer, 2008).

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small probabilities are overweighted and large probabilities are underweighted. For example, a participant could perceive a probability of 5% as 7.5% and a probability of 95% as 92.5%. In recent years, some researchers have elevated probability weighting from a modeling assumption to the status of an empirical phenomenon, but there is no direct empirical evidence that people weight probabilities when making risky choices. Crucially, this claim is only necessary when one views human behavior through the lens of expected utility theory.

Katsikopoulos and Gigerenzer (2008) proved that the four-fold pattern of risk attitude is logically implied by the priority heuristic, which does not assume probability weighting. This explanation rests on the mathematical analysis of a simple parameter-free sequential heuristic for making risky choices between two gambles. In the case of gambles with gains, the priority heuristic is depicted on Figure 8. The objective values of probabilities, not any weighted probabilities, can be used to stop

information search and make a choice. The priority heuristic has the same building blocks as both fast and frugal trees and take-the-best: a search rule, stopping rule, and a decision rule. Katsikopoulos and Gigerenzer (2008) showed analytically that users of the priority heuristic would also exhibit the four-fold pattern of risk attitude. The result delineates the conditions under which risk averse and risk-seeking behaviors are predicted to occur. For example, if the probability of a gain is larger than 10%, a priority heuristic user will be risk averse, while if the probability of a gain is smaller than 10%, a priority heuristic user will be risk seeking. Because the priority heuristic has no free parameters, it *implies* the four-fold pattern rather than merely being consistent with it for one particular parameter setting. To summarize, this work shows how major violations of expected utility theory can be explained without appealing to probability weighting, but are implied by a heuristic which relies on limited search, a stopping rule, and aspiration levels.

## Social Rationality

Social rationality is a specific form of ecological rationality, capturing the fact that social species need to make decisions in an environment that may be constructed by the actions of others. By studying social rationality, we attempt to understand the cues and heuristics that underlie cooperation and group decision making, and to uncover the role of emotions in social heuristics. These social heuristics represent adaptive solutions to recurring social problems faced by humans during their phylogenetic and ontogenetic development.

### Key Reference

**Biele, G., Rieskamp, J., & Czienskowski, U. (2008).** A model of reciprocity: Explaining cooperation in groups. *Organizational Behavior and Human Decision Processes*, 106, 89–105.

### How Can Cooperation Be Maintained When Contributing to Public Goods?

Contributing to public goods (PG) often presents a social dilemma: If nobody contributes, everyone is worse off than if everyone had contributed, but each individual group member benefits most from not contributing. Consequently, it is difficult to maintain cooperation in PG situations. Biele, Rieskamp and Czienskowski (2008) examined whether reciprocal strategies can predict people's behavior better than alternative learning models. In past research, it has been showed that reciprocal strategies, such as tit-for-tat, can outperform alternative noncooperative strategies in repeated social interactions. Biele et al. (2008) argue that, compared to PG games, cooperation is more easily maintained in two-person interactions, such as the prisoner's dilemma, because in the latter individuals can reciprocate directly, whereas in the former they must react uniformly to the heterogeneous group. If people reciprocate cooperation in iterated PG games, then cooperation should increase when the PG can be divided among the group members, thus strengthening dyadic interdependencies. To test this prediction, Biele et al. (2008) compared cooperation in a standard PG game with a social dilemma network (SDN) game. In the SDN game, the public project is split into multiple public projects, such that every

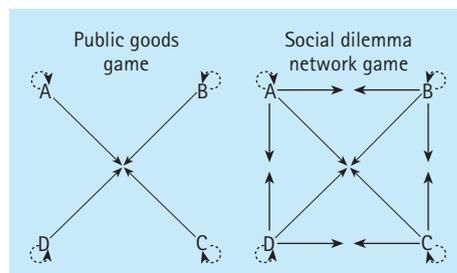
individual can cooperate simultaneously in several two-person public projects (see Figure 9).

In the experiment, one group of participants played the SDN game. Every point invested into the joint projects was multiplied by 1.5 and divided equally among two members of the project. Two other groups of participants played a standard iterated PG game with four members. Again, every invested point was multiplied by a constant. The two groups differed only by the incentive given for cooperation, so that points that were invested to the PG were increased by different magnitudes. In one group, the incentive to cooperate had the same magnitude as in the SDN game, whereas in the second group it was twice as high. Therefore, if incentives for cooperation matter, then cooperation should have been highest in the high incentive PG group, whereas if reciprocity principles underlie cooperation in groups, then the highest cooperation should be observed in the SDN game.

The results were clear cut: The median contributions in the SDN game were about 50% higher than in the two standard PG games (with similar contribution levels). To predict participants' decisions Biele et al. (2008) compared the prediction of a reciprocity model with two other learning models. The reciprocity model and one of the two learning models described the decisions equally well. However, only the reciprocity model was also able to predict participants' information search preceding their decisions. The information search was recorded using an information board paradigm: Information about the behavior of other players, and their own payoffs and decisions, had to be acquired by clicking on information boxes. In line with the reciprocity model, participants focused their information search on the contribution of the

*Figure 9.* Public goods game and the social dilemma network game. Solid lines represent possible contributions to public projects. Dotted lines represent the possibility to keep resources for oneself.

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other players instead of accessing information about their own payoffs, as predicted by learning models. In particular, in the SDN game, 80% of the participants were classified as searching for information as predicted by the reciprocity model. In sum, Biele et al. (2008) showed that cooperative decisions in groups are best predicted by a reciprocity model, which also predicts that cooperation increases when the opportunity for dyadic interactions are given.

### How Does Advice Influence Learning?

In many real-life situations, people make their decision on the basis of past experience, on the basis of social information, such as the advice of others, or on the combination of both. Biele, Rieskamp, and Gonzalez (in press) examined how social information can be incorporated into individual learning models to predict how people's learning processes are influenced by advice. The learning processes were examined using the Iowa Gambling Task (IGT), where participants try to obtain high rewards by repeatedly choosing the best out of four choice options. Participants receive feedback about the outcomes of their choices and learn which options provide the highest average payoff. The challenge of the IGT is that the good options with positive average payoffs are associated with only moderate gains and small occasional losses. In contrast, the bad options with (on average) negative payoffs are associated with high gains, but even higher losses. In the experiment, participants had to solve the IGT after they had received advice about which option leads to the highest payoff. The results of the experiment showed that advice improved performance: Participants who had received advice received a higher payoff in comparison to participants who did not receive any advice. Participants who received advice also chose the recommended deck more frequently than the corresponding deck with the same expected payoff. However, examining the choices of advice receivers over time showed that receivers did not follow the advice blindly. Instead, they first followed the advice, then explored other options, and finally returned to choosing the advised option.

To examine the underlying learning mechanisms, Biele et al. (in press) compared one individual and four social learning models. The individual learning model assumed that each option has an expectancy which changes with received feedback and that choices are made probabilistically as an increasing function of the options' expectancies. The influence of advice was examined by modifying the different submechanisms of individual learning, such as initial expectations, evaluation of outcomes, and the updating of expectations. All social learning models predicted the actual learning process better than the pure individual learning model. The best social learning model—the outcome-bonus model—assumed that advice results in the outcome of recommended options being evaluated more positively. This advantage was clearly demonstrated in a second experiment, where all options led, on average, to negative payoffs. In such a situation, the social learning model that assumes slower forgetting for advised options predicts that people will choose nonrecommended options quickly. In contrast, the other social learning models still predict a preference for the recommended options. As predicted by the outcome-bonus model, advice receivers in the second experiment chose the recommended deck more frequently than the corresponding deck with the same expected payoff. Only the outcome-bonus model correctly predicted receivers' adherence to advice and predicted more adherence to good than to bad advice (see Figure 10). These experimental studies show that people *combine* individual reinforcements and the advice of others to make good decisions. Only a minority of participants relied exclusively on advice, and nobody relied exclusively on individual learning. The results also indicate that a one-time recommendation has a long-lasting influence on behavior. Thus, generalizing from our findings, repeated advice seems not to be necessary to guide behavior in a particular direction. Therefore, successful advice could focus on a single convincing recommendation. People neither ignore nor blindly follow advice, rather, they integrate advice to accelerate the individual learning process and arrive at solutions quicker.

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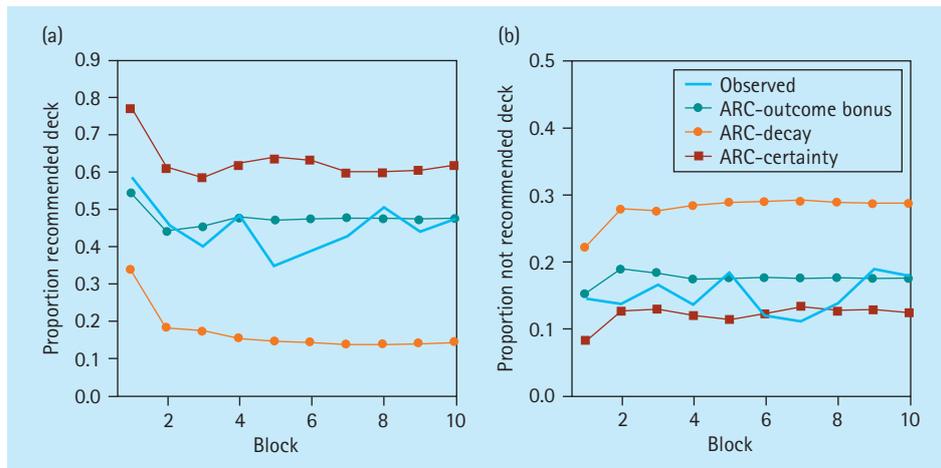


Figure 10. Can the effect of advice on decision making be predicted? These two plots examine the performance of the outcome bonus model of Biele et al. (2008). Receivers' observed and predicted choice proportions in Experiment 2 (described in the main text) for (a) the recommended deck or (b) the corresponding deck with the same average payoff. Only the outcome-bonus model predicts choices well, whereas the decay model overestimates the preference for the not-recommended deck and adaptive reinforcement combination. The certainty model overestimates the preference for the recommended deck.

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### Are the Chinese More Generous Than Germans?

How do differences in age and cultural background impact on group decision making? In a series of studies, we used game theory as a paradigm to examine this question in relation to cooperation. This is an interdisciplinary approach which integrates economics and moral developmental psychology. We explored children's and adolescents' sharing of resources in the context of two experimental games (Gummerum, Keller, Takezawa, & Mata, 2008; Keller & Canz, 2007), allowing us to examine individual and cooperative decision making in a group context. We were interested both in the decision heuristics used, and the argu-

ments given, by people of different ages and cultural backgrounds.

Following up on experiments described in the previous report on individual and group decision-making processes when sharing, we studied children and adolescents in China and in Great Britain (Leman, Keller, Takezawa, & Gummerum, in press). About 15 groups of children and adolescents of ages 9, 12, 14, and 17 years played two experimental games: In the *dictator game*, one group (proposer) had to decide unilaterally whether and how to share a sum of money (20 coins of different value, overall 2, 4, 4, 6 Euros) with another anonymous group (responder) who could only accept the offer. In the *ultimatum game*, the responder group has the power to accept or to reject the offer of the proposer group. If the responders accept the offer, the money is distributed according to the suggestion of the proposers. In the case of rejection, neither of the groups receive any money.

Game theory predicts that a rational actor will allocate nothing to the other group in the dictator game, and give only one coin in the ultimatum game. Empirical research with adults has refuted these predictions, but little is known about children and adolescents. Our research with German pupils

Figure 11. Chinese children participating in the group dictator game.

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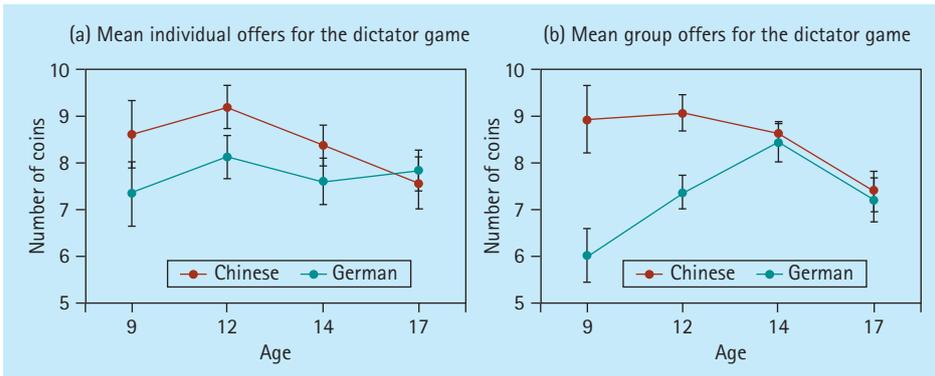


Figure 12. In the dictator game, younger German children are less generous than Chinese children, both individually and as groups. These plots show the individual (a) and group offers (b) made by Chinese and German children in the dictator game. The total sum to be divided was 20 coins.

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demonstrated that children and adolescents offered more than adults in the dictator game (on average 35% compared to 25% of the stake). It also revealed a preference for using an equal split heuristic, resulting in sharing across all age groups, both with respect to individual and group offers. The analysis of the arguments given during negotiations revealed that reference to the fairness norm and the ascription of positive characteristics to the other group supported higher offers, while selfishness and negative group stereotypes served to lower offers (Gummerum, Keller et al., 2008). Drawing on the distinction between individualistic Western and collectivistic Asian societies, we hypothesized that participants from Great Britain would be similar to the German sample, while Chinese children should offer more than their Western counterparts. For the dictator game, the findings in the three cultural settings showed that the offers of children and adolescents were more generous than those found for adults, and the equal split heuristic was dominant across all age

groups and cultures (Leman et al., in press). Figure 12 shows the comparisons between the age groups in China and Germany for the dictator game. Overall, in individual offers, Chinese participants offered more than Germans with the exception of the 17-year-olds. As for group offers, Chinese participants offered significantly more than Germans, with the difference in large part being due to the offers of the 9- and 12-year-olds, while the offers of the 14- and 17-year-olds did not differ. In the ultimatum game, the equal split heuristic described the typical offer for all ages, in both countries, in individual and group settings. This was consistent with previous findings relating to adults. Contrary to the hypothesis that Chinese share more than Germans, no overall effect was found for culture. However, an age-specific comparison of individual offers revealed a systematic pattern: Younger Germans gave less than the younger Chinese, while the reverse was true for the 17-year-olds (Figure 13). Age-specific comparisons revealed an opposite cross-over

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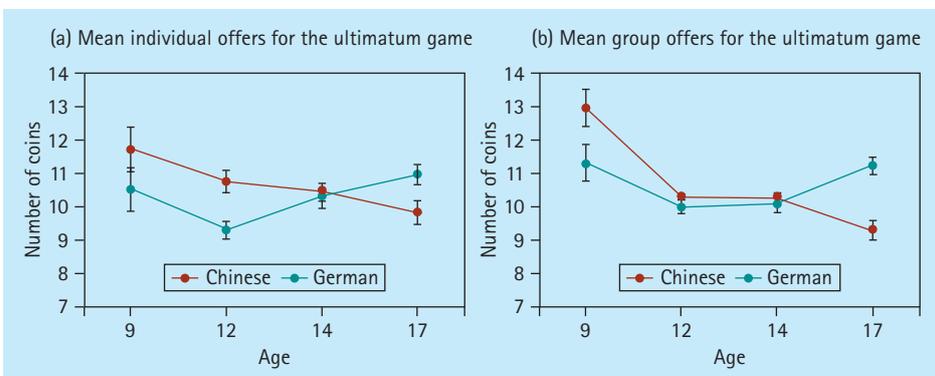


Figure 13. In the ultimatum game, younger German children are less generous than Chinese children, both individually and as groups. These plots show the individual (a) and group (b) offers made by Chinese and German children in ultimatum game. The total sum to be divided was 20 coins.

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Barrett, C., Keller, M., Takezawa, M., & Wichary, S. (2007). Relationships and emotions in children's understanding of social contract violations. *Journal of Evolutionary Psychology*, 51, 213–234.

pattern for group offers: Younger German groups offered less than younger Chinese groups, while, by age 17, this pattern was reversed as Germans become more generous. A first analysis of the arguments provided during the group discussions for the dictator game revealed that, in both Chinese and German participants, fairness was the most frequently mentioned type of argument across all age groups. The German children in the youngest group used selfish arguments much more frequently while the Chinese children were more concerned with psychological characteristics of the other group. The 12-year-old German children were more concerned with reciprocity (e.g., how much the others would give them) than their Chinese counterparts. This helps to explain why German children in these two age groups offered less than German children in the dictator game group discussions. Overall, the results reveal similarity across cultures concerning the dominance of the equal split as a simple heuristic of sharing. But there exists also an interaction of culture and age which will have to be further explored.

### Happy Victimizers, Unhappy Moralists

Moral emotions, such as guilt and shame, which are associated with the consequences of moral transgressions, are important cues for the motivational acceptance of moral norms. In our previous research, we examined the "happy victimizer" phenomenon in young children (e.g., attributing positive feelings to a moral-rule violator in spite of moral knowledge that the violation is not right) by exploring emotions of violator and victim in a situation of contract violation. More recently, Barrett, Keller, Takezawa, and Wichary (2007) followed up on a finding that contract violation in parent-child relationship was accompanied less frequently with feelings of guilt than in peer relationships. Based on evolutionary considerations, we controlled the relevant parameters by using the same contract and controlled for relatedness and nonrelatedness. We could not replicate the previous finding, which suggests that emotions to contract violation are not specific to any particular type of relationship.

In addition, we studied moral emotions using the moral dilemma-approach, which enabled us to study both moral emotions of guilt due to violating an obligation and positive moral feelings of pride due to acting in accordance with obligations. Keller, Brandt, and Sigurdardottir (in press) had proposed different types of emotion patterns beyond the "happy victimizer." Keller and Malti (in press) analyzed these types in four age groups of 7-, 9-, 12-, and 15-year-old Icelandic and Chinese participants, where the task was to reason about a moral dilemma of self interest, altruism, and friendship loyalty. The results revealed that the "happy victimizer" phenomenon was highly infrequent because even the youngest children mostly understood the consequences of violating a promise to the best friend. Typically, Icelandic children were "unhappy victimizers" when giving precedence to self-interest over friendship. On the other hand, some younger Icelandic children were "unhappy moralists" by showing selfish regret over keeping the promise, but missing a good opportunity. In contrast, most Chinese children and adolescents were "unhappy moralists" who felt guilty whatever choice they made because they interpreted the conflict as either violating obligations of friendship or altruism toward the third child. This research demonstrates that emotions are dependent on the interpretation of the situation, which is itself dependent on development and culture.

## Evolutionary and Comparative Psychology

An evolutionary approach lies at the heart of many research projects undertaken by the ABC Research Group and motivates the central concepts we work on. In this section, we focus on use of evolutionary principles and models to understand human behavior (evolutionary psychology) and study decision making in other animal species (comparative psychology). First, we focus on recent empirical studies of foraging decisions both in the external world and inside the mind. Second, we outline work exploring how comparative psychological studies of other animals can inform our notion of ecological rationality.

### Foraging Decisions

When should we move on to greener pastures? Humans and other animals face decisions of this type in a variety of common domains. Whenever resources are distributed in space or time, it is important to decide when one could do better by switching to a different source. People searching for blackberries must assess whether there are enough ripe berries on the current plant, or if it would be better to move on to the next plant. Optimal foraging theory has proposed the optimal solution to the problem. The classic theory is the marginal value theorem, which states that you should leave a patch when the current rate of return is less than the mean rate in the environment under the optimal strategy. Finding the optimal policy requires complicated computations, but biologists do not assume that animals solve differential equations. Instead, they assume that natural selection has endowed individuals with simple heuristics (sometimes referred to as "rules of thumb" by biologists) that approximate the optimal outcomes. A number of these decision rules for foraging have been tested in a variety of animal species, shown in Figure 14. Hutchinson, Wilke, and Todd (2008) examined the decision rules used by humans when foraging in a computer game environment. Participants were given the task of fishing at a succession of ponds and earned money by catching fish (Figure 15). Brief glimpses of fish in the pond were shown to the participants. The appearance of fish was stochastic, at a rate proportional to how many fish remained in the pond. Participants could move to a new pond any point, but doing so cost them time. From the perspective of ecological rationality, some decision rules will perform better than others, depending on the properties of the

environment. Foraging decision rules are no exception, and Hutchinson et al. (2008) tested their participants in three environments, with an even, random, or aggregated distribution of fish across ponds. Like other animals tested in patch-foraging situations, the human participants stayed

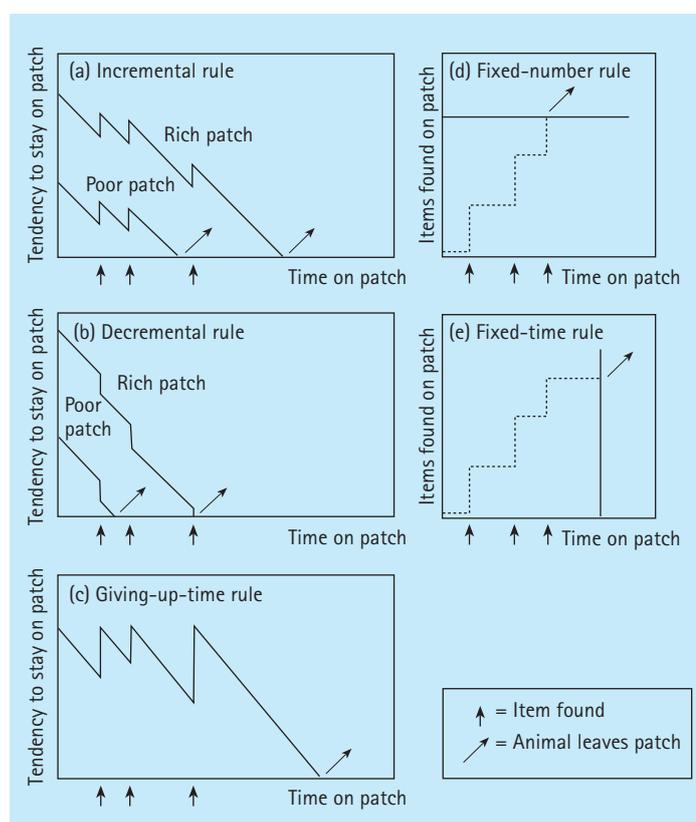
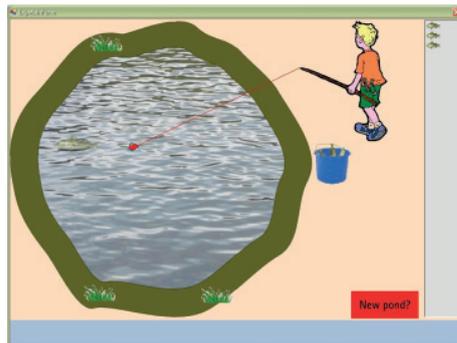


Figure 14. Biologists have tested a number of patch-leaving rules. (a) With an incremental rule for deciding when to leave a patch, each resource capture (indicated by small arrows) increases the probability of staying in a patch. (b) With a decremental rule, each resource capture reduces the probability of staying. (c) With a giving-up time rule, the tendency to stay in the patch declines with unsuccessful search and is reset to a maximum with each resource found. (d) With a fixed-number rule, a patch is left after a fixed number of items have been found. (e) With a fixed-time rule, the patch is left independent of the number of food items found.

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Figure 15. Participants had to decide how long to stay at a pond to catch fish.

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longer than predicted by the optimal policy. Furthermore, regardless of the distribution of prey, they spent longer at ponds where they had found more items. This suggests that participants did not simply use the total number of fish caught or the total time spent fishing when deciding to switch. Instead, they appear to be using a very rough version of a giving-up time rule (illustrated in Figure 14 [c]), where the time since the last capture and the interval between the previous two captures play a prominent role in determining when to leave. Although in an aggregated environment this type of rule performs well, in even and random environments it performs poorly relative to the optimal policy. Despite this, the participants typically used the same rules equally in the three environments: Humans did not appear to switch strategies as expected, but tended to use a single strategy.

### Foraging in the Mind

In addition to foraging in patchy environments in the external world, humans spend much of their time seeking information resources internally, from memory. Like animals maximizing their rate of energy intake, optimal information foragers might maximize the long-term rate of valuable information gained per unit time. Wilke, Hutchinson, Todd, and Czienskowski (2009) examined this issue by studying the mechanisms people use for moving through a succession of cognitive information-foraging tasks: The problem of seeking anagrams in a "patch" of letters. For example, which words can you find in the sequence LGIRNAHEM? Perhaps RING, NAME, ANGEL, and LAGER come to mind quickly. Yet, as with the feeding-patch paradigm, reward

rate declines with time spent in each patch, so that at some point it is better to switch to the next patch of letters. Do people use similar rules when rewards are produced by thinking and searching in internal memory, rather than by exploring the external environment? As in the fishing task, Wilke et al. (2009) provided subjects with different environments: either an even environment with roughly the same number of words per patch, or an aggregated environment in which patches contained either many or few words.

The results for this internal foraging task closely matched those for the external foraging task. Among the most important cues used when switching patches were the time since finding the previous solution and the interval between finding the previous two solutions. Again, whether the participants experienced the even or aggregated environment had little influence on their performance or the cues that predicted switching behavior. Thus, there are striking similarities between human foraging in the outside environment and in the mind. Importantly, the cues used to make these foraging decisions do not differ according to variation in the distribution of items in the environment.

If the brain uses domain-specific decision rules, why does it not respond to the different environments confronted in these two foraging tasks? One possibility is that most environments that we experience (and that our ancestors experienced) are aggregated, not evenly dispersed. In addition, the costs of treating an aggregated environment as evenly dispersed are higher than costs of treating an evenly dispersed environment as aggregated. For these reasons, decision rules that bet on aggregation may perform well on average. In both the fishing and word-puzzle tasks, people seem to use rules and cues that perform well in aggregated environments. To explore this issue further, Wilke and Barrett (in press) measured people's predictions of how dispersed certain objects were in the environment. For instance, if you found a fruit, are you likely to find another fruit nearby? Would you expect the same pattern after finding a bird's nest? Despite receiving feedback suggesting that find-

ing or not finding another fruit was equally likely, participants demonstrated a preference toward predicting that more fruit would be found following a previous find. Thus, the participants showed a preference toward assuming that the items were distributed in patches when, in fact, they were randomly distributed. Additionally, this preference was found for objects that are dispersed rather than patchy in the real world (e.g., bird nests and bus stops). These results were found for both UCLA undergraduates and members of the Shuar—a group of hunter-horticulturists from Amazonian Ecuador—suggesting that we may see the world as patchy, and, if we find a resource in one place, there will likely be more resources around. Wilke and Barrett suggest that this may account for the “hot hand” phenomenon described in the judgment and decision-making literature. People often perceive streaks or repetitions in data when they do not exist. From an evolutionary perspective, this may prove adaptive in a world which is largely patchy.

### Ecological Rationality in Other Animals

An important tool in the evolutionary biologists' toolbox is the comparative method. By comparing species that differ in specific aspects of their world, we can test hypotheses about the selective pressures particular environments place on organisms. For instance, the snow cover of the arctic tundra favors white fur and feathers: Camouflage is important both when hunting and when avoiding being hunted. Similarly, cognitive and behavioral traits of animals are selected to fit their environments. This then suggests an evolutionary aspect to the definition of ecological rationality: Adaptive behavior results from the fit between the mind's mechanisms and the structure of the environment in which it evolves (Stevens, 2008).

The notion of adaptive specialization in cognition is common (although not uncontroversial) in the animal cognition literature. For instance, primates that forage for fruits have been shown to have larger brains than those that forage for leaves, with the explanation that tracking the temporal and spatial variations in the distribution of fruit in

the environment requires more complicated cognition than tracking the more stable distribution of leaves. This provides only a weak test of ecological rationality. More direct tests have explored how chimpanzees and bonobos respond to delayed or risky outcomes. These two species provide a unique opportunity to test questions about ecological rationality because, in addition to being our closest living relatives, they share many morphological and behavioral characteristics; however, they differ markedly in their foraging behavior. Bonobos rely more heavily than chimpanzees on plant material, such as stems and leaves, whereas chimpanzees hunt for meat more often than bonobos. This is an interesting difference because hunting requires waiting until food is captured and entails risk associated with an unsuccessful hunt. Foraging on plants, in contrast, requires neither waiting nor risk because the plants are plentiful in the environment. Thus, an ecological rationality perspective would predict that chimpanzees should be more patient and risk seeking than bonobos because the time delays and risks associated with hunting are higher than those associated with foraging for plants. Rosati, Stevens, Hare, and Hauser (2007) tested the ecological rationality of intertemporal choice in chimpanzees and bonobos in a laboratory task. Here, subjects chose between two grapes available immediately and six grapes available after a time delay (Figure 16). The time delay in receiving the six grapes was increased gradually until each subject chose the two immediate grapes and the six delayed grapes equally. This offered a point



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Figure 16. Chimpanzees and bonobos chose between two grapes available immediately or six grapes for which they had to wait.

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Figure 17. Chimpanzees and bonobos chose between safe and risky rewards hidden under bowls. The blue bowl contains four grapes, whereas the yellow bowl contains either one grape or seven grapes with equal probability.

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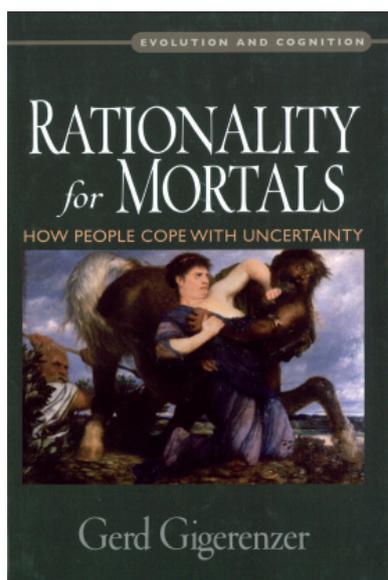
at which subjects were indifferent between the two options and gave a measure of how they valued future rewards. As predicted by the ecological rationality hypothesis, the chimpanzees tolerated longer delays than the bonobos: when given a choice, two grapes immediately or six grapes after a delay, bonobos waited about one minute (mean 74.4 s, SE =  $\pm 8.5$  s) whereas chimpanzees waited about two minutes (mean 122.6 s, SE =  $\pm 15.9$  s). The hunters waited longer than the gatherers. Hunting involves not only waiting but also the risk associated with an unsuccessful attempt at capturing prey. Heilbronner,

Rosati, Stevens, Hare, and Hauser (2008) applied the same logic as Rosati et al. (2007) to questions of risk instead of delay. In this experiment, chimpanzees and bonobos chose between a "safe" option of always receiving four grapes and a "risky" option of receiving either one grape or seven grapes with equal probability (Figure 17). The bowls offered the same payoff on average, so any preference for one option over the other indicates sensitivity to risk. In this task, five out of five bonobos preferred the safe option whereas four out of five chimpanzees preferred the risky option. Like the time delay results, these findings support the ecological rationality hypothesis: That the risks chimpanzees face in hunting have molded their risk preferences more generally.

Both intertemporal and risky choices in chimpanzees and bonobos match the time delays and risks seen in the species in the wild. Similar findings in two monkey species, tamarins and marmosets, further support the importance of feeding ecology on intertemporal and risky choice. Thus, it seems likely that ecological circumstances have strong influences on the decision mechanisms dealing with time and risk. These types of comparative studies offer valuable insights into ecological rationality because we can test how key aspects of a species' ecology influence their decision making.

## Decision Making in the Wild

As we have shown, the study of bounded, ecological, and social rationality conceives of behavior as the result of an interaction between cognition and environment. This approach implies two ways of improving decision making: first, changing the environment so that people can better understand and act in a successful way and, second, changing people's heuristic strategies so that they can better handle a given environmental task. Our work on decision making in the wild includes improving police hunches in locating criminals (Gigerenzer & Brighton, 2007), and facilitating financial investments (Ortmann, Gigerenzer, Borges, & Goldstein, 2008). We will focus here, however, on our work in health care and energy choice.



### Helping Doctors and Patients to Make Sense of Health Statistics

In Gigerenzer, Gaissmaier, Kurz-Milcke, Schwartz, and Woloshin (2007), we—a team of psychologists and physicians—describe a societal problem that we call *collective statistical illiteracy*. The qualifier *collective* signals that lack of understanding is not limited to patients with little education; many physicians, journalists, and politicians do not understand health statistics either. We provide evidence that statistical illiteracy is: (1) a widespread phenomenon; (2) created by nontransparent framing of information that is sometimes an unintentional result of a lack of understanding but can also be a result of intentional efforts to manipulate or persuade people; and (3) a problem which can have serious consequences for health. In what follows, we illustrate this ethical and societal problem with several cases and studies.

### What is the nature of human wisdom?

For many, the ideal image of rationality is a heavenly one: an omniscient God, a Laplacean demon, a super computer, or a fully consistent logical system. Gerd Gigerenzer argues, in contrast, that there are more efficient tools in our minds than logic; he calls them fast and frugal heuristics. These adaptive tools work in a world where the present is only partially known and the future is uncertain. Here, rationality is not logical, but ecological, and *Rationality for Mortals* (published in 2008 by Oxford University Press) shows how this insight can help remedy even the widespread problem of statistical innumeracy.

### Higher Survival Rates Do Not Mean a Longer Life

In a 2007 campaign advertisement, former New York City mayor Rudy Giuliani said: "I had prostate cancer, five, six years ago. My chance of surviving prostate cancer—and thank God, I was cured of it—in the United States? Eighty-two percent. My chance of surviving prostate cancer in England? Only 44 percent under socialized medicine." For Giuliani, these health statistics mean that he was lucky to be living in New York and not in York, since his chances of surviving prostate cancer appear to be twice as high. This was big news. It was also a big mistake. High-profile politicians are not the only ones who do not understand health statistics or misuse them. Giuliani's numbers were survival rates that are meaningless for making comparisons across groups of people who differ dramatically in

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how they were diagnosed. In the US, most prostate cancer is detected by PSA screening, whereas, in the UK, men are screened much less frequently, with the majority diagnosed from symptoms. The bottom line is that to learn which country is performing better, we need to compare mortality rates. Imagine a group of patients all diagnosed with cancer on the same day. The proportion of these patients who are still alive 5 years later is the *5-year survival rate*:

$$\text{5-year survival rate} = \frac{\text{number of patients diagnosed with cancer still alive 5 years after diagnosis}}{\text{number of patients diagnosed with cancer}}$$

To calculate a mortality rate, imagine another group of people. Members of this group are defined as *not* having a cancer diagnosis. The proportion of people in this group who are still alive after 1 year (the typical time frame for mortality statistics) is the *mortality rate*:

$$\text{Annual mortality rate} = \frac{\text{number of people who die from cancer over 1 year}}{\text{number of all people in the group}}$$

The key difference in these two rates is the word *diagnosed*, which appears in the numerator and denominator of survival statistics. Screening profoundly biases survival in two ways: It affects (1) the timing of diagnosis and (2) the nature of diagnosis, by including people with nonprogressive cancer. The

first is called the *lead time bias*, illustrated in Figure 18. Imagine a group of prostate cancer patients currently diagnosed at age 67, all of whom die at age 70. Each survived only 3 years, so their 5-year survival is 0%. Now imagine that the same group is diagnosed with prostate cancer by PSA tests 7 years earlier, at age 60. From the date of diagnosis, all have now survived 10 years, and thus their 5-year survival rate is 100%. Yet although the survival rate has risen dramatically, nothing else has changed: Whether diagnosed at age 67 or at age 60, all patients die at age 70. This simple example demonstrates how survival rates can be increased by setting the time of diagnosis earlier, even if no life is prolonged or saved.

The second phenomenon that leads to spuriously high survival rates is the *overdiagnosis bias*, illustrated in Figure 19. Overdiagnosis is the detection of pseudodisease—screening-detected abnormalities that meet the pathologic definition of prostate cancer, but will never progress to cause symptoms in the patient's lifetime. These are also called nonprogressive cancers. Figure 19 (top) shows 1,000 men with progressive cancer who do not undergo screening. After 5 years, 440 are still alive, which results in a survival rate of 44%. Figure 19 (bottom) shows a population of men who participate in PSA screening; the test detects both progressive and nonprogressive cancers. Imagine that screening identifies 2,000 people with nonprogressive cancers—who by definition will not die of cancer in the following 5 years. These are now added to the 440 who survived progressive cancer, inflating the survival rate to 81%. Again, although the survival rate has increased dramatically, the number of people who die has not changed at all.

Due to the overdiagnosis bias and the lead time bias, changes in 5-year survival rates have no reliable relationship to changes in mortality. For example, consider the 20 most common solid tumors in the US over the last 50 years. A study examining the correlation coefficient relating changes in 5-year survival to changes in mortality for these cancers between 1950 and 1995 found the correlation to be  $r = 0.00$ ! In the context of screening,

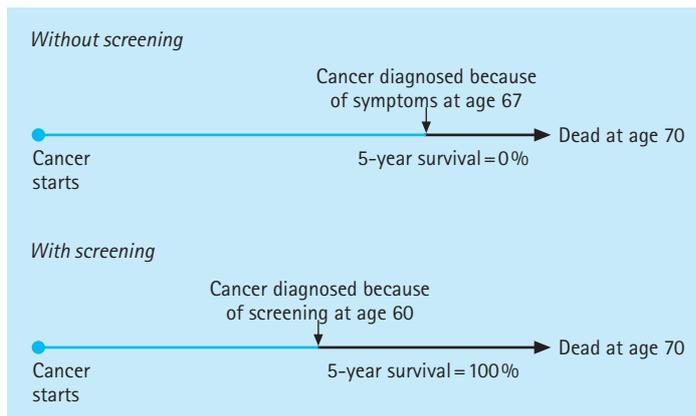


Figure 18. Why can survival rates be misleading? An illustration of the lead time bias. Even if the time of death is not changed by screening and thus no life is saved or prolonged, advancing the time of diagnosis can result in increased 5-year survival rates.

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survival rate is always a biased metric. In the US, screening for prostate cancer using the PSA test began in the late 1980s and spread rapidly, despite the lack of evidence that it saves lives. As a result, the number of prostate cancer diagnoses soared. In the UK, PSA testing was introduced later and is not used routinely. Consequently, prostate cancer incidence in the UK has risen only slightly. This largely explains why 5-year survival for prostate cancer is so much higher in the US. But the real story is about mortality: Are American men half as likely to die from prostate cancer than British men? The answer is no; mortality is about the same. If we take prostate cancer as a criterion for judging a health-care system, the "socialist" English system appears to win since there are fewer diagnoses, that is, less overdiagnoses, but about the same mortality rate. Many American men have been unnecessarily diagnosed (i.e., overdiagnosed) with prostate cancer and undergone unnecessary surgery and radiation treatment. This has led to between one third and two thirds of these men to suffer from lifelong incontinence or impotence.

**Are Patients Prepared to Make Informed Decisions?**

In several countries, health systems are currently being reformed to provide more room for patients to choose treatments, doctors, or even health insurers. Yet we and others have shown in study after study that patients do not understand the information communicated by health organizations and do not know which questions to ask. We first need to educate the public before we can expect public policy changes to be effective. Here is an illustration taken from cancer screening, which involves people who do not have symptoms and whose responses are not likely affected by fear or any other intense emotion. In the US and the EU, the benefits of breast cancer screening using mammography are typically communicated in the following way: Screening reduces the risk of dying from breast cancer by "25%." This percentage is a *relative risk reduction*, which is a nontransparent form of communication—and like survival rates, both suggestive and mislead-

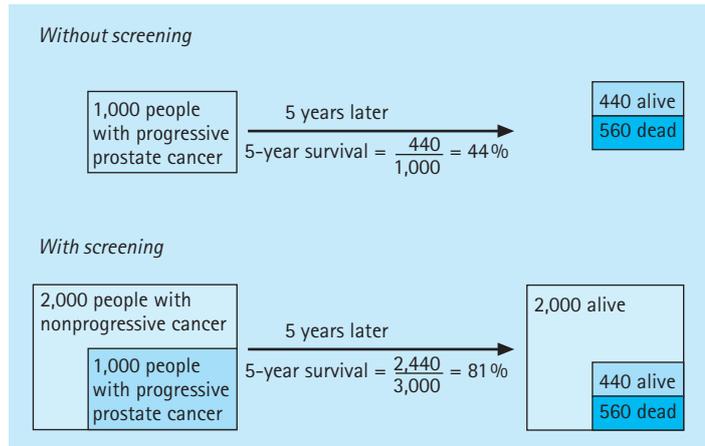


Figure 19. Why can survival rates be misleading? An illustration of the overdiagnosis bias. Even if the number of people who die is not changed by screening, and thus no life is saved or prolonged, screening-detected nonprogressive cancers can inflate the 5-year survival rates.

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ing. For instance, we asked a representative sample of 1,000 German citizens the following question: "Early detection with mammography reduces the risk of dying from breast cancer by 25%. Assume that 1,000 women age 40 years and older participate regularly in screening. How many fewer would die of breast cancer?"

Figure 20 shows that the general public has no idea what 25% means. The estimates

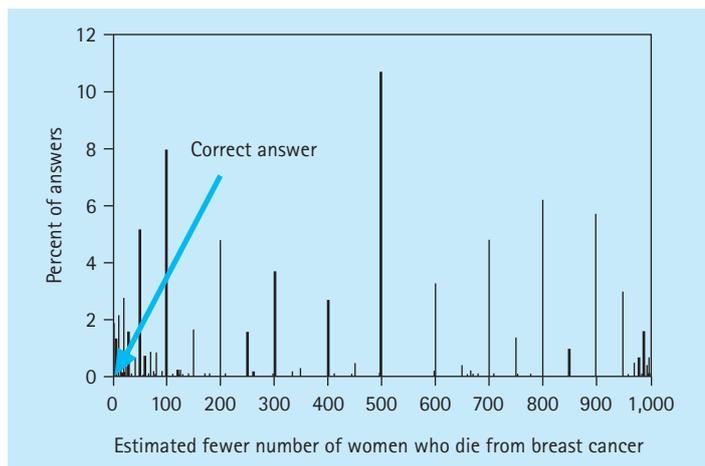


Figure 20. Illustration of statistical illiteracy among the public. A representative sample of 1,000 German citizens were asked: "Early detection with mammography reduces the risk of dying from breast cancer by 25%. Assume that 1,000 women aged 40 and older participate regularly in screening. How many fewer would die of breast cancer?"

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spanned the entire spectrum, with 500 in 1,000 as the most frequent estimate. The 25% figure stems from randomized studies that found that, out of 1,000 women age 40 and older who did not participate in screening, 4 died of breast cancer within 10 years and that, out of 1,000 women who did participate, this number dropped to 3. From 4 to 3 is a 25% relative risk reduction, which is an *absolute risk reduction* of 1 in 1,000, or 0.1%. Only about 1% of the general public seems to understand this fact, and a separate analysis revealed that even less women in the age group invited for screening understood it. This study shows that the general public do not understand the benefit of screening and, thus, cannot make an informed decision about it. It also shows that the problem is not simply inside the human mind, but in the way information is framed by health-care institutions. Many institutions have a conflict of interest, pursuing the paternalistic goal of increasing the participation rates at the expense of complete and transparent information.

### Do Doctors Understand Health Statistics?

According to the German Health-Care Reform of 2007, adults covered by statutory health insurance are required to visit a doctor to be instructed on the pros and cons of breast, cervical, and colon cancer screening. If they

choose not to visit, and are later diagnosed with cancer, their personal expenditures are capped at 2% (otherwise 1%) of their annual income for cancer-related medical expenses. What the health-care reform did not envision was the possibility that doctors are not in a position to inform patients adequately because they have no efficient training in statistical thinking.

In 2006 and 2007, Gerd Gigerenzer trained 1,000 experienced gynecologists in risk communication as part of their mandatory further education. At the beginning of each training session, he asked the following question, designed to test the doctors' ability to explain a positive mammogram to a patient.

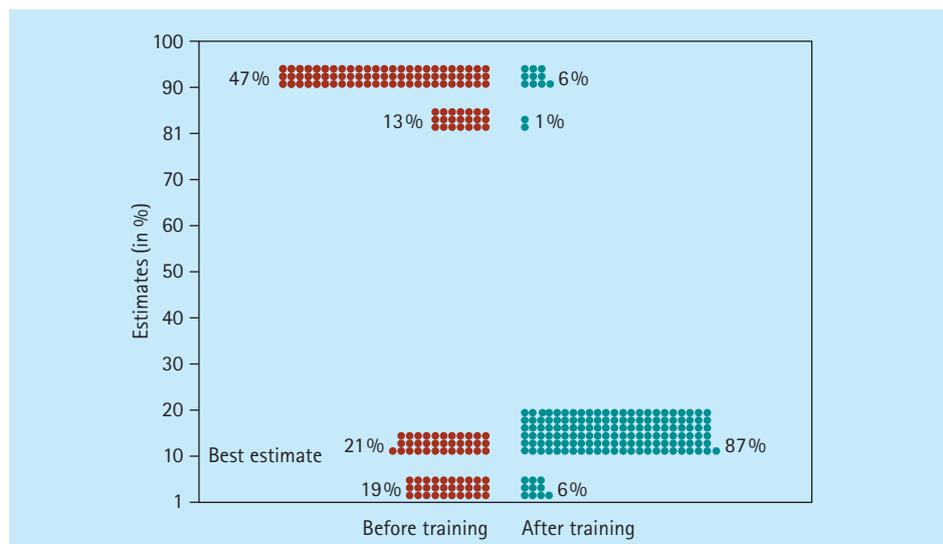
Assume you conduct breast cancer screening using mammography in a certain region. You know the following information about women in this region:

- The probability that a woman has breast cancer is 1% (prevalence).
- If a woman has breast cancer, the probability that she tests positive is 90% (sensitivity).
- If a woman does not have breast cancer, the probability that she nevertheless tests positive is 9% (false-positive rate).

A woman tests positive. She wants to know from you whether that means that she has breast cancer for sure, or what the chances are. What is the best answer?

Figure 21. Illustration of statistical illiteracy among physicians. One hundred and sixty gynecologists estimated the probability that a woman has breast cancer given a positive mammogram, before and after learning how to translate conditional probabilities into natural frequencies.

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- (a) The probability that she has breast cancer is about 81 %.
- (b) Out of 10 women with a positive mammogram, about 9 have breast cancer.
- (c) Out of 10 women with a positive mammogram, about 1 has breast cancer.
- (d) The probability that she has breast cancer is about 1 %.

Gynecologists could simply recall what they should have known already or derive the answer from the health statistics provided. In either case, the answer is (c)—that only about 1 out of every 10 women who test positive in screening actually has breast cancer. The other 9 are falsely alarmed.

Figure 21 (left) shows that only 21 % of doctors knew and responded with this answer (less than chance), whereas the majority grossly overestimated the woman's probability of cancer. Another troubling result was the high variability in physicians' estimates, ranging between 1 % and 90%. Consider what unnecessary fear doctors' innumeracy causes women who participate in screening. Again, our thesis is that there is nothing wrong with these physicians' mental capacities (although gynecologists should know this 1 in 10 figure by heart), but that the information is again framed in a confusing way. *Natural frequencies* are a transparent alternative to the *conditional probabilities* used in medical training (such as sensitivities and false-positive rates). Here is the same information in a transparent way:

- Ten out of every 1,000 women have breast cancer.
- Of these 10 women with breast cancer, 9 test positive.
- Of the 990 women without cancer, about 89 nevertheless test positive.

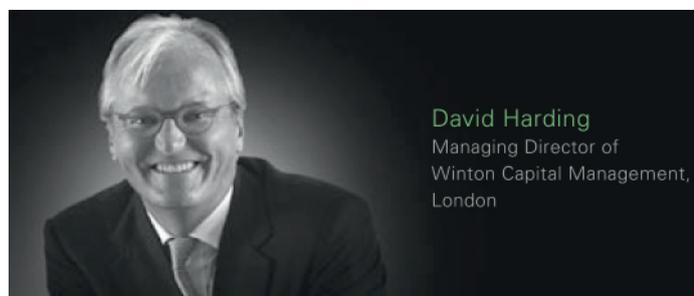
After a 75-minute training session, in which they learned how to translate conditional probabilities into natural frequencies, the gynecologists' confusion disappeared; 87 % understood that 1 in 10 is the best answer and only 13 % appeared to be hopeless cases (Figure 21, right). This approach to helping doctors is rooted in laboratory experiments by Gigerenzer and Hoffrage (2007), who showed that natural frequencies facilitate insight because they perform part of the Bayesian computations.

These examples illustrate the phenomenon of collective statistical illiteracy as well as techniques that can substantially reduce the problem. The major challenge is to find efficient ways to implement learning the art of understanding statistics in medical school and physicians' further education and to establish guidelines for transparency in reporting medical studies in journal articles, brochures, and the media.

To this end, David Harding, Head of the London investment firm Winton Capital Management, donated 1.5 million Euros to Gerd Gigerenzer to found a center for risk literacy, whose primary goal is to improve the public's

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David Harding  
Managing Director of  
Winton Capital Management,  
London

"It was the outstanding research at the Max Planck Institute for Human Development in Berlin that convinced me that it would be the ideal setting for a privately financed 'Harding Center for Risk Literacy'. It is my aim to promote the proper use of statistical analysis in policy development, for the benefit of the public, and I am convinced that the excellent scientists at the institute will succeed in an area which will be of ever increasing importance for the future."

David Harding

#### The Harding Center for Risk Literacy

In spring 2009, the Harding Center for Risk Literacy was founded at the Max Planck Institute for Human Development, Berlin. Its mission is to help create a society of informed citizens who are competent to deal with the risks of a modern technological world. Basic and applied research will be united at the Center. In the area of basic research, questions to be investigated cover how risks can be more effectively communicated and why certain risks loom larger than others (even when they are not). The results will be applied in particular to health care and to school education in statistical thinking, with the intention of developing new and effective methods. At the same time, the Center aims at demonstrating, to a broader public, the importance of dispelling illusions of certainty and zero risk and learning to live in an uncertain world. The Center will also serve as the hub of a worldwide network of experts who are working on risk literacy, including the international Cochrane centers for evidence-based medicine, national medical associations, the Winton Chair for the Public Understanding of Risk at the University of Cambridge, and the Bank of England.

The Harding Center for Risk Literacy is headed by Gerd Gigerenzer and Wolfgang Gaissmaier and comprises a team of psychologists and physicists. The first network conference will be held in October 2009, when 40 medical researchers, medical journal editors, health economists, social scientists, and representatives of health insurances will meet for a 5-day Strüngmann Forum. It will be chaired by Gerd Gigerenzer; Sir Muir Gray, Head of the UK National Screening Program; and Günter Ollenschläger, Head of the German Agency for Medical Quality, Berlin. This conference is entitled "Better doctors, better patients, better decisions: Envisioning health-care 2020."

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understanding of risks and uncertainties, an essential skill in a modern technological world (see Box p. 55). Learning to live in an uncertain world presents an emotional challenge to relinquish the illusion of certainty, the fiction of zero risks, and the paternalism that reigns in much of health care and beyond.

### "Green" Energy: A Matter of Decisions or Defaults?

Renewable energy, environmental protection, and "green" electricity are promoted by nongovernmental organizations and governments all around the world. But how do people actually decide which energy resources to purchase? One widespread view is that decisions are caused by internal factors, such as personal preferences, environmental attitudes, or knowledge states. This view only looks inside the mind for causes. The perspective of ecological rationality, in contrast, suggests that behavior is a function of heuristics and the environment. If this is correct, one cannot automatically expect that a person favoring "green" electricity will actually buy it. We report here on natural and laboratory experiments that suggest that most people's decisions on which energy resource to purchase are determined by the default heuristic and that the default is set by the environment rather than by the individual (Pichert & Katsikopoulos, 2008). This heuristic can be defined as: *If there is a default, do nothing.* The first natural experiment occurred in Schönau, a picturesque little town in the Black Forest, with a population of 2,500. As a reaction to the Chernobyl disaster, a citizens' group proposed to take over the local electricity grid in order to establish an environmentally friendly supply. The proposal caused so much conflict that 90% of those eligible to vote participated in a referendum. It was accepted by a close margin of 52% of the votes, and the initiative managed to raise enough money to buy the grid. For Schönau, the default became "green" energy generated from renewable and solar energy. Although the community was polarized, as the vote indicates, in 2006 (8 years after the default was implemented) about 99% had remained with the default, compared to a typical value

of 1% in other German towns where "gray" energy is the default.

In the case of Schönau, opting out required some search for alternatives. In the second setting we examined, there were no search costs, since the same energy provider provided three new tariffs where previously there had been only one. In 1999, *Energiedienst GmbH* mailed 150,000 letters to private and business customers in southern Germany, offering three options: a "green" (waterpower) option, a "gray" economical option (about 8% cheaper), and a more "expensive green" option that included a higher share of electricity generated by new facilities (23% more expensive). The "green" option was offered as the default, that is, customers did not need to respond if they chose it. To opt out, customers only had to tick one of the two other options listed and mail off the letter. Nevertheless, the resulting behavior was close to that in Schönau: 94% did nothing and remained with the default, 4.3% did not follow the heuristic and switched to the "gray" option, 1% selected the "expensive green" option, and .7% switched to a different supplier. We conducted two experiments to test whether energy choice follows the default heuristic, but this time under controlled laboratory conditions using hypothetical scenarios (Pichert & Katsikopoulos, 2008). Young adults ( $n = 225$ ; 18–35 years old, mostly students) were asked to imagine that they had moved to another town. In their new apartment, they had a choice between two electricity suppliers, one advertising "clean electricity" generated from environmentally renewable sources (30 Euros per month) and the other offering an economically priced "gray" alternative (25 Euros per month). In one condition, the "green" electricity was the default, in the second the "gray," and in the third there was no default. When there was no default or a "green" default, 67% and 68%, respectively, stated that they would choose the "green" electricity. Yet when the default was "gray," this number sank to 41%, that is, the majority remained with the "gray" default. Asked for the reasons behind their decisions, 71% of the participants mentioned price and 62%

named environmental protection, whereas only 15% referred to reasons indicating awareness of the default heuristic. In the second laboratory experiment, 82 participants of the same population as in the first laboratory experiment were tested in two conditions. In the *willingness to pay* (WTP) group, participants were asked whether they were willing to switch to "green" electricity if they currently had "gray" electricity, and, if so, what extra premium they were willing to pay per month. In the *willingness to accept* (WTA) condition, they were asked whether they were willing to switch to "gray" electricity if they currently had "green" electricity, and, if so, how much cheaper the "gray" electricity would have to be to make them switch. In both cases, participants were assured that there were no switching costs. Nearly half of the subjects in the WTA group refused to switch for any amount of money, emphasizing that environmental values are not for sale. Among the remaining participants, there was a substantial difference (Cohen's  $d = 1.03$ ) be-

tween the willingness to pay a small premium for switching to "green" electricity (mean WTP = 6.59 Euro) and accepting the considerably larger compensation for giving up "green" electricity (mean WTA = 13.00 Euro). Both the natural and laboratory results suggest that a considerable proportion of decisions about energy sources are based on the default heuristic. In the wild, where real decisions are made (or not made), more people seem to follow the default heuristic than in laboratory experiments with better control, but where little is at stake since the decision is hypothetical. Together with previous work on organ donation and on retirement plans, these results indicate that many important decisions are not made actively, but are based on defaults. This insight explains why sending mass mailings on organ donation or "green" energy has been largely ineffective and opens up a different approach to public policy, as recently popularized by Thaler and Sunstein, that installs the desired defaults while leaving open the possibility of opting out.

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#### The ABC Research Group in October 2008



Left to right: Christian Elsner, Wolfgang Gaissmaier, Hansjörg Neth, Ana Sofia Morais, Konstantinos V. Katsikopoulos, Nadine Fleischhut, José Quesada, Jenny Volstorf, Angela Neumeyer-Gromen, Uwe Czienskowski, Monika Keller, Florian Artinger, Elke M. Kurz-Milcke, Henry Brighton, Björn Meder, Julian N. Marewski, Michel Regenwetter, Henrik Olsson, Bettina von Helversen, Jeffrey R. Stevens, Gerd Gigerenzer, Marco Monti, Özgür Simsek, Linnea Karlsson, Juliet Conlin, Mirta Galesic, Odette Wegwarth, Edward T. Cokely, Adrien Barton, Lael J. Schooler, and Fabrice Le Lec.

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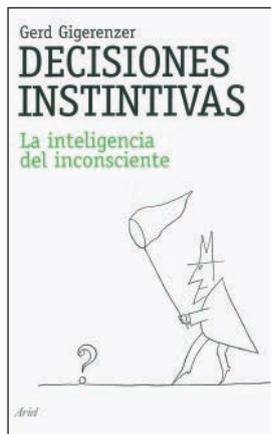
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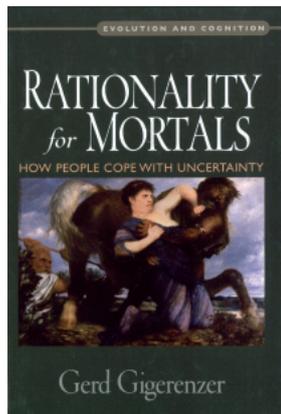
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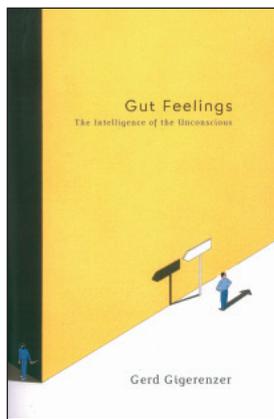
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**Center for  
Educational Research**

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## Introductory Overview

The specific concern of the Center for Educational Research is the study of development and learning from the perspective of institutionalized education. Educational settings, such as schools, provide a specific structure of opportunities and constraints for learning and development. This structure offers a variety of developmental opportunities, but, at the same time, excludes others. How do the learning gains of students in different schools or school types differ? How do teachers' pedagogical knowledge, content knowledge, and pedagogical content knowledge differ, and to what extent do these differences influence student learning gains? How do aspects of schooling affect the intra- and interindividual differentiation of personality traits and guide career-forming processes? How strongly do students themselves actively influence their own academic development—for example, by selecting or switching learning environments? What role does family background play in student development, the selection of learning environments, and the optimization of academic outcomes? These and other questions are explored by a multidisciplinary team including educational scientists, psychologists, mathematicians, and sociologists.

### Conceptual Orientation: Knowledge Acquisition and Psychosocial Development in the Context of Institutional Learning Settings

Learning in institutional settings is a complex and multidetermined process. It is fundamentally difficult to determine whether a school career and a student's learning outcomes can be described as successful. It is even more difficult to identify the causes of success or failure. Although popular with the public, press, and policy makers, simple explanatory models relying on a single factor to explain successful or unsuccessful learning processes are usually insufficient, if not entirely misleading. Given the complexity of learning in institutional contexts, our Center's research program is guided by multiple perspectives. The interactive nature of individual student characteristics and institutionalized learning settings must be taken into account. In all of our research, learners are perceived as the coproducers of their own development. Special attention is paid to how cognitive activation and self-regulation can be stimulated and supported by instructional environments. Moreover, we assume that individual students proactively select and shape their developmental environments.

A comprehensive analysis of institutional opportunities and constraints requires researchers to consider several contextual levels, including countries, schools, classrooms, and the family. Accordingly, our research is

embedded in a multilevel perspective, both conceptually and methodologically, and addresses these different contextual levels. It is important to analyze the effects of various facets of these learning contexts simultaneously. For this reason, our research models incorporate conceptually different facets, such as the curriculum, the quality of instruction, and the composition of the learning group.

Because both educational systems and society as a whole change over time, it is crucial that researchers remain attuned to the historical time in which learning takes place. We therefore embed our research in historical analyses and conduct studies to document the effects of changes in institutional settings. The domain specificity of knowledge acquisition is determined by the way in which educational institutions structure content areas into different academic subjects. Our research focuses on domains of knowledge, such as reading, mathematics, English as a foreign language, and sciences. These domains represent basic cultural tools that are critical for individual development in modern societies.

Although the acquisition of knowledge in core domains is the central variable in learning settings, it is not the only aspect of interest. We also investigate students' motivation, personality, personal goals, and values as both outcomes of institutional learning and predictors of academic success and choices.

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We use various methodological approaches to identify powerful learning environments, with experiments and intervention studies complementing large-scale longitudinal studies.

### **Summary Outline**

Work at the Center for Educational Research is organized into four Research Areas, which also provide the structure for this Annual Report. It should, however, be noted that there is considerable overlap between the Research Areas in terms of researchers, topics, and methods.

**Research Area I** focuses on the relationship between the opportunity structures of schools and the optimization of individual development in terms of cognitive competencies, motivational and social resources, value commitment, and successful transitions to university education, vocational training, and the labor market.

**Research Area II** examines how institutional, individual, and familial factors relate to transitions in the educational system. A main focus of the activities in this Research Area is the Center's participation in the Trends in International Mathematics and Science Study (TIMSS), with the development of an additional module to examine the transition from elementary to secondary school. Another emphasis is on the transition from school to university.

The research questions being addressed within **Research Area III** draw on a key finding of PISA 2000, 2003, and 2006. In Germany, at least 25% of the upcoming generation can be identified as potentially at risk in terms of reading literacy. Research Area III uses longitudinal, cross-sectional, and experimental studies to examine how students' reading literacy and language skills develop, and how they can be effectively assessed and promoted.

**Research Area IV** investigates teacher competence as an important antecedent of educational quality. Drawing on earlier research that identified factors of successful learning environments, the research focus has now shifted to the role that teachers play in creating such high-quality instructional settings. Based on a theoretical model of teacher competence, we investigate how teachers' knowledge, beliefs, and psychological functioning determine their instructional practices. Moreover, we examine how these aspects of teacher competence are shaped and changed within formal learning settings, such as the practical phase of teacher education.

## Research Area I Opportunity Structures of School and Individual Development in Adolescence and Young Adulthood

The successful development of human beings across the lifespan is dependent both on individual characteristics and on external socializers, such as significant others and social institutions. The social institution of school plays a major role during childhood and adolescence, particularly in the domain of academic learning and, more generally, cognitive development. Furthermore, schools influence the development of motivation, emotions, attitudes, and other personal characteristics. Major research topics addressed in Research Area I include the opportunity structures open to students from different backgrounds, academic achievement trajectories across secondary education, the educational standards attained in German upper secondary schools, the comparability of the school-leaving qualifications awarded across Germany, and determinants and consequences of different academic biographies.

### The Empirical Database

Given its theoretical focus on institutional influences on human development, the research conducted within Research Area I entails longitudinal multilevel studies that collect data at the country, state, school, class, and individual levels, cover more than one knowledge domain, and allow both intraindividual change across domains and interindividual differences in patterns of intraindividual change to be investigated. The Research Area's flagship studies were designed to investigate how learning contexts in school and college environments affect human development while meeting the requirements of multilevel longitudinal designs. This applies to *Learning Processes, Educational Careers, and Psychosocial Development in Adolescence and Young Adulthood* (BIJU; see Figure 1), *Transformation of the Secondary School System and Academic Careers* (TOSCA; see Figure 2), and the new study *Tradition and Innovation: Development at Hauptschule and Realschule in Baden-Wuerttemberg and at Mittelschule in Saxony* (TRAIN; see Figure 3).

The analyses conducted in Research Area I also draw on PISA and TIMSS data as well as on additional data sets collected at our Center. Because the longitudinal modeling of hierarchically structured data is methodologically difficult, data analysis requires specific and complex methods, and our Center is involved in optimizing research designs and analytical strategies (see Lütcke, Marsh et al., 2008).

### Schools as Differential Learning Environments: An Overview of Recent Research

Research in Area I has yielded a multitude of theoretically and practically significant findings in recent years. We first give a brief overview of several key results before describing some selected research endeavors in more depth.

#### *Differential Learning Environments and Academic Achievement*

One continued focus of research has been on student performance and learning gains in differential learning environments. Germany is characterized by its differentiated secondary system, with the vocational track *Hauptschule*, intermediate track *Realschule*, and academic track *Gymnasium*, although there is much flux in the structure of the school system in many German states at the moment, with several states reducing the number of school types to two.

A main hypothesis of our Research Center is that the different school types represent differential developmental environments, potentially resulting in differential student learning gains at different school types (fan-spread effect). There are three main explanatory approaches to this fan-spread effect (see Baumert, Stanat, & Watermann, 2006). The first explanation attributes differential developmental trajectories in German secondary schools to differences in students' performance and learning speed that existed before they entered secondary school. Thus, differing developmental trajectories are an expression

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of differential learning rates and a function of entrance selectivity to the three school types. The second approach focuses on the differential effects of school types and school systems relying on differing timetables, curricula, teacher training, and teaching cultures; these effects are "institutional" in nature (Baumert et al., 2006). The third explanation refers to composition effects arising from differences in the achievement, social and cultural background, and educational biographies of student populations. According to this approach, differences in learning trajectories are not, or are only partially, dependent on attending a certain school type. Rather, they are a consequence of the characteristics of the specific learning group. It is quite possible that all of these influences take effect at the same time.

How consistent are empirical findings on the differential effects of school types on student achievement gains? In his recently completed dissertation project, Michael Becker systematically analyzed the available studies of school type effects in Germany. His findings showed that the empirical evidence is not conclusive. Many studies, including investigations conducted in our Research Center (e.g., Becker, Lüdtke, Trautwein, & Baumert, 2006; Neumann et al., 2007), have found evidence for school type effects; others have not. For mathematics, the evidence seems to be in favor of school type effects; for reading comprehension, in contrast, trajectories seem to be more uniform across school types. Becker identified several methodological issues that make it generally more difficult to detect differential school type effects, even when they exist. Moreover, he examined the extent to which any differences in the learning gains of students in different school types are causally attributable to attending a certain school type. Becker used the potential outcome approach introduced by Donald Rubin to define causal effects. According to this approach, causal conclusions can be drawn only when it is possible to control the assignment mechanism to the different school types (ignorable treatment assignment). In his own study, Becker used propensity score matching, an approach in which the control of the assignment

mechanism is separated from the outcome analysis. His findings indicate substantial differences in student learning across school types, at least when students have been in that environment for some time. Future studies need to examine whether the findings from Germany, with its special form of ability grouping, generalize to other systems with different forms of student grouping (e.g., differentiation by curriculum).

#### *Differential Learning Environments: Impacting Student Self-Concept*

The effects of differential learning environments are not restricted to the domain of academic achievement but also apply to student motivation, emotion, and behavior. In a series of studies, we have continued our research program examining frame-of-reference effects on self-related cognitions. Herbert Marsh coined the term *Big-Fish-Little-Pond Effect* (BFLPE) to describe the finding that students in high-achieving groups develop lower self-concepts than equally proficient students in low-achieving environments. In recent years, we have documented frame-of-reference effects on the physical self-concept of elementary school students (Trautwein, Gerlach, & Lüdtke, 2008): When actual physical ability was controlled, students whose classmates showed high physical ability reported lower physical self-concepts. Moreover, low physical self-concept was associated with less leisure-time physical activity. An interesting additional finding was that the negative frame-of-reference effect on physical self-concept was still observable after the transition to secondary school, despite the change of reference group (Gerlach, Trautwein, & Lüdtke, 2007).

Evidently, the frame-of-reference effects predicted by the BFLPE are not restricted to academic self-concepts. But quite how broad is the scope of the BFLPE? Marsh, Trautwein, Lüdtke, and Köller (2008) used PISA data to address this question. Critical factors seem to be the nature of the social comparison process—comparison with generalized others (class- or school-average) or with individuals (target classmate)—and the nature of self-belief constructs that invoke normative (social

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### Data Collection in TOSCA

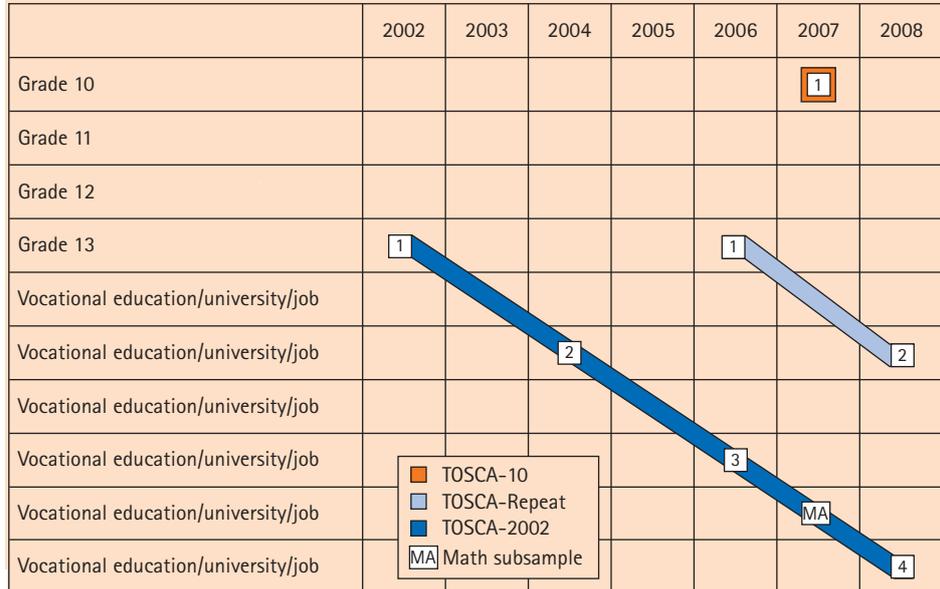
At Time 1 of the TOSCA 2002 cohort, a representative sample of 4,730 students in their last year of upper secondary education (aged about 17 to 19 years) was sampled between March and May 2002. All students were attending either traditional *Gymnasium* schools or one of the five (now six) forms of vocational *Gymnasium* schools that have been established in Baden-Wuerttemberg. More than 60% of these students consented to be recontacted for follow-up studies. The second wave of data collection took place from February to May 2004 with 2,315 students. The third wave took place from February to May 2006 with 1,912 students. In early 2007, a subsample of participants was administered a set of mathematics and cognitive ability tests. Finally, another wave of data collection took place in 2008, with more than 1,500 participants.

A second TOSCA cohort ("TOSCA-Repeat") was recruited in 2006, comprising almost 5,000 students in their last year of upper secondary education at more than 150 schools in Baden-Wuerttemberg. TOSCA-Repeat was designed to assess the effects of the structural reform of upper secondary education (the last 3 years of schooling before the *Abitur*). The school system in Baden-Wuerttemberg has experienced major changes since 2002. The most important change at upper secondary level has been the introduction of core competence subjects and the abolition of the traditional advanced courses (*Leistungskurse*). About 3,000 TOSCA-Repeat participants were recontacted and administered a questionnaire in 2008.

A third cohort ("TOSCA-10") comprises *Realschule* and *Gymnasium* students who were in grade 10—that is, approaching the end of lower secondary education—in 2007. Again, achievement tests and questionnaires were administered. One focus of our analyses is on which student characteristics are particularly powerful predictors of whether or not a student enters the preuniversity track (*gymnasiale Oberstufe*).

Figure 2. Study design of the TOSCA project.

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comparison) or absolute frames of reference. In a large cross-national study (26 countries; 3,851 schools; 103,558 students), school-average ability negatively affected academic self-concept, but had little effect on four other self-belief constructs that did not invoke social comparison processes (e.g., self-efficacy and effort persistence).

*Differential Learning Environments:  
The Case of Homework Assignments*

We have also addressed differential learning opportunities within the Homework as Learning Opportunities (HALO) project. This project, which has strong links to Research Area IV, uses several data sets to explore the effects of teachers' homework assignments and students' homework completion. Building on our earlier work (Trautwein & Köller, 2003; Trautwein, Lüdtke, Schnyder, & Niggli, 2006), we have systematically expanded our research program in the past two years. For instance, one of our recent articles (Pieper, Trautwein, & Lüdtke, in press-b) challenged the widespread assumption that more time spent on homework is generally associated with higher achievement. This cross-cultural study analyzed the relationship between homework time and mathematics achievement, drawing on data from 231,759 students in 9,791 schools and 40 countries who participated in PISA 2003. Multilevel analyses found a positive association between school-average homework time and mathematics achievement in almost all countries, but the size of the association decreased considerably when socioeconomic background and school track were controlled. At the student level, no clear-cut relationship was established between homework time and achievement across the 40 countries. The results highlight the need to use multilevel analyses and to control for confounding variables in homework research.

Although homework per se does not lead to better learning outcomes, it seems likely that the quality of homework assignments plays a significant role. Indeed, several of our studies have shown that homework quality as rated by students or external observers is related to important outcomes, such as homework

effort and school grades (Schnyder, Niggli, & Trautwein, 2008; Trautwein & Lüdtke, in press; Trautwein, Schnyder, Niggli, Neumann, & Lüdtke, 2009). Further studies are currently in the data analysis stage.

**Differential Learning Environments and Students' Social Dominance Hierarchy**

Another area of research that we have expanded over the past two years is work on how the classroom structures students' social hierarchies, status, and friendships. Adolescents spend about half of their waking hours with peers, primarily at school. The peer group of the classroom, like any other group, involves different roles and norms. In one of the studies conducted for her dissertation project, Kathrin Jonkmann focused on students who are actively involved in establishing peer norms, whose opinions matter to classmates, who hold high prestige and authority, and who are highly visible and often the center of attention—in short, social dominants. These are the students that teachers have in mind when they think about the few who shape the classroom climate; they may well be the classmates that other children tell their parents about over dinner. Whether the influence of these socially dominant students is beneficial or harmful might depend on their personal characteristics and attributes. Who are these socially dominant teenagers? Is their status in the classroom solely attributable to positive qualities—or do problem behaviors, such as disruptive and deviant behaviors, also play a role? Furthermore, how does the classroom influence who becomes socially dominant? Drawing on data from 5,468 participants of the BIJU study, Jonkmann, Trautwein and Lüdtke (2009) identified four types of highly influential grade 7 teenagers who differ tremendously in the means they use to gain social influence, and showed that classrooms can differ widely with respect to the rules determining who becomes dominant.

Jonkmann and colleagues asked each student to name up to four classmates who were influential and therefore often the center of attention. Overall, we found that social dominance related to a number of positive

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### The TRAIN Study—Aims and Data Collection

The TRAIN (Tradition and Innovation) Study investigates students' developmental trajectories and learning gains in the differently structured educational systems of two German states, Baden-Wuerttemberg and Saxony. The focus of our analyses is on the lower and intermediate tracks (*Hauptschule* and *Realschule*), which are separate in Baden-Wuerttemberg, but implemented in a combined *Mittelschule* in Saxony.

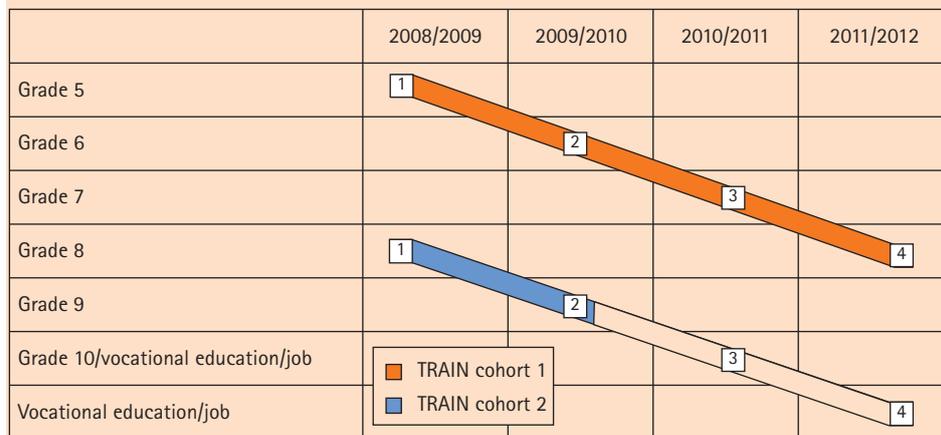
TRAIN addresses important research questions that prior studies were not able to examine in sufficient detail. Most important, TRAIN will investigate the consequences of different forms of ability grouping and the impact of class composition. Moreover, intervention modules (e.g., remedial reading support) will be implemented with the aim of identifying effective means of improving the motivation and achievement of at-risk students. In addition, we will analyze the educational careers of students with specific learning difficulties or behavioral or psychological problems and their influence on the learning and development of their classmates.

Data collection began in November of the 2008/09 school year. Participants were some 6,000 grade 5 and grade 8 students in 60 *Hauptschulen* and 24 *Realschulen* in Baden-Wuerttemberg and 22 *Mittelschulen* in Saxony (see Figure 3). Data were also obtained from the students' teachers and parents. The students were administered a comprehensive battery of tests and questionnaires over a 2-day period. The achievement tests covered the domains of mathematics, English as a foreign language, and German. Basic cognitive ability, concentration, and career knowledge were also assessed. The questionnaires focused on student motivation, interests, family background, self-concept, psychological problems, learning difficulties, uptake of additional and remedial instruction, and covered various aspects of the form tutor's work. In Saxony, social network data were additionally obtained. Teacher ratings of each student's behavioral problems, participation, and motivation were also obtained in both states.

Data are to be collected annually over a 4-year period (for the grade 5 cohort). We intend to continue monitoring the students of the grade 8 cohort after they have left school.

Figure 3. Study design of the TRAIN project.

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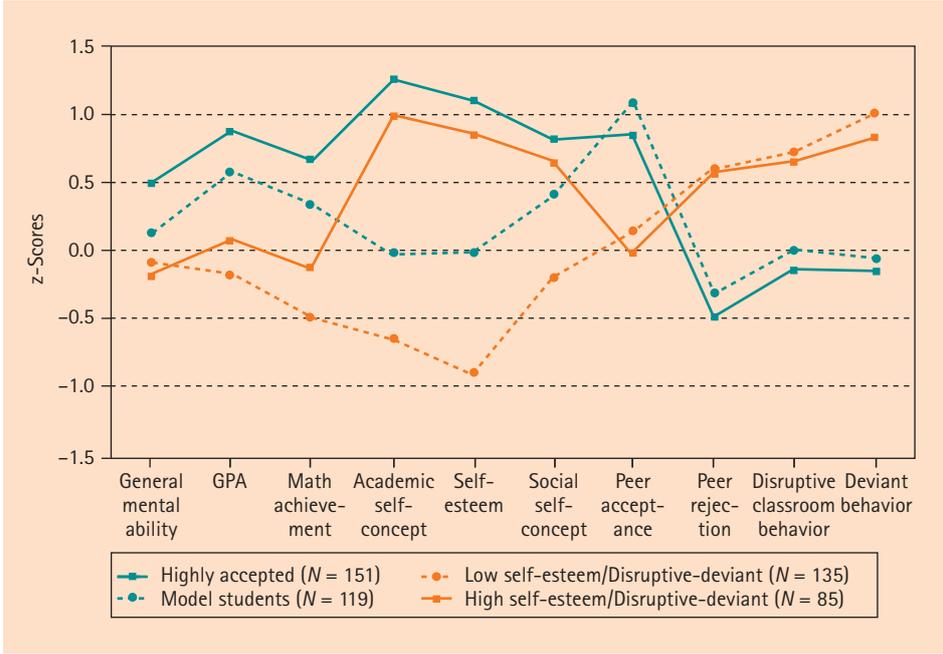


Figure 4. Latent profiles of socially dominant students.

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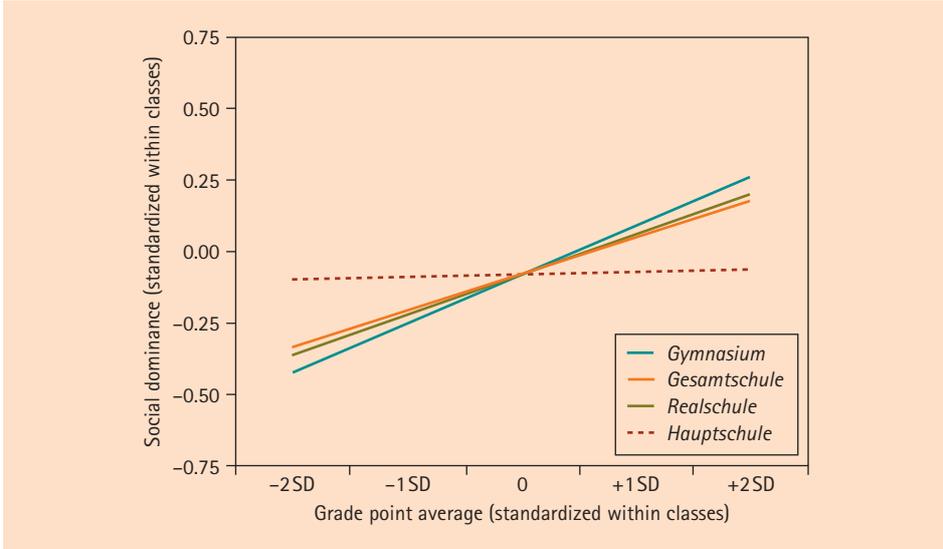


Figure 5. Association between GPA and social dominance in different classroom contexts.

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characteristics, such as being liked by many classmates, better grades, higher cognitive abilities, and higher academic self-esteem, as well as to more negative characteristics, such as being disliked by peers and disruptive or deviant behaviors. We successfully disentangled these seemingly contradictory findings by using latent profile analysis to look more closely at the two most dominant students in each classroom (Figure 4). Four ways of

gaining peers' attention were discernable: The model students in the first group were very good academic achievers with a very positive self-image. The students in the second group were exceedingly popular among their peers. The third and fourth groups were both characterized by very high levels of disruptive and deviant behaviors. Interestingly, one of these groups showed high self-esteem, whereas the other showed low self-esteem and academic

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engagement. This latter group may be at particular risk for a career of delinquency and further maladjustment.

Jonkmann and colleagues also found that the social context is important in determining who is dominant: Multilevel analyses revealed that, in classrooms with low average achievement (*Hauptschule*), a student's grade point average (GPA) was inconsequential for his or her social status. In more achievement-oriented environments, especially the *Gymnasium*, however, higher GPA was associated with greater influence (Figure 5). Hence, similarly to programs addressing aggressive behavior, interventions for teenagers who seriously neglect their school work may be doomed to failure if they do not include the peers who reward academic disengagement and disruptive and deviant behaviors with social prestige.

## Differential Learning Environments: Methodological Aspects of Assessing Contextual Effects

A key assumption of most educational research is that cognitive, motivational, emotional, and behavioral student outcomes are substantially shaped by features of the social context, such as learning climate, instructional quality, and the social composition of the class or school. In the last two decades, multilevel modeling has become the standard approach for assessing contextual effects in the social sciences. A major strength of multilevel modeling (MLM) lies in the possibility of simultaneously exploring relationships among variables located at different levels. In the typical application of MLM in educational research, outcome variables are related to several predictor variables at the individual level (e.g., students) and the group level (e.g., schools, classes). Despite the progress that has been made in the estimation of multilevel models in recent decades, there are still a number of open questions regarding the assessment of contextual effects in educational research. Our Research Center's work in this area has focused on two issues. First, group characteristics are frequently assessed by aggregating individual student data across groups. We have evaluated different

approaches to assessing the psychometric properties of such aggregated data. Second, we have developed statistical methods that can correct for unreliability when multilevel models are used to estimate contextual effects.

## Psychometric Properties of Group Characteristics

One simple and efficient research strategy for assessing contextual characteristics that is often used in educational research is to ask students to rate several specific aspects of their learning environment. At the *individual level* these student ratings represent the individual student's perception of the learning environment. Scores aggregated to the *classroom or school level* reflect perceptions of the shared learning environment, corrected for individual idiosyncrasies.

Once researchers have identified the classroom or school level as the theoretically appropriate level of their analysis, they need to investigate the psychometric properties of the aggregated student ratings. In other words, they need to show that the student responses can be used to adequately measure the respective construct at the class or school level. There are two complementary approaches to assessing the psychometric properties of aggregated student ratings of the learning environment (Lüdtke, Trautwein, Kunter, & Baumert, 2006): the reliability of the aggregated student ratings and the within-group agreement of the students in a group (e.g., class).

In the multilevel literature, the intraclass correlations ICC(1) and ICC(2) are used to determine whether aggregated individual-level ratings are reliable indicators of group-level constructs. These indexes are based on a one-way analysis of variance with random effects, where the individual-level rating at level 1 is the dependent variable and the grouping variable (e.g., class, school) is the independent variable. Whereas the ICC(1) indicates the reliability of an individual student's rating, the ICC(2) provides an estimate of the reliability of the group-mean rating. When aggregating data from the individual to the group level, it is only possible to distinguish relationships

on the group level if the aggregated data are sufficiently reliable.

In contrast to the reliability of student ratings, there has as yet been very little research on the *agreement* of student ratings of group-level constructs in educational research. James, Demaree, and Wolf proposed a method for assessing agreement among a group of raters who have all rated the same stimulus (e.g., students rating their teacher's behavior). The basic idea is that, when there is strong agreement between the students in a class, the variance between the students' ratings should be as small as possible—in the case of perfect agreement, it should be zero. The crucial question is when the variance between the raters in a group can be considered "small." Lüdtke and Robitzsch (in press-a) critically evaluated a data-driven approach that utilizes random-group resampling (RGR) procedures to determine the variance that would be expected to follow from raters making their ratings at random. They showed mathematically and by means of simulation studies that the probability of obtaining statistically significant within-group agreement when applying the RGR procedure strongly depends on characteristics of the total sample of groups, such as the ICC(1) and the group sizes. Consequently, they strongly recommend that the RGR procedure not be

used to determine the level of within-group agreement.

#### A Multilevel Latent Covariate Model

One problematic aspect of assessing contextual effects using multilevel modeling is that the observed group average obtained by aggregating individual observations may not be a very reliable measure of the unobserved group average if the number of individuals sampled from each group is small. For example, if only 10 students are sampled from each school to obtain an estimate of school climate, the school-average student ratings from each school will not be a very reliable measure of the true school climate. The relationship between the expected bias and the ICC(1) as well as the group size is depicted in Figure 6 for different values (.5 and .8) of the contextual effect. In both panels, the bias becomes smaller with larger group sizes  $n$ . In other words, when the group mean is more reliable due to a higher  $n$ , the contextual effect can be more precisely approximated by the manifest group-mean predictor. The bias also decreases as the ICC(1)—the reliability of an individual student rating—increases. Together with Herbert Marsh (University of Oxford), Tihomir Asparouhov, and Bengt Muthén, we have developed a latent variable approach that takes the unreliability of the

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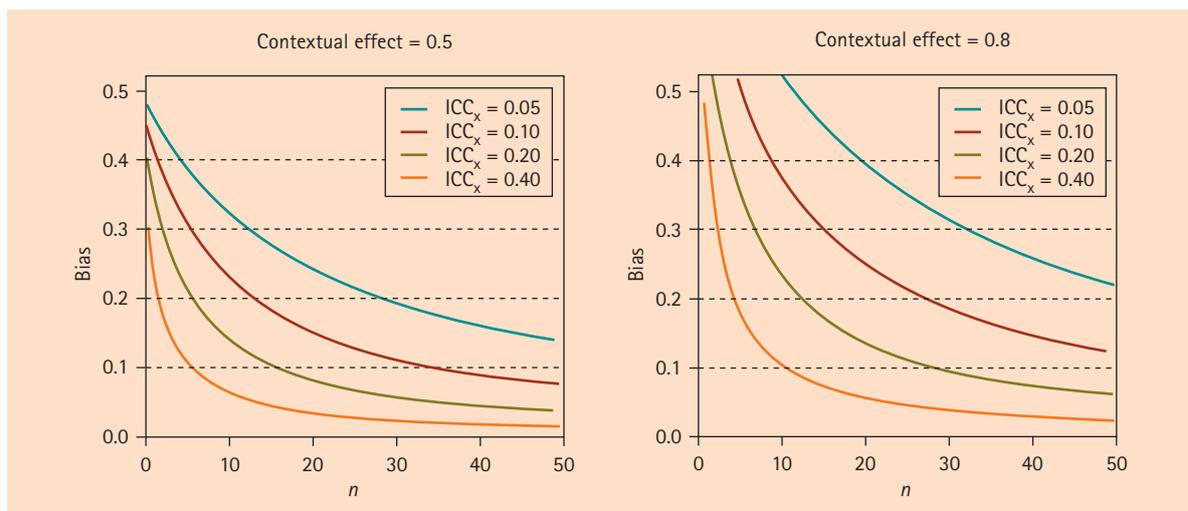


Figure 6. Relationship between bias, group size ( $n$ ), and intraclass correlation (ICC) for different contextual effects.

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## The IPEA Project

Standardized achievement testing has been a key component of educational monitoring systems in the United States and Great Britain for decades; similar developments are now observable in many other countries. Yet studies show that systems of governance based exclusively on performance-oriented measures can have serious adverse effects, ranging from teachers intervening in the selection of the students who participate in evaluations to teaching to the test.

The negative effects of performance-based monitoring in English-speaking countries are well documented. However, the empirical findings available to date are not able to inform the development of more effective systems. The International Project for the Study of Educational Accountability Systems (IPEA) has been set up to analyze the consequences of standardized achievement testing in more depth. The project's primary concern is to examine the effects of monitoring systems in schools. To this end, it aims to examine the effects of administering certain tests on instructional practice, to track changes in test scores over successive years, to identify the factors underlying these processes, to promote the enhancement of test designs, and to investigate the relationship between school evaluation and standardized achievement testing.

An international research group was initiated by Daniel Koretz at Harvard Graduate School of Education, Cambridge; the IPEA network now spans several countries. The partner organizations include several German research institutes (Institute for Educational Progress, Berlin; Institute for School Quality, Berlin; Leibniz Institute for Science Education, Kiel; German Institute for International Educational Research, Frankfurt a. M.)—that is, the institutions involved in conducting national tests, monitoring educational standards, and running large-scale international studies. The international partners come from the Netherlands (CITO, Arnhem), Israel (National Authority for Educational Measurement and Evaluation, Tel Aviv), Hungary (University of Szeged), and the US (Harvard University; RAND Corporation).

In order to track the effects of implementing and extending system and school monitoring, the IPEA project partners will examine—in national and international comparison—how systems change when specific factors (e. g., high- vs. low-stakes testing, methods of test administration, availability of past papers) vary or are changed. This may involve comparisons of trends between state-specific and supraregional or international tests, as in U.S. research. In the German context, we can draw on data from state-specific, nationwide, and international tests (e. g., TIMSS, PISA, PIRLS). In addition, we are currently developing test instruments to gauge change in the handling of standardized testing. To this end, student and teacher questionnaires aligned with U.S. and OECD research are currently being constructed.

The new international IPEA project has a number of precursors in the Center. We have, for example, previously investigated the extent to which literacy tests, such as those implemented in PISA, are sensitive to targeted training measures. In an experimental study, Brunner, Artelt, Krauss, and Baumert (2007) found that student performance on the PISA tests could, in principle, be enhanced by a comprehensive and multifaceted coaching program, but that such extensive programs are scarce in practice—of course, this may change in the future. Moreover, the findings of an experimental study by Baumert and Demmrich (2001) suggest that the PISA 2000 results in Germany were not significantly affected by lack of student motivation. Again, however, there is no guarantee that future data will point in the same direction.

group mean into account when estimating the contextual effect (Lüdtke, Marsh, Robitzsch, Trautwein, Asparouhov, & Muthén, 2008). Because the group average is treated as a latent variable, we call this approach the *multilevel latent covariate model*. The "traditional" multilevel modeling approach, in contrast, treats the observed group means as manifest and does not infer from them to an unobserved latent construct that controls for unreliability. Our simulation studies have shown that the traditional approach indeed tends to yield a more biased estimate of the group effect than the latent approach. In certain data constellations (low ICC [1] and low number of level-2 units), however, the estimate yielded by the latent approach exhibits greater variability than that yielded by the traditional approach. This is a critical point, as it means that the estimate obtained by the

latent approach in specific applications may—given its greater variability—be further from the true value than the estimate obtained by the traditional approach.

Further, Lüdtke et al. (2008) argue that it is important to consider the extent to which the assumptions of the latent approach (e.g., unobserved group average) are consistent with the nature of the group construct investigated. Despite these issues, the latent approach implemented in Mplus offers a promising tool for dealing with the problem of unreliable group means in multilevel models, and is thus of great relevance for investigating school context effects in empirical educational research. Currently, we are working on an extension of the multilevel latent covariate model to cases in which group constructs are assessed by multiple indicators (e.g., students rate their teacher's instruction on several items).

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**Research Area II  
 Transitions in the Educational System**

The biographies of young people are characterized by a host of transitions. Beyond the biological changes and psychological transitions from childhood to adolescence and adulthood that each individual needs to negotiate, young people have to make several transitions within the educational system, each governed by specific institutional, legal, and societal regulations. These transitions require complex decisions that, particularly in tracked systems, have far-reaching effects on students' educational and vocational biographies. The analysis of transitions has a long tradition within the Center for Educational Research. Research Area II integrates all of the Center's projects and subprojects that deal explicitly with the analysis of transitions at various stages of educational careers, placing a particular focus on family background.

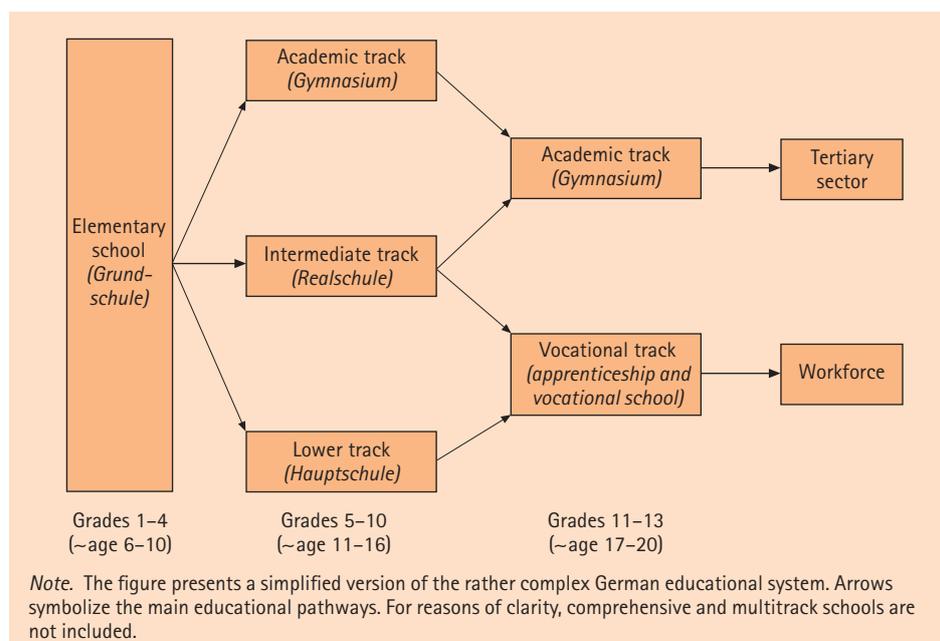
The specific importance of educational transitions in the German school system results from the structure of the educational system. Students in Germany are selected to different secondary tracks at the end of grade 4 or 6, when they are about 10 or 12 years of age (Figure 7). There is considerable variation across the German states in terms of the number and quality of these tracks. Although between-school tracking is the major form of achievement differentiation, within- and between-school differentiation are used concurrently in some states. In addition, some major reforms have been implemented in many German states in the last few years,

with a clear shift toward a two-track system. Nevertheless, the "tripartite" system of *Hauptschule*, *Realschule*, and *Gymnasium* remains the best known in Germany, and most of our data sets were collected when there were still three or more secondary tracks in most German states.

Figure 7 shows a simplified version of the German school system. *Hauptschule* is the academically least demanding track; *Realschule*, the intermediate track; and *Gymnasium*, the college-bound track. *Hauptschule* students, who graduate after grade 9 or 10, typically enter the dual system, which combines part-time education at vocational school with an

Figure 7. The German educational system.

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apprenticeship. *Realschule* students graduate after grade 10; most of them also enter the dual system, usually aspiring to more skilled occupations. *Gymnasium* students graduate after grade 12 or 13; the final *Gymnasium* examination (*Abitur*) is a requirement for university entrance (Maaz, Neumann, & Trautwein, 2009; Maaz, Trautwein, Lüdtke, & Baumert, 2008). Although the educational pathways illustrated are the most common, it is also possible for students to transfer to a higher or lower track at various points in their school careers.

The philosophy guiding the tracked secondary system is to provide all students with an education commensurate with their aptitudes and needs that allows them to reach their fullest potential. To what extent this strategy succeeds has been examined widely, for example, in Research Area I. The findings of this research indicate that the school types of the tracked secondary system represent differential learning and developmental environments and that students in the different school types learn different amounts. The secondary school type attended can thus critically influence the learning trajectories observed in the following years. Moreover, Maaz, Trautwein et al. (2008) have shown that student achievement and transition decisions covary with social disparities in the tracked secondary system, which can result in social disparities increasing over the secondary school years. Although various opportunities have been put in place to correct previous decisions in the educational biography, there has been little research into student uptake of these opportunities. There is, however, much evidence to show that the qualifications obtained at school are related to later occupational success. Relative to other countries, the association between the educational and the occupational systems is particularly strong in Germany across the entire occupational spectrum. Indeed, the prestige of the first job and the financial return on educational investment is very strongly dependent on the educational qualifications acquired.

In all German states, academic achievement is the main determinant of the secondary

school type attended. Parents can also influence the transition decision, however, and various systematic (e.g., regional structures) and unsystematic factors (e.g., "measurement errors") may play a role. Whether and how students are able to transfer from one track to another during lower secondary education also depends on various factors.

In view of the significance of the transition to the tracked secondary system, Research Area II addresses theoretical and practical questions, such as the following:

- How close is the association between family background and the transition decision? What are the mechanisms underlying this association?
- How permeable is the school system? Which students take advantage of this permeability?
- What role do teachers play at decisive points of transition? How do they approach the difficult diagnostic task of recommending a secondary track?
- Are there undesired reference group effects at points of transition, similar to those known to exist for grading, for example?
- Do students from immigrant families face specific challenges at the transition to secondary education?

### Systematic Disparities at Transition Points

In recent years, work in Research Area II has focused on investigating two systematic disparities at points of educational transition: social disparities and reference group effects.

#### *Social Disparities at Transition Points*

The PISA data have allowed in-depth investigations of social disparities in the educational participation of 15-year-olds. Evidence has been found for serious social inequalities, particularly in *Gymnasium* attendance. Students from professional families are around three times as likely as students from working class families to attend a *Gymnasium* rather than a *Realschule*, even given comparable aptitude and achievement. These findings have reignited the scientific and public discussion on social disparities in the educational system and have informed our analyses of social inequalities.

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In collaboration with: Franz Baeriswyl, University of Fribourg, Switzerland

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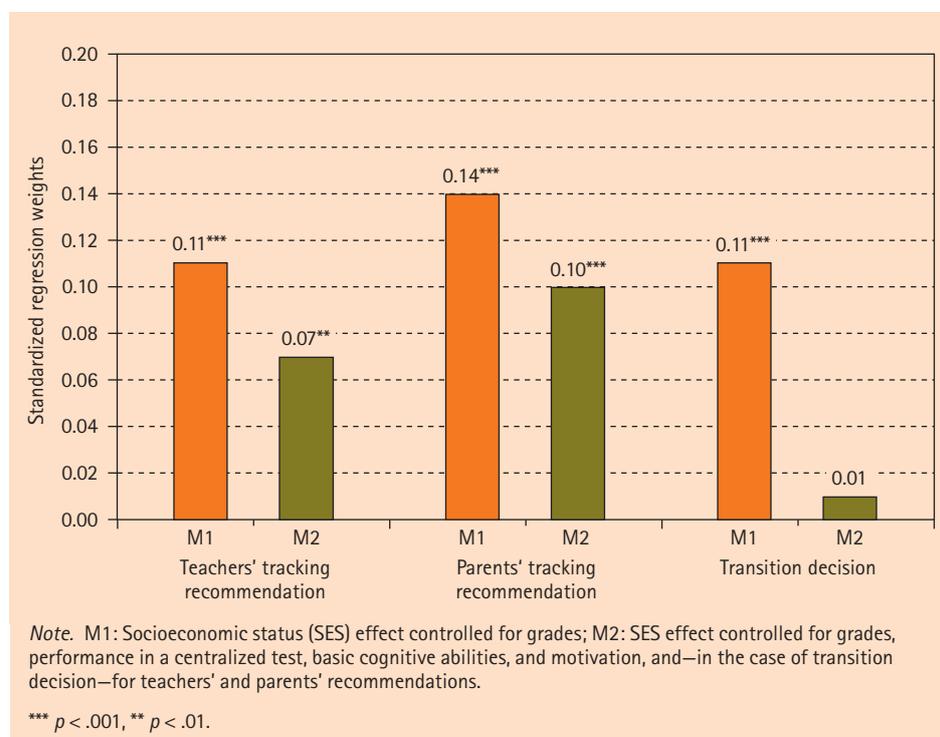
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In an international cooperation project with the University of Fribourg (Switzerland), Baeriswyl, Wandeler, Trautwein, and Oswald (2006) investigated transition behavior from elementary to lower secondary education in German-speaking schools in the canton of Fribourg. In the Fribourg model, assessment of student aptitude and achievement is standardized through centralized achievement tests, teachers take students' motivation and learning behavior into account in their tracking recommendation, parents are closely involved in the transition decision, and pathways to upper secondary education are open to all students. We investigated the effects of this model on the transition to secondary education, drawing on data from a complete population of grade 7 students. We were particularly interested in whether the model succeeded in reducing or eliminating undesired family background effects. In addition, we examined the degree of agreement between teachers' recommendations, parents' preferences, and students' test scores. Results show that the Fribourg model succeeds in suppressing the effects of family background

at the transition from primary to secondary education. Socioeconomic background did impact the transition decision via teachers' and parents' tracking recommendations, but its absolute effects—when grades were controlled—were relatively weak (Figure 8). The evaluation sheet that teachers and parents use, in addition to grades, as a basis for their tracking recommendation seems resistant to effects of family background. How can the effects observed be systematized in theoretical models? To some extent, the allocation of students to different secondary school types reflects differences in achievement that are already present at school entry or that emerge over the elementary school years. These differences in achievement are not independent of the students' social, ethnic, and cultural background, however. In fact, the assignment of students to different secondary tracks on the basis of their achievement is always associated with social, ethnic, and cultural disparities. Based on the work of R. Boudon, sociocultural differences in educational participation that are attributable to differences in student ability and per-

Figure 8. Impact of social background (ISEI) on teachers' and parents' tracking recommendations and on the transition decision (standardized regression weights).

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formance are called *primary* disparities. These disparities are consistent with the principles of meritocracy—although, from a normative perspective, they may well be criticized as too large. Additionally, however, parents from different social and ethnic backgrounds may differ systematically in the secondary track they choose for their children. These differential choices produce new disparities in educational participation at the transition to secondary schooling. These *secondary* disparities violate the principles of meritocracy, in that they are independent of ability and attainment. In taking into account the primary and secondary effects of social background, we follow Boudon's microsociological approach, according to which educational decisions result from the interplay of students' academic performance, the selection mechanisms of the educational system, and decision-making processes within the family. Social disparities in educational decisions result primarily from differences in educational aspirations and in students' academic achievement; these disparities lead to educational inequalities. Track choice can be seen as the result of a combination of primary and secondary effects of social background. Primary effects in terms of student achievement levels determine the probable success of an educational investment; secondary effects lead to additional background-related differences in cost-benefit calculations. As a theoretical framework for our research, we therefore take an extended value-expectancy approach that allows sociological rational choice theories to be tested against more psychological value-expectancy models.

#### *Primary and Secondary Effects From a Comparative International Perspective*

In view of the well-documented social disparities in educational participation that result from the interaction of primary and secondary background effects at points of transition, Maaz, Watermann, and Baumert (2007) investigated the social selectivity of access to college-bound schools from a comparative international perspective. Secondary disparities were analyzed in four tracked secondary systems—in Austria, Germany, Switzerland,

and the Flemish part of Belgium. Analyses revealed differences in the proportion of students attending college-bound schools, with the highest proportions in the Flemish part of Belgium and in Austria. In both of these systems, it is possible to correct transition decisions made at the end of primary education by transferring to a college-bound school later in the educational career. The data showed that, in Austria, where the first transition—like in Germany—is made after grade 4, selection to *Gymnasium* is less closely associated with achievement than in Germany or Switzerland. When the second point of transition was taken into account, however, the effect of reading achievement was more pronounced, and findings were comparable with those obtained for Germany. Primary and secondary social disparities were evident in all four systems. Whereas findings on the effects of social background variables were comparable across the systems, findings on the effects of family structure and process characteristics differed. These results indicate that analyses of social disparities relying exclusively on family structure variables paint an incomplete picture of the effects of family background variables. Although family structure characteristics are, in large part, mediated by family process characteristics, the latter also have effects on educational participation in secondary education that are independent of social background.

#### **Reference Group Effects at Educational Transitions**

The second focus of our research on disparities at points of educational transition in recent years has been on reference group effects. Reference group effects are a well-known phenomenon in psychology. Studies conducted in Research Area I have found reference group effects on academic self-concept. In particular, much evidence has been found for the big-fish-little-pond effect, which hypothesizes that the self-concept of students is negatively correlated with class-mean achievement.

Can similar reference group effects be observed in teachers' assessments of student aptitude and achievement, and consequently in transition decisions? To date, there has

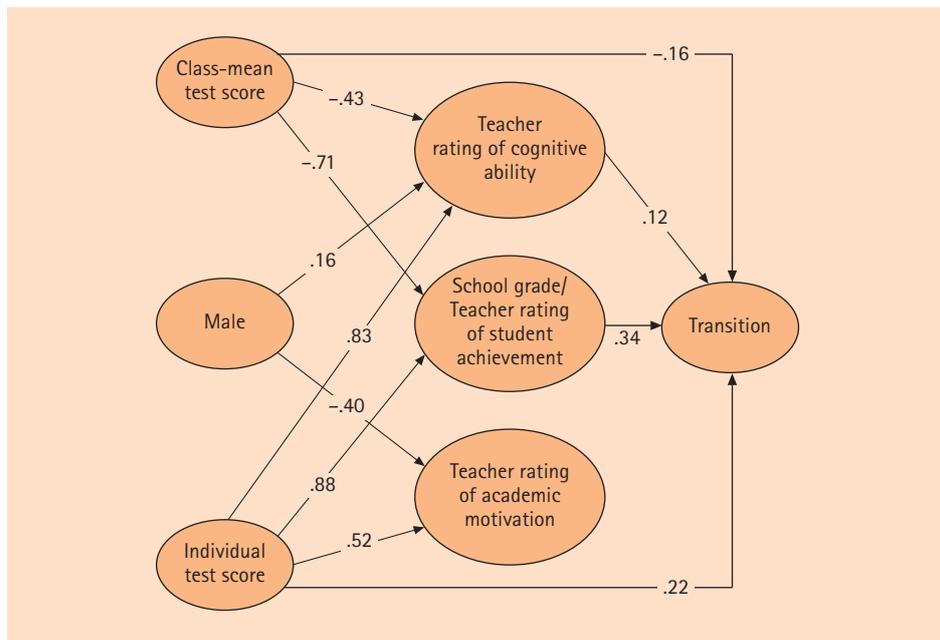
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Figure 9. Model predicting the transition decision: Key findings from multilevel analyses.

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been little empirical research on the potential impact of reference group effects on the transition process. Trautwein and Baeriswyl (2007) therefore investigated whether teachers' tracking recommendations and students' transition decisions are systematically related to class-mean achievement. We expected that—when individual achievement was controlled—teachers' recommendations and students' decisions would be lower in higher achieving classes than in lower achieving classes. This hypothesis was tested in a study with 741 students from practically all German-speaking classes in the Swiss canton of Freiburg. The students were administered a standardized achievement test at the end of elementary schooling. In addition, teacher ratings of student achievement, academic motivation, and cognitive ability were obtained. As expected, multilevel analyses controlling for individual achievement level showed a negative regression coefficient of class-mean achievement on teacher ratings of student achievement and cognitive ability as well as on teacher recommendations and the actual transition decision (Figure 9).

Another study examined the tracking recommendations made by elementary teachers

in Berlin (Maaz, Neumann et al., 2008). In Berlin, teachers' ratings of students' general academic ability take on particular significance when a student's grade point average does not clearly indicate a specific tracking recommendation. Findings showed that the legal regulations governing student allocation to the tracks of the secondary system were observed in almost all cases in which students' grades fell within the specified ranges. However, in approximately 37% of cases in which their grades fell between these ranges, and the recommendation given was at the teacher's discretion, it could not be inferred directly from the student's grade point average. In most of these cases, teachers recommended the less demanding track. In further analyses of elementary teachers' ratings of students' general academic ability, we investigated whether—beyond the predictive effect of individual achievement variables and social background indicators—teacher ratings were systematically related to class-mean achievement. The empirical analyses drew on data from a sample of 976 students approaching the end of elementary schooling in Berlin. Multilevel analyses showed that, as expected, achievement indicators and socioeconomic status were positively associ-

ated with ratings of general academic ability. When individual achievement was controlled, moreover, there was a negative regression coefficient of class-mean achievement level on the teacher rating of general academic ability. This key finding of the study can be interpreted as a reference group effect. Although teacher ratings of students' general academic ability may have predictive validity for secondary school achievement over and above grades, their power to neutralize reference group effects at the transition to secondary education therefore seems limited.

### Opening of Educational Pathways and Permeability of the Secondary System

Given the long-reaching effects of entering a specific educational channel and the systematic disparities observed at points of transition, it is crucial that educational pathways in tracked school systems be flexible and permeable. The opening of educational pathways and provision of alternative routes to qualifications are thus seen as key steps in the modernization of the tracked secondary system; corresponding reforms have been implemented, at least formally, in all German states. As yet, however, there has been no systematic investigation of the extent to which students take advantage of the permeability of the system, what characterizes these students, or the barriers to permeability. One of our recent projects aims to close this research gap.

#### Opening of Educational Pathways Against the Background of Institutional Regulations

As part of the cooperative project with the University of Fribourg, outlined above, Trautwein, Baeriswyl, Lüdtke, and Wandeler (2008) used data from the Swiss canton of Freiburg to examine the opening of new routes to educational qualifications. To this end, 525 students from German-speaking schools were tracked from the end of elementary schooling to the transition to upper secondary education at *Gymnasium* or its alternatives. Almost half the students who attended *Gymnasium* at upper secondary level came from a general secondary school (and not a *Progymnasium*), indicating a considerable level of permeabil-

ity in the system. Moreover, results showed that even students whose performance at the end of elementary schooling was relatively weak can succeed in making the jump to *Gymnasium* at upper secondary level. However, findings also showed that attending a *Progymnasium* has a channeling effect on the educational biography. *Progymnasium* graduates were about twice as likely as otherwise comparable students to attend *Gymnasium* at upper secondary level. Likewise, students from more advantaged social backgrounds were more likely to enter upper secondary education. The two lines in Figure 10 symbolize the probability, predicted by logistic regression, of attending *Gymnasium* at upper secondary level depending on the type of lower secondary school attended and social background (ISEI score), controlling for mathematics and German achievement at the end of elementary schooling. As is shown, the probability of attending *Gymnasium* at upper secondary level increased as a function of both attending a *Progymnasium* and social status.

Measures have also been undertaken to increase the permeability of the German school system, ensuring that lower secondary level qualifications can be acquired indepen-

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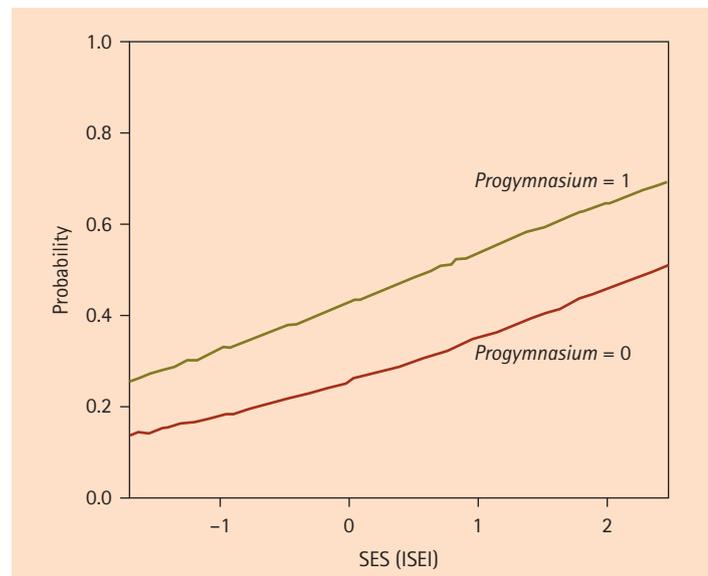


Figure 10. Probability of attending *Gymnasium* at upper secondary level: Predictions from logistic regression models.

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dently of the school type attended. To date, there has been little scientific study of the effects of this process. Given that students are much more likely to take advantage of the option to obtain an alternative leaving qualification than to switch to another school type, however, it may well have a more important role to play in the correction of previous educational decisions. However, the institutional conditions (in terms of entrance and exit criteria) regulating the qualifications obtained by *Hauptschule* students, in particular, differ markedly from one federal state to the next. Based on the theory of rational action, Schuchart and Maaz (2007) used PISA 2000 data to analyze the influence of social background characteristics, gender, and immigration status on parental aspirations for *Hauptschule* students given the state-specific "opportunity structures." Their findings show that parents' educational aspirations vary significantly as a function of social and ethnic background, whereby the social background effects, in particular, were subject to institutional influence. In states with more flexible entry and exit criteria, parents from lower social strata were much more interested in their children attaining a higher level of qualification than in states with more restrictive criteria.

In another study on the opening of educational pathways, Maaz, Gresch, Köller, and Trautwein (2007) focused on forms of access to upper secondary education. The opening of alternative routes to higher education has had important consequences for educational careers. Given good achievement levels at the end of grade 10, comprehensive school students have the option of transferring to the academic track and obtaining the *Abitur* qualification. But new institutional regulations in many federal states now also allow high-achieving students who have completed their lower secondary education elsewhere to graduate to the academic track. Against the background of this modernization process, the study focuses on two states (Baden-Wuerttemberg and Hamburg) whose educational systems differ markedly in some respects. In Hamburg, 15% of students who qualify for higher educa-

tion attended comprehensive schools. The *Abitur* qualification can also be acquired at *Aufbaugymnasium* schools catering specifically for *Hauptschule* and *Realschule* graduates (6%) or at *Gymnasium* schools specializing in economics (10%) or technology (2%). Students in Baden-Wuerttemberg can now qualify for higher education at a traditional *Gymnasium* or at one of six types of vocational *Gymnasium* schools. This opening of the educational system is intended to offer capable students from diverse family backgrounds the opportunity to qualify for higher education, even if they did not attend a *Gymnasium* at lower secondary level. Overall, our findings revealed considerable variability in educational careers in Hamburg and Baden-Wuerttemberg. Moreover, a substantial proportion of *Abitur* holders did not take the traditional *Gymnasium*-based route. In Baden-Wuerttemberg, 70% of all students attending a vocational *Gymnasium* had not attended *Gymnasium* at lower secondary level (Hamburg: 55%). Our analyses of educational trajectories show that the opening of routes to higher education in both Hamburg and Baden-Wuerttemberg is manifest primarily in the establishment of alternative college-bound paths at upper secondary level. Most students in these school types did not attend a *Gymnasium* at lower secondary level.

Comparison of *Abitur* students in Hamburg and Baden-Wuerttemberg revealed that the similarities in family background and cognitive ability outweighed the differences. The mean cognitive ability scores of students from Hamburg and Baden-Wuerttemberg were similar; their mean socioeconomic status was practically identical. Slight differences were found in certain aspects, especially immigration status. The percentage of students from immigrant families among the *Abitur* holders was higher in Hamburg than in Baden-Wuerttemberg; in fact, students from immigrant families were only slightly underrepresented among *Abitur* holders in Hamburg. Larger differences emerged within states than between states. Findings confirmed that comprehensive schools, *Aufbaugymnasium* schools (Hamburg), and vocational *Gymna-*

sium schools (Hamburg and Baden-Wuerttemberg) indeed provide students who would previously probably have been excluded from this kind of educational career with access to higher education.

*Education Across the Lifespan*

The qualifications gained at school are crucial determinants of transitions to occupational training and, later, the labor market. The distribution of qualifications awarded to school leavers gives a first impression of the general qualification structure. There are, however, various possibilities for students to return to education or upgrade their school-leaving qualifications later in life. Maaz (in press) drew on data from the West German Life Course Study initiated by Karl Ulrich Mayer to examine acquisition of general educational qualifications in the 1972 cohort. The findings showed that the proportion of respondents with no school-leaving qualifications de-

creased to 1.7% by the age of 26 years. Substantial numbers of respondents in the lower educational categories evidently went back to school later in life. Corrections of previous educational decisions were also observed in higher educational categories, however. For example, the proportion of *Abitur* holders increased from 35% at 21 years to 42% at 26 years (Figure 11). Furthermore, inspection of changes in the qualification structure of different social groups shows change for all groups up to the age of 26. However, the data also show that the available opportunities to acquire or upgrade educational qualifications do not suffice to even out the marked inequalities in educational participation that have been highlighted, for example, by the PISA data. For instance, 80% of respondents from professional families had obtained the *Abitur* qualification by the age of 26 years, compared to just 21% of those from working class families.

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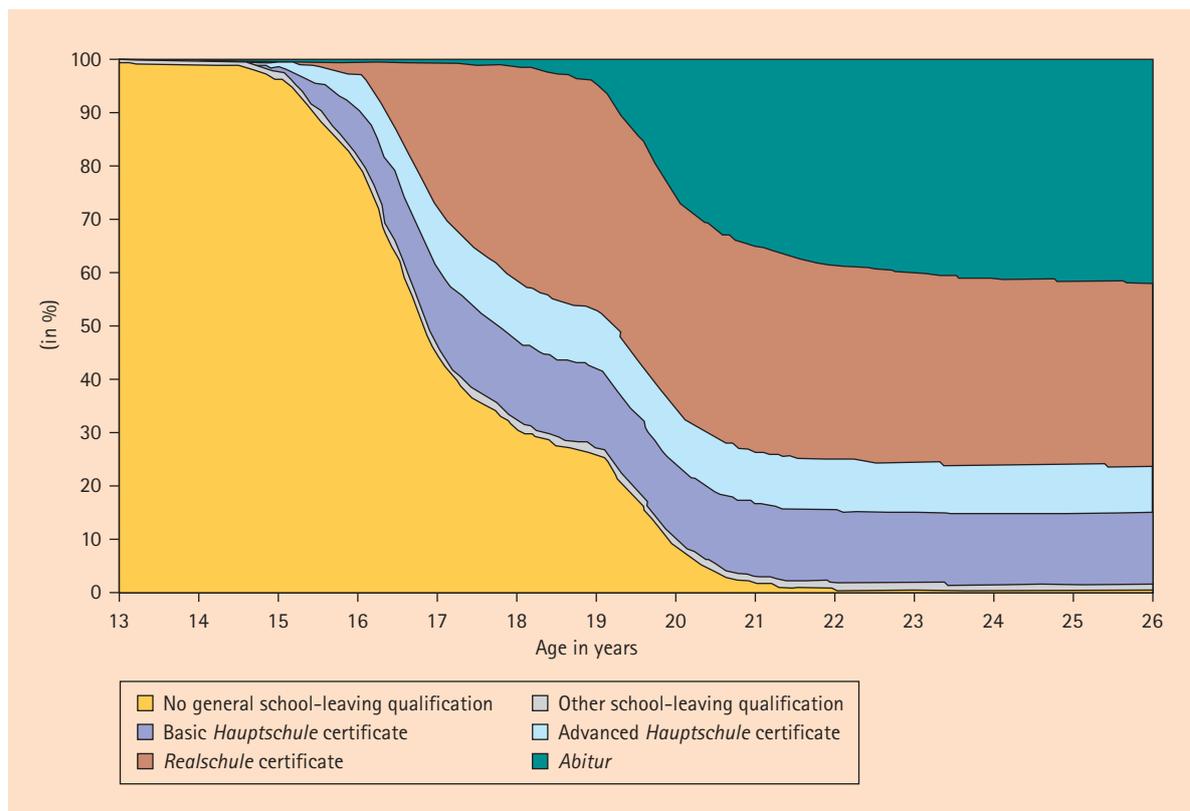


Figure 11. Distribution of school-leaving qualifications in the 1971 West German cohort at age 13 to 26 years.

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#### The Transition Project

The studies described above have enhanced our understanding of the effects of social background characteristics at different points of transition in educational systems. Many questions remain unanswered, however, especially regarding the transition to secondary education. These questions relate to the effects of social background variables and decision-making processes within the family, on the one hand, and the impact of institutional regulations and regional factors on educational aspirations, teacher recommendations, and transition behavior, on the other. Moreover, very little is yet known about the decision-making mechanisms of students from immigrant families. A new project has therefore been initiated to address these questions: The Transition study, a cooperative project of the Max Planck Institute for Human Development, Berlin, the Department of Education at the University of Göttingen, the Institute for School Development Research (IFS) at the University of Dortmund, and the Institute for Educational Progress (IQB) at the Humboldt University, Berlin, examines issues of meritocracy and regional, social, and ethnic-cultural disparities in the transition to secondary education.

#### Theoretical Background

Comparison of data obtained for schools or small areas, such as administrative districts or residential areas, already provides first insights into the effects of social disparities at the transition to secondary education. For example, the proportion of students attending an academic-track *Gymnasium* can range from 10% to 80% depending on the district. Likewise, the probability that a student from a certain background will be enrolled in an intermediate-track *Realschule* or an academic-track *Gymnasium* varies considerably from school to school and from region to region, irrespective of the permeability of the secondary sector.

How do these kinds of differences develop? Is it possible to reduce them, and, if so, how? Any attempts to answer these questions highlight just how little we know about the

transition from elementary to secondary school. We can only speculate that performance differences and secondary social and ethnic disparities in educational participation emerge from the interaction of the cultural background and social status of the parental home, the students' actual performance, teachers' recommendations, institutional regulations, and, not least, the cultural, social, and economic environment. Very little is known about the decision-making process itself, however.

Insights into this process are needed if we are to understand the logic and social dynamics of the German school system as a whole. For example, we know that the low *Gymnasium* attendance of certain student groups at lower secondary level can be compensated by establishing alternative college-bound paths at upper secondary level. Opening up the secondary system in this way also leads to a reduction of social disparities. However, it remains unclear whether it can compensate for secondary disparities arising at the transition from elementary to secondary school, about which little is known. Knowledge of the other educational pathways is even more limited.

#### The Transition Study—Aims and Design

Germany's participation in the TIMSS 2007 study of grade 4 students has provided an ideal opportunity to considerably extend scientific knowledge of how parental intentions, cultural, social, and economic backgrounds, teachers' recommendations, and institutional regulations interact at the transition from elementary to secondary school. The main objective of the Transition study is to analyze parental decisions on the transition from elementary to secondary school against the background of the following factors:

- students' achievement and attitudes at elementary school;
- the parental decision-making process as a function of the social, ethnic, and cultural background;
- the secondary track recommended by the elementary school teacher;
- the process of parent-teacher consultation;

- institutional regulations;
- the regional structure of the secondary system and the regional provision of secondary schools;
- the cultural environment of the school's catchment area; and
- the regional economic and labor market structure.

The objectives of the study are, to us, specially developed scales to identify critical variables influencing both the parental decision process and elementary school teachers' tracking recommendations, and then to model the interactions of these indicators, rather than relying on single indicators. The studies' four main lines of research are as follows:

- (1) modeling the decision process in the parental home;
- (2) examining the situation of immigrant families separately;
- (3) reconstructing elementary teachers' recommendation behavior and determining their diagnostic competence; and
- (4) analyzing the importance of different institutional regulations.

A further objective of the study is to analyze how students and their parents cope with the process of transition. As such, two further waves of data collection were undertaken after the transition to secondary school (6 months later to coincide with the grade 5 mid-term report card and one year later to coincide with the final grade 5 report card). The Transition study is embedded within the design of TIMSS 2007. Its sample (5,819 students in 253 classes) comprises most of the classes participating in TIMSS, excluding the federal states of Berlin, Brandenburg, and Mecklenburg-Western Pomerania, where students do not transfer from elementary to secondary schooling until after grade 6. The sample was extended to include an additional 26 classes with a higher rate of students from immigrant families. Parents, students, and teachers were interviewed. Moreover, institutional and regional context factors were assessed.

Data collection and preparation are complete, and analyses are currently in progress. First publications of key results are planned in 2009.

### Reliability and Validity of Social Background Information

Indicators of social background have always been among the standard instruments of empirical educational research. Indeed, these indicators are used in all studies conducted in our four Research Areas, often representing key variables. However, it is important not to forget that assessing and coding social background characteristics can entail measurement problems.

Assessment of background variables presents the first challenge. In educational assessments, social background variables are obtained using either student or parent questionnaires. Data on parents' education and occupation obtained from students constitute proxy responses. A second major challenge is posed by the complex coding processes necessitated by occupational data, in particular. Before information on parental occupations can be used in empirical analyses, responses first have to be categorized by the research team or specialist coders on the basis of a coding scheme. Measures of "prestige" or socioeconomic status are then derived from these categorizations. To date, little is known about the reliability of the coding process. A collaborative project has therefore been initiated with the University of Maryland and the University of Göttingen to examine potential problems and bias in the assessment of social background variables. Using data provided by a random sample of 300 *Gymnasium* students on parental occupations, Maaz, Trautwein, Gresch, Lüdtke, and Watermann (in press) examined the intercoder reliability of occupational classifications according to ISCO-88 principles as well as the ISEI values generated on the basis of these classifications. The student data were double coded: by a team of professional coders, on the one hand, and by our own research team, on the other. Results revealed marked discrepancies in the coding of the students' open-ended responses on occupational activities, with complete agreement in the 4-figure ISCO code allocated by the two coding institutes in just over half of the cases. The validity of the ISEI values generated on the basis of these classifications can, in contrast, be described

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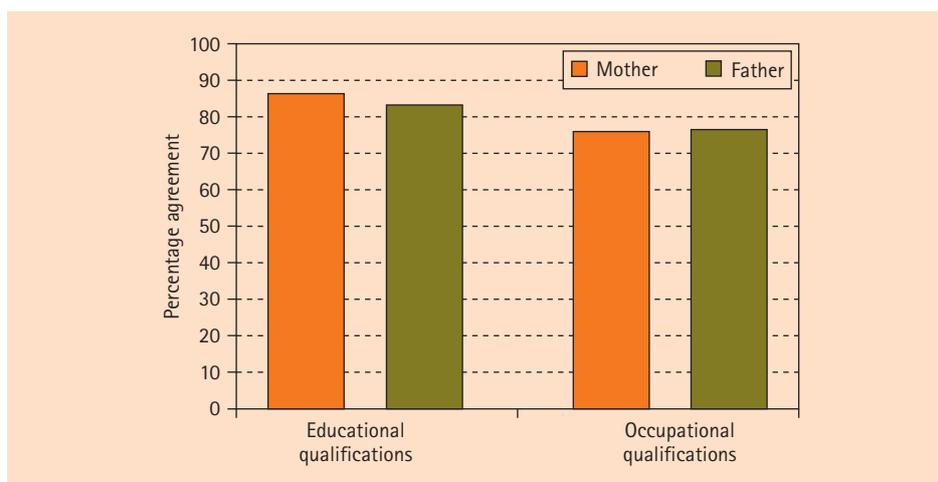
**Maaz, K., Gresch, C., & Baumert, J.** (in press). Spezifikation des sekundären Herkunftseffektes beim Übergang von der Grundschule in die weiterführenden Schulen des Sekundarschulsystems. In J. Baumert, K. Maaz, & U. Trautwein (Eds.), *Bildungsentscheidungen in mehrgliedrigen Bildungssystemen*. Wiesbaden: VS Verlag für Sozialwissenschaften.

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**Maaz, K., Hausen, C., McElvany, N., & Baumert, J.** (2006). Stichwort: Übergänge im Bildungssystem. Theoretische Konzepte und ihre Anwendung in der empirischen Forschung beim Übergang in die Sekundarstufe. *Zeitschrift für Erziehungswissenschaft*, 9, 299–327.

Figure 12. Percentage agreement of parent and student ratings of parental educational level.

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as very good, with very high interrater correlations. The predictive power of family background did not vary depending on the coder. In other words, there do not seem to be any systematic differences between the ISEI codes allocated by different (well-trained) coders, but this does not rule out the possibility that the relationship with other variables might be higher overall if the assessment of social background were “error free.”

Analyses of PISA data showed that there is, in general, a good level of agreement between parents' and students' responses on key features of the social background (Maaz, Kreuter, & Watermann, 2006). The analyses revealed that responses on general educational qualifications are less prone to error than responses on vocational qualifications (see Figure 12), and that students were better able to report their parents' profession than their vocational qualifications.

In further studies, Kreuter, Maaz, and Watermann (2006) examined the consequences of various types of measurement error for correlational analyses. Providing data on parents' educational and vocational characteristics demands cognitive effort and a certain degree of abstraction from students. The associated measurement error and its correlation with the dependent variable can lead to systematic distortion of results. For example, inspection of the bivariate regression coefficients of mathematics test scores on various measures of the father's vocational training shows that regression coefficients are lower when

student data on parents' vocational qualifications are used than when parent data are used. This simple bivariate regression highlights the effects of measurement errors and of potential bias. The resulting underestimation is low, but statistically significant. It can be assumed that the underestimation of the effect of parents' vocational qualifications can be offset in multivariate models when several indicators are combined to measure social background.

## Research Area III Reading Literacy and Language Skills

### Introduction and Project Overview

In Research Area III, we examine students' language skills and reading literacy. Using longitudinal, cross-sectional, and experimental approaches, we investigate how these skills develop and how they can be effectively assessed and promoted.

Written language, whether in print or on the computer screen, is probably the most important medium for communicating information in school and daily life. Accordingly, reading literacy is a core competency for education, training, and working life. Yet large-scale assessment studies like PISA have revealed considerable interindividual differences in reading proficiency in all phases of reading development. Most alarmingly, many students in German secondary schools are unable to comprehend texts on a deeper level; their understanding is limited to simple information retrieval. This applies particularly to students from immigrant families or families with low socioeconomic status. One major focus of our research is, therefore, on the determinants of reading development and its promotion in disadvantaged students.

The foundations for reading proficiency are laid at elementary school. However, even after transition to secondary school, students' reading literacy is one of the most important factors in their educational progress, affecting the course of the whole school career. Accordingly, our research projects are closely connected to the studies on transitions in the educational system conducted in Research Area II.

In the past two years, two main projects in Research Area III have addressed key aspects of the development of reading proficiency—from the acquisition of basic reading skills in elementary school to the effective assessment and promotion of reading proficiency in secondary school:

(1) The development of reading proficiency from grade 3 to 6 and its individual and social predictors have been examined in a longitudinal study, the *Berliner Leselängsschnittstudie* (Berlin Longitudinal Reading Study). In complementary projects, we have developed questionnaire measures to assess teacher

knowledge of reading literacy and student reading strategies.

(2) Little is known about how students process texts that incorporate instructional pictures or how teachers can use these texts effectively in their teaching. A new project on text-picture integration (BiTe), conducted in cooperation with the University of Landau and funded by the German Research Foundation (DFG), was initiated in 2007 to examine how students develop the ability to integrate text- and picture-based information with their teachers' guidance.

An additional project (CLAss: Cognitive Language Assessment) has investigated how general and language-based subskills influence student performance on reading assessments.

### Berlin Longitudinal Reading Study

#### Overview

Despite the vital importance of reading for educational, professional, and day-to-day life, recent assessment studies have repeatedly identified serious deficiencies in student

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#### Berlin Longitudinal Reading Study—Data Collection

- 772 students
- 33 participating whole classes
- Elementary schools in Berlin
- Study period: end of grade 3 (basic reading skills usually acquired) to end of grade 6 (transition to secondary school)
- Student, teacher, and parent questionnaires; student reading assessments

**Key Reference**

**McElvany, N., Kortenbrück, M., & Becker, M. (2008).** Lesekompetenz und Lesemotivation: Entwicklung und Mediation des Zusammenhangs durch Leseverhalten. *Zeitschrift für Pädagogische Psychologie*, 22, 207–219.

reading literacy in Germany. Moreover, reading motivation seems to decrease with age. Apart from being a valued resource in its own right, intrinsic reading motivation is positively related to reading performance. In the Berlin Longitudinal Reading Study (LESEN 3–6), we therefore investigate the development of reading comprehension and reading motivation from grade 3 to 6, analyzing their complex mutual influences from both a cross-sectional and a longitudinal perspective. If higher motivation indeed coincides with higher competence, it is important to examine the mechanisms underlying this correlation: Why is it that children who are intrinsically motivated also read better? One potential mediator is reading behavior.

*Reading Motivation, Reading Behavior, and Reading Comprehension: Development and Mutual Influences*

Our findings confirm the expected developmental trajectories, with reading comprehension increasing, but reading motivation decreasing, from grade 3 to 6. Path analyses show mutual cross-sectional and longitudi-

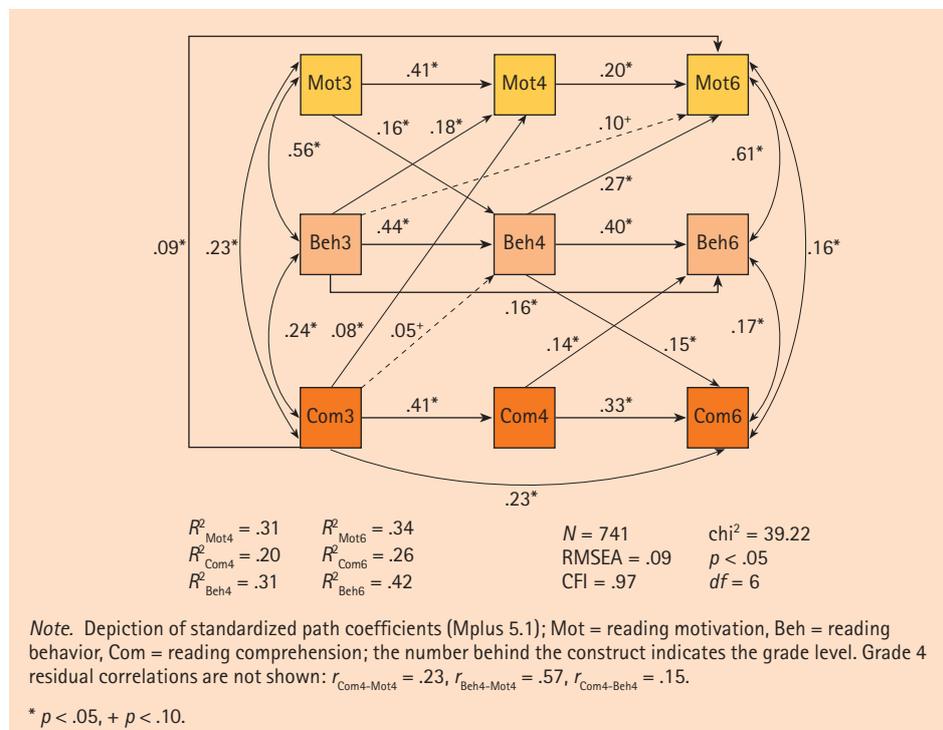
nal influences of reading motivation, reading behavior, and reading comprehension, as well as an indirect effect of early reading motivation on later reading comprehension mediated by reading behavior (see Figure 13). Overall, the power of reading motivation and reading behavior to predict reading comprehension is relatively small; conversely, both constructs are influenced by reading comprehension (McElvany, Kortenbrück, & Becker, 2008).

*The Role of Family Background*

Another research issue being addressed within the Berlin Longitudinal Reading Study is how the family background influences reading comprehension and individual reading-related characteristics (see Figure 14). Although reading skills are usually acquired in school, reading literacy as a key cultural tool is determined not only by instructional and individual characteristics but also by the environment. As the most important component of the out-of-school environment, family background can lead to further performance differences between students. Many studies point to the relevance

Figure 13. Longitudinal autoregressive cross-lag panel model of reading motivation, reading behavior, and reading comprehension from grades 3 to 6.

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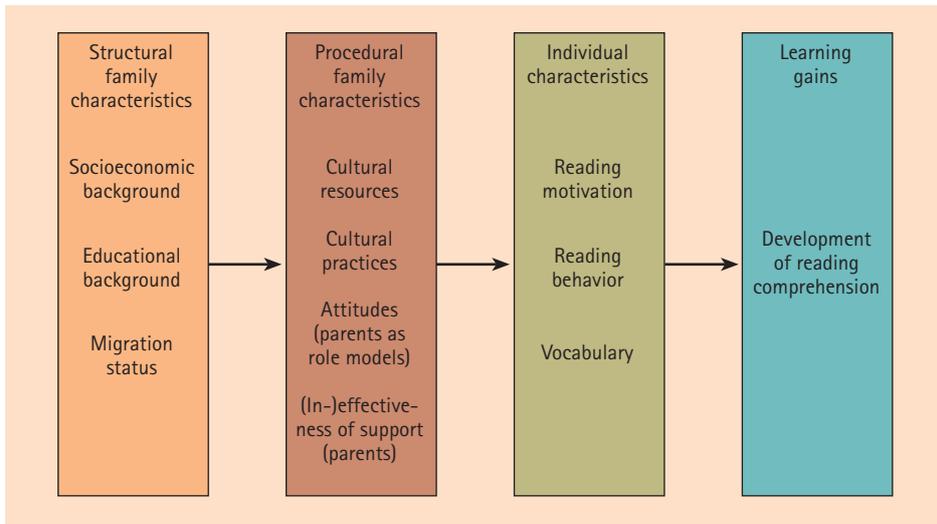


Figure 14. Simplified model of family influences and individual characteristics (inter-correlations are not shown).

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of preschool reading socialization within the family, but comparatively few empirical studies have gone beyond cross-sectional correlations with family socioeconomic status when examining the effects of family characteristics *during* school. The Berlin Longitudinal Reading Study sheds first light on the multifactorial structure of reading socialization in the family. Its results reveal complex and differentiated influences of structural and process family variables on reading comprehension, reading motivation, and reading behavior. The longitudinal data confirm the relevance of the families' social, educational, and language background for reading comprehension. These influences are mediated by cultural resources (number of books in the home) and by individual vocabulary skills. Family structural characteristics have also been found to influence family process variables (McElvany, Becker, & Lütke, in press).

#### Additional Research Foci

We have also addressed a number of research questions relating to teachers, parents, and systematic reading training in the context of the Berlin Longitudinal Reading Study. A Diploma thesis by Camilla Rjosk examining teachers' ability to diagnose students' basic reading skills was awarded the Marie-Schlei award of the Free University Berlin. The analyses showed that teachers substantially overestimate their students' basic reading

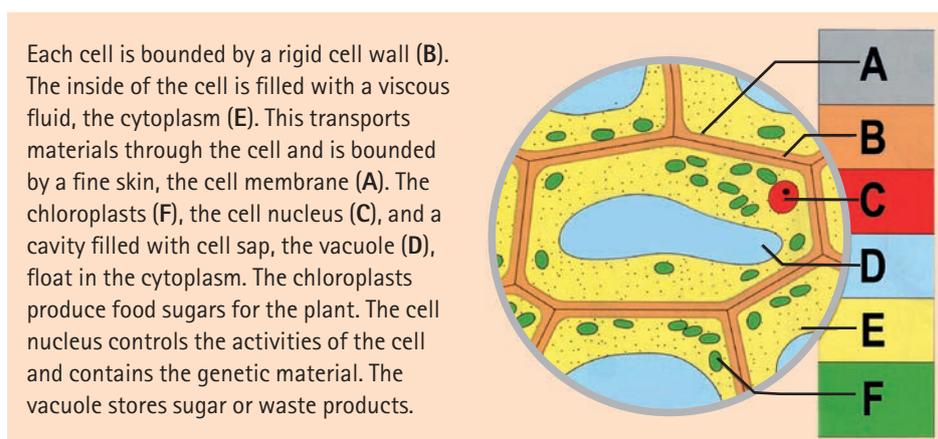
skills, which may prevent them from providing adequate support in this area. McElvany and Schneider (2009) reviewed approaches designed to support reading and related skills in the school, home, and elsewhere in different target populations. A quasi-experimental intervention study integrated within the Berlin Longitudinal Reading Study examined the potential of a systematic intervention based on a parent-child reading program to support reading literacy and strategy use (Berlin Parent-Child Reading Program; McElvany, 2008; McElvany & Artelt, 2009). We are currently cooperating with researchers from the universities of Amsterdam and Tilburg on a meta-analysis of studies on the effectiveness of family literacy programs. Given the critical importance of teacher competencies (see Research Area IV), we have recently developed a questionnaire to assess teacher competencies in the area of reading, based on the COACTIV framework. The questionnaire covers teacher knowledge, motivation, beliefs, self-regulation, and diagnostic competencies ("Conditions for the Development of Reading Literacy at School," CODE R). Pilot studies were conducted in 2007 with elementary school teachers and in 2008 with lower secondary teachers (McElvany, in press-a). Additional research addressed the problem of barriers to proficiency in school-related language among second language learners (Eckhardt, 2008).

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Figure 15. Example of a task involving text-picture integration.

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Each cell is bounded by a rigid cell wall (B). The inside of the cell is filled with a viscous fluid, the cytoplasm (E). This transports materials through the cell and is bounded by a fine skin, the cell membrane (A). The chloroplasts (F), the cell nucleus (C), and a cavity filled with cell sap, the vacuole (D), float in the cytoplasm. The chloroplasts produce food sugars for the plant. The cell nucleus controls the activities of the cell and contains the genetic material. The vacuole stores sugar or waste products.

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### Developing and Assessing Proficiency Models of Text-Picture Integration (BiTe)

#### Background

Teaching materials used in many subjects at lower secondary level involve texts containing instructional pictures (see example in Figure 15). Instructional pictures may be realistic (e. g., photographs) or highly abstract (e. g., complex charts or diagrams). To build appropriate knowledge structures, learners need to extract information from both sources (text and picture), correlate the text and picture information by means of surface and deep structure level mapping, and engage in integrative processing. The demands of integrating text and picture information differ, from extracting detail information to establishing complex relations.

Analogous to skill development in other domains, the development of students' ability to integrate textual and graphical information is likely to be considerably influenced by the instruction that their teachers provide. Accordingly, models describing the structure and development of this competence at the student level should be complemented by corresponding models of teacher competence, particularly diagnostic skills.

#### Project Overview

The Developing and Assessing Proficiency Models of Text-Picture Integration (BiTe) project has been initiated in cooperation with researchers at the University of Koblenz-Landau to develop and evaluate proficiency models and instruments assess-

ing the integration of texts and images at the student and teacher levels. At the student level, we analyze structural features characterizing text-picture integration skills and examine the influence of school type and age on proficiency levels. At the teacher level, we examine the abilities of teachers of different subjects to promote successful text-picture integration and the extent to which these abilities depend on their training and teaching experience. One of the key features of teacher competence is the ability to diagnose student strengths and needs. In order to teach their subject successfully, teachers must be able to judge whether their students understand the text-picture materials featured in school books and worksheets and to identify potential comprehension difficulties. Only then can they teach their subject in the manner most appropriate to the students' current level of performance. Such diagnosis is particularly demanding in the area of text-picture integration, as it involves judgment of the text, the picture, and the demands of developing a full understanding of their content.

For the purposes of discriminative construct validation, these proficiency models of text-picture integration will be compared, at both student and teacher level, with models of reading proficiency.

Both newly developed instruments were evaluated in February 2008 in a pilot sample of 48 grade 5 to 8 classes and with 116 German-language, biology, and geography teachers in three different school types.

The main study will take place in February 2009 and a second project phase is planned for 2010–2011. The project is funded by the German Research Foundation (DFG) as part of its Priority Programme on proficiency models assessing individual learning outcomes and evaluating educational processes.

### Language Assessment and Cognitive Predictors of Reading Ability

It has recently been alleged that the tests used in large-scale educational assessments do not assess domain-specific competencies—defined as the contextualized knowledge and skills that enable students to master various situations within a specific knowledge domain (Baumert, Brunner, Lüdtke, & Trautwein, 2007)—but rather general intelligence. In response to these allegations, we have shown that measurement models that account for the domain-specificity of the competence structure are empirically superior to general unidimensional models. In order to understand how such a misconception could have arisen in the first place, we need to look at specific knowledge domains (Baumert, Lüdtke, Trautwein, & Brunner, in press). In the domain of reading, for example, it is difficult to distinguish at first glance between general reasoning ability and specific reading proficiency. Most tools designed to measure reading pro-

iciency focus on high-level comprehension and text understanding at a very general level. While inferencing and reasoning abilities are necessary prerequisites for success on such tasks, they are clearly not sufficient. Instead, they are believed to enable the language- and text-specific cognitive processes that underlie comprehension. The CLAss (Cognitive Language Assessment) project was initiated in summer 2008 to clarify the relationship between reading proficiency tests and the cognitive processes specific to reading. In one study, we compared the cognitive demands of different reading test-taking strategies. Previous research has shown that students are able to guess the right answer to reading multiple-choice items, even if they have not read the corresponding text. We hypothesized that the cognitive processes driving this guessing strategy differ from those driving normal responding after text reception. Approximately 350 students from 15 intermediate- and academic-track schools in Berlin participated in the study. All students were administered a reading comprehension test in two of three conditions. In the first condition, students read a short text and then answered multiple-choice items in the usual way. In the second “no text” condition, students were not shown the texts, but asked to guess the right answer.

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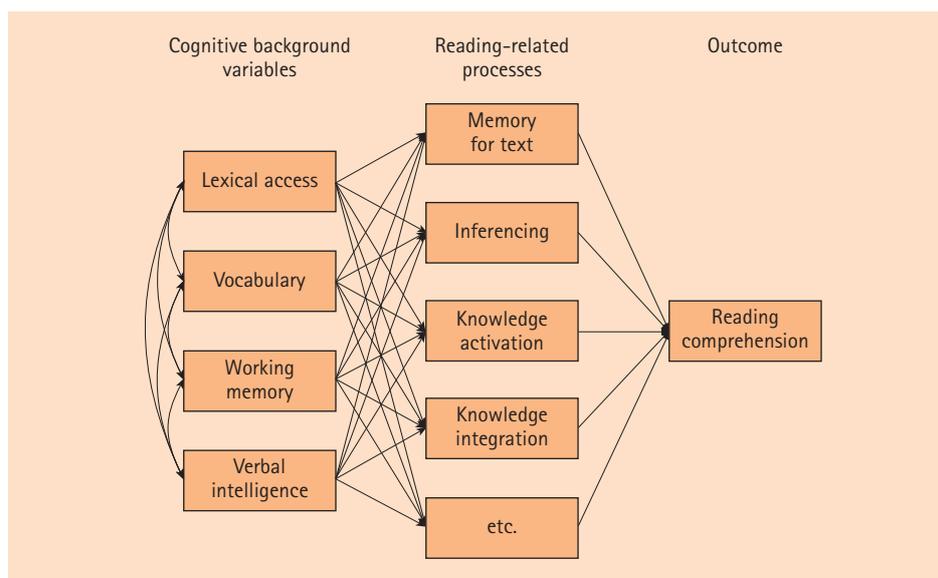


Figure 16. Mediation model.

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Figure 17. The first words of a text as read in the moving-window paradigm.

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In the third "no text/no question" condition, students were not even given the question for the four response options. In a separate session, before the reading comprehension tests, students were tested on several general cognitive ability measures (verbal intelligence, working memory, etc.) and on language-related subskills (text inferencing, memory for text, etc.).

Our preliminary analyses confirm that the students were indeed able to guess the right answer to reading multiple-choice items. However, the relationship between students' test scores in the three conditions and their cognitive and language-related abilities differed considerably. Overall, students' test scores in the "normal" condition were strongly predicted by cognitive variables. In contrast, test scores in the "no text" and "no text/no question" conditions were only weakly related to cognitive functioning. To disentangle the effects of general intelligence and language-related skills in the three conditions, we fitted a mediation model to the data as shown in Figure 16.

In this model, cognitive background variables are assumed to drive language processing, which, in turn, influences the reading process and reading comprehension. We found that language-related variables predicted reading comprehension test scores only if students had read the corresponding text. In contrast, processing in the "no text" condition was driven primarily by general cognitive abilities and was only weakly related to language processing skills.

In a follow-up study, we addressed an associated question: If reading comprehension tests indeed reflect the differential effectiveness of language-related skills, then scores on these tests should, in turn, predict actual reading behavior. To test this assumption for reading speed, we asked 125 students to read the reading comprehension test texts on the computer using the "moving window" method. In this paradigm, the letters of a text are replaced by the symbol "~." When the reader presses the space bar, the first word of the text is revealed. At the next press of the space bar, the first word is concealed again and the second word revealed, and so forth (Figure 17). After reading the text in this manner, the students answered the corresponding questions. We were thus able to measure how much time each reader spent on each word of a text and, at the same time, to assess reading comprehension.

Preliminary multilevel analyses indicate that there are no overall differences in text processing speed between good and poor comprehenders. Rather, most processing differences are attributable to interactions between text characteristics and reader characteristics. For example, the poor readers sped up as they read a text, reading the end faster than the beginning. It seems that they tried to reduce cognitive load by skipping difficult passages and by shallower processing. In contrast, good readers kept their reading speed steady, even as the processing load accumulated. They were generally more sensitive to the linguistic structure of the text.

## Outlook

The projects reported here focus on the fundamental principles guiding the development of reading literacy and its central determinants. In direct continuation of these studies, we are currently preparing two new projects in which this knowledge is applied to promote students' language and literacy skills more directly. The first project involves the development of a new instrument to assess student reading strategies that differentiates between habitual and text-specific strategy use. The second project centers on the evaluation of an intervention program designed to foster the reading skills of lower track secondary students.

Reading strategies are assumed to have high relevance for reading and learning from texts. However, empirical results to date are mixed. One reason for these inconclusive results may be the lack of instruments to measure both text-specific and habitual reading strategy use, drawing on a comprehensive theoretical framework of cognitive and metacognitive strategies. To close this gap, we are currently

evaluating a newly developed instrument to assess reading strategies, the Berlin Reading Strategy Inventory. The inventory includes six subscales assessing cognitive (elaboration, memorizing, organization) and metacognitive (planning, monitoring, regulating) strategies during reading and exists in two versions (text specific/general). We hope that this instrument will yield more conclusive results on the role of reading strategies in self-regulated learning. Second, large-scale studies, such as PISA, have shown that the reading skills of students in lower track secondary schools are particularly impoverished. The TRAIN project located in Research Area I has been initiated to investigate whether it is possible to remediate these deficiencies. An intervention has been designed to improve the reading competencies of lower track students by enhancing their general reading motivation and providing intensive training on a wide variety of reading tasks. It is hoped that participating students will learn to read more efficiently and extensively at school as well as in everyday nonschool settings.

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### The Center for Educational Research in February 2009



From left to right, in front: Jürgen Baumert, Uta Klusmann, Swantje Pieper, Nele McElvany, Mareike Kunter, Nicole Husemann;  
behind: Tamar Voss, Kathrin Jonkmann, Michael Becker, Dirk Richter, Marko Neumann, Cornelia Gresch, Gabriel Nagy, Axinja Hachfeld, Jürgen Elsner, Kai Maaz, Sascha Schröder.

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## Research Area IV

### Professional Competence of Teachers and Cognitive Activation in the Classroom

Research Area IV focuses on the teacher as a crucial lever for improving the functioning and outcomes of the educational system. Building on our earlier research on powerful learning environments, our research program has shifted from describing features of high-quality classroom instruction to determining the knowledge and skills that teachers need to create such successful learning environments. Drawing on a theoretical model of teacher competence, we have developed tools and procedures to tap interindividual differences in the knowledge, beliefs, and psychological functioning of teachers and found that these aspects of teacher competence are systematically linked to differences in instructional quality. We have recently begun to investigate how teachers acquire these professional competencies—for example, by examining the learning opportunities provided by preservice teacher education. We complement this research on the antecedents and consequents of teachers' competence with studies that investigate specific aspects of instructional quality in more depth. Drawing on our understanding of classrooms as powerful learning environments, we focus on identifying factors that foster active knowledge construction.

Methodologically, we combine correlational and (quasi-)experimental studies, many of them including both teacher and student data, to gain insights into the instructional process. The flagship of Research Area IV is the COACTIV study, which was embedded in the longitudinal part of the PISA 2003 assessment and investigates how aspects of mathematics teachers' competence relate to their classroom instruction. New projects, such as the COACTIV-R study, complement the COACTIV research program by investigating the beginning of teachers' professional development.

#### Theoretical Framework: Insightful Learning in Powerful Learning Environments

Work in Research Area IV is guided by a theoretical framework that conceptualizes teachers, lessons, and students as the three cornerstones of teaching and learning processes in classroom instruction. The framework draws on aspects of teacher expertise, the process-mediation-product model, and the (social-)constructivist approach. Our theoretical framework is outlined in Figure 18.

Our theoretical framework is based on the idea that conceptual understanding is a central aim of mathematics instruction. It is now widely accepted that new concepts and insights are not acquired through passive

knowledge transmission of the teachers' knowledge to the learner's mind, but rather that they are the result of the learner's active process of constructing increasingly complex and elaborated cognitive structures. Powerful classroom environments are those that stimulate students to apply themselves cognitively and that are structured in such a way that active and independent knowledge construction is possible.

Our research focuses on three general features of instruction that are crucial for insightful learning processes in secondary school mathematics: cognitively activating elements, classroom management, and individual learning support (see below for detailed descriptions). It is important to note that the uptake of the learning opportunity depends both on the students themselves (in terms of their individual strengths and weaknesses) and on situational affordances and constraints. Successful instruction thus hinges on the degree to which instructional strategies are suited to the needs of both the situation and the students. Instructors need to provide challenging tasks, monitor student learning, and adapt their teaching as appropriate to support active and independent knowledge construction for many learners. For teachers in classroom situations, this is a demanding task—it is no easy matter to create challenging and suitable learning

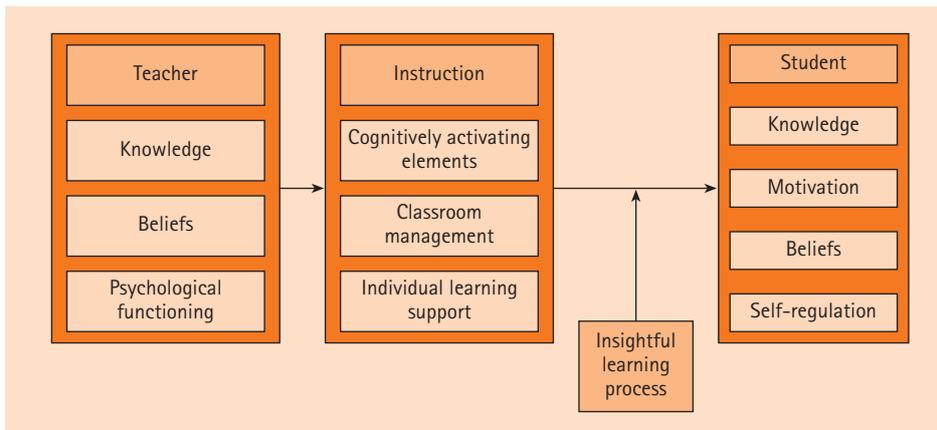


Figure 18. Teacher competence, mathematics instruction, and student learning: The theoretical framework guiding research in Research Area IV.

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conditions for groups of students who may differ greatly in terms of motivation or prior knowledge. Such deliberate, but, at the same time, flexible and adaptive classroom practice is dependent on a solid knowledge base supported by adaptive beliefs and psychological functioning. The professional competence of teachers and its empirical assessment is, therefore, a major aspect of our work. Until recently, professional competence was rarely measured by quantitative means. We have, therefore, developed a model of professional teacher competence and instruments for its empirical assessment (Kunter, Klusmann et al., 2007). The model combines aspects of knowledge, beliefs, motivations, and psychological functioning. It is based on the assumption that teachers acquire their professional competence during their initial training as well as in classroom practice. Hence, we see teachers not only as providers of education but also as professional learners. Like their students, teachers acquire their skills through the active construction of knowledge and the uptake of the learning opportunities available to them. Our research program encompasses several objectives, which we are addressing step by step. In a first step, we developed and validated empirically sound measures to tap the theoretically postulated aspects of teacher competence. Second, as a crucial part of the validation process, we have investigated the link between teachers' competence and the quality of their instruction, examining the relative importance of the different dimensions of teachers' domain-specific knowledge.

Building on these results, we have, in a third step, extended our theoretical approach from a focus on teachers' subject-related knowledge and skills to a broader model of teacher competence that encompasses noncognitive aspects, such as motivation and self-regulation as well as subject-unspecific aspects of professional knowledge. Fourth, in our current work, we investigate the malleability of teacher competence and how it can be improved in formal teacher education.

#### Professional Competence of Teachers

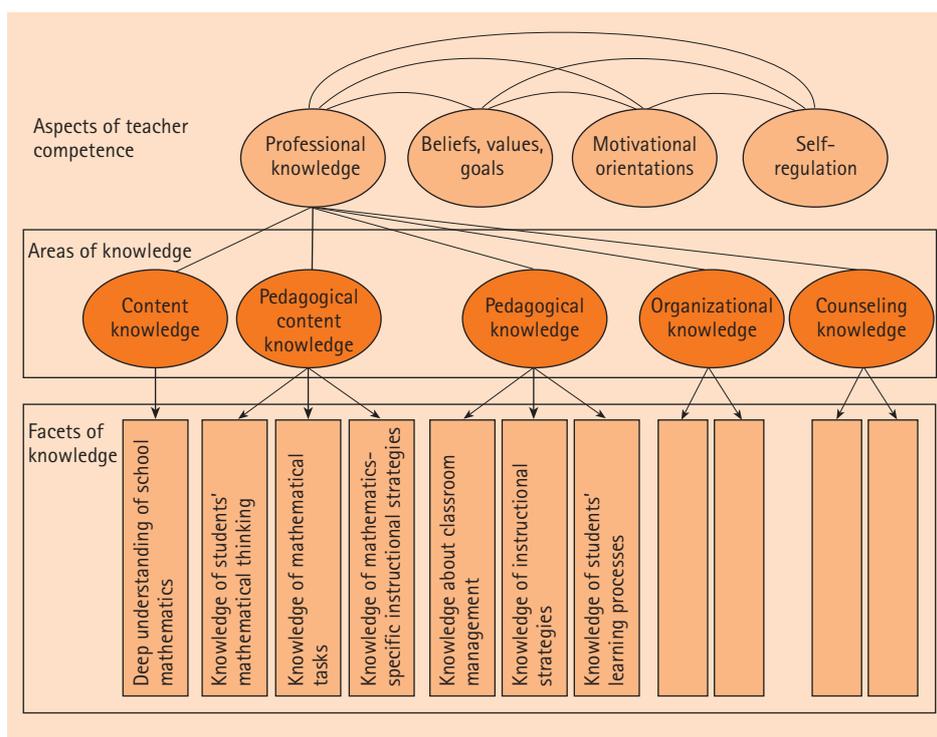
Fostering the professional competence of teachers is considered one of the keys to improving instructional quality and the educational system at large. However, despite a widely shared understanding that teachers are crucial agents in the instructional process, there has been little investigation of which teacher characteristics are particularly relevant for creating high-quality learning situations. Likewise, research on how professional competence is acquired during institutionalized teacher training is scarce. In Research Area IV, we work at closing this empirical gap. Drawing on a generic model of professional competence, we have identified aspects that may be particularly relevant for successful mathematics teaching. We have put this theoretical model to empirical test and found evidence for its predictions. In our ongoing research, we are concerned with which aspects of competence can predict instructional quality and how teachers' competence changes and develops.

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Figure 19. A model of teacher competence as specified for mathematics teachers.

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#### A Model of Teacher Competence

Our theoretical model of teachers' professional competence draws on a general model of professional competence and specifies aspects relevant for the teaching profession (see Figure 20; Baumert & Kunter, 2006). The "competence" concept extends on previous approaches to teacher professionalism in a number of important respects. In its narrow meaning, "competence" is limited to cognitive aspects. In its broader meaning, it covers both the ability and the willingness to act. It thus describes a broader spectrum of individual characteristics than, for example, the knowledge-based concept of teacher expertise, also taking account of motivational, metacognitive, and self-regulatory aspects. Moreover, competencies are generally assumed to be learnable and teachable, which has direct implications for quality assurance in teaching, as it places a much stronger emphasis on aspects of preservice and in-service training than on selection to the profession. It is, though, that the process of professional competence acquisition can continue throughout the occupational career, from university training to retirement.

Our model of professional teacher competence rests on the assumption that teachers, as the agents primarily responsible for orchestrating instruction, have to be equipped with certain knowledge and skills. It is teachers who determine the goals pursued in the classroom, the organization and content of instruction, and the support provided for individual students. The professional competence to meet these demands derives from an interaction of professional knowledge, values and beliefs, motivational orientations, and metacognitive self-regulatory skills. Each of these domains comprises other more specific facets—as illustrated in Figure 19 and summarized briefly below.

#### Professional Knowledge

Knowledge of learning content and of instructional strategies can be considered core components of teachers' professional competence. Work by Shulman and Bromme, the COACTIV model distinguishes five domains of teachers' professional knowledge:

- content knowledge,
- pedagogical content knowledge,
- pedagogical knowledge,

- knowledge about school organization and the school system, and
- knowledge about counseling.

*Content knowledge* is conceptualized as a deep mathematical understanding of the content to be taught. This professional knowledge includes a masterly command of the content of the school mathematics curriculum, but neither this school-level knowledge nor everyday mathematical knowledge equip teachers for the challenges of preparing and delivering instruction. Content knowledge is, therefore, distinguished from *pedagogical content knowledge*, which Shulman defines as the knowledge necessary to make mathematics accessible to students. Three facets of pedagogical content knowledge are considered crucial: knowledge of strategies for representing and explaining learning content in a specific subject, knowledge of the didactic potential of tasks and sequences of tasks for learning processes, and knowledge of subject-specific student cognitions. Another dimension of knowledge that is directly relevant to instructional practice is *pedagogical knowledge*: the generic cross-curricular knowledge needed to create and optimize teaching and learning situations, including a basic understanding of developmental and educational psychology and knowledge of lesson planning, instructional methods, and classroom management strategies. Our theoretical conception of professional competence in COACTIV focuses on aspects that are directly relevant to the practice of teaching. Of course, an exhaustive description of teachers' professional competence would include further dimensions of knowledge that are relevant for their work outside the classroom, such as knowledge about school organization and the school system and a command of adaptive and effective communication, particularly with laypeople.

#### *Beliefs and Values*

We define teachers' beliefs as implicit or explicit conceptions that influence their perception of the environment and their behavior. We distinguish professional values and ethics; epistemological beliefs about the structure, development, and validation of knowledge;

and beliefs about learning content, lesson planning, and instructional practice. Specifically for mathematics instruction, two opposing belief sets can be described both theoretically and empirically. On the one hand, teachers may take a "transmission view" that draws traditional learning theories and tends to see students as passive receivers of information. On the other hand, teachers may take a constructivist view that endorses the principles of active and constructive learning as outlined above (Dubberke, Kunter, McElvany, Brunner, & Baumert, 2008). Clearly, the latter is thought to be more conducive to high-quality instruction than the former.

#### *Motivational Orientations and Self-Regulation Skills*

The teaching profession is characterized by a relative lack of external constraints on—or control of—teachers' behavior. The typical career path offers few direct incentives or rewards to enhance occupational commitment. At the same time, the profession makes high demands on teachers' attention, energy, and frustration tolerance. Adaptive motivational orientations and self-regulation skills are thus vital for teachers to succeed in their jobs on the long term. Aspects of motivation (e. g., intrinsic motivational orientations in terms of enthusiasm, interests, control beliefs, and self-efficacy beliefs) seem important for the development and maintenance of occupational commitment (Kunter et al., 2008). At the same time, self-regulation skills (i. e., the ability to distance oneself from one's work and to cope adaptively with stress) are needed to maintain occupational commitment on the long term and to preclude unfavorable motivational and emotional outcomes (Klusmann, Kunter, Trautwein, Lüdtke, & Baumert, 2008b).

#### **Assessing Teacher Competence**

Although notions of teacher competence are convincing from the theoretical perspective, empirical evidence to support them is as yet sporadic. One prime aim of our research was to develop valid and reliable measures capable of tapping inter- and intraindividual differences in all aspects of teacher competence.

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### The COACTIV Study—Aims and Data Collection

The aim of the COACTIV study is to investigate mathematics teachers' competence and how this competence relates to instructional processes. By assessing the knowledge, beliefs, motivation, and self-regulatory skills of mathematics teachers, and then linking these aspects to features of their classroom instruction and to the development of their students' mathematical literacy, we aim to provide unique insights into the prerequisites for students' mathematical learning. The COACTIV study was embedded in the longitudinal component of the PISA 2003 study. Both the students sampled for PISA and their mathematics teachers were assessed twice—once at the end of grade 9 and once at the end of grade 10. We are thus able to combine student achievement and questionnaire data with their teachers' data and to observe changes over a school year. Information on mathematics instruction was obtained from three sources: teacher reports, student reports (standardized questionnaires), and analyses of the teaching material used in the given period. To this end, teachers were asked to submit the tasks they had assigned their PISA classes (homework assignments, exams, and tasks used in introductory lessons). These tasks were coded by trained raters using a newly developed classification scheme to gauge the cognitive potential of the tasks. To assess teachers' competence, we developed an array of new instruments focusing on content knowledge and pedagogical content knowledge.

Our teacher sample consists of 351 teachers and their mathematics classes in the first wave, and 240 teachers and their classes in the second wave (the reduction in sample size is due to students from vocational schools no longer being included in the assessment at the second wave). A total of 178 teachers participated in both waves of the assessment and taught the PISA classes over the whole school year.

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The assessment of teachers' knowledge represented a particular theoretical and methodological challenge, as no standard instruments were previously available. The theory-based construction of the tests was a multidisciplinary and a multistep project. Researchers in (mathematics) education, psychology, and secondary mathematics teachers collaborated in writing, piloting, and analyzing items. The successful construction of a set of valid and reliable measures tapping aspects of teacher competence was one of the most important milestones of the COACTIV study. These new measures (see Figure 20 for sample items) now allow us to learn more about the relations between the different aspects of teacher competence, to compare different groups of teachers, and, most importantly, to investigate which of the competence aspects are particularly relevant for educational outcomes.

### Linking Teacher Competence and Instruction

A particular strength of the COACTIV design is that it allows us to link aspects of teacher

competence to features of classroom instruction and to student performance. We can thus determine the extent to which differences in teachers' professional competence are indeed reflected in their instructional practice and in student learning gains. Our findings show that all aspects of teacher competence identified on the basis of our theoretical considerations show systematic relationships to instructional quality, which, in turn, influences student learning outcomes. Along with results on teachers' beliefs, motivation, and judgment accuracy, our findings on teachers' subject-specific knowledge and self-regulatory skills are particularly interesting.

### *Knowing Your Math Is Not Enough*

There is consensus in the teacher education literature that a strong knowledge of the subject taught is a core component of teacher competence. Opinions on what exactly is meant by subject matter knowledge are divided, however, particularly for mathematics. While some educational theorists and policy makers contend that teachers seldom have an adequate understanding of their

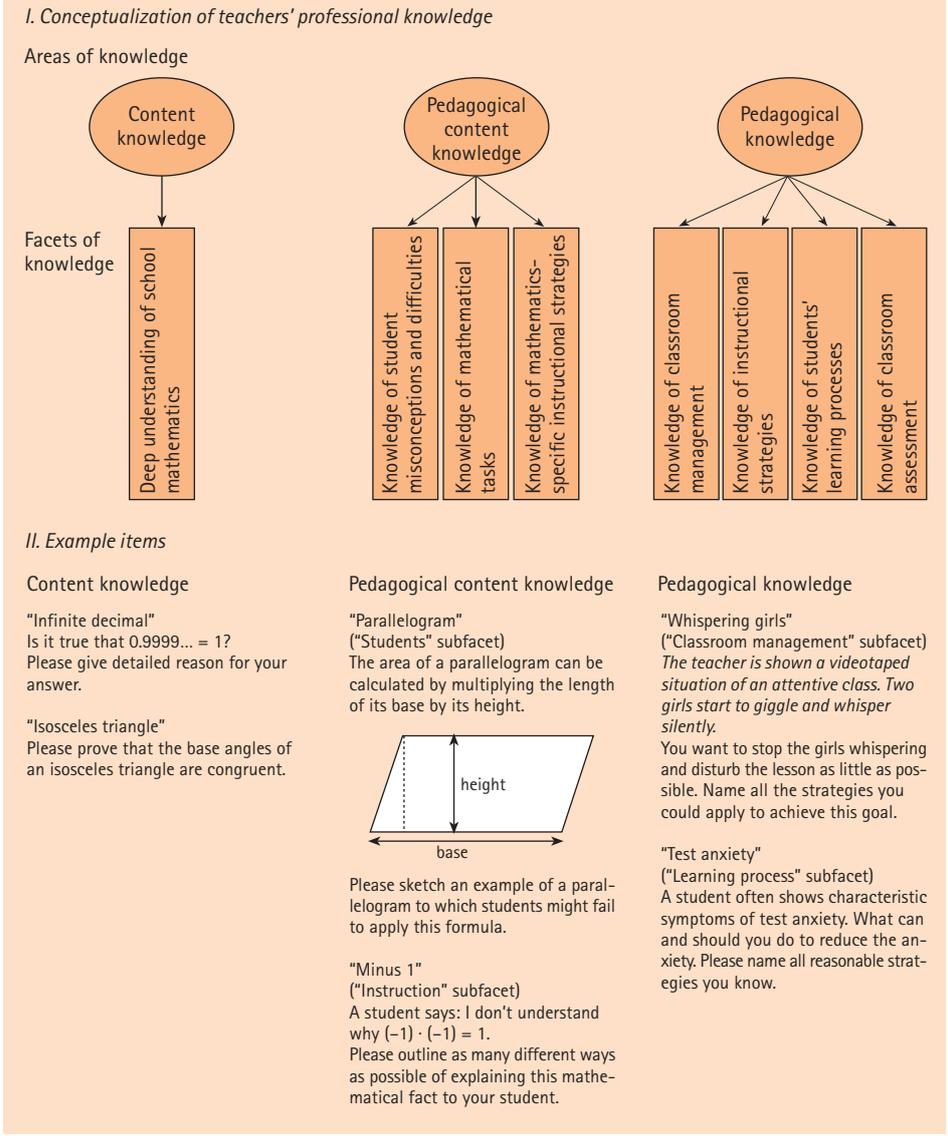


Figure 20. Assessing teacher knowledge: Sample items from the COACTIV study.

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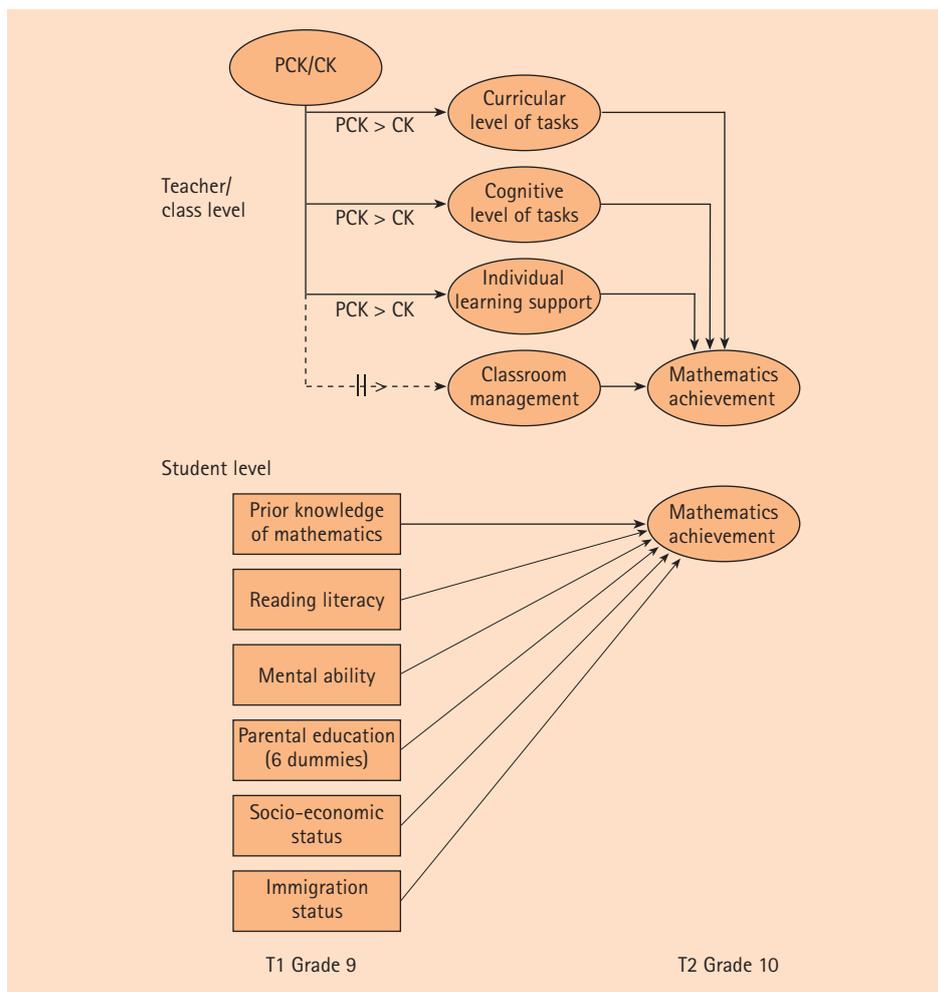
subject and thus need more subject matter instruction during teacher training, others argue that teachers' subject matter expertise is relatively good, but that their pedagogical knowledge, both domain-specific and general, needs to be improved. Upon closer inspection, the empirical evidence for both standpoints is surprisingly weak. In COACTIV, we addressed this issue by constructing two separate scales to measure teachers' understanding of their subject—that is, their content knowledge (CK)—and their knowledge of how to make that content ac-

cessible to students—that is, their pedagogical content knowledge (PCK; see Figure 20). We found that the two knowledge aspects can be distinguished empirically, although they are positively related. These findings raise the urgent question of whether PCK or CK is decisive in the classroom or whether the two components of professional knowledge are interchangeable. Our theoretical assumption is that PCK is inconceivable without a substantial level of CK, but that CK alone is not a sufficient basis for teachers to deliver cognitively activating

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Figure 21. Hierarchical linear model testing the significance of teachers' pedagogical content knowledge for instructional quality and student learning.

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instruction that, at the same time, provides adaptive support for individual students' learning.

In a study combining our teacher data with the student data from the PISA 2003/2004 assessment, we found that CK and PCK both make unique contributions to explaining differences in quality of instruction and student outcomes. Drawing on the longitudinal PISA 2003/2004 data, we were able to control the assignment of students to teachers, thus creating a quasi-experimental situation in which differences in student achievement could be directly attributed to differences in teacher knowledge. Figure 21 presents results from multilevel structural equation models, which showed that a substantial positive effect of PCK on students' learning gains was mediated

by the provision of cognitively activating and adaptive instruction.

This effect applied only to PCK, however: CK was not found to have any direct effect on students' learning or instructional quality. In other words, knowing your math does not necessarily make you a good teacher. It would, however, be unwise to interpret these findings as implying that CK is unimportant for teachers. It is inconceivable that PCK can be acquired and applied without a solid basis of CK. In fact, our findings have shown the correlations between CK and PCK to increase as a function of the mathematical expertise of the teacher group (Krauss, Brunner et al., 2008). In our ongoing research, we are, therefore, especially interested in capitalizing on quasi-experimental situations that allow us to

disentangle the causal relationships between the two knowledge components (e.g., Krauss, Baumert, & Blum, 2008, and in the new COACTIV-R study presented below).

*Beyond Knowledge: The Importance of Noncognitive Aspects of Teachers' Professional Competence*

Within the COACTIV framework, we argue that teachers' professional competence extends to the emotional and motivational skills they need to cope effectively with the many demands of their profession. We focus on the intraindividual interplay of two self-regulatory behaviors that are highly relevant in the occupational domain: engagement and resilience. Based on Conservation of Resources Theory by Hobfoll and the work by Schaarschmidt, we assume that the *optimal balance* between work *engagement*, which can be seen as the investment of resources, and *resilience*, which can be seen as the conservation of resources, is the most adaptive self-regulatory style in the work context. We hypothesize that individual patterns of self-regulation predict two key outcomes that have rarely been studied together: high levels of occupational well-being and better instructional performance, which, in turn, leads to favorable student outcomes. Recent research by Schaarschmidt has suggested four interpersonal patterns of engagement and resilience (see Figure 22). The "healthy-ambitious" (H) type, with high scores on both engagement (sample item: "I spare no effort at work") and resilience (sample item: "I can switch off easily after work"), is seen as the best adapted pattern. The "unambitious" type (U) is characterized by low engagement, but high resilience. The other two types are thought to be at particular risk for low occupational well-being. The "excessively ambitious" type (A), scoring high on engagement and low on resilience, is characterized by excessive engagement, striving for perfection, and an inability to recover emotionally from work. The "resigned" type (R) is characterized by low engagement and low stress resistance. Applying different cluster analytic methods to the COACTIV teacher sample, we consistently identified the four theoretically predicted

patterns with their prototypical profiles of engagement and resilience (Klusmann, Kunter, & Trautwein, in press; Klusmann et al., 2008b). Latent profile analysis identified 29.2% of our teachers as belonging to the healthy-ambitious type, 25.4% to the unambitious type, 16.4% to the excessively ambitious type, and 29.0% to the resigned type (Klusmann et al., 2008b). Did individuals of the four self-regulatory types differ in terms of the level of occupational well-being they reported? As expected, we found substantial differences in the emotional exhaustion ("I often feel exhausted at school") reported by the four types. Teachers belonging to the healthy-ambitious type reported the lowest emotional exhaustion, followed by the unambitious type. The excessively ambitious type and the resigned type scored highest on emotional exhaustion. Similar results were found for job satisfaction (sample item: "Given the choice, I would definitely become a teacher again"). As expected, the healthy-ambitious type scored highest on job satisfaction, followed by the unambitious type. Teachers of the excessively ambitious and resigned types scored lowest. The results remained stable when age, gender, and school track were controlled. Furthermore, we found that the self-regulatory patterns predicted teachers' occupational well-being one year later. Teachers of the two "at-risk" types (excessively ambitious and resigned) showed more emotional exhaustion after one year than teachers of the two other types. We also found a negative spillover effect for the excessively ambitious type, who reported significantly less overall life satisfaction one year later than the healthy-ambitious type. We expected to find that teachers' self-regulatory patterns were differentially related to their instructional performance in terms of

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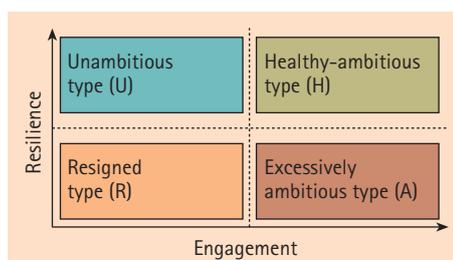
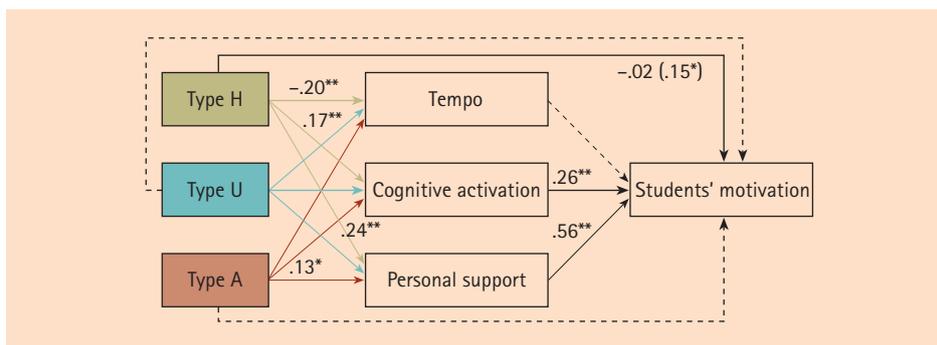


Figure 22. Interpersonal patterns of engagement and resilience.

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Figure 23. Predicting instructional quality and student outcomes by teachers' self-regulatory styles.

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classroom management, interaction tempo, cognitive activation, and personal support as rated by their students. A set of linear regression models was conducted to test (a) the effect of self-regulatory type on instructional performance and (b) whether instructional performance mediates the effect of self-regulatory type on student motivation (see Figure 23). From the students' perspective, there were considerable differences in the instructional performance of the four teacher types. Teachers of the healthy-ambitious type received more favorable ratings on interaction tempo than teachers of the resigned type, indicating that their instructional pace was evaluated as being more appropriate to student needs. Teachers of the healthy-ambitious type also outscored teachers of the resigned type on the level of cognitive activation provided in mathematics lessons and the personal support provided for students. The excessively ambitious type likewise outscored the resigned type on cognitive activation. However, none of the self-regulatory types predicted classroom management as reported by students. Interestingly, we found an effect of the healthy-ambitious type on students' motivation in mathematics that was mediated by cognitive activation and personal support. Teachers' self-regulatory patterns are thus manifest in their classroom behavior.

### Why Do Teachers Differ With Respect to Their Competence? Investigating Teacher Learning

Our results to date show that teachers differ considerably in all aspects of competence investigated, especially in the extent and structure of their knowledge. However, our findings

also show that these differences cannot be attributed solely to years of teaching experience. Rather, it seems that the foundations for these differences are laid early in teacher education. COACTIV provided first support for this hypothesis with findings showing that differences between teachers are closely related to the type of training they received, with teachers who trained to teach at *Gymnasium* schools outperforming their peers. Teacher training in Germany consists of two phases. During the first phase, university-based, teacher candidates acquire theoretical knowledge. It is only in the second phase, teaching placement (*Referendariat*), that they gain practical knowledge by observing lessons and teaching themselves. During this two-year phase, teacher candidates are both teachers and students, teaching their own classes, but being supervised by a mentor, and attending preparatory seminars. These structured learning opportunities offer great potential for development. The new COACTIV-R study (R meaning *Referendariat*) has been initiated to examine the processes and outcomes of the *Referendariat* in more depth.

### What Level of Competence Do Teacher Candidates Exhibit at the End of Their University Training?

In Germany, teacher candidates aspiring to teach at secondary level must choose between teacher education programs qualifying them to teach either in the academic track (*Gymnasium*; 5-year training program) or in the other secondary tracks (e.g., *Realschule*; 4-year training program). We do not expect teacher candidates approaching the end of

their university training to have achieved knowledge levels comparable to those found for the experienced teachers sampled in COACTIV. However, we expect to find systematic differences in competence levels at the end of the first phase of training, with candidates training to teach at *Gymnasium* schools exhibiting higher levels of subject knowledge and lower levels of pedagogical content knowledge and general pedagogical knowledge than their peers training for the other tracks.

*How Do Teacher Competencies Change During the Teaching Placement?*

During the *Referendariat*, teacher candidates are placed in the school track for which they trained. They gain their first real practical experience and receive supervision and meaningful feedback: formal evaluation (including examinations) as part of their training, on the one hand, and the direct responses of their students and mentors, on the other. It can be assumed that all aspects of professional competence change as a consequence of these experiences, but that nature of this change may differ. For instance, we expect to find roughly linear growth in general pedagogical knowledge and pedagogical content knowledge in all participants. At the same time, we expect to observe a so-called "practice shock" in teachers' beliefs, self-efficacy, and motivation. Teacher candidates seem to enter the profession highly motivated and with rather idealistic progressive beliefs that plummet when they experience the demands of full-time teaching for the first time. Motivation

and well-being are also likely to fluctuate considerably. COACTIV-R will thus investigate long-term changes and short-term fluctuation in teacher candidates' knowledge, beliefs, and motivational and emotional characteristics.

*Which Factors Cause Change; What Role Do Structured Learning Opportunities Play?*

Teacher candidates are afforded different learning opportunities during the *Referendariat*. However, the extent to which these opportunities actually foster learning hinges on two factors: First, on the quality of the learning opportunities themselves (i. e., whether their structure fosters insightful learning processes) and second, on the candidates' individual uptake of those learning opportunities (e. g., reflection, actual learning behavior, effort, help-seeking, etc.), which may be influenced by their individual characteristics (basic cognitive abilities, prior knowledge, attitudes to learning, motives, goals, interests, etc.). COACTIV-R will examine the relative importance of different learning opportunities and individual characteristics for the learning process of teacher candidates during the *Referendariat*. To ensure that a broad range of different learning opportunities is covered, the study will compare teacher candidates from training systems with markedly different structures.

*Design of the Study*

COACTIV-R is a longitudinal study with two main measurement points and two cohorts: teacher candidates in the first and second year of the *Referendariat*. The target popula-

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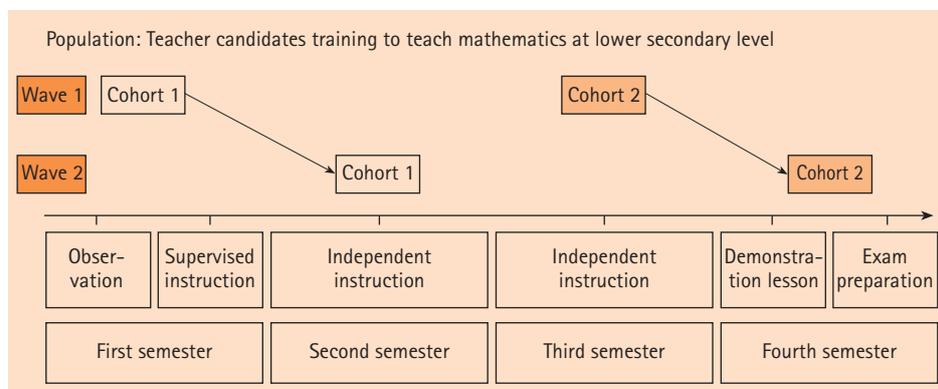


Figure 24. Design of COACTIV-R, a study investigating the development of teacher candidates' professional competence.

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tion for the study was teacher candidates training to teach mathematics at lower secondary level in all school tracks. The first wave of data collection took place between fall 2007 and spring 2008 in four federal states: Bavaria, Baden-Wuerttemberg, North Rhine-Westphalia, and Schleswig-Holstein. The reason for choosing these four states was that they differ systematically in the structure of the *Referendariat*. Data have been obtained from 856 teacher candidates. The second wave of data collection ran from fall 2008 to spring 2009. Figure 25 shows how the measurement points are embedded in the structure of the *Referendariat*. Beyond the two main measurement points, more detailed research questions, such as nonlinear growth trajectories of motivation and beliefs and the role of supervision for the learning process, will be investigated with subsamples from North Rhine-Westphalia.

**The Basis for Teachers' Success:  
Investigating the Quality of Instruction**

Our model of teacher competence derives from the idea that effective teaching—that is, planning, structuring, and guiding lessons in such a way that they become powerful learning environments for students—is the key task to be mastered by all teachers. As an ongoing line of research in Research Area IV, we complement our recent work on teacher competence with studies examining dimensions of instructional quality in more detail. Classroom instruction can be described in various ways. As a first approach, it is often useful to describe the organizational structure of the learning environment, for instance, the general lesson scripts or the use of particular learning settings, such as whole class discussion, group work, or partner work. However, instructional research has shown that these surface features alone do not decide whether students will engage in insightful learning processes, and thus do not necessarily predict learning outcomes. In order to describe strengths and weaknesses of instruction, researchers need to examine the interaction between teacher and students in the instructional process in more detail. Within our theoretical framework, we

distinguish three aspects of the instructional interaction between teacher and students that are crucial for initiating and sustaining insightful learning processes. These general dimensions of instructional quality may be specified to describe instructional processes in various subjects; in our work, the focus has been on mathematics (see Figure 18). The first, subject-unspecific, dimension is *efficient classroom management*. How well is the class organized and how efficiently is time used? To initiate insightful learning processes, instruction should be structured in such a way that learning time is maximized and frictions between students and teachers are minimized. Second, given that opportunities for insightful learning in the mathematics classroom are determined primarily by the types of problems selected and the way they are implemented, we consider the frequency of *cognitively activating elements* of instruction. Cognitively activating tasks in the mathematics classroom might, for example, draw on students' prior knowledge by challenging their beliefs. Cognitive activation may also take place in class discussion if the teacher does not simply declare students' answers to be "right" or "wrong," but encourages students to evaluate the validity of their solutions for themselves. Third, we consider the *individual learning support* provided by the teacher. Studies based on motivational theories show that providing challenge is not enough to get students to engage in insightful learning processes, but that their learning activities need to be supported and scaffolded. Continuous diagnosis of difficulties and calibrated support that respects student autonomy is not only important for student motivation but is an essential component of a powerful instructional environment in terms of cognitive outcomes. Several studies conducted in Research Area IV have investigated these three dimensions of instructional quality from different perspectives. All of these studies seek to represent the complexity of classroom instruction in an authentic way, consider multiple outcomes—that is, students' domain-specific learning as well as their motivational development—and see learning as a co-constructive process in which instructional processes are actively

shaped by learners and teachers in interaction. Employing different methodological approaches, they address overarching questions, such as the following:

- To what degree are the three dimensions of instructional quality observable in classroom instruction and are there systematic differences, for instance, across school types?
  - What is the specific impact of each quality dimension on students' learning and motivation?
  - How can instructional quality be improved?
- As shown by the research examples below, the three dimensions of instructional quality paint a comprehensive picture of the antecedents and consequences of high-quality instruction.

#### *In-Depth Analyses of Mathematics Instruction Using Large-Scale Assessments*

The Center for Educational Research has a long tradition of involvement in large-scale educational assessments, both national and international (see Research Areas I and II). One prime principle of our research is to use these data not only to report mean levels and changes in achievement but also to inform in-depth analysis of the instructional processes that may underlie the differences. Our current research program builds on earlier work carried out in the context of studies, such as BIJU, TIMSS, and PISA, which provided first insights into the features of classroom instruction essential for student learning. In these large-scale studies, instructional quality is typically assessed via student questionnaires (and sometimes teacher questionnaires). Supported by methodological analyses confirming the reliability and validity of this measurement approach, we have constructed a comprehensive battery of instruments to assess instructional quality in a valid and ecological way. In addition, as in our secondary analyses of the 1996 TIMSS Videotape Classroom Study, we have linked classroom observation data with student data. This has enabled us to describe, for example, how cognitively activating elements of instruction (e.g., in the tasks set or in teacher-student discourse) affect

student outcomes, including motivational development. Within the framework of the COACTIV study, we have taken another novel approach to measuring instructional quality by classifying the homework and exam tasks assigned by teachers in terms of their didactic potential. A standardized coding system has enabled us to describe the cognitive challenge of mathematics instruction in objective and detailed terms.

In sum, our in-depth analyses of large-scale data have shown that mathematics instruction in German secondary schools is not optimally suited to trigger insightful learning processes (Jordan et al., 2008; Kunter, Baumert, & Köller, 2007). In line with prior findings (e.g., based on TIMSS data), studies drawing on the PISA 2003 and COACTIV data show that German mathematics lessons typically focus on drilling routines rather than on developing conceptual knowledge. Our recent task analyses have shown that typical homework or exam tasks require only factual or computational knowledge, and that tasks requiring students to actively engage in mathematical problem solving and to link concepts or strategies are relatively rare. This low level of cognitive activation characterizes German mathematics instruction in general, but it is specifically pronounced in the non-academic tracks. At the same time, students in the nonacademic tracks report more individual learning support than their peers in the academic track. The school type-specific patterns of instruction, clearly apparent in German mathematics classrooms, are one explanation for the differential learning gains observed in the different tracks. However, even within tracks, there are substantial differences in instructional quality. The question now is what causes these differences. Our recent work has thus focused on teacher characteristics that may explain the observed differences in instructional quality.

#### *Instructional Quality and Student Motivation: An Intraindividual Approach*

The feelings and emotions that students experience on a day-to-day basis play an important role in their learning. In her dissertation project, Yi-Miau Tsai investigated

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how student motivation emerges and changes in the day-to-day classroom context. Drawing on self-determination theory, she hypothesized that autonomy-supportive instruction would enhance interest and competence perception in the classroom. Tsai investigated three specific aspects of autonomy-related instructional behavior: autonomy-supportive climate, controlling behavior, and cognitive autonomy support.

In addition, the project revisited the theoretical notion that motivational experience tends not to be solely situation-driven, but to derive from both the situation (e.g., teachers' instructional practice) and individual characteristics and resources. Tsai took a short-term intraindividual approach to examine how both the learning situation and individual motivational resources shape students' motivational experience. Specifically, the objectives of the project were (1) to describe the extent of intraindividual variability of students' motivation and emotion in daily lessons, (2) to predict the rise and fall of students' motivation and its correspondence to need-supportive climate in the classroom, (3) to investigate individual differences in the extent to which students are sensitive and reactive to environmen-

tal supports and constraints, and (4) to investigate the domain specificity of these relationships by collecting data on three school subjects.

A group of 261 grade 7 students and their teachers from two *Gymnasium* schools in Berlin participated in a lesson-specific assessment spanning three consecutive weeks. After each German, mathematics, and second foreign language lesson, a short questionnaire was administered to assess the students' experience and perception of the teacher's instructional behavior during the lesson. The students were also recruited for a follow-up assessment in grade 8.

Results from this project suggest that students' interest experience and felt competence in the classroom are not fixed entities (see Tsai, Kunter, Lüdtke, Trautwein, & Ryan, 2008; Tsai, Kunter, Lüdtke, & Trautwein, 2008), and that both motivational resources and classroom instruction contribute to students' classroom experience. The findings make it clear that educators make a real difference to students' competence beliefs, values, and affect in learning situations. Furthermore, they provide insights into how it may be possible to generate motivating contexts in educational settings.

### Supporting Students' Autonomy in Science Lessons: An Experimental Study

Cognitive activation and individual learning support are features that are also discussed in the context of new methods of problem-based or constructivist teaching, as advocated in recent reforms of science education. A common feature of these reform-based approaches is that they conceptualize teachers as providers of guidance and scaffolding more than as sources of authority, and students as actively engaged in the learning process rather than as passive recipients of knowledge. Although these reform-based approaches have gained a significant foothold, they have been found difficult to implement successfully, and their effectiveness in increasing student learning and motivation has yet to be proven. The small-scale experimental study "Supporting Autonomy in Science Activities (SASA)" has addressed these issues, investigating the effectiveness of a reform-based lesson script for students' learning and motivational development. The instructional experiment places a specific focus on autonomy support. Drawing on self-determination theory, it further categorizes autonomy-supportive classroom environments in terms of the procedural autonomy support (e.g., students are allowed to choose and handle their own experimental materials) and cognitive autonomy support they offer (e.g., students may find multiple solutions to problems, receive informative feedback, and are supported in the reevalua-

tion of misconceptions). A focus on these two categories of autonomy support may help to clarify the nature of the guidance that students need in reform-based learning contexts, and the ways in which their autonomy might best be supported. For example, students might benefit from support in reevaluating their misconceptions during a lesson (cognitive autonomy), but their learning might, in fact, be hindered by too much freedom to choose materials (procedural autonomy). To test this hypothesis, we conducted a study with a  $2 \times 2$  pre-posttest experimental design, with conditions combining two levels of procedural autonomy (hands-off vs. hands-on activities) and cognitive autonomy (controlling vs. supportive). The treatment conditions were embedded in two lesson units in which students measured and graphed uniform and nonuniform motion. The lessons took place in the laboratory classroom at the Center of Educational Research (see Figure 25) and were delivered by two trained science teachers who followed semistandardized teaching scripts that varied according to the experimental condition. Students were allocated to the conditions through stratified random assignment. The experimental phase was successfully implemented and data analyses are currently in progress. In addition to standardized measures of achievement and motivation, observational data are being analyzed to learn more about critical differences in student-teacher interactions.

### The Research Team

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Figure 25. Observation of a lesson in the SASA project.

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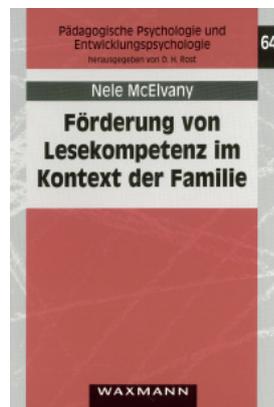
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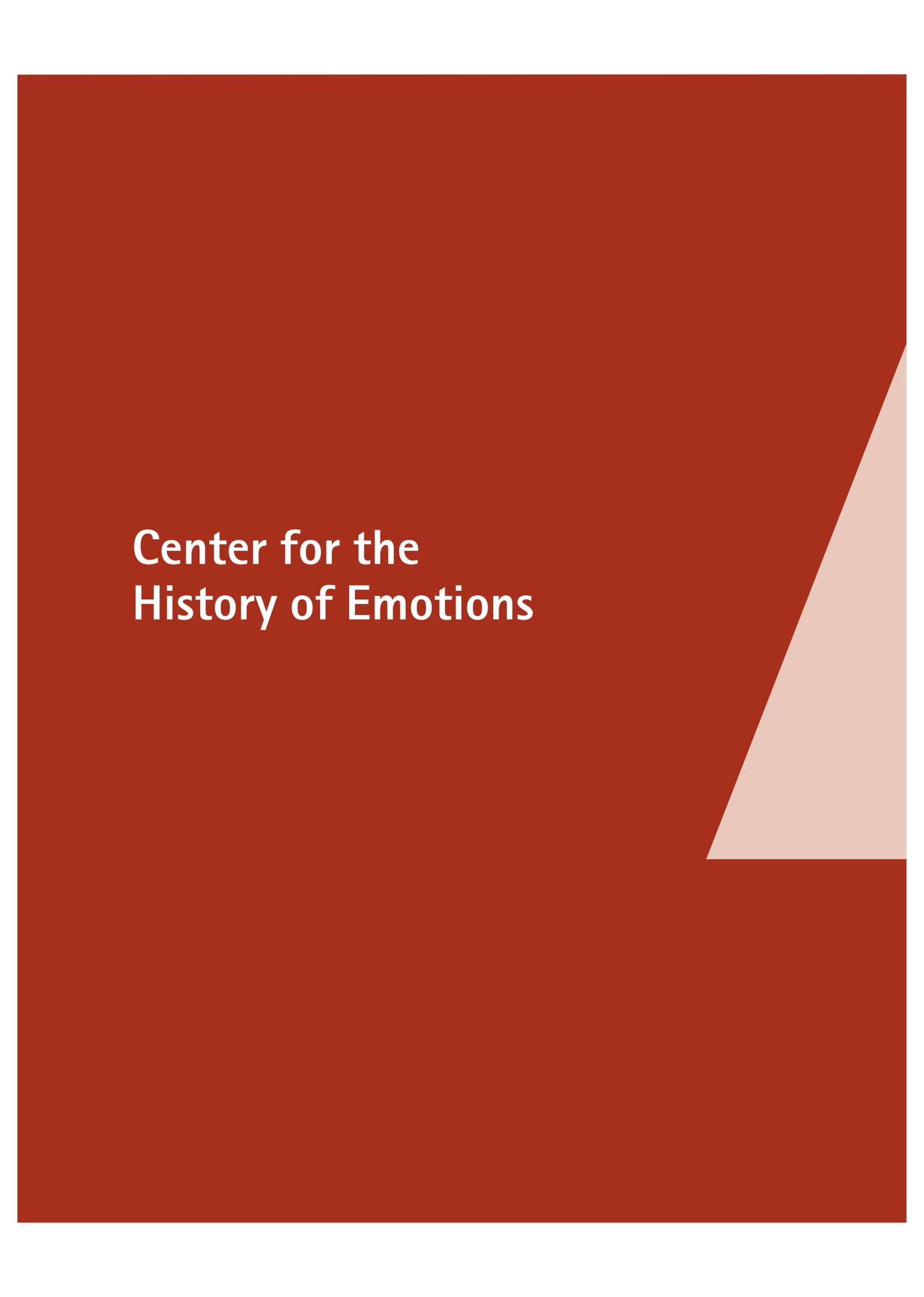
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**Center for the  
History of Emotions**

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## Introductory Overview

In January 2008, a new research center was established at the Institute: the Center for the History of Emotions. An interdisciplinary group of historians, anthropologists, and educational scientists has embarked on a type of research that had hitherto been widely neglected, as historians had been turning a blind eye on emotions, and psychologists had not considered that emotions might have a history.

### Emotions and Human Development

The Center was formed under the assumption that emotions matter to and in human development. On the level of personal development, emotions constitute a crucial asset of individuality and personhood. Someone who has lost their emotions (e. g., by a traumatic experience or brain damage) lacks an important quality of self that facilitates social interaction. Emotions enable and stabilize interpersonal communication, as much as they stimulate individual memory. But most emotions are not given by birth, they have to be learnt and acquired, either by imitation or by socialization. Here, the level of social development comes into sight. The degree to which a person embodies and expresses emotions depends on a set of social factors comprising gender, class, religion, nationality, and age. Emotions are not stable, but change over the lifespan. Institutions like family, school, workplace, and the military, as well as verbal and visual representations of emotions (in novels, poems, cinema, theatre, paintings, photographs, etc.) play a formative role.

Emotions can thus be considered as entities that contribute greatly to human development, both on the individual and on the collective level. At the same time, they are themselves shaped by human culture, both material and immaterial. The *éducation sentimentale* recounted by Gustave Flaubert in his 1869 masterpiece highlighted this in a powerful way: Firstly, it stressed the importance of emotions for the process of character-shaping. It then questioned how emotions were "educated," that is, taught, learnt, and cultivated through the course of adolescence. All along, Flaubert made it crystal-clear that this education took place at a specific historical moment. The passion of his generation, as he described it,

existed "only today," as an "inactive passion." Other generations, so Flaubert invites us to think, might have different passions and undergo different processes of *éducation sentimentale*.

### Main Assumptions

The Center for the History of Emotions follows this invitation. We perceive emotions mainly as cultural artifacts modeled and influenced by social forces. Different institutions, we argue, display different emotional styles or regimes. They develop specific emotional scripts and ensure that their members know how to read those scripts. They also determine what kind of emotional commitment should be shown in what kind of social relationship. Societies thus create various *emotionologies*, that is, standards of feeling and emotional expression. They might differ between men and women, children and grownups, and slaves and masters. They vary according to social context and situational settings and they change due to new challenges and power relations.

Our first assumption, therefore, is that emotions have a history. They are susceptible to change, both in the way in which they are individually expressed and in the way they are socially assessed and valued. To give just one example: Anger in Greek-Roman antiquity bore a different meaning compared to anger in the 19th century. Its status in the socio-cultural fabric of society differed as much as its functions within social groups. Who was allowed to be angry and behave accordingly differed as well. Furthermore, the language of anger, its bodily gestures and facial expressions, underwent considerable changes. To what degree this might reflect changes in the proper experience of anger is an open and fascinating question. Cultural historians, aware of the power of language to shape



Figure 1. K. Malewitsch (ca. 1930). Three female figures.

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and construct reality, are inclined to answer this question in the positive. Psychologists might disagree—which then offers a great opportunity for interdisciplinary debate and controversy. This debate has already started at the Institute and will continue within both disciplines.

Our second assumption refers to the power of emotions to make history. Emotions are not only subject to change; they also induce change and bear a considerable impact on social, economic, and political developments. As much as interests do, emotions motivate people's decisions and actions. They help to start and uphold communication and interaction among people, but they are also responsible for groups breaking up and disintegrating. Social movements that formed during the modern period heavily depended on shared emotions that kept them dynamic and going. Without the power of empathy and solidarity, neither abolitionism nor socialism and anti-colonial movements would have succeeded to mobilize and bind millions of people. On another tone, the thrust of anti-Semitic or antifeminist groups relied on evoking strong feelings of hatred, distrust, and fear among their followers. Feeding and channeling these emotions has been crucial for the success or failure of social and political movements that are considered a defining element of modern societies.

#### Time Frame and Historical Shifts

Although the history of emotions can be traced back at least 3,000 years, the Center focuses on the modern period, starting in the 18th century and continuing to this very day. We assume that during this period there were major shifts in the way people perceived and conceptualized emotions. The first shift took place in the late 18th century with a heightened interest in subjectivity and the advent of sentimentalism. The latter was not confined to the level of the individual; it also encompassed a serious reconfiguration of how the individual related to other persons and to society at large. Emotions were considered as major elements of sociability, civility, and identity formation. At the same time, they were seen as vital components of social bonding and political action on a systemic scale. Revolutionary and reform movements set out to consciously instill and educate new emotions among citizens, and social institutions closely monitored the educational process. The next major shift in the history of emotions came in the second half of the 19th century, framed by the rise of the natural sciences and by colonialism. Both were predicated on theories of natural and social evolution which profoundly influenced the nature of the European presence in non-European societies. European discourses on civility/barbarism and race became reconfigured in a way that not only altered perceptions of colonized peoples but also of the lower strata of European societies. This had severe repercussions on how emotional norms, standards, and regimes were constructed. The colonial encounter transported European discourses to the far reaches of the Empire and, at the same time, it deeply affected perceptions of the self and the other in the metropolis. Shifts in the gendering of emotional regimes were closely intertwined with discourses on "the East," and emotional standards were set by a dual distancing from the female and the "oriental." A third shift occurred, so we argue, in the early decades of the 20th century. High capitalism and a growing consumer culture ("mass culture") forced a rethink of the boundaries and relationship between the individual and society. Emotions gained a public

visibility that pervaded all areas of human life. Political mass movements made ample use of emotional language in order to mobilize and integrate new members. In Europe, commercials intentionally and intelligently tapped the reservoir of emotions in order to steer consumer behavior. Industrial relations became susceptible to emotional management and therapy. The family—the nuclear family in Europe as well as the joint family in other parts of the world—was reconsidered as a place of emotional tension and conflict (between fathers and sons, mothers and daughters, husbands and wives) and consequently was regarded as in need of advice and support. Those (and other) developments changed the ways in which emotions were defined, read, and judged.

### **Conceptual History**

In order to test these hypotheses, we have begun working on a collaborative project that investigates the conceptual history of emotions. This project starts from two assumptions: Firstly, the way that historical actors classify and label emotions provides us with insights into how they perceive emotions. This assumption links up with research conducted by historians of science. Secondly, we assume that labeling shapes the manner in which emotions are experienced. Here, we are informed by psychological approaches that stress the cognitive components of emotions and connect them to physiological changes.

Following those assumptions, we are collecting and analyzing articles on emotions and related words that have appeared in European encyclopedias from the 18th century until today. We are tracing the development of those words ("feeling," "affect," "passion," "sensitivity," "emotion," etc.) in comparison and relation to one another. This allows us to discover shifts and ruptures in word usage and meaning. It also allows us to discover discourses that influence those developments and shifts. At this point, it seems that theological and philosophical discourses were gradually outnumbered and outperformed by medical, psychological, and neurological reasoning. The triumph of social and life sciences

then brought along a complete change of key references—from God to nature, from the soul to the body, and, eventually, to the brain. It will be a major challenge to link those epistemic shifts to societal developments and exigencies. This will be done by adding other lemmata to our list. We thus contextualize the information gained by the analysis of emotion-words and connect it to discourses and practices in other domains, that is, gender relations, class and ethnic structures, or the politics of sex and religion. In the end, we will produce a monograph presenting the conceptual history of emotions not only as the interface between various disciplinary discourses striving for hegemony but also as a dynamic field reflecting power struggles and social cleavages in the modern world. As such, it is intended to sharpen sensibilities as to our own present day use of language and to enhance intellectual self-reflection, not just among historians, but in other disciplines as well.

### **Research Areas**

Apart from the collaborative project that engages all post-doctoral members of the Center, each scholar has worked on his or her own project. Altogether, they cover a broad array of topics—from love to fear, from honor to trust, from "civil" to "barbarous" emotions, and from emotions in religious practice to those in social and political movements. As a common denominator of our work, we use the two basic statements mentioned above:

- Emotions have a history.
- Emotions make history.

Each project sets out to prove these statements in its own way by using a wide range of source material, research strategies, and methods. Many work with written sources exclusively, while others add pictures and oral interviews. Several employ discourse analysis as a tool of tracing emotion-talk and emotion-work, some apply theories of ritualistic expression and enactment of emotions, and others rely heavily on theories of linguistic and semantic change.

The projects are not only linked by the stated assumption that emotions are subject to historical change as much as they have an

impact on historical events and developments. They also share the opinion that, first, emotions bear an intense relationship to culture, that they are intentionally and unintentionally cultivated, and, in turn, strongly influence the way people see themselves as human and social beings. As this cultivation and identity-formation usually takes place in institutions (family, schools, the military, religious communities, clubs, etc.), an institutional focus is common to all projects. Secondly, they pay close attention to the fact that emotions are embodied, that they are felt and expressed through bodily gestures and movements. Thus, they cannot be studied without regard to the changing concepts and uses of the body. Bringing the body into the historical analysis of emotions opens up an intense dialogue with the natural and life sciences. As historians, though, we assume that not only emotions but the body itself has a historical dimension. Thirdly, every single project takes into account that emotions have power and make power, albeit to varying degrees. Displaying emotions is closely linked to power structures in a society or social group. Certain emotions qualify those in power and distinguish them from the powerless. As power structures shift, so do emotions. Culture/Cultivation, Body, and Power are thus considered the building blocks of our theoretical framework. They provide common ground for all projects on which to build hypotheses. With regard to culture/cultivation, we follow the assumption that educational efforts to shape and change individual emotions are increasing throughout the modern period due to heightened concerns about individuality and sociability. But it would be misleading to expect a growing tendency toward homogeneity. Even if hegemonic structures cannot be overlooked, the dynamics of modern life leave room for counterdiscourse, deviation, and alteration of emotional self-concepts. In relation to the body, we share the concept that it is the location of experiencing and expressing emotions. Social norms regarding emotional displays are implemented via techniques of controlling the body. This, in turn, affects the experience of emotions that are mediated by knowledge about how emotions

work in the body. Thus, the epistemological transformations within the life sciences that produce new ideas about the emergence and plasticity of emotions are bound to leave an imprint on day-to-day bodily practices. As for power relations, they tend to periodically install new balances between the private and public, with severe repercussions on the quality and quantity of emotions exchanged between those with more or less power. Negotiating power relations increasingly involves emotion-talk, with apparent shifts in terminology and semantics. This is particularly striking in the realm of political history, with regard to "national honor," or trust/mistrust of politicians.

Although all projects share this common ground and contribute to building and testing those hypotheses, they do so with different points of emphasis and focus. This is why it seemed useful to group them into different research areas. This does not mean that their focus is exclusive; it only means that those projects grouped together have more in common with one another than with those found under another heading.

### **Regional Variation and Research Policies**

The emotional world that the projects set out to investigate is by no means conceived as flat and homogenous. Rather, we start from the assumption that concepts and practices of emotion follow different logics that depend on succinct cultural influences. The place and function that a society (an institution, a social group, etc.) allocates to particular emotions vary according to needs and cultural setups. Religious traditions have a great impact here, as much as self-concepts that mediate between former experiences and future expectations. Under this assumption, it is necessary to cover different areas in order to get a sense of how great (or small) differences and entanglements actually are and were. Comparison permits us to overcome the danger of perceiving culturally specific characteristics as universal.

Under this comparative approach, the Center brings together areas which have historically been kept apart as "the West" (Europe and North America) and "the East" (India).

It thereby challenges not only the alleged dichotomy between them but also the alleged homogeneity within each category. Instead of considering them as unified cultural spaces, we are interested in differences as much as similarities. While all the projects are united in their effort to introduce comparative perspectives into their conceptual design, several explicitly compare two or more countries in order to define the relative impact of religion, political structures, and social composition on the politics and culture of emotions. Comparison deliberately includes a keen interest in encounters, entanglements, and mutual influences. As much as those encounters have brought forth the categories of "West" and "East," they have shaped the discourses on and practices of emotion in each country. It should be stressed that this is an altogether new research strategy that is unique to the global academic landscape. Traditionally, research in the humanities and social sciences on Western and non-Western countries has been separated both intellectually and institutionally. If there was a contact at all, it proceeded along a one-way lane, setting out to decide whether concepts gathered from the European and North American context might be applied to situations in Asia or Africa. This could lead to stating similarities or differences, without, however, challenging the concepts and the epistemological dominance of the West. The refusal of post-colonialism to accept universal categories and its insistence on fragmentation are also to be read in this perspective.

The Center wants to cut across this mutually exclusive arrangement. Right from the beginning, we have brought together scholars working on Europe, the US, and India. While discussing a broad range of disciplinary approaches to emotions (in psychology, anthropology, sociology, philosophy, literary studies, art, music, film, and history), we aimed at an equal input from both academic traditions into the development of our own concepts and methodology. Thus, our emphasis is less on studying historical encounters (though this does have a place in individual studies, see below) than on provoking present-day encounters in theory and methodology.

It would be asking too much to expect each scholar to turn into a specialist on both regions. But we constantly expose researchers working on Europe and the US to such knowledge on India (and vice versa) that makes discussion meaningful and the evolution of a common frame of reference possible. The Center thus provides a model for integrating Western and non-Western knowledge into a common epistemological framework. If successful, this might offer a blueprint for the reorganization of academia, notably as to the position of "area studies" within social science and humanities.

### Cooperation

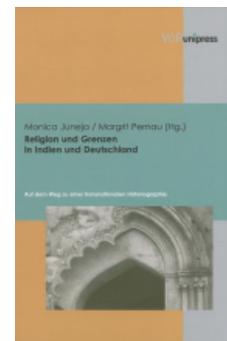
During its short existence, the Center has consciously fostered links of cooperation, both internally and externally. Within the Institute, we started interdisciplinary conversations with the other Centers and the Independent Junior Research Group (IJRG) on "Affect Across the Lifespan." We discussed different perspectives on the emotional framing of doctor-patient relationships with the Center for Adaptive Behavior and Cognition. We asked the Center for Educational Research for advice on teacher-student interaction. We cooperated with neuroscientists from the IJRG on "Neurocognition of Decision Making" in a common project on musical expression of emotions (see under Pernau). We engaged in a ground-breaking dialogue with developmental psychologists from the Center for Lifespan Psychology on respective research questions and methods. This is the most rewarding and intellectually stimulating type of cooperation: approaching other disciplines in order to learn how they perceive emotions on the level of behavior, (re)cognition, and perception/interpretation.

Externally, we cooperate with the newly established Cluster of Excellence at the Free University Berlin that works on "Languages of Emotion." We share crucial questions, and we benefit from the large amount and high quality of scholars in literary studies, musicology, film, and art who participate in the Cluster's research program. Several of those scholars have taken part in our weekly colloquium and vice versa. In addition, close contacts have

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been established with the Einstein Forum that stages a conference series on "Passions in Culture," with the Centre Marc Bloch, with the Graduate School for Muslim Societies and Cultures at the Free University, and with the Institute for African and Asian Studies at Humboldt University.

Internationally, we cooperated with a number of Indian institutions (preparing a workshop in Delhi in March 2009) as well as with the initiative to develop the history of emotions and the history of medicine at Queen Mary, University of London. We established contact

with numerous American, British, Canadian, French, Israeli, Austrian, Swiss, and Scandinavian scholars. Their names either appear in our colloquium series or on the list of guests who will pursue their work on the history of emotions at the Institute in 2009 and 2010. Furthermore, we started talks with relevant colleagues at Yale University (Steven Pincus), at the Graduate Center of City University of New York (Dagmar Herzog), and at the University of Chicago (Dipesh Chakrabarty, Rochona Majumdar) in order to organize joint conferences (summer schools) for graduate students.

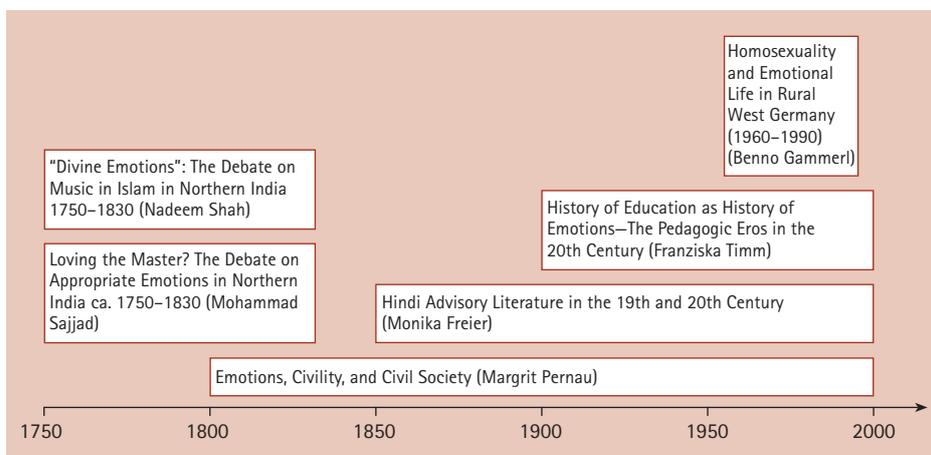
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#### The Center for the History of Emotions in April 2009



Left to right, front row to back row: Ute Frevert, Margrit Pernau, Nina Verheyen, Christa Hämmerle, Benno Gammerl, Salil Misra., Maritta Schleyer, Monique Scheer, Claire Bielby, Franziska Timm, Daniel Brückenhaus, Susanne Michl, Christian Bailey, Mohammad Sajjad, Nadeem Shah, Jan Plamper, Anne Schmidt.

## Research Area: Cultivation of Emotion



### Emotions, Civility, and Civil Society

This project poses two central questions. First: Society is built not just upon a set of institutions but also on certain rules of interaction and, hence, on an emotionology, on knowledge about appropriate emotions. Can we be more precise on the emotional foundation of political and social structures? Second: Civility is often perceived as the foundation of civil society. This concept is, at the same time, historical and normative, endowing the development of the West since the 18th century with universal validity. How does this Western civility relate to other concepts of civility? Taking up Shmuel Eisenstadt's idea of "multiple modernities," can we speak of "multiple civilities"? What is the specificity of the European attempt to civilize emotions? What are the repercussions for the genealogy of civil society?

These questions, with particular consideration to Indian Muslims, are being followed up from the early 19th century to the present, within three different settings. Courtly civility is being investigated with reference to the kingdom of the Asaf Jah dynasty of Hyderabad in southern India. Founded by a general of the Mughal emperors in the early 18th century, the state came under British indirect rule at the turn of the century. While Hyderabad was never isolated from either North India or from the developments in the larger Islamic world, it saw itself as the heir and preserver of

Mughal court culture. Courtly emotions were traditionally symbolized in the twin image of the rose—the nobleman's feelings for the arts and his ability to be moved by love and by the plight of his fellow humans—and the sword—standing for righteous anger, sternness, and courage. It could be suggested that three major shifts occurred during the period under investigation, first the shift from a military to a civil aristocracy in the beginning of the 19th century, second the introduction of administrative reforms and higher education in English for the elite since the 1870s, and, finally, a second wave of bureaucratization and a rising influence of the national movement since the First World War, which tended to delegitimize court culture altogether. The second field of investigation focuses on the rise of the North Indian middle class, which since the middle of the 19th century depicted itself in opposition to the old nobility and to old forms of religiosity. Instead of the importance of the ruler or the saint for upholding a moral world order, in which civility and civil emotions were alone held possible, they emphasized the responsibility of every individual. The methodical lifestyle advocated made the control of emotions necessary. As for the Victorians, but in no direct and unequivocal genealogical dependence from their ideas, it was the family and (later) the nation that provided a refuge for legitimately strong emotions. Up to the present day, social mobil-

### Researcher

Margrit Pernau

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Figure 2. 25th jubilee of the coronation of Mir Osman Ali Khan, Nizam of Hyderabad (1936).

Source. Yadgar-e Silver Jubilee-e Asaf Sabe'.

ity is predicated upon the learning of rules of deportment and of feeling, which alone can transform a newly rich into a respectable person. The third field of investigation concentrates on Unani medicine. This medical system originated in the reception of classical Greek (Ionian) medicine and its humoral pathology by Arab scholars and later integrated elements of the Hindu Ayurveda. The knowledge on the interrelations between the body, the emotions, and civility laid down in treatises and journals of the 19th and 20th century emphasizes that, while the bodily constitution of a person predisposes him/her for certain feelings—an excess of yellow bile for instance inducing anger, the inverse also holds true: Health, the equilibrium of the humors, can be reached through the equilibrium of emotions. Together they form a precondition for virtue, on the individual as well as on the social level. Besides charting the field of the secondary literature, a substantial part of the sources on Indo-Persian emotionology has been collected, ranging from princely mirrors, panegyric biographies, educational texts, ethical treatises,

journals, and advice literature in Urdu and Persian, which remain to be translated. First in-depth analyses have permitted to refine the methodology, notable in the field of the entanglement of colonial and indigenous notions of civility.

A number of PhD theses explore complementary aspects of this project. The dissertations of Nadeem Shah and Muhammad Sajjad focus on the transition period from the 18th to the 19th century and hence permit to gauge the impact of colonial rule through its comparison to developments already under way before. The dissertation of Maritta Schleyer, on the other hand, permits a detailed view on the interrelationship between religious and nationalist emotions in the first half of 20th century North India. As the entanglement between Muslim and Hindu emotionology has as yet hardly ever been explored, the dissertation by Monika Freier provides the opportunity to draw out the interactive elements in the construction of religious identities of both communities.

### Nonverbal Expression of Emotions

Verbal sources provide information about emotionology; they are also one of the means through which people express their emotions. This project aims to look at possibilities to

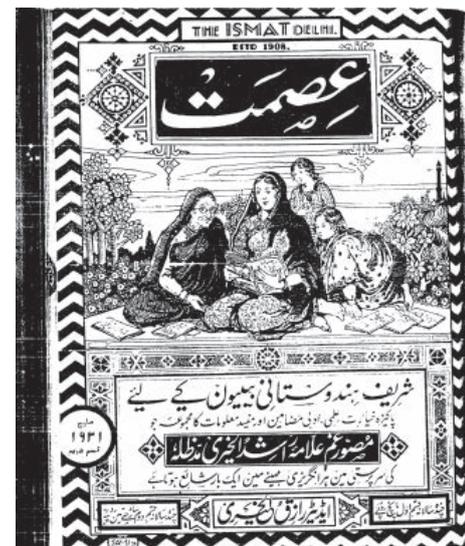


Figure 3. Magazine for Educated Ladies, Delhi.

Source. Ismat, Issue March 1931.



Figure 4. Workshop with Vidya Shah, October 2008.

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get at emotions expressed through nonverbal media, even if the actors do not themselves provide a "translation" into language. In a workshop on Indian music conducted in cooperation with Isabel Dziobek from the Independent Junior Research Group, Neuro-cognition of Decision Making of the Institute, we tried to explore whether cooperation with psychologists and neuroscientists could help us to decipher these emotions. In a live performance, Vidya Shah, an Indian vocalist, sang songs expressing different emotions. Participants with different degrees of familiarity with Indian classical music were asked to identify the expressed emotions and to classify their own reactions to the music. While the setting of the experiment certainly would require further refinement, it has shown that emotions can be evoked without language. The German audience, even without prior knowledge, had no difficulty of "feeling the music." However, a commu-

nication about the precise kind of emotional experience is not possible without language. Every form of scientific testing and interpretation of test results takes place within a very specific linguistic and cultural frame, to which a direct access, circumventing the learning and translation process, is not possible. The basic difference between the approaches of the disciplines thus has not been eradicated, but confirmed. However, disagreement is not the end, and discussions on how to integrate music and other nonverbal expressions of emotions into the core of our projects are presently going on. Clifford Geertz's dictum might become a motto for the collaborative ventures at the Max Planck Institute for Human Development: "Progress is marked less by a perfection of consensus than by a refinement of debate. What gets better is the precision with which we vex each other" (C. Geertz, 1973, *The interpretation of cultures*, p. 29).

**Researcher**  
Nadeem Shah

**“Divine Emotions”: The Debate on Music in Islam in North India 1750–1830**

There has been a perennial debate in Islam on the permissibility of “music.” Despite opposition from certain sections, some Sufis have practiced spiritual music throughout history. For them, the spiritual music engenders a feeling of deep ecstasy and love and helps them unite with the Ultimate Reality. Viewed from the methodological standpoint of emotionology, the study of Sufi music during the late 18th and 19th century opens up new vistas of research. As the era was one of intense debates, reforms, and discourses among the religious/literary elites, the debate on music came to represent diverse “rules of feeling.” The preliminary research conducted on the basis of existing theories of emotions indicates that there exists a possibility to find out if there was a trend toward cultivating new emotions or to give new orientation to the emotions regarding music. The debate among the reformers on the appropriate emotions regarding music appears to have placed emphasis on more constraints and regulations. However, a great deal of ambivalence

and inconsistency in their stated positions on music poses a greater challenge to the existing theories of emotions.

A comprehensive study of the available sources will put the theories of emotions to a close scrutiny. Secondary literature indicates that this particular phase (1750–1830) was a watershed in the history of Indian Muslims, marked by an overall intellectual churning. It triggered off numerous debates and discussions on discourses of religious reforms, perceptions of colonial intervention, and sociopolitical vision of Muslim elites in the contemporary period and subsequently. It is, indeed, worthwhile to assess the dominant emotionologies on music of this period within context. The ideas and attitudes of the contemporary Sufis/Ulema (religious elites) toward music offer an insight into the overall emotional flux in North India at this time. The multiple emotionologies on music which appear to have been formulated during this period hold out a promise to review the developments in literary, cultural, political, and religious activities in North India during the late 18th and 19th century.

Figure 5. Sufi musicians.

© Margrit Pernau



### Loving the Master?

#### The Debate on Appropriate Emotions in North India ca. 1750–1830

In Islamic mysticism, the relationship between the spiritual master and the disciples is based on love and devotion. The Sufi masters prescribed for the disciples a strict discipline containing "emotion rules." This project looks at the standards for the love relationship between the master and his disciples in late 18th and early 19th century India.

In this period, the nature of this relationship underwent a change. It was debated by the reformist scholars who asked the Muslims to rethink their practices, access the primary sources, and shift their focus from the other-worldly to this-worldly aspects of Islam. Hence, they criticized the intercessionary beliefs and customary Sufi practices and rituals, such as Sufi music and the annual festive ceremony, performed at the Sufi hospices or shrines in the name of expressing devotion, respect, and love to the masters. The reformists redefined the meaning of human and divine love. This study aims to trace the link between emotions and the effective strategies

of the reformist movement to purge Indian Islam of local influences and ultimately wage a war against the Sikhs and the British. The debate helps to understand how emotions were shaped by the contemporary sociocultural situation and provides the background behind the division of Indian Muslims into different sects in the 19th century. The study assumes that there were different groups or institutions within the Indian Muslim community holding different notions of emotions and styles of expressing them. This debate will also demonstrate the ideological positions of the contemporary mystics and scholars on the appropriateness or inappropriateness of certain emotions. At the initial stage, the sources and materials that shed light on the contemporary social and religious conditions, as well as the precepts and practices of different mystical traditions, are collected. This study endeavors to place the different attitudes of the mystics and scholars of India within the larger framework of the history of emotions and will, in future, contribute to a comparative study of emotions in different cultures.

### Researcher

Mohammed Sajjad



Figure 6. Morning prayers at the tomb of Hazrat Nizamuddin Aulia, Delhi.

© Agentur VII, John Stanmeyer

**Researcher**  
Franziska Timm

### **History of Education as History of Emotions—The Pedagogic Eros in the 20th Century**

Pedagogic eros is still in our days thought to motivate teachers to conduct their work with enthusiasm and passion. It is surprising at this point that pedagogic engagement is perceived as "eros," whose sexual connotations are inappropriate for contemporary education concepts. It would be justified to claim that this idea, whereby there is a close relationship between sensual love and educational practice, is an euphemism for perversity and sexual violence. This project aims to investigate the idea of pedagogic eros in the 20th century in a historically systematic approach and with the application of semantic field analysis, to explore four different research areas.

- (1) Firstly, in the area of pedagogic and educational discourse, treatises and professional documents, apologies and newspaper articles, as well as writings related to educational science and lexica are analyzed with regards to the meaning and legitimizing of pedagogic eros.
- (2) Secondly, the project aims to shed some light on pedagogic advice literature that was supposed to shape teacher behavior and professional ethos. Relevant keywords in those sources are terms like "personality of the teacher" and "favorite student."
- (3) As the subtle practices of pedagogic eros are not discussed in the previously mentioned areas, the fictional treatment of the subject is taken into consideration. Autobiographical novels highlight the pupils' perspective, in particular, and offer an insight into the emotional world harbored within pedagogic relationships, for instance, "Girls in Uniform" by Christa Winslow, "Entangled Emotions" by Stefan Zweig, or "Ruth" by Lou Andreas-Salomé.
- (4) Finally, specific cases, where the teacher-pupil relationship was characterized as pedagogic eros, are studied. Recently, published documents lead to further research on this subject in archives like the Secret State Archive, the Diary Archive in Emmendingen and the Odenwald School.

Until now, the first and the fourth areas of research have produced results. Although eros is only marginally mentioned in teacher advice literature, education specialists often referred to it in order to discuss pedagogic matters. What seems to be problematic is the antinomy between coming close and keeping a distance, the personal as opposed to the objective, elites versus equal chances, or the femininity in educational relationships. For the daily teaching practice, eros was a controversial reference value. Cases from modern history include the pedagogic relationship between Alfred Schmid, founder of the youth group "Grey Corps" (1930), and the young Dietmar Lauer mann, or between Hans Dietrich Hellbach, music and German teacher at the Paulsen School in Steglitz, Berlin, and his students during the 1940s and 1950s. In both cases, eros was manifested in two individuals involved in an educational relationship, echoing the archetype of the ancient Greek pederasty and serving as a mechanism for the reproduction of a patriarchal social model. However, aside from those important discrediting aspects, it could be suggested that eros performs an essential conciliating function between generations. It can be argued that the gap between teachers and pupils, growing larger through adolescence, could be bridged with the idolizing associated with pedagogic eros.

### Hindi Advisory Literature in the 19th and 20th Century

This research project focuses on the importance of the cultivation of emotions in North India from 1870 to 1947, exploring both individual (subject-formation) and collective (community-formation) levels. Analyzing advisory literature will draw light on notions such as Indian and Hindu identity in a period of extensive socioeconomic and political change.

Methodological starting point of this project is the concept of emotionology. The cultivation of certain emotions, as propagated in advice manuals, sets up standards or “feeling rules” that transcend the private domestic sphere. Existing studies on advisory literature in Indian languages underpin this argument, often focusing on female gender roles and societal shifts in the late 19th to early 20th century.

Looking at a broader context for Hindi advisory literature will allow us to better understand the negotiation and mainstreaming

of political, religious, and gender identities. Specifically looking at Hindi advice manuals, it is argued that they mirror the establishment of an alleged homogenous identity. The concept of an ideal Hindu behavior, drawn from images of past glory, is linked to the dissociation from cultural practices that are depicted as foreign and, therefore, threatening. This historical process is demonstrated in the way emotional standards are set up and undergo changes in advisory literature.

It is essential for the initial stage of this research project to examine a broad range of source material. A representative collection of advice manuals can be accessed in several North Indian libraries as well as the British Library. Supplementary sources—fictional works that explicitly state an educational aim, magazines addressing female and male audiences—will also be taken into consideration. Textual analysis of the sources reveals the ways in which emotions are depicted, the mechanism of cultivating and controlling them as well as underlying body concepts. Further in-depth research includes the influence of institutions, such as the colonial state and Hindu religious reformatory groups, working through schools, associations, and publishers.

By defining advisory literature as part of a wider cultural practice, the research project aims to draw conclusions on how changes in emotional patterns interact with, or even precede other aspects of social change. In order to set up a methodological tool box, the role of emotions in contemporary Hindi advice manuals will be investigated first.

**Researcher**  
Monika Freier

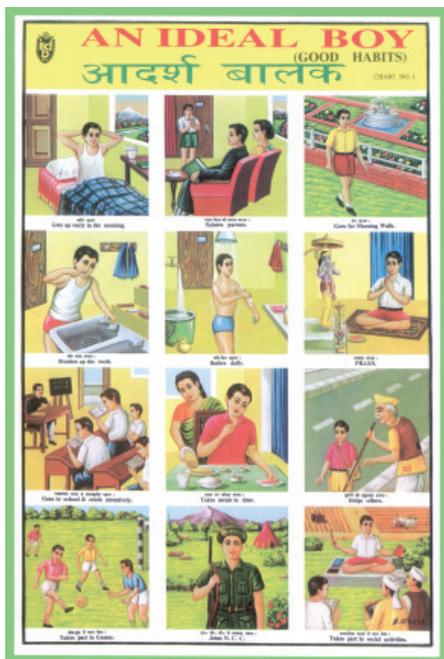


Figure 7. Educational poster used for classroom instruction and as decoration.

Source. Rao, Sirish, Geetha, V., & Wolf, G. (Eds.). (2001). *An ideal boy: Charts from India*. Published by Dewi Lewis.

**Researcher**  
Benno Gammerl

**Homosexuality and Emotional Life in Rural West Germany (1960–1990)**

This research project explores the emotional history of rural homosexuality that has not gained much attention so far and, by applying qualitative research methods, it aims to answer the following questions: How and why did emotional concepts and practices, role models and behavioral patterns, change between 1960 and 1990, that is, while the social acceptance of homosexuality (slowly) increased? Which emotional repertoires –between friendship and love or handshake and kiss–were influential within intimate same-sex relationships, and how were they implemented, appropriated, and transformed by individual actors in specific situations? Thus, the project operates on two different levels. On the one hand, it scrutinizes the available models for intimacy and emotional repertoires by analyzing gay and lesbian magazines as well as certain films and books. On this level, the changing patterns of heterosexual intimacy—for example, the growing acceptance toward unmarried couples or the attribution of therapeutic qualities to relationships, to name but two, are also taken into account. On the other hand, a number of contemporary witnesses are interviewed as part of the project. These oral history sources allow the author to reconstruct individual emotional biographies and to discern different types of handling and expressing feelings in particular situations and constellations. While analyzing those differences, a number of criteria have to be taken into account, including gender, generation, and the contrast between rural and urban settings. As the main work that has been done so far was dedicated to the second level, the

preliminary results gained on the first level of research will only be summarized shortly to indicate the outline of the argument. Through an analysis of numerous male-to-male “lonely-hearts” advertisements it emerges that the desired relationships were often described as “comradeship” (*Kameradschaft*) and “ideal friendship” (*ideale Freundschaft*) in the 1960s, whereas the word “love” (*Liebe*) was not used until the late 1980s. Another significant change is that from the 1970s onward, a willingness to talk (*Gesprächsbereitschaft*) was increasingly expected from the prospective partner. These shifts exemplify what can be referred to as the transition from a hearty (*herzlichen*) to a tender (*zärtlichen*) emotional vocabulary or repertoire for male-to-male intimacy between 1960 and 1990. These changes correspond to the growing social acceptance of homosexuality, as well as to the transformation of heterosexual relationship patterns. They demonstrate the ways in which different models for the understanding and expression of feelings between same-sex partners were available at different historical moments.

On the second level, the research project explores the ways in which these varying models and patterns were appropriated, adopted, and negotiated within individual emotional practices. These questions will be addressed on the basis of qualitative interviews with 32 women and men aged between 36 and 75 years, who have lived in rural areas of Germany and have experienced intimate situations with persons of the same sex between 1960 and 1990. We searched for suitable contemporary witnesses via the internet by distributing flyers and through advertisements in gay and lesbian magazines as well as in local newspapers.

Table 1  
Survey Sample by Gender and Age Group

Gender	Age group								Total
	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	
Female	3	2	1	3	4	0	2	0	15
Male	1	2	3	3	2	2	2	2	17
Total	4	4	4	6	6	2	4	2	32



Figure 8. Logo of the project "anders fühlen."

© Frank Schulz

More than 100 people responded to our appeal. Out of those, a group of 15 women and 17 men was selected, constituting a multifaceted cluster based on their age and level of education.

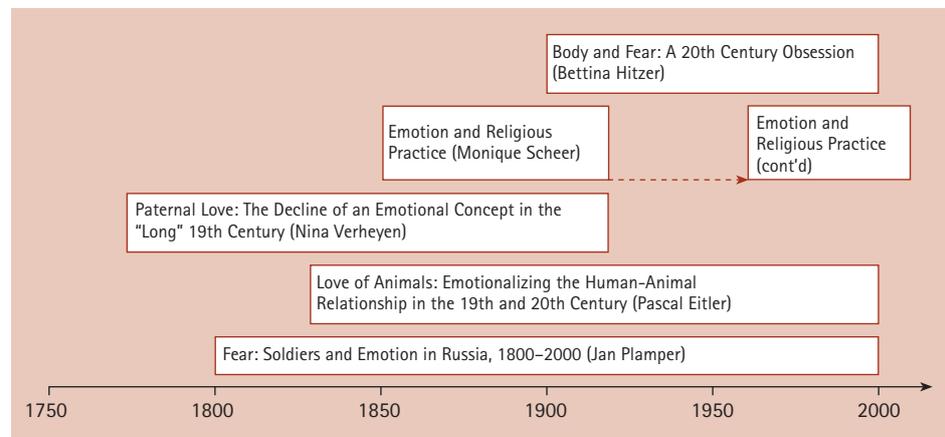
So far, 15 interviews have been conducted, and it has already become evident that the biographical experiences of the interviewees are quite varied. Several of them are or were married, several of them have children, most of them have moved from a rural to an urban environment, however, a number also moved in the opposite direction, for instance, founding lesbian communities in the countryside in the 1970s. There are two conversations with each respondent, usually on two consecutive days. The first one is a narrative/biographical interview that helps to reconstruct the biographical context and background of the emotional experiences and practices that are the subject of the second talk. The latter is a semistructured interview that follows an outline covering a range of nine different topics. The questions are partially adjusted to each individual case, based on the information gathered in the first conversation. They primarily address the handling and the expression of emotions in different contexts and situations.

These qualitative data containing memories and stories related to experiences will, on the one hand, be summed up in emotional biographies concentrating on the ways in which respondents described, understood, and

made sense of the changing manner in which they dealt with their feelings during their life course. On the other hand, the data will be analyzed by identifying certain semantic, narrative, metaphorical, or rhetoric patterns and by looking for significant recurrences and distributions of these patterns. These findings will subsequently allow for the formulation of a typology describing different modes of emotional experience in the context of homosexuality and of recalling and reporting those experiences. At a final stage, the goal is to find out whether these types can be related to a distinction between rural and urban contexts, whether they are gender specific, or whether they can be linked to certain generational characteristics.

Finally, the two levels of analysis will be combined by establishing connections between the models of perceiving and displaying emotions that were available at certain historical moments in magazines, films or otherwise, and the individual memories and narratives. By describing approximations, contradictions, and modulations, and by relating these to changes within the social context at large, the aim is to develop a framework for interpreting the change of emotional patterns and performances.

## Research Area: Emotion and Body



### Researcher

Pascal Eitler

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### Love of Animals: Emotionalizing the Human-Animal Relationship in the 19th and 20th Century

A large part of modern society takes the love of animals for granted. On an individual level, this phenomenon was already quite known in the Middle Ages, as in early modern times. However, on a social level, this form of emotionalizing the human-animal relationship was, to a great extent, unknown until the mid-19th century.

This research project explores discourses and practices of emotionalizing and de-emotionalizing the human-animal relationship between the mid-19th and the end of the 20th century in Western Europe and North America with the focus on Germany. During this period, public awareness and social relevance regarding the love-of-animals phenomenon really exploded not only in Germany but also in Switzerland, Britain, France, and the United States. The project aims to view this phenomenon within a historic and social context, posing questions concerning the changes in the cultural conditions and ramifications of the love of animals. In this manner, the goal is not only to prevent a scientifically unproductive moralizing of the human-animal relationship; instead, it must be argued that (in contrast to the common claim) animals do not simply "have" feelings by nature; furthermore, the feelings that animals "have" are not more basic forms of human emotions, as is often

supposed according to Darwin. What is much more important is that particular emotions were at first attributed to particular animals, an attitude that was later challenged. Drawing on the example of the love of animals, this research project is directed against a problematic naturalization of emotions. From the perspective of cultural history and discourse analysis, in order for emotions to be experienced, not only does one have to display and perceive them, one must also match and classify them, recognize, or deny them. In this sense, the human-animal relationship represents a reference value for people to define themselves and their emotions in a wider context: People need to be recognized and respected by themselves and by other people, they must be shown to differ from animals, and one important aspect of this is the way they deal with emotions. In this regard, the project is aimed at three different directions:

- the changes in the relationship of humans with their pets within families;
- people's views toward laboratory animals used for experiments;
- the different reactions concerning "wild" animals kept in zoos.

Between the mid-19th century and the end of the 20th century, those three kinds of human-animal relationships went through a social process of emotionalizing (or de-emotionalizing). This process was interacting in hugely varied ways with processes of moralizing and

politicizing as well as processes attributing to those relationships aesthetic and pedagogic values. The love of animals was not, therefore, an isolated phenomenon. With the emphasis on Germany, the research combines different groups of sources, such as periodicals of the animal protection movement, advice literature, scientific compendiums, and lexica, as well as selected newspapers, novels, and films. Based on these references, the project demonstrates that for the past 150 years the love of animals has been tightly connected with controversial disputes regarding the questionable relationship between politics and morality, the possible importance of scientific progress, and the constantly changing family role models and education standards. At this point, the research on the love of animals with the focus on laboratory animals is almost complete. In the case of the growing protests against animal testing (in Britain already since the 1840s and in Germany since the 1880s), the emotionalizing of the human-animal relationship was combined with a successive moralizing of animal life and feelings. The protest against animal testing was in this respect also a struggle concerning the hegemonic interpretation of the terms "life" and "feelings," between life sciences and conventional medicine, on one side, and philosophy and alternative medicine, on the other. In this connection, the borders differentiating humans from animals have shifted more and more during the 19th and 20th century, and there have actually been occasions when those borders were completely blurred: Since the mid-19th century and in reference to Arthur Schopenhauer, on the one hand, and Charles Darwin, on the other, man has been linked to animals as "relatives." With Schopenhauer and Darwin in mind, emotions obtained an important position within this social debate regarding the human-animal relationship. The question was posed: Do animals possess emotions? If yes, then which emotions? Should humans have emotions toward animals? If yes, toward which animals? In this context, the project examines different groups of sources especially for changing semantics of emotions (contrasting, e.g., "affects" and "reflexes") and different

strategies of emotionalizing animals (e.g., by referring to the "pain" or "fear" of laboratory animals). It can be argued that portraying such emotions was not only the most successful way of emotionalizing and moralizing the human-animal relationship but probably of verifying emotions as such.

The next step from this stage is to historically reconstruct the relationship between laboratory animals and pets: Often it was the same animals, cats and dogs in particular, dominating public awareness and private affirmation during the 19th and 20th century. Until the 1970s, it was mainly mammals, mostly cats and dogs, that were in the focus of this process of emotionalizing and moralizing; hardly any feelings were attributed to other kinds of animals. It can, therefore, be suggested that the emotionalizing of the human-animal relationship moved from the private sphere into the public arena.

On this question, as well as others, the project treads on new scientific territory, considering the gaps in the current research. What has been available until now is a wide range of philosophical interpretations, but hardly any empirical research on the human-animal relationship from a historical perspective (especially for the German case). For this reason, the project is focusing on reconstructing and analyzing historically significant changes in the human-animal relationship, concentrating on specific time frames and developments in the love of animals regarding processes of emotionalizing or de-emotionalizing.



Figure 9. Illustration of the debate on vivisection.

Source. Christoph Schultz, *Ein Beitrag zur Vivisectionsfrage*, Berlin, 1881, p. 34.

**Researcher**  
Bettina Hitzer

### Body and Fear: A 20th Century Obsession

The research project examines the changes in the way people dealt with body fears during the 20th century, particularly in Germany between 1890 and 1970. The term body fear includes a group of fears caused by potential changes to the body. At the foundation of the project, several assumptions have been taken into consideration.

The healthy body acquired a specific meaning and importance in the West during the 20th century. Infant and child death rates decreased significantly during the 19th century, while life expectancy rose. The spectacular successes of bacteriology in the late 19th century against a number of infectious diseases led to an unprecedented euphoria and the belief that all illnesses could be eradicated with the inexorable progress of medicine. At the turn of the 20th century, the idea of a healthy body was compressed into the image of a young, beautiful, and productive (in both senses of the word) body, and this was the desired model for the nation. The development and popularization of technologies, enabling people to preserve and improve their health, is tightly connected with the idea that health can be universally achieved (Foucault). The concept of precaution, or even prevention that became keynote in the

20th century is also related to that development. This modern form of prevention interferes directly with the body as it manipulates it and is tightly connected to a turn of the body toward medicine and drugs as well as an increasing risk discourse regarding the body. Prevention is increasingly important as part of the individual's sense of self-responsibility, perceived as a moral and financial duty that everyone owes to society.

How and why did fears related to the body change in the 20th century?

The first results indicate that body fears, in the sense of fears regarding the deterioration of the body, pain and loss of body autonomy, seem to have gained ground, whereas fear of the "great" death seems to have subsided. With regard to the relationship between body fears and anxieties of the soul, there does not seem to be a linear development, rather, this relationship was defined by a complexity of factors. In any case, it seems that cases of deterioration of the body are mentioned as an issue more toward the end of the 19th century than at the beginning of the 1960s. It was first during the 1960s that a series of taboos was broken, and people started to be more open about deterioration of the body. For the first time, the feelings of the affected people, such as fear, pain, and sense of shame became the focus of attention, whereas before those feelings were only hinted at.

The idea that everyone can manage to stay healthy and even to avoid death proved to be extremely important. Since this idea was proposed by various health industry stakeholders, people had to learn to care for prevention and awareness regarding the dangers that threatened their bodies but also to have the responsibility for their own health or illnesses. To what extent and in which ways this was managed will be among the questions further examined within this project. Another question posed as the project continues is whether prevention and the promise for a healthy body possibly caused more body fears by raising the hopes that people could cheat death or at least delay it by enjoying better health.

These questions and hypotheses are highlighted through two relevant examples: on the one hand, how people deal with cancer in

Figure 10. Campaign against cancer, 1931.

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public and, on the other, the social perception of old age. Following the decrease of infectious diseases during the 20th century, cancer has become the most dreaded disease in the West and is, therefore, particularly relevant to the project. At the same time, old age acquired a new meaning in the 20th century, when society became fixated upon staying young, efficient, and productive. The new credo is: live long and stay young. Prevention and rejuvenation appear to be more and more achievable. Therefore, old age is also of vital importance in relation to body fears. Within the research project, three areas related to fears of body changes have been identified:

- (1) the perspective of those who could be possibly affected;
- (2) the public display and representation of emotions;
- (3) how people coped with those emotions as well as the social, political, and financial relevance of those anxieties.

In order to explore these levels, a variety of sources will be used, namely, newspaper and journal articles, novels, photos, films, reviews, letters (written in response to relevant publications, events, campaigns, as well as medical and pharmaceutical innovations and scandals), archive material from pharmaceuticals, and insurance companies and health authorities (regarding prevention, prescribing medicine, and research).

The next phase of the project will include an analysis of the interrelation between body fears and body hopes in the sense of managing to be healthy, with detailed reference to the social perceptions about cancer and old age as well as regarding health policies and economic relevance of body fears. It will also be useful, at this point, to examine how various health specialists assess body fears, and which role those ratings play in offering, financing, and marketing preventive and early diagnostic treatments.



Figure 11. The ladder of life.

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## Researcher

Jan Plamper

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## Fear: Soldiers and Emotion in Russia, 1800–2000

"The most important feeling which governs all thoughts and actions before and after combat, (...) is the feeling of fear," wrote the Russian émigré General P. N. Krasnov in 1927 (Krasnov, 1927). This project investigates these feelings of fear from several perspectives. On the one hand, it attempts to reconstruct the specific notions of fear circulating in and among soldiers, to understand how they actually dealt with their fears, and to examine how fear influenced soldierly actions in a concrete situation like a battle. On the other hand, it seeks to describe the army's attempts to shape and regulate these emotions, including the place of fear within Russian military psychiatry's diagnostic tools and treatment of "shell-shocked" troops. Related constructs, like panic and hysteria, but also honor, bravery, and especially the issue of masculinity, will likewise figure prominently. The corporeal dimension is critical here—hence, the inclusion under Research Area "Emotion and Body." The focus is on the Russian army and the Russo–Japanese War and the First World War (1904–1905, 1914–1918), an apt case to probe these issues: Few armies exhibited a more volatile mixture of modern and premodern characteristics, and few wars in history have left more written traces of fear-talk by soldiers, officers, military theorists, and military psychiatrists.

Specifically, the project asks:

- (1) how soldiers were conditioned to cope with their fear,
- (2) how they actually dealt with their fear, and
- (3) how they were treated when they could not cope and broke down with fear-related symptoms.

The tentative structure of the monograph conforms to these three questions:

### *Part One: Conditioning*

Chapter 1: Drill: The Formation of an "Emotional Regime"

Chapter 2: Detering Fearful Behavior: Legal Discourse and Legal Practice

### *Part Two: Practices*

Chapter 3: Acting out of Fear, Coping With Fear

### *Part Three: Trauma*

Chapter 4: Military Psychiatry: Diagnosis and Treatment

Chapter 5: Masculinity: Resocialization and Honor

In Part One, Chapter 1 deals with the training of recruits and the emergence of a distinct "emotional regime" (Reddy, 2001). A number of sources informed Russian military drill. One was military theory, for example, by General M. Dragomirov, who developed a doctrine of "controlled berserkerdom," according to which the superiority of Russian peasant soldiers over their "decadent" Western counterparts rested on the capacity to unleash (and reign in) their animalistic premodern selves on command. This military theory belongs in other scholarly contexts (philosophy, theology, and social sciences) as well as literary and non-Russian contexts (e.g., Tolstoy's and von Clausewitz's writings). This chapter also examines such sources as officer handbooks for the training of recruits and the sermons of military priests, Imans, and Rabbis who were instrumental in justifying killing despite religious taboos. Chapter 2 moves from the norms of abstract training and practical drill to everyday discipline, that is, the reinforcement of the army's emotional regime by way of punishing its transgression. It thus addresses how military authorities responded to certain forms of undesirable behavior that were attributed to fear—desertion, mass panic, and self-mutilation. Its basis is published legal sources and unpublished files of military tribunals.

Part Two turns to soldiers who had undergone military training and to their experience of fear before and in combat. Based on memoirs, letters, ethnographic studies, and archival sources (e.g., perustration reports), Chapter 3 reviews the entire spectrum of fearful behavior among soldiers. It describes such phenomena as the deliberate missing of a target and the somatic markers of fear (trembling, profuse sweating, and involuntary urination). It details the objects of fear, ranging from fear-inspiring persons (officers) to the experience of having to look into the eyes of a dying enemy soldier, a trope one frequently encounters in memoirs. Furthermore, it inquires

into how soldiers made sense of their fear. In particular, it reconstructs how soldiers conquered their fear by dehumanizing the enemy and with the aid of religion, superstition, and psychological rationalization ("if I hadn't shot him, he would have shot me"). It also treats the issue of solidarity in the microcommunity of the military unit (constituting a mirror of the macrocommunity of the nation). This community was held together both by outside threat and by the fear of shame, for instance, for being apprehended as a coward by one's fellow soldiers. Under the rubric of "strategies of coping," the chapter subsumes phenomena like battle cries, humor, cursing, alcohol, singing but also breathing techniques and the compulsive repetition of everyday tasks, such as cleaning one's rifle. The chapter also attempts a thick description of a specific battle, for which it hopes to provide a fresh reading by taking into account fear as an explanatory factor for soldiers' actions that have, so far, seemed enigmatic.

Part Three turns to those soldiers who could not cope with fear, the greatest psychological stress in warfare. Based on published military psychiatry and first studies on Russian military psychiatry, Chapter 5 discusses the Russian diagnoses, etiologies, and therapies of "shell shock." Chapter 6 deals with the reintegration of traumatized soldiers into society. Through the prism of social welfare, this chapter touches on questions of valor, honor, and masculinity, all of which were enmeshed with the emotion of fear.

While the project has led to such spin-offs as the first book-length introduction to the history of emotions, the special value of a Russian case study—much like the Indian case studies in the Research Center "History of Emotions"—is this: As a prime exemplar of "combined underdevelopment" (Leon Trotsky) or the "simultaneity of the un-simultaneous" (*Gleichzeitigkeit des Ungleichzeitigen*, Ernst Bloch), Russia casts a new light on Western European developments in the areas of emotions and military psychiatry. Wherever possible, the project looks back into the 19th century and forward into the 20th. Ultimately, an understanding of the historically grown culture of fear in the Russian military might

allow us, for example, to better comprehend the actions of Russian forces in today's Chechnya and Georgia. This contemporary relevance extends beyond Russia, as problems associated with soldiers' fear are not likely to go away any time soon. Thus, in 2003 during the Iraq War, the U.S. Army initiated its first cowardice prosecution since 1968, charging Sergeant Pogany, aged 33, with "cowardly conduct as a result of fear" (Glassman, 2004). In so doing, it reconnected to an old pattern of punishing fear-related behavior by soldiers, a pattern that goes back to the ancient Chinese and Greek military thinkers. This pattern was put on hold during the Vietnam War because of the inroads psychoanalysis had made in military psychiatry. Today, with a new generation of antidepressants widely prescribed by military psychiatrists, tolerance for fear-related behavior has decreased and brought punishment back on the agenda. It is surprising that the story of soldierly fear, that "most important feeling which governs all thoughts and actions before and after combat," has never been told in greater depth. This project seeks to remedy this.

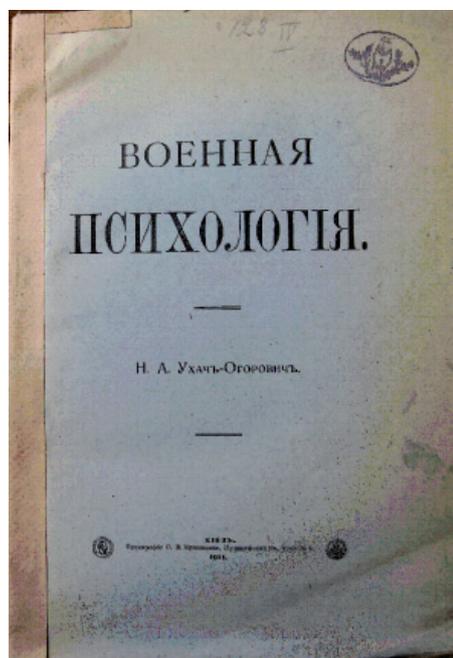


Figure 12. Book cover of N. A. Ukhach-Ogorovich. (1911). *Voennaiia psikhologija* [Military psychology]. Kiev: S. V. Kulzhenko.

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Monique Scheer

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## Emotion and Religious Practice

In the last of his lectures on the "Varieties of Religious Experience," William James takes stock of the typical characteristics of religion. "In illustrating these characteristics," he writes, "we have been literally bathed in sentiment. In re-reading my manuscript, I am almost appalled at the amount of emotionality which I find in it." Though James the psychologist continually displayed great sympathy for the subjects of his study and essentially agreed that religious belief was rooted in physical experience, emotional rather than rational ("Instinct leads, intelligence does but follow"), James the bourgeois subject could not but be offended by the extravagant expression of that feeling. Theologians, too, (which James was not) have their difficulties with religious emotions. Whether the "feeling" of a supernatural reality can be trusted, and, therefore, whether emotional intensity should be sought in devotional practice, is a subject of intense debate across religions and time periods. Like any other feeling, religious emotion is also subject to social regulation and interpretation. What is more, social rules regarding the experience and expression of emotion in religious practice are constitutive of religious identities. Becoming a member of a certain religious group entails learning to feel and to express in accordance with the conventions and beliefs of that group. The project on "Ecstasies, Outbursts, and Rants: Emotional Religious Practices Among Revivalist Protestant Groups in Germany Since the 19th Century" analyzes the relation between emotional norms and religious experience among those who cultivate highly emotional practices as well as among those who scorn them.

The study combines anthropological and historical approaches. Fieldwork among neo-Pentecostals—known for the intensity of their emotional practices—and among mainline Protestants focuses on how they talk about emotions in relation to their religious practice. This information is situated in broader historical contexts through the examination of sources which discuss the same issues in the 19th century, including polemics against revivalist groups, apologetic writings defend-

ing the cultivation of intense emotional states in church, and first-person conversion accounts that discuss religious experience in terms of emotions. The recent history of enthusiastic religious practices in Germany is closely intertwined with that of the US: early Methodists from England and the US communicated with German Pietists, and German immigrants to America often returned to their homeland as converts to a new revivalist-style religiosity. This transnational network also plays into debates about emotional styles between different religious communities, and it remains visible today in neo-Pentecostal/charismatic churches.

Religious feelings are generally seen as "arising" when they are "triggered" by religious practices, such as singing a hymn, murmuring a prayer, and listening to a sermon. Social rules only regulate the extent to which individuals are "permitted" to express these emotions—for example, it is thought that in the Black American church they are allowed to flow freely, without much constraint, whereas in a German Lutheran church one is expected to keep such feelings to oneself. The approach taken in this investigation challenges this view, assuming, rather, that emotions (and their absence) are learned and practiced, as a "technique of the body" (M. Mauss). The religious practices of a particular group are bound up with the emotional practices they cultivate; they are designed to produce certain feelings, which are nevertheless experienced as involuntary, adding to their persuasive force.

Different religious cultures privilege different senses in the cultivation of their emotional practices. The Catholic case, for instance, foregrounds sacred images, emphasizing the primacy of vision as a channel for the cultivation of emotionally charged communication with the divine and culminating in the apparition experience. Another important sensory channel is hearing, from the inspiration provided by music and speech to the experience of supernatural auditions. The study currently underway tests the hypothesis that charismatic Christians see emotion itself as a form of communication with the divine: The perception of bodily feelings is

learned, practiced, and interpreted as a part of religious practice.

A previous study on Marian apparition cults in postwar Germany showed that they rely heavily on the expression of emotion by child "seers" who act as mediators for the assembled devotees in their interactions with divine beings, such as the Virgin Mary and the child Jesus. In one particularly well-documented apparition cult, the sources are a window on the seers' activities, indicating that they use bodily techniques from play habits to learn to experience religious emotions. It also became clear that the emotions of the participants observing and interpreting the children's activities contribute to the conviction that the divine beings are there to help them cope with war-related anxiety and grief. It can be argued that the Christian models underlying these emotional expressions function according to a circular logic: While learning to quell their fear, to console their grief, participants also learn to be fearful and to express their pain. This is confirmed by polemics directed against these religious practices: Critics claimed that rather than consoling, Marian apparitions engendered unacceptable images of a vengeful God and struck fear into the hearts of devotees. The current project builds on this work on the relation between religion and emotional practices as well as the use of a broad range of historical sources to access conflicting discourses.

The approach based on the notion of "bodily techniques," which allows for emotions to be learned and cultivated, their expression practiced, at times "merely performed" and at others experienced as involuntary and spontaneous, conceptually unites cognitive and bodily knowledge, bridging the gap between discourse and experience.

This approach emphasizes that cognitive and physical components of emotions are inextricably intertwined, that learning to name a feeling and learning to have it cannot be neatly separated. Thus, a study of emotions in religious practices must take discourses about emotions into account if one wants to understand what people are experiencing and why. Throughout this period, debates between "enthusiasts" and "antienthusiasts" are also debates about the status of emotions—where they come from and what they mean. On the one hand, emotions are seen as spontaneous, "natural," and therefore somehow "authentic." The religious meanings given to emotions—feelings of joy as evidence of the presence of the divine, for example—only become plausible based on this consensus about emotions. But other discursive forces pull them into the opposite direction: These discourses disqualify "mere emotion" as disconnected from thought and having no meaning whatsoever. The examination of the shifting currency of such discourses in different social groups from the 19th century to the present day aims to historicize religious experience and contribute to a broader history of the way we learn to "trust our feelings" or not, why some groups value open expression and intense experience of feelings and others do not.



Figure 13. Children in religious service.

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**Key Reference**

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**Paternal Love: The Decline of an Emotional Concept in the "Long" 19th Century**

The project sets out to analyze the history of emotions through the lens of masculinities and family life, examining the decline of "paternal love" as an emotional concept during the 19th century. While motherly love has been intensively studied, fatherly love has barely been scrutinized in academic research. Its neglect is not coincidental, but a result of precisely the historical process this research seeks to understand: While in the late 18th century maternal and paternal love drew at least equal interest in normative writings, during the 19th century the latter fell into oblivion. Against this background, the project investigates coexisting and competing models of "paternal love" within the family, especially the model of an openly loving and affectionate fatherhood as a key feature of masculinity. Geographically, the study focuses on Germany, with France and Britain adding a transnational perspective. In terms of social strata, it deals primarily, though not exclusively, with the educated elite and the newly emerging middle class, which particularly emphasized the ideal of the affectionate fatherhood. Methodologically, this project is based on normative texts, letters, and autobiographies, as

well as family portrayals, and is viewed from a moderate social constructionist perspective.

The main questions posed are the following:

- How was "paternal love" defined and how did the semantics change over time?
- Which social groups tried to push or oppose the normative ideal of openly affectionate paternity, when, where, and why?
- What kind of social, political, and economic structures restricted the arena for openly expressed paternal love as a social practice?
- How did men experience and represent their fatherhood?

In Germany, the decline of paternal love as an emotional concept took place in a very obvious and, possibly, more radical way than in France and Britain. In public discourses of the late 18th century, one found the claim for both maternal and paternal love: In line with the cult of sensibility and the esteem for intimate family life, a number of educationalists and other members of the intellectual elite shaped the ideal of a father who took care of his children regularly, intensively, and affectionately. Accordingly, several middle-class men and even certain aristocrats presented themselves in autobiographies and family portraits as the emotional hub of the family; others, however, were quick to criticize the model, fearing such fathers would lose their ability to pose strict family rules. The extent to which normative texts on paternal love as well as visual self-representations of affectionate fathers reflected the social practice of everyday family life, remains an open question; in any event, the ideal itself quietly disappeared during the 19th century. While normative texts increasingly glorified maternal love as a natural instinct, paternal love was taken for granted or was even ignored. In family portraits, the father, now often dressed in black, slowly drifted from the middle to the edge of the frame, more physically distant from a tender mother-child dyad painted all in white. Furthermore, in novels of Imperial Germany, the father was often portrayed as authoritarian, distanced and emotionally controlled. Sometimes, even the term *Vaterliebe* no longer referred to his emotions toward his children, but rather to their emotions toward him.

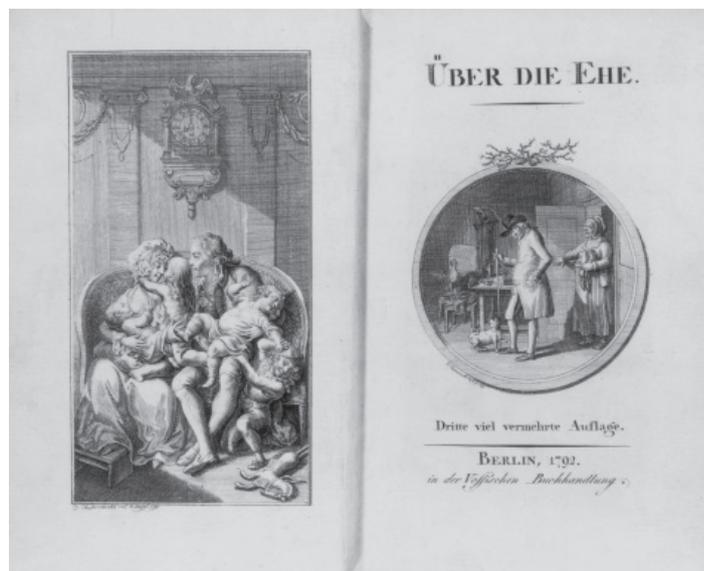


Figure 14. Etching by Daniel Chodowiecki. (1791). In Theodor Gottlieb Hippel, *Über die Ehe*. Berlin: Voss.

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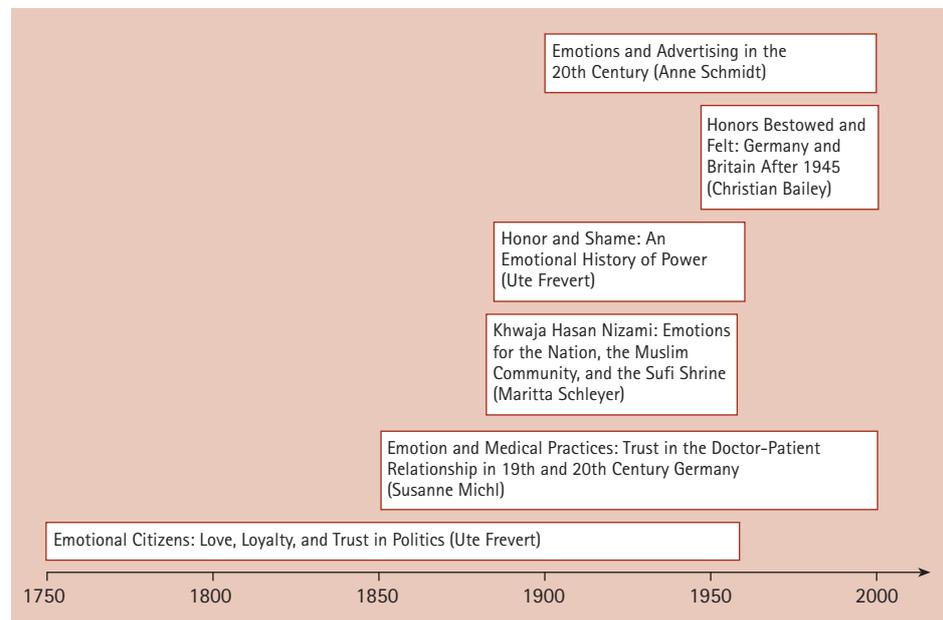
Family history is one of the rare fields of research that has always taken the importance of feelings into account—as they signify both social behavior and power relations. In fact, more than 30 years ago, family historians received broad public recognition for their bold and questionable argument that the emotionality of family life only emerged with the “modern” family itself. At the same time, feminists unmasked the concept of maternal love as a paternalistic invention of the age of the Enlightenment that tied women to the household while it set their male counterparts free. In this line, the project assumes a close connection between concepts of emotions and the division of labor both inside and outside the family. Still, overvaluing motherly love in modern times can only be understood in relation to undervaluing fatherly love, whose decline was probably entangled with socioeconomic processes in the course of the 19th century, such as the industrialization and urbanization. However, those trends alone cannot explain the shrinking interest in fatherly emotions, since recent research on fatherhood in Victorian England shows that the dynamics of an industrialized world could even increase the longing of middle-class males for domestic pleasures. In any case, from a male point of view, the decline of paternal love as a normative demand could be seen as an advantage as well as a deficit: It allowed men to pursue time-consuming careers and intensive public lives, however, several men felt pushed out of their families to a point where they had to seek emotional compensation and power assertion outside a feminized “private” life.



Figure 15. Domestic happiness—Häusliches Glück. (1808). In *Rosaliens Vermächtniß an ihre Tochter Amanda oder Worte einer guten Mutter an den Geist und das Herz ihrer Tochter: Ein Bildungsbuch für Deutschlands Töchter* (pp. 338–339). Leipzig: Glatz, Jakob.

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## Research Area: Emotion and Power



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### Emotional Citizens: Love, Loyalty, and Trust in Politics

Overlooked by most political scientists, modern societies see strong emotional bonds between citizens and politicians. Heads of state seem to be the prime objects of citizens' affection and anger. They are flooded with letters (nowadays e-mails) that voice all kinds of concerns, material as well as immaterial. They themselves invite direct communication by presenting themselves as fatherly (sometimes motherly) figures, sensitive to citizens' needs and sorrows. The project traces this relationship back to early modern practices of rule and government. It follows the development of modern politics in different constitutional forms (monarchical, republican) and analyzes the changing vocabulary of citizens' emotional offerings. By focusing on love, dedication, veneration, trust, and fidelity/loyalty (as well as their absence, negation, and opposites), it explores the emotional landscape of political communication. This implies looking at both parties within this communication process: those in power and those who address power. Main sources are letters written by citizens to heads of state as well as official speeches and proclamations of the latter.

How can we make sense of the emotional landscape of politics? Does it not run against the grain of modern conceptions of political power as utterly depersonalized? While early modern politics in continental Europe, so the familiar story goes, were based on the absolutist power of an omnipotent ruler, modern systems rely on a multitude of power networks that become more and more impersonal and volatile. Politics in general put on a rational and prosaic attire. Bereft of the decorum of early modern practices of representation, they pretend to be cloaked in grey flannel suits, rather than sumptuous brocade. Furthermore, they replace obedient subjects with self-assured citizens, well-informed and able to judge their representatives objectively and without emotional commitment. That is as far as the theory goes. But practices are different, and they cast doubt on the notion of rational politics and citizens. The language of modern representative politics is heavily tainted by strong emotions that are supposed to connect citizens and governments. To a certain degree, this language seems to be borrowed from premodern systems, mainly when it comes to love, dedication, veneration, and loyalty. Other emotional

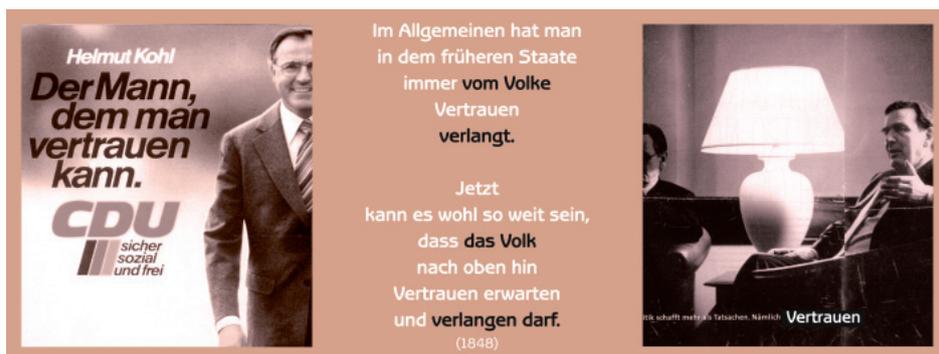


Figure 16. Collage of campaign advertisement in Germany focusing on trust.

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Collage by MPI for Human Development

concepts like trust and distrust enter the field as original innovations and carry new aspirations and expectations. On the whole, and this is the main point, modern politics depend on emotional inputs that accompany citizens' empowerment and orchestrate their political mobilization. Rather than depersonalizing and objectifying power relations, modern political regimes—be they parliamentary democracies or totalitarian dictatorships—take great interest in tapping into people's emotions and using them as means of stabilization, integration, and legitimization.

The project explores those emotional politics by asking three types of questions:

- (1) Where does the emotional language of politics come from? Where and how is it formed, and how does it travel—not only in time but also from one area to the other? What role does religion play? How are the private (family) and the public connected?
- (2) Who uses emotional language for what reasons? What do citizens and politicians expect when they “talk emotions”? What genres and media do they prefer to send out emotional messages?
- (3) How does emotional language work? How do certain genres and media shape and create structural forms of emotional expression that, to a certain degree, define what is expressed? What kind of meaning do these expressions transport? What kind of references do they evoke? Under which conditions do they fail to work? What happens, for example, during political ruptures, when references are no longer stable?

As these questions are fairly broad, they need a clear methodology. This is provided by a well-defined set of primary sources. It consists of letters that citizens wrote to major politicians, mainly heads of state. These letters are collected in great numbers in federal archives and offer a wealth of information. On the other hand, the source material includes political speeches, addresses, and proclamations whose emotional appeal is being analyzed from the perspective of the questions mentioned above.

The time frame covers the modern period, starting in the early 19th century and ending in the 1950s. At this initial stage, the project focuses on Germany (Imperial period, Weimar Republic, National Socialism, GDR and Federal Republic). At a later stage, France, Britain, and the US will be included.

During 2008, the rather scant secondary literature was thoroughly examined. At the same time, the process of reading and copying the relevant letters (from all periods) has started; those are stored both in the *Geheimes Staatsarchiv Preußischer Kulturbesitz* (Imperial period) and the *Bundesarchiv* in Berlin, Lichterfelde (Weimar, NS, GDR). Several lectures on the relationship between trust and fidelity have been given, and a short essay appeared in the journal “Merkur” (January 2009).

**Researcher**  
Ute Frevert

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Figure 17. Torn-up picture poster of a political convention of the NSDAP 1936 "Parteitag der Ehre."

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Human Development

**Honor and Shame: An Emotional History of Power**

A hundred years ago, the search for honor figured prominently on the list of major human emotions. Men killed and were killed because they strove to save their honor. Insults were perceived as acts against honor of a person and received a fervent rebuke. Today, at least in Western countries, honor seems to have lost its prevalence. It is no longer seen as motivating people's actions and nonactions. The same holds true for national honor. Although many people tend to feel patriotic and proud of their country, they seldom think in terms of national honor and dishonor. In other regions of the world, though, honor still reigns. Honor killings persist until this very day, and international relations are often represented as questions of honor.

So what has happened to Western notions of honor during the course of the 20th century? How can we understand the emotional drain-out, in contrast to the persistence of honor-based emotions and actions in non-Western societies? What does it tell us about power relations and about the inequality of those who participate in them? How does power translate into honor, and what kind of power—cultural, political, economic, etc.—is at stake? Does the alleged decline of honor

reflect, as Max Weber suggested, the rise of capitalism as a way of structuring social relations according to economic interests? Do feelings of honor interrupt and undermine the smooth functioning of market forces and are, thus, to be eliminated? Have international relations become interest-driven as well, so that practices of honor and shame no longer play any role?

The project seeks to test (and possibly refute) Weber's hypothesis by singling out four research areas. They are closely connected and follow the assumption that social and national honor are profoundly intertwined. Firstly, the project explores to what degree the alleged loss of honor in the West is merely a semantic problem. Can it be, so the question goes, that honor is no longer mentioned because its substance has been incorporated into other emotional concepts like pride, dignity, and respect, etc.? A study of modern encyclopedias and dictionaries seems to point to this direction. It also reveals interesting national differences. While honor has become marginal in West German linguistic discourse after 1945, it has kept much of its salience in Great Britain, the US, and France. This might be due to the abundance of honor talk during National Socialism and its thorough repudiation after the collapse of the "Third Reich." As part of the *Lingua Tertii Imperii* (Victor Klemperer) honor, it seems that it became an un-word in the Federal Republic, like many others (e.g., fidelity). Employed only reluctantly in public discourse, those words found it hard to retrieve a positive meaning. In other Western countries, the rupture was much less dramatic. Interestingly, the GDR presents yet another case. Here, honor was revived immediately after the foundation of the East German state and put to its service. The regime created a vibrant culture of honor largely modeled after the Soviet example and drawing on the experiences of earlier socialist movements. To what degree this culture managed to reach and influence people's behavior and emotions is an open question. In order to provide an answer, the project looks, secondly, at the rituals and practices of honoring individual people. Christian Bailey's project concerns this matter.



On a third level of investigation, the project focuses on those practices that are meant to insult and shame a person. Insults are legally defined as attacks on the honor of a person. So at least the law must have an idea of what this honor is about and of what it consists. By looking at legal texts (codifications, commentaries) over the course of the 19th and 20th century, I expect to see changing concepts of what an insult was meant to be and why a certain behavior was considered harmful to the honor of a person. These concepts, so the hypothesis goes, lend themselves to changing notions of civility that govern the expression of emotions in social behavior (here, my project links up with Margrit Pernau's). As a next step, archival sources (mainly court cases) have to be consulted in order to reconstruct both norms and practices of insult and shaming. No decision has been taken as to now, if the archival work will expand in countries like Britain, France, and the US in addition to Germany, both West and East.

Fourthly, and finally, the project explores the notion of national honor and the practices attached to it, mainly, language, images, and rituals. Here, the scope is again an international one. On a comparative basis, both internal and external usages of honor will be analyzed throughout the 20th century. A first examination of diplomatic sources has revealed to what extent all European powers employed a language of honor when they prepared to go to war in 1914. During the war and in its aftermath, honor was again heavily in demand. It seems that especially nations like Germany, Austria, and Italy felt, thought, and argued in terms of honor and shame. There is multiple evidence that they were extremely susceptible to what they perceived as shaming strategies on the part of victorious nations. This hypothesis is tested by means of media articles, political speeches, posters, and citizens' communications with politicians. Particular attention is given to those practices that linked personal and national honor as well as personal and national shame. The phenomenon of the "shorn women" who were accused of having dishonored the nation by engaging in sexual relationships with

enemy soldiers is a case in point. Shaving these women's heads was used as a humiliating practice that took away their honor and subjected them to public shame. The fact that gendered notions of honor and shame transcend national and regional boundaries becomes apparent when we introduce India as an object of comparison. During Partition, women on both sides sought to save their honor by committing suicide. Female honor here became closely linked to communal honor. How far this analogy goes will be examined in greater depth, first on the basis of secondary literature, later by using published primary sources.

So far, the focus of the project has been on conceptual work, collecting primary sources on honor and related concepts throughout the modern period (1740–1960) for countries like Britain, Germany, Italy, and France. Encyclopedia articles have mainly been used, as they allow to follow the development of the concept over time. Primary material has also been collected concerning conflicts over honor and shame during the early 20th century, especially during and after World War I and World War II.



Figure 18. "A la France bientôt l'Alsace réunie," postcard 1915.

© Historical postcard collection, University of Osnabrück

**Researcher**  
Christian Bailey

### **Honors Bestowed and Felt: Germany and Britain After 1945**

This project analyzes the act of bestowing honors, the ritual of awarding honors, the wearing of honors as decorations, and the reception of such public commendations by national publics. The practices of honors-giving and receiving are highlighted as instances of emotional control on the part of the state and of emotional arousal on the part of the publics.

The ritual of honors-giving is described as one of a number of symbolic gestures within cultures that has structured the emotional life of the citizens. During the 20th century, unprecedented numbers of citizens have been recruited to fight and kill within wars and have then been expected to reorient themselves within a peaceful political order. For this, the institution of honors-giving has been crucial, helping individuals to manage the emotional transition between war and peace. The emotions aroused by engaging in destructive acts against an enemy, and the accompanying danger, are stabilized by rituals of honors-giving and receiving that promise to offer the individual a permanent position within the elite of a nation.

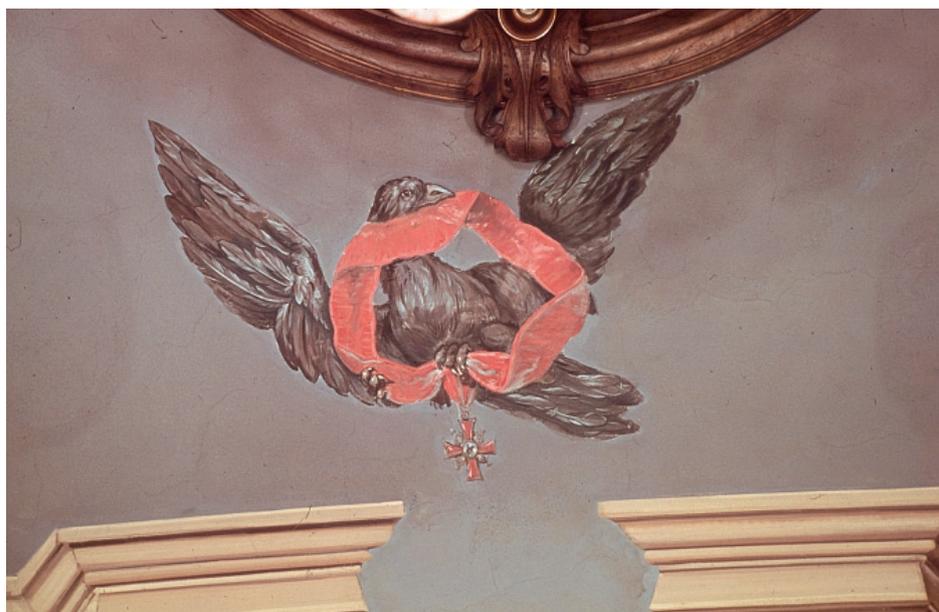
An investigation into the honors system in the post-1945 period economically provides a

broad perspective on the social, political, and cultural history of Germany and Britain. The great number of honors awarded in Britain after the Second World War suggests that political leaders sought to recognize and regiment the emotional labor expended in fighting this protracted conflict. By contrast, the abolition of honors-giving and decoration-wearing in post-Second World War occupied Germany implies that the postwar authorities sought not to validate the emotional labor expended by German soldiers. However, the revival of an honors system in both the Federal and Democratic Republics suggests that, without such symbolic gestures, German political leaders would not have been able to secure the emotional investment of their citizens in the state. Indeed, such emotional commitment needed to be created anew after the discrediting of German political authority that accompanied military defeat and widespread condemnation of the National Socialist Regime.

This project is not, however, merely designed as a study of postwar *Vergangenheitsbewältigung*. The study assesses the place of the honors system in the creation of two new German states and in the reinvention of the British state during the postcolonial era. The retention of an Imperial honors system in Britain during a period of decolonization and

*Figure 19.* Castle Molsdorf; detail: Eagle with medal. Painter: Peter Weingart (1738).

© Zentralinstitut für Kunstgeschichte, München



fading great power status offers a revealing insight into the challenges faced by a political leadership in maintaining an emotional regime domestically, while losing power internationally. Similarly, in German states, whose provisional status within an unstable Cold War international context was potentially harmful to their legitimacy, the ritual of bestowing honors was an important part of the (re)establishment of state sovereignty. Honors functioned as a means of encouraging citizens' emotional investment, either in a West German state eager to prove its credentials as a member of a Western liberal democratic bloc or in an East German state that strived to be part of the Soviet global vanguard. The analysis of the honors system as an instance of an emotional regime established and policed by the modern state involves a consideration of a complex of emotions. However, this research will particularly interrogate the relationship between the honors system and the notion of honor as an emotion. It benefits from recent historical scholarship that has demonstrated how honor, regarded in the early modern period as an individual and private quality, became a public, or even nationalized, emotion in the 19th and 20th centuries. An analysis of the honors system offers a valuable perspective on the political appropriation and policing of this emotion, particularly after earlier notions of national honor had been disavowed, having appeared to provoke foreign policy aggression and military conflict. The endurance of honors systems suggests that the arousal and evocation of the emotion of honor has been deemed essential for establishing stability, consensus, and hierarchy within the modern nation-state.

In spite of the overall endurance of the honors system in Britain and Germany, there have been striking instances of prominent individuals refusing or renouncing such official accolades. This project directs attention to such examples of refusal, which illustrate the limits of the emotional regimes in both countries. When individuals accept the recognition of their work, they accept they have provided a service to the state and thus render their labor to the state. Similarly, when they

acknowledge being honored by the state, they internalize the state's emotional regime: They will be honored. However, when individuals, such as the Nobel Prize winning novelist Doris Lessing, declined being honored, they refused to hand over their labor and refused to "feel" the emotions encouraged by the state. When others, like Günter Grass, renounced their honors, they declined continuing to place their work at the service of the state and to have their emotional lives structured by the state.

The study analyzes military and governmental records as well as media reportage, personal testimonies, and material culture sources such as medals, uniforms, and iconography. Much of the research is being conducted in the *Bundesarchiv* in Berlin, the Royal Archives in Windsor, and the National Archives in Kew.

Researcher  
Susanne Michl

### Emotion and Medical Practices: Trust in the Doctor–Patient Relationship in 19th and 20th Century Germany

The medical encounter between doctors and their patients does not take place in an emotionally neutral space. Numerous emotions are generated, negotiated, and suppressed in the supposedly rational field of therapeutic practice. Especially the claim for trust lies at the heart of the relationship between medical practitioners and their patients, not least because this emotional pattern is able to negotiate the power relations between the two parties.

In this project, trust and trust production stand for a complex emotional management that is effective in the range of health practices by patients and doctors. How are emotions regulated, steered, encouraged, or impeded, and by whom? Which forms of emotional expression are judged as adequate or inadequate? Which emotional rules and norms are set up, and how are these rules dealt with? Therefore, the focus is on the changing processes and strategies of emotional attachment and distancing as well as the attribution of specific emotional dispositions and expectations, for example,

the circumstances under which empathy and compassion became a desirable aspect of the medical encounter. Comparative aspects with other European countries, especially France, are included in the project.

Firstly, the medical literature concerning the doctor–patient relationship has been scrutinized: medical text books and newspapers, teaching materials for medical students and reference books of medical psychology with the objective of pointing out the quantitative and qualitative changes in the discourse on trust occurring in the 19th and 20th century. This general overview permits, at a further stage, to examine, in more detail, the emotional management in different sociocultural settings. The focus is here particularly on general practitioners and on various patient groups, such as women, workers, and families. Popular journals and newspapers as well as patient–doctor correspondence and diaries serve as historical sources in exploring the ways patients dealt with emotions in the medical encounter.

At two turning points in medical history, approximately in the second half of the 19th and in the first half of the 20th century, the discourse on trust was particularly intensified and the emotional management changed considerably.

(1) The shift from a prescientific medicine to a medicine with its specialized knowledge, expensive instruments and disease agents occurred in the second half of the 19th century. Various facets of this shift have been studied by medical historians. Still, it remains a *desideratum* of research to demonstrate how the discourse on the need to trust and be trusted and the conceptualization of other feelings accompanying the therapeutic encounter changed, given the emergence of a highly complex and functionally differentiated modern health system. According to the sociologist Anthony Giddens, there are two kinds of commitment in the modern world intensely connected with the need for and development of trust: the *facework* commitments and the *faceless* commitments. Whereas the former implies a face-to-face or personal trust between those who



Figure 20. Pharmaceutical advertisement, ca. 1950.

© b p k bildagentur für Kunst, Kultur und Geschichte, Berlin

know one another, at the core of the latter lies a rather abstract expert system based on different mechanisms of trust. In this approach, encounters between doctors and patients could be perceived as access points which are, according to Giddens, "sources of vulnerability for abstract systems." As first results suggest, the emergence of scientific medicine in the middle of the 19th century strengthened the perception that emotions disturb the doctor's clinical gaze upon the patient's body. Still, great efforts had to be made in order to suppress the emotions emerging during a medical encounter. The trust production, though, had to rely even more on external habits and conducts than on emotional patterns.

- (2) In the 20th century, the doctor-patient relationship did not remain static. There is a consensus in the research literature to describe the changing doctor-patient relationship in the 20th century by means of shifting power relations. In the first half of the 20th century, the paternalistic type of the medical encounter, as it developed during the 19th century, was still predominant. Particularly when it came to medical decision-making, the practitioner exerted his authority over the patient like a father taking care of his family. This model, though, seemed to falter in the second half of the century, when what could be described as a partner relationship emerged, notably with the introduction of an ethical concept developed in the US and concerning the medical decision-making: the concept of informed consent.

In the course of the century, more attention was paid to psychological dimensions of the medical encounter. Particularly in a psychoanalytic approach, the emotions of the patient as well as the doctor were scrutinized in their interaction. The famous book "The Doctor, His Patient and the Illness" by psychoanalyst Michael Balint had an enormous impact on the conceptualization of a highly emotional doctor-patient encounter. For a successful therapy, Balint strongly emphasized upon the self-cultivation of the general

practitioner who is required to control and dose his or her emotions conceived as drugs accelerating or slowing down the patient's recovery.

Finally, the project is related to an interdisciplinary field of medical history and medical ethics as well as medical psychology and medical sociology; the relevant institutes of medical faculties in Germany are committed to training medical students and doctors in psychology and communication skills and ensuring that they share the commonly accepted standards of ethical practice. Cooperation with those institutes is necessary for this project in order to reach those dealing with the management of emotions in their daily practice.

**Researcher**  
Maritta Schleyer

### **Khwaja Hasan Nizami: Emotions for the Nation, the Muslim Community, and the Sufi Shrine**

Khwaja Hasan Nizami (1878–1955), a Sufi of the Chishti Islamic mystic order—an emotionally expressive devotional practice by tradition—was an influential figure in the public life of Delhi and North India in the first half of the 20th century. Not only was he a religious teacher, reformer, and missionary but also a highly prolific author and journalist, who took part in various religious and political discourses, often closely interwoven. The historical backdrop of Khwaja Hasan Nizami's work was marked by the Indian nationalist movement against the British colonial power, a variety of flourishing religious reform movements and growing tensions between Hindus and Muslims.

This project aims to shed light on particular ways in which devotional Islam responded to the challenges of a changing political and religious landscape. Khwaja Hasan Nizami's appropriation of the nationalist cause, his usage of modern communication techniques and orthodox rhetoric, and the propagation of a new set of religious emotional norms can be interpreted as tools expressing negotiations of identity and influence as well as survival strategies for Sufism in a situation where it faced growing marginalization.

In the initial phase of research, published and unpublished sources are gathered from South Asian and European libraries and archives, consisting of Khwaja Hasan Nizami's large literary output and of secondary sources that locate him within the ongoing debates among different religious groups and the nationalist movement.

The subsequent study phase of the project is devoted to an in-depth analysis of the material questioning the interrelation between Khwaja Hasan Nizami's religious agenda of defence and modernization of Sufi practice and an Islamic mission, on the one hand, and his political activism, on the other. The study, therefore, aims to prove that, in Nizami's work, emotions form a link between the political plateau and the religious realms, as manifested, for instance, in his evocation of an "emotional community" of Indian Muslims

of the past glorious Mughal kingdom and of a possible future "Muslim" Indian nation. Emotions are thus perceived to be connecting social, political, economic, and religious conflicts on the local level, individual motives and the nationalist cause.

In addition to theories on the history of emotions, Foucault's concept of "governmentality" is being explored as a further possible tool to establish this conceptual link between the two strands of Khwaja Hasan Nizami's work, both reflecting on his deep emotional involvement and referring to his conscious use of techniques of power.

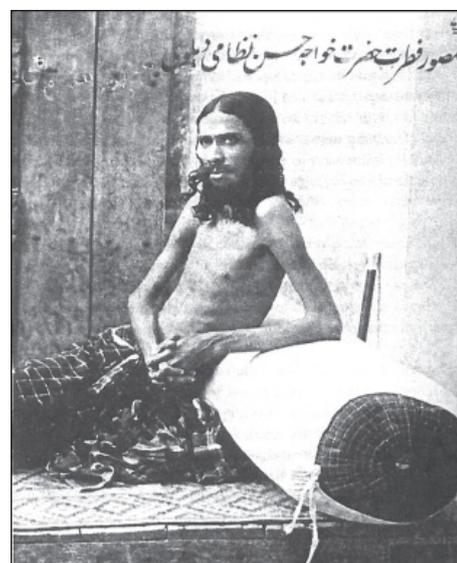


Figure 21. Portrait of Khwahja Hasan Nizami, 1924.

Source. Hermansen, Marcia. (2001). Common themes, uncommon contexts: The Sufi movements of Hazrat Inayat Khan and Khwaja Hasan Nizami. In Pirzade Zia Inayat Khan (Ed.), *A pearl in wine: Essays on the life, music and Sufism of Hazrat Inayat Khan* (pp. 323–354). New Lebanon: Omega Publications.

### Emotions and Advertising in the 20th Century

This research project explores the changing meaning and importance of emotions in advertising and marketing in the 20th century. Its aim is to grasp the core of those changing processes, to present them, and to pose questions regarding their implications on the whole of the society. Therefore, the study analyzes selected marketing strategies and advertising campaigns against the backdrop of the social and political framework and the theoretical knowledge available at that time. The project starts by accepting the following: During the 20th century, emotions played an increasingly important role for marketing and advertising, and this constantly growing emotional charging corresponded with certain fundamental cultural changes in society. In the past one hundred years, advertising professionals have taken an interest in human emotions like few other specialists. With the ongoing scientific progress, groundbreaking innovations in the media sector, growing markets, changing consumer habits, and users' increasing technical skills, those professionals changed their preconceptions dramatically regarding the interrelation between advertising and emotions as far as the public is concerned. As an example, one has to think of Lucian Bernhard, on the one hand, who, in about 1908, presented an advertising poster with a limited amount of writing as a visual solution with an aesthetic and, therefore, emotional appeal; on the other hand, in the early 1990s, the textile manu-



Figure 22. Advertisement for a shoe shop, 1908.

© VG Bildkunst

facturer Benetton, based on the concept that one could reach consumers through shocking campaigns, criticizing society, advertised using the picture of a young man dying of AIDS, surrounded in his final moments by his mourning family in a manner resembling classic *Pietà* representations. By analyzing those shifts, the project aims to demonstrate the strong links between developments in history and culture, on the one hand, and emotions as well as how those are perceived, on the other. One must point out that those changing processes often took place from the bottom upwards and not the other way round; moreover, they did not seem to follow a linear but rather a circular progress pattern, and they were, at the same time, extremely dynamic and conflict ridden.

The history of advertising in Germany is at the focus of the study. However, in order to comprehend the developments in Germany, one needs to examine what happened abroad. America, in particular, appears to offer a trendsetting role model and to be important even as a negative example to be avoided. However, one must observe that influences were mutual: More than ever, during the National Socialism era and during World War II, a number of distinguished advertising and communication specialists immigrated to the US, shaping developments there in a decisive manner. Those developments were later partly adopted by Europeans.

Looking beyond Germany is important for a further reason: Internationally operating companies and global businesses in the process of penetrating new markets would consider whether the people they targeted would function and react like the German consumers. How would one think about people and their emotions in other cultures? What means could be used to reach new customers on an emotional level? Could advertising strategies be customized and, if so, in which way and with what results?

Research on three different levels is important for the practical analysis: the level of science, that of practice, as well as the level that deals with response to advertising campaigns. The following questions are relevant to those levels.

**Researcher**  
Anne Schmidt



Figure 23. AIDS—David Kirby, Benetton campaign 1992.

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*Firstly: Scientific Level*

What were the political, economical, and social perceptions regarding advertising, emotions, and consumerism? What was known about the emotional impact of advertising? What were the people's hopes and fears? Which sources generated knowledge? Which personal and social images were behind them? In which ways and for which reasons have perceptions changed in the past one hundred years? Which assumptions were established and what was rejected?

*Secondly: Practical Level*

Which ways were used to implement theoretical knowledge? Which strategies and techniques were tried out in order to reach people's feelings, to manipulate and shape them? Which media, verbal and audiovisual expression tools were available? What did

people expect from those various tools and how were they used? Did advertising create new models and concepts or was it rather commanded by established perceptions in order to reach potential customers?

*Thirdly: Response*

How did people respond to advertising campaigns? How were campaigns rated in the media, in politics, and in business? How were the consumers' reactions evaluated? Moreover, what implications did those evaluation processes have, in their turn, on how advertising was perceived and on the concrete working practice of advertising specialists? The sources are multiple: Apart from analysis of advertising media and campaigns themselves, I will examine debates and decisions on an executive, legislative, and judicial level in order to highlight relevant political and legal aspects. Scientific reports from disciplines such as psychology, sociology, and communication studies, as well as publications by advertising specialists, consumer psychologists, and textbooks on advertising methodology and practice will be used in order to analyze the changing perceptions regarding advertising and emotions. Furthermore, my research will include newspapers and, eventually, TV reports and talkshows on the topic of advertising in order to investigate reactions to marketing strategies and advertising campaigns. Finally, material from company archives and advertising agencies will highlight aspects of business policies and advertising agencies' practices.

## Publications 2008

(last update: April 2009)

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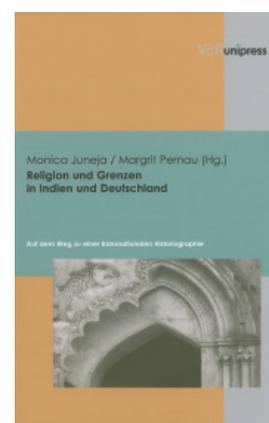
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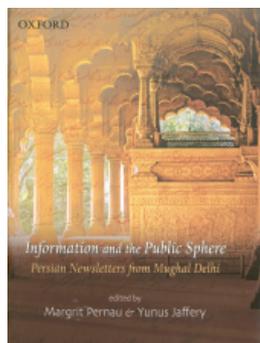
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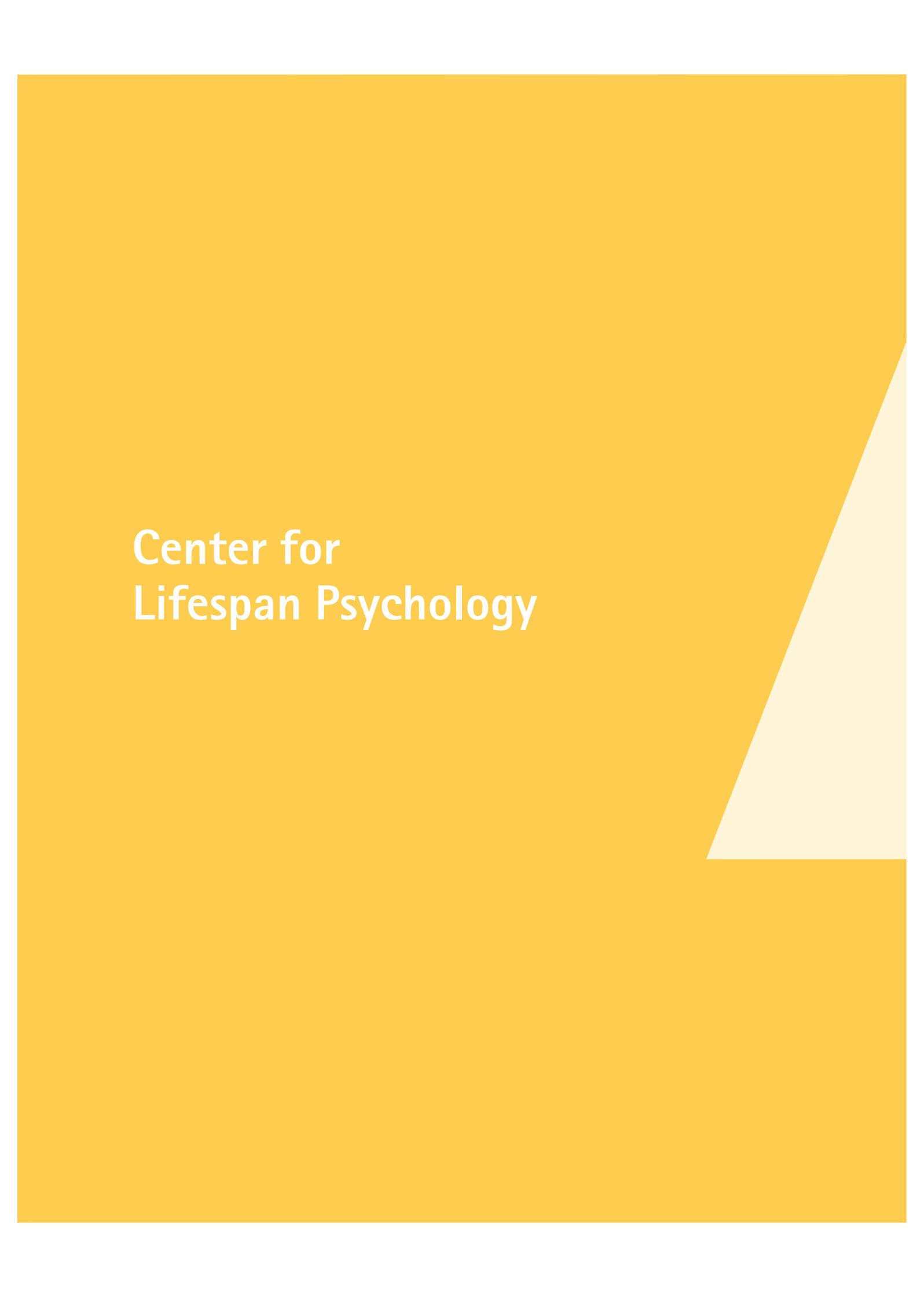
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Center for  
Lifespan Psychology

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But ... its eminent modifiability, and its predisposition to self-initiated action, may it develop little or much, and may it differ in amount between different individuals, is among the immutable features of humankind, which can be found wherever humans exist.

*Johann Nicolaus Tetens, 1777, I, p. 766*



J. N. Tetens (1736–1807), philosopher of the Enlightenment Era

## Introductory Overview

Founded in 1981 by the late Paul B. Baltes, the Center for Lifespan Psychology at the Max Planck Institute for Human Development has helped to establish lifespan psychology as a distinct conceptual approach within developmental psychology. Since 2004, the Center has extended its research program into developmental behavioral neuroscience. Work at the Center is guided by three propositions: (i) to study lifespan changes in behavior as interactions among maturation, learning, and senescence; (ii) to develop theories and methods that integrate empirical evidence across domains of functioning, timescales, as well as behavioral and neuronal levels of analysis; (iii) to identify mechanisms of development by exploring age-graded differences in plasticity. The Center continues to pay special attention to the age periods of late adulthood and old age, which offer unique opportunities for innovation, both in theory and practice. At the same time, it has intensified its interest in early periods of ontogeny including infancy and early childhood.

### Three Guiding Propositions

For more than two decades, the Center for Lifespan Psychology has promoted a perspective on behavioral development that seeks to integrate age periods, domains of functioning, timescales, and levels of analysis. In part, through these efforts, lifespan psychology has evolved into a distinct conceptual approach within developmental psychology (e.g., Baltes, 1987; Baltes, Lindenberger, & Staudinger, 2006). The Center's current research agenda can be summarized by three interrelated theoretical propositions that reflect this tradition (Lindenberger, Li, Lövdén, & Schmiedek, 2007). In line with the general tenets of lifespan psychology, these propositions emphasize conceptual and methodological issues in the study of lifespan behavioral development, and thereby provide a general script for formulating research questions in more specific domains of interest.

#### Proposition 1: Lifespan Changes in the Individual's Behavior as Interactions Among Maturation, Learning, and Senescence

The general goal of developmental psychology is to identify mechanisms that generate invariance and variability, constancy and change in behavioral repertoires from infancy to old age. By identifying the commonalities,

differences, and interrelations in the ontogeny of sensation, motor control, cognition, affect, and motivation, both within and across individuals, developmental psychologists attempt to arrive at more or less comprehensive theories of behavioral development. To provide explanations that qualify as psychological and developmental, the effects of agents external to the developing individual, such as parents' affect attunement, teachers' classroom behavior, or a state's retirement policies, need to be mapped onto mechanisms and organizational laws that operate and evolve within the developing person. Hence, as John Nesselrode, Peter Molenaar, and others have emphasized, developing individuals, rather than groups of individuals or domains of functioning within individuals, form the privileged system of analysis and explanation. Individuals organize their exchange with the physical and social environment through behavior (see Figure 1). On the one hand, the changing brain and the changing physical and cultural environment shape behavioral development. On the other hand, behavior alters both the brain and the environment. Hence, environment and brain act not only as antecedents but also as consequents of moment-to-moment variability and long-term changes in patterns of behavior. The components of

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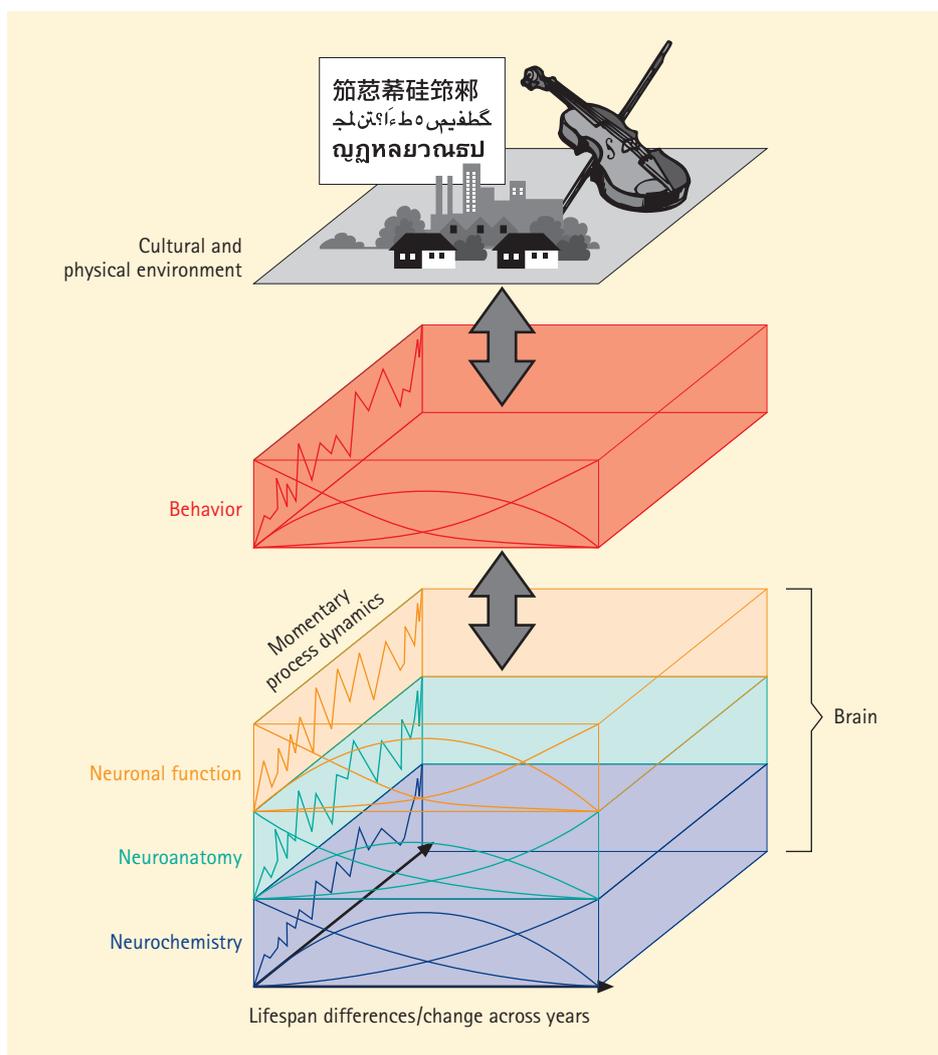
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Figure 1. Environment and brain as antecedents and consequents of moment-to-moment variability and long-term changes in patterns of behavior. Lifespan changes in brain-behavior mappings are shaped by interactions among processes related to maturation, learning, and senescence. The identification of key players in the ontogeny of brain-behavior dynamics requires a coalition between formal tools for synthesis across levels of analysis and timescales as well as empirical methods for studying variability and change in brain and behavior (adapted from Lindenberger, Li, & Bäckman, 2006).

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this system, brain, behavior, and environment, are constantly coupled and cannot be reduced onto each other, as they jointly condition an individual's life trajectory through recursive self-regulation.

In attempts to explain the age-graded evolution of this system, *maturation* and *senescence* denote the operation of age-graded brain mechanisms and their effects on changes in behavior, which are especially pronounced early and late in life. In addition, *learning*, at any point during ontogeny, denotes changes in brain states induced by behavior-environment interactions. Note, however, that maturation cannot take place without *learning*, and that learning cannot

take place without maturation. Similarly, the ways in which senescence takes its toll on the brains of aging individuals depend on individuals' past and present learning and maturational histories. To complicate matters even more, processes commonly associated with maturation are not confined to early ontogeny, and processes related to senescence are not restricted to old and very old age. For instance, neurogenesis and synaptogenesis, as expressions of maturation, continue to exist in the adult and aging brain. At the same time, declines in dopaminergic neuromodulation, which indicate senescence-related changes in brain chemistry, commence in early adulthood (Li, Lindenberger, Nyberg,

Heekeren, & Bäckman, in press). Thus, maturation, senescence, and learning mutually enrich and constrain each other throughout the lifespan and must be understood and studied as interacting forces driving the brain–behavior–environment system. In this endeavor, psychologists occupy a central position because they possess a rich and adequate repertoire of experimental and methodological tools to describe and modify the organization of behavior.

**Proposition 2: Lifespan Theory and Methodology Need to Integrate Evidence Across Domains of Functioning, Timescales, and Levels of Analysis**

If the lifespan development of behavior is defined to originate from recursive interactions among maturation, learning, and senescence, with the developing individual as the privileged system of analysis, then developmental psychology is faced with three difficult integrative tasks. First, there is the need to integrate theorizing and research practice across

functional domains to attain a comprehensive picture of individual development. For instance, sensorimotor and cognitive functioning are more interdependent in early childhood and old age than during middle portions of the lifespan, and developmental changes in either domain are better understood if studied in conjunction. Similar observations can be made for many other domains of functioning whose changes generally have been studied in isolation, such as the ontogeny of social interaction and cognition, or of emotion regulation and motivational states. Empirically, dense multivariate time-series data are needed to assess short-term variability and long-term changes in across-domain dependencies. Second, there is a need to understand the mechanisms that link short-term variations to long-term change. Short-term variations are often reversible and transient, whereas long-term changes are often cumulative, progressive, and permanent. Establishing links between short-term variations and long-term changes is of eminent heuristic

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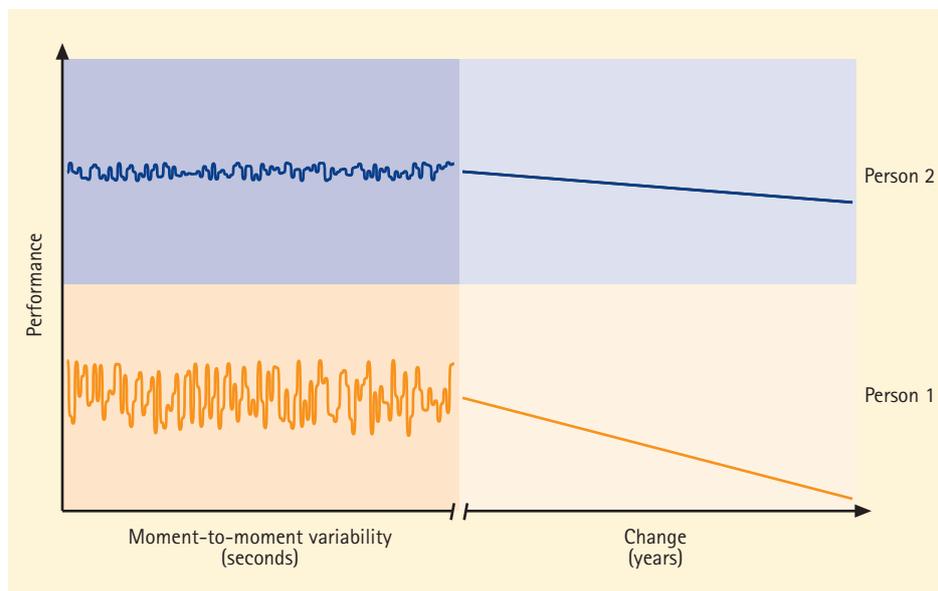


Figure 2. Example for predictions linking moment-to-moment variability to long-term change, and brain changes to behavioral changes. Senescent changes in neuromodulation lead to greater moment-to-moment fluctuations in neural signaling, enhance the prominence of background noise, reduce the distinctiveness of processing pathways and representations, and increase variability of cognitive performance. Aging individuals with greater moment-to-moment process fluctuations at a given point in time are expected to show greater subsequent longitudinal decline in mean levels of functioning than individuals who fluctuate less. Recent empirical evidence supports this prediction (Lövdén, Li et al., 2007; adapted from Lindenberger et al., 2006).

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value, as it helps to identify mechanisms that drive development into different directions. For instance, aging cognitive systems show an increase in maladaptive moment-to-moment fluctuations or decrease in processing robustness at both behavioral and neuronal levels of analysis. These maladaptive changes may signal impending long-term changes in other characteristics of the system (see Figure 2; Lövdén, Li, Shing, & Lindenberger, 2007). In contrast, other forms of moment-to-moment variability indicate an individual's ability to bring a wide variety of different strategies to the task and are positively related to long-term change in both childhood and old age.

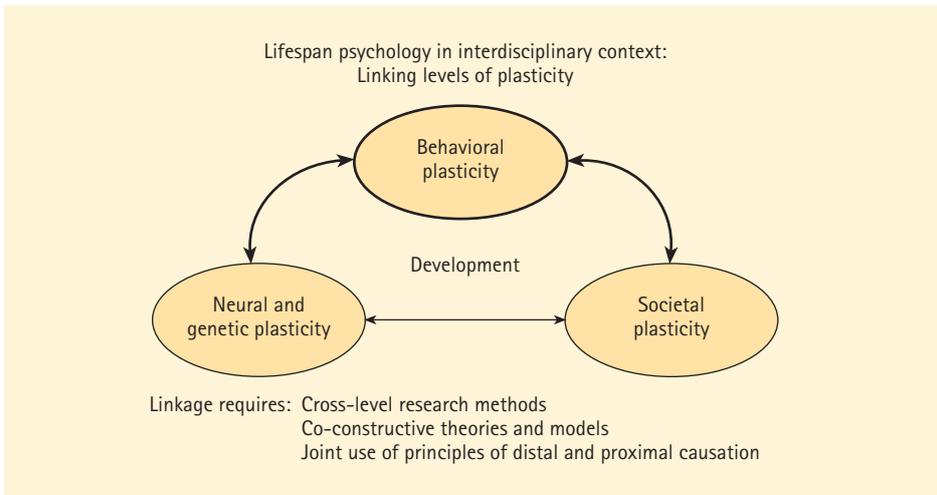
Third, to arrive at mechanistic explanations of behavioral change, there is the need to integrate behavioral and neuronal levels of analysis. At any given point in the lifespan, one-to-one mappings between brain states and behavioral states are the exception, rather than the rule, as the brain generally offers more than one implementation of an adaptive behavioral outcome (Li, 2003). Therefore, ontogenetic changes in behavioral repertoires are accompanied by continuous changes in multiple brain-behavior mappings. Some of these remapping gradients may be relatively universal and age graded, whereas others may be more variable, reflecting genetic differences, person-specific learning histories, the path-dependent nature of developmental dynamics, or a combination of the three. The resulting picture underscores the diversity and malleability of the organization of brain and behavior as well as the constraints on diversity and malleability brought about by (a) universal age-graded mechanisms associated with maturation and senescence, (b) general laws of neuronal and behavioral organization, and (c) cultural-social as well as physical regularities of the environment (Baltes et al., 2006).

In summary, developmental psychology needs theory and methodology apt to integrate (a) multiple domains of functioning, (b) multiple timescales, and (c) multiple levels of analysis. In recent years, the Center for Lifespan Psychology has relied on two methodologies that seem well suited to these conceptual

demands. First, random coefficient modeling (RCM), latent growth curve modeling (LGCM), and related statistical techniques have served as versatile tools for the analysis of multivariate data with nested time structures, such as trials, blocks of trials, days, weeks, and years. Dynamic extensions of these methods, such as the dual-change score model introduced by John J. McArdle and Fumiaki Hamagami, permit the investigation of directed lead-lag hypotheses with longitudinal panel data (e.g., see Gerstorff, Lövdén, Röcke, Smith, & Lindenberger, 2007; Lövdén, Li et al., 2007). Second, neurocomputational modeling, such as the neurocomputational theory of cognitive aging proposed by Shu-Chen Li and colleagues (Li, Lindenberger, & Sikström, 2001), has facilitated conceptual integration of empirical findings and concepts from a wide range of behavioral and neuronal research traditions and provides a theoretical basis for major portions of the Center's research program.

### **Proposition 3: The Exploration of Age-Graded Differences in Behavioral Plasticity is a Powerful Tool for Identifying Mechanisms of Development**

Behavioral plasticity, or the alteration of developmental trajectories through experience, is a precious phenomenon (Figure 3). This statement holds both from scientific and societal perspectives (Hertzog, Kramer, Wilson, & Lindenberger, in press). Scientifically, inquiries into the plasticity of human behavior are a rich source of developmental information. Through the assessment of "changes in change," they offer the promise to observe the operation and proximal consequences of developmental mechanisms. In particular, cognitive intervention studies, in which research participants of different ages are instructed and trained to perform one or more cognitive tasks, come with important validity benefits, such as (a) an increase in experimental control, (b) the identification of age differences near asymptotic performance levels, and (c) the assessment of transfer and maintenance effects. If neurochemical, neuroanatomical, or neurofunctional imaging measures are assessed before, during, and after training, intervention studies also offer new insights into

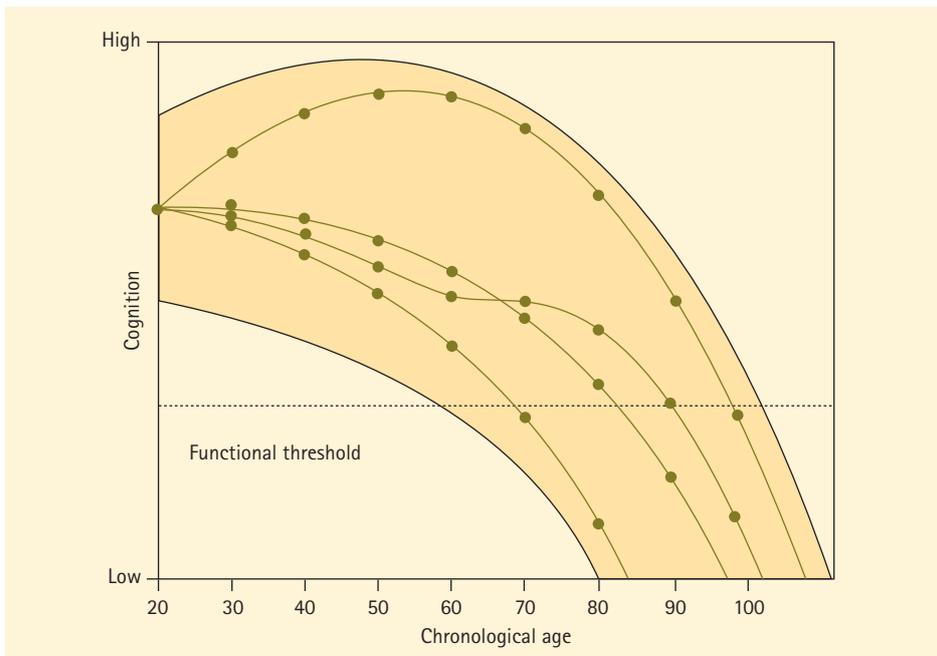


*Figure 3.* Lifespan development as biocultural co-construction. A central goal of lifespan psychology is to describe, explain, and optimize human potential and to identify its societal and neural causes and consequences.

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relations between behavioral and neuronal levels of plasticity. Thus, by partly taking control over behavior–environment interactions, the mechanisms of learning can be studied in the context of maturation and senescence. When longitudinal information is available, intervention studies bridge the gap between short-term alterations in performance and long-term developmental trajectories (e.g., Lövdén, Li et al., 2007). From the larger perspective of societal evolution, cognitive intervention studies explore

the range of possible development or what could be possible, in principle, if conditions were different (see Figure 4). The resulting knowledge about the plasticity of developmental trajectories is essential for improving human welfare. Hence, investigations of age changes in the plasticity of development carry the potential to explain and ameliorate human development. For these reasons, age-comparative intervention studies with a focus on behavioral and neuronal manifestations of plasticity are the foundation stone of



*Figure 4.* Hypothetical illustration of the zone of possible cognitive development for a given individual, along with four developmental curves indicating specific possible outcomes (adapted from Hertzog et al., in press).

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empirical research at the Center for Lifespan Psychology.

### Overview of Research Projects at the Center for Lifespan Psychology

The empirical and conceptual work at the Center is currently structured into eight research projects or teams of Researchers (see Table 1). The research activities pursued in these projects cover a wide array of developmental topics. To provide a few examples for illustration, recent studies have addressed the following questions: (a) How and why do cognitive functions, such as episodic memory, differ within and across age periods, and how and why do genetic differences contribute to these differences? (b) How and why do the relations between body and mind change from childhood to adulthood and from adulthood to old age? (c) How often and how strongly do adolescents, younger adults, and older adults experience positive and negative emotions in their daily lives, and how often do they wish to influence these emotions? (d) How can

human engineering technologies facilitate the transition from early adulthood into old age? (e) How do young children learn to coordinate their behavior with others, and how does interpersonal action coordination affect their social and cognitive development?

### Sofja Kovalevskaja Award

In 2006, Martin Lövdén received the Sofja Kovalevskaja Award of the Alexander von Humboldt Foundation. Financed by the Federal Ministry for Education and Research, this one million Euro award enables young scientists from outside Germany to finance their own research groups at a German university or nonuniversity research institution of their choice. Martin Lövdén's independent research group is affiliated with the Center for Lifespan Psychology. In 2007–2008, the group has initiated a series of extensive training studies to examine training-induced changes in behavior and brain among younger and older adults in the functional domains of spatial navigation and working memory.

Table 1  
The Center for Lifespan Psychology: Overview of Research Projects

<i>Name of the project</i>	<i>Research scientists and postdoctoral research fellows</i>	<i>Predocctoral research fellows</i>
Neuromodulation of lifespan cognition	Shu-Chen Li**, Lars Bäckman, Hauke R. Heekeren, Ulman Lindenberger	Agnieszka Zofia Burzynska, Dorothea Hämmerer, Irene E. Nagel, Susanne Passow, Viola Störmer
Intra-Person dynamics across the lifespan	Florian Schmiedek**, Martin Lövdén**, Yee Lee Shing, Manuel Völkle, Markus Werkle-Bergner, Ulman Lindenberger	Annette Brose, Julia Wolff
Cognitive and neuronal dynamics of memory across the lifespan (CONMEM)	Yee Lee Shing**, Markus Werkle-Bergner**, Roman Freunberger*, Ulman Lindenberger	Yana Fandakova, Myriam Sander
Sensorimotor-cognitive couplings	Sabine Schaefer**, Ulman Lindenberger	Michael Schellenbach, Julius Verrel
The Berlin Aging Studies (BASE)	Ulman Lindenberger**, Julia A. M. Delius, Hauke R. Heekeren, Shu-Chen Li, Florian Schmiedek	Julia Wolff
Developmental regulation of affect, motivation, and abilities (DRAMA)	Michaela Riediger**, Sabine Schaefer, Antje Rauters*, Ulman Lindenberger	
Interactive brains, social minds	Ulman Lindenberger**, Anna Kleinspehn-Ammerlahn*, Franziska Kopp, Shu-Chen Li, Viktor Mueller	Karen Bartling
Formal methods in lifespan psychology	Timo von Oertzen**, Ulman Lindenberger	Andreas Brandmaier

*Note.* The table refers to projects and project members as of December 2008; for updates, visit [www.mpib-berlin.mpg.de](http://www.mpib-berlin.mpg.de).  
\*\*principal investigator; \*postdoctoral research fellow

## Research Project 1 Neuromodulation of Lifespan Cognition

### Conceptual Overview

Cognitive development across the lifespan consists in age-graded co-constructive interactions between cultural and biological systems of influence (Li, 2003). The brain implements these interactions at the individual level. Human brains have about one hundred billion neurons and most of them are highly interconnected. Neurons release neurotransmitters for communication. Neurotransmitters shape the dynamics of neural networks in the course of development and modulate behavior from moment to moment in the service of goal-directed behavior (Bäckman, Nyberg, Lindenberger, Li, & Farde, 2006).

Fundamental aspects of cognition, such as processing speed, processing robustness, attention, working memory, episodic memory, and reinforcement learning, increase monotonically from childhood to early adulthood and decrease from early adulthood to late adulthood, with accelerated decline in old age (Li, Lindenberger, Hommel, Aschersleben, Prinz, & Baltes, 2004). These changes in behavior are paralleled by neurochemical, neuroanatomical, and functional changes in the brain (Lindenberger, Li, & Bäckman, 2006). The central goal of this project is to understand how maturational and senescent changes in neurotransmitter systems contribute to neuronal and behavioral development across the lifespan. For this purpose, the project uses a large and integrated array of conceptual tools and empirical paradigms, ranging from neurocomputational studies for theory development over genetically informed behavioral studies for understanding the relations between neurally relevant genotypes and cognitive phenotypes to genomic and pharmacological imaging studies for investigating developmental changes in brain-behavior relations, and the individual differences therein.

### Subproject I: Neuromodulation in Cognitive Aging

This subproject has the longest history. Its current research activities are a direct empirical outgrowth of our theoretical work on the relation between senescent changes in dopaminergic neuromodulation and cognition (Li, Lindenberger, & Sikström, 2001). The efficacy of neurotransmitter systems wanes during normal aging (Bäckman et al., 2006). In our modeling work, we capture the

aging-related decline in dopaminergic neuromodulation through neurocomputational modeling by stochastically attenuating the gain control (G) of the sigmoidal activation function modeling presynaptic to postsynaptic transfer (see Figure 5). With large inputs, reducing the slope of the activation function leads to increased within-network random activation variability. This, in turn, results in increased performance variability in simulated aging networks with attenuated G. If G is increased beyond the optimum to excessive values, activation variability depends critically on the amplitudes of the inputs because information transfer is governed by a step function. Hence, and in line with empirical findings, stochastic G tuning predicts an inverted-U function between dopaminergic neuromodulation and cognitive performance.

In 2006, we started the AGE-COG-DA study, a large-scale empirical study combining genomic, pharmacological, and brain imaging approaches to investigate the triadic relation between adult age, dopaminergic neuromodulation, and cognition (see Figure 6). The major aims of the AGE-COG-DA study are to investigate dopaminergic neuromodulatory efficiency in relation to (a) age; (b) dopamine-relevant genetic polymorphisms, such as the Catechol-O-Methyltransferase (COMT) gene; and (c) pharmacological intervention with a dopamine agonist. The study consists of two parts, a large-scale behavioral assessment followed by a pharmacogenetic imaging experiment. By January 2009, about 800 younger adults aged 20–30 years and 800 older adults aged 60–70 years had participated in the behavioral assessment, which

### Researchers

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Institute, Stockholm;  
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Awardee, Alexander  
von Humboldt Foun-  
dation)

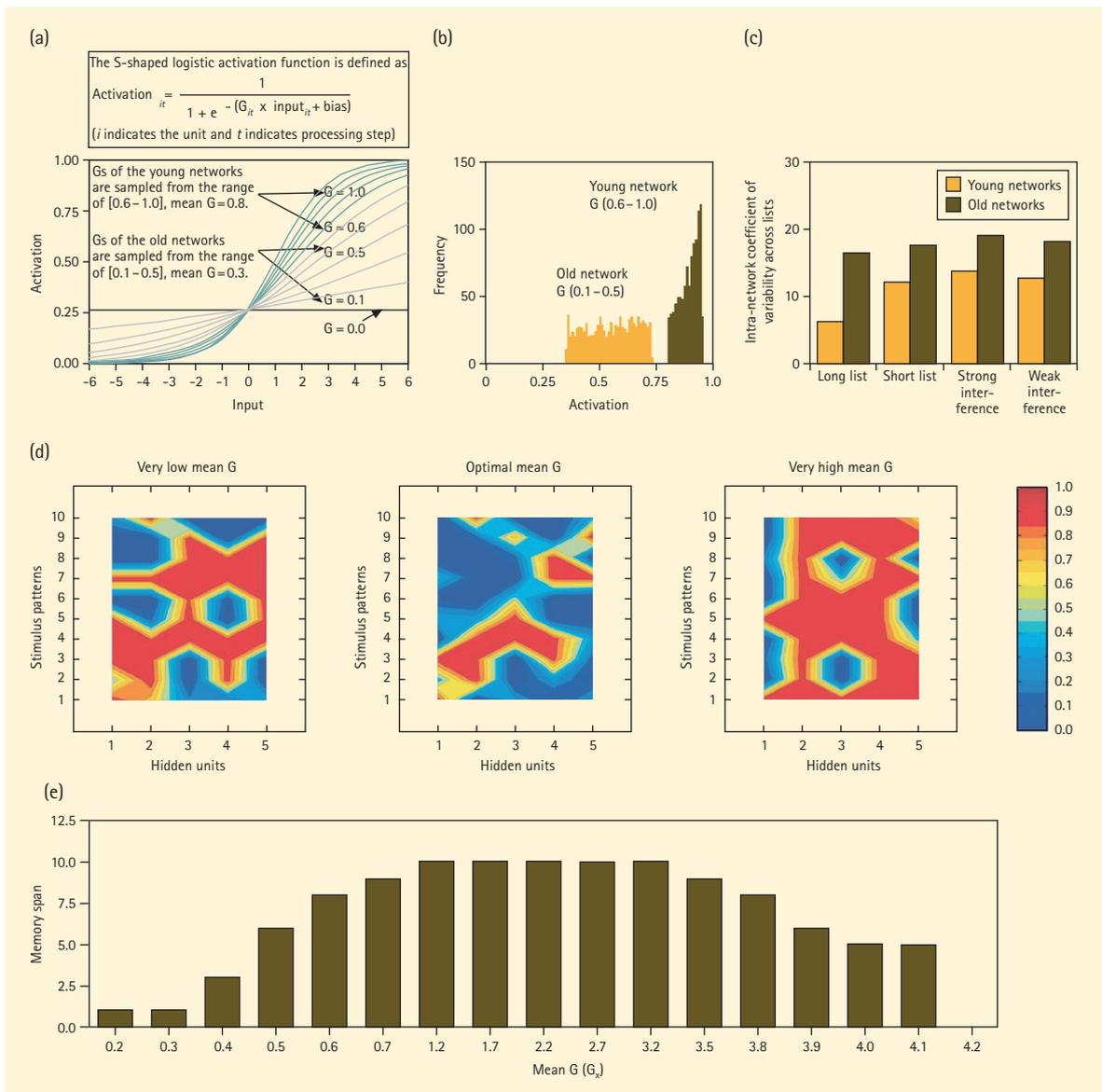
Christian Chicherio  
(postdoctoral  
research fellow until  
10/2008)

Agnieszka Zofia  
Burzynska  
Dorothea Hämmerer  
Irene E. Nagel  
Susanne Passow  
Viola Störmer  
(predoctoral research  
fellows)

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**Figure 5.** Modeling the effects of depleted, optimal, and excessive dopamine levels on the distinctiveness of cortical representations and cognitive performance. (a) Simulating aging-related losses in dopaminergic neuromodulation by reducing stochastic gain tuning. Reduced gain tuning increases (b) random activation variability and (c) performance variability in simulated old networks (adapted from Li, Lindenberger, & Sikström, 2001). Stochastic gain tuning captures the inverted-U function relating DA modulation and functional outcomes of (d) distinctiveness of activation patterns and memory performance (adapted from Li & Sikström, 2002). (e) The relation between gain and the network's memory span follows an inverted u-shape function.

Source. Li, S.-C., & Sikström, S. (2002). Integrative neurocomputational perspectives on cognitive aging, neuromodulation, and representation. *Neuroscience and Biobehavioral Reviews*, 26, 795–808.

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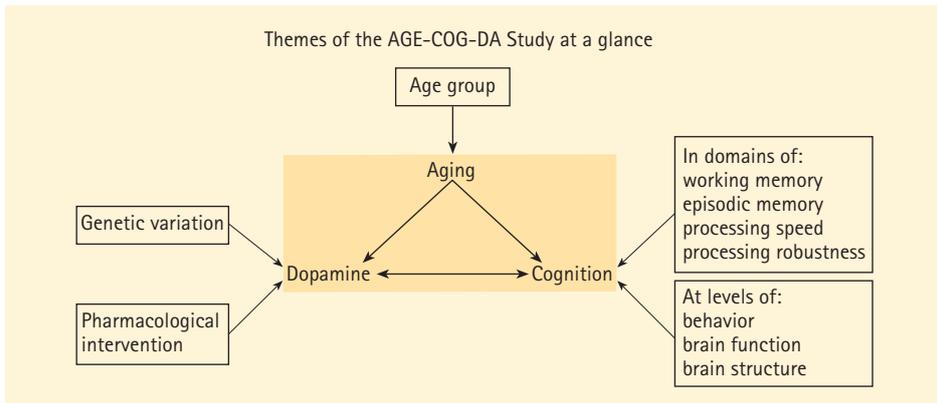


Figure 6. Combined genomic, pharmacological, and brain imaging investigations of interactive relations between aging, cognition, and dopaminergic modulation.

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covers a wide range of cognitive functions with a special emphasis on perceptual decision making, working memory, and episodic memory.

To provide an illustration of the general approach, we summarize our current findings of the COMT gene's effect on working memory performance in old age. COMT enzymatic activity results in degradation of dopamine, influencing endogenous dopamine levels in the prefrontal cortex. A common polymorphism of the COMT gene is associated with individual differences in intrinsic dopamine levels in the human prefrontal cortex. Specifically, COMT enzymatic activity is three to four times higher in Val homozygotes than in Met homozygotes. The lower enzymatic activity among Met carriers leads to less frontal dopamine degradation and, hence, greater dopamine availability at the receptors. Given that dopamine levels decrease with advancing adult age and that the function relating dopamine signaling to cognitive performance is assumed to be nonlinear, we predicted that the effects of COMT genotype of cognitive performance would be more pronounced among older adults than among younger adults (see Figure 7).

Recent data from our laboratory support this prediction, showing that older individuals show particularly low performance on tasks taxing executive control and working memory when they are homozygotic for the Val allele of the COMT gene (Dissertation project Irene E. Nagel). Based on our neurocomputational work (see Figure 5), we assume that the dopamine-related behavioral impairments

of the older Val homozygotes are accompanied by more diffuse brain activations. In the pharmaco-genetic imaging part of the study, which is restricted to COMT gene homozygotes, we are currently testing this hypothesis by examining whether older Val homozygotes show greater improvements in working memory performance and more pronounced sharpening of the task-related functional brain activation patterns when being given a dopamine agonist (i. e., D-amphetamine) than older Met homozygotes, or younger adults of both genotypes. In fact, we expect that younger Met homozygotes may show *reduced* levels of working memory performance when given the dopamine agonist, in accordance with the curvilinear shape of the function relating dopaminergic signaling

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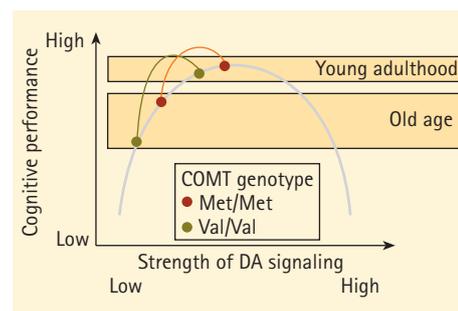


Figure 7. Function relating the strength of frontal DA signaling to cognitive performance. The inverted-U shape of the curve implies that performance differences between Met and Val carriers of the COMT gene are greater for older adults than for younger adults, reflecting the decline in dopaminergic neuromodulation with advancing adult age (adapted from Nagel, Chicherio et al., 2008).

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**Key Reference**

Lindenberger, U., Nagel, I. E., Chicherio, C., Li, S.-C., Heekeren, H. R., & Bäckman, L. (2008). Age-related declines in brain resources modulates genetic effects of cognitive functioning. *Frontiers in Neuroscience*, 2, 234–244.

strength to cognitive performance. A total of 96 individuals, equally distributed by age and COMT genotype, is planned to participate in this randomized double-blind clinical trial. By January 2009, two thirds of the participants had completed the study. The larger goal of the AGE-COG-DA study is to create a database for genetically informed investigations of age differences and age changes in behavior and brain functions. For instance, given that cognitive functions, such as episodic memory and working memory, depend on interactions among multiple transmitter systems, and not just on dopamine, genes relevant to other neurotransmitters, such as serotonin, acetylcholine, glutamate, and GABA, are also assessed. Furthermore, in collaboration with Project 5 (Berlin Aging Study), we received funding from the Federal Ministry of Research to conduct whole-genome scans on an initial sample of close to 1,000 individuals

who had participated in the behavioral assessment of the AGE-COG-DA study. During the reporting period, we also conducted additional brain imaging studies to gain a more detailed understanding of adult age differences in brain activation patterns during working memory performance (Dissertation project Irene E. Nagel; see also Project 3) and to examine the relation between age-related losses in white-matter integrity and cognitive performance (Dissertation project Agnieszka Zofia Burzynska). Of special interest was the question whether some of the conflicting findings in the literature, regarding the degree and functional interpretation of higher and lower levels of task-dependent brain activation in older adults relative to younger adults, can be better understood if individual differences in performance level within age groups are taken into account. To examine this issue, we carried out several experiments in which

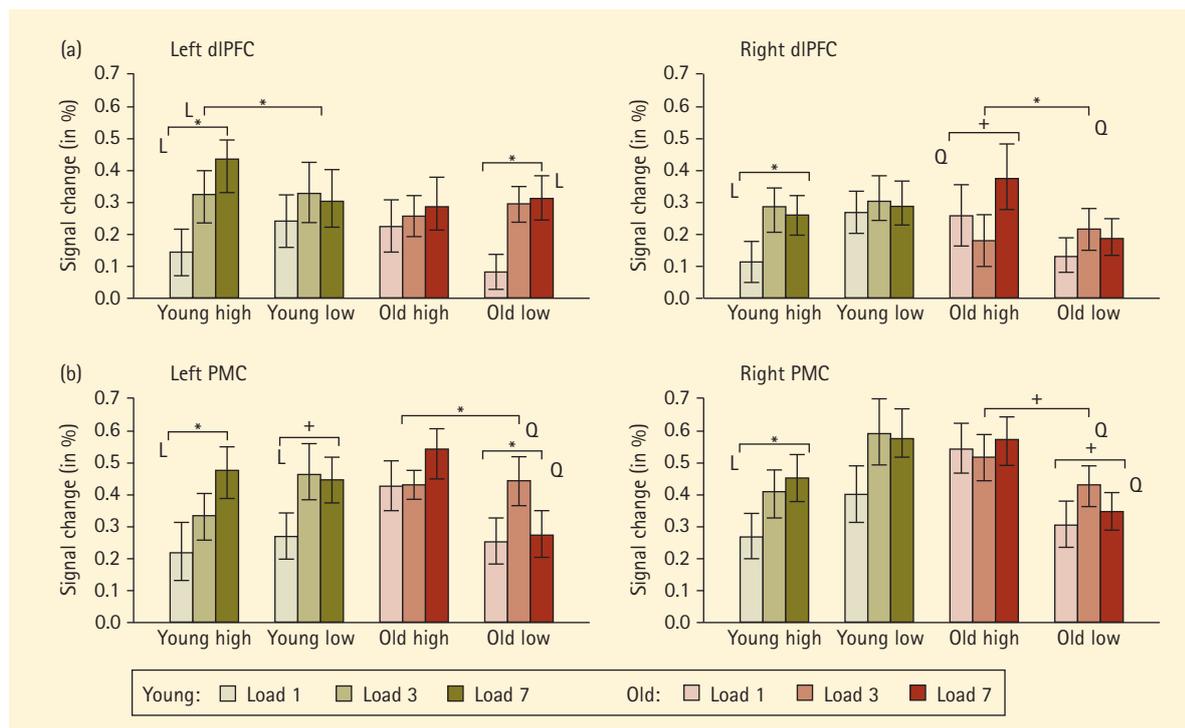


Figure 8. Region-of-interest analyses of desolateral prefrontal cortex (a) and premotor cortex (b) for the extreme groups. BOLD signal changes in high- and low-performing younger and older adults across load (younger adults: green; older adults: red; lower task demand is represented by lighter colors). \*  $p < .05$ , + trend  $p = .051-.1$ ; L = linear contrast; Q = quadratic contrast. There are marked differences in BOLD response between high and low performers within age groups. dIPFC = dorsolateral prefrontal cortex; PMC = premotor cortex; PPC = posterior parietal cortex (Dissertation project Irene E. Nagel).

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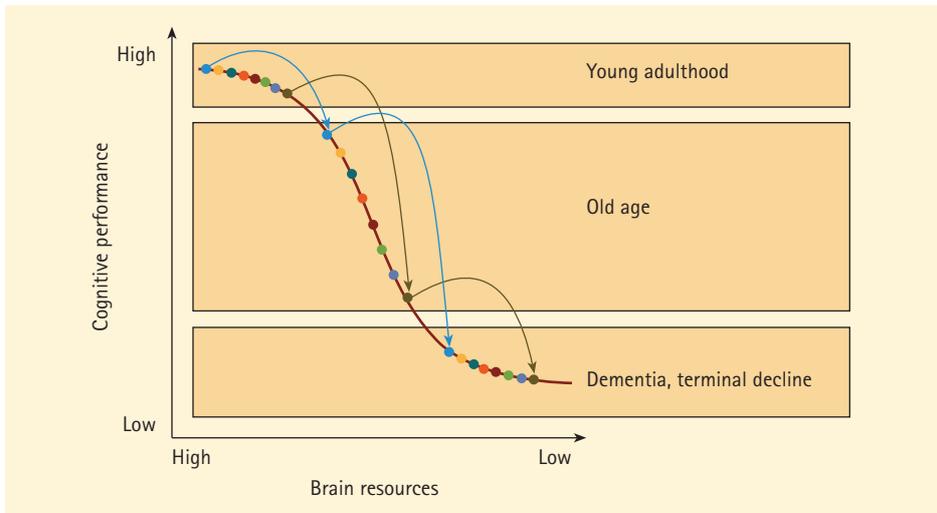


Figure 9. The resource modulation hypothesis posits that losses in chemical and structural brain resources associated with normal aging modulate the effects of common genetic variation on cognitive performance. The colored circles represent eight individuals with different combinations of genetic polymorphisms as they move from early adulthood over old age to dementia or terminal decline (adapted from Lindenberger, Nagel et al., 2008).

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we divided participants in either age group into high-performing and low-performing subgroups.

The analysis of blood-oxygen-level-dependent (BOLD) signals showed that activity in brain regions commonly involved in working memory performance increased with working memory load in high-performing individuals of both age groups. However, in low-performing older individuals, BOLD signals increased up to the condition with intermediate working memory load, but decreased in the condition with the highest memory load (see Figure 8). These results underscore the importance of taking performance level into account when investigating aging- and genotype-related differences in cognitive and brain functions.

Finally, based on neurocomputational modeling, item response theory, and the results obtained by Nagel, Chicherio et al. (2008), we raised the question whether the modulatory effects of age-related declines in brain resources on the relation between genetic differences and cognitive performance may generalize to other genes beyond COMT, and to other neurotransmitter systems beyond dopamine (see Figure 9; Lindenberger, Nagel, Chicherio, Li, Heekeren, & Bäckman, 2008). Initial results from our laboratory regarding the effects of the brain-derived neurotrophic factor (BDNF) gene on episodic memory suggest that this may indeed be the case.

### Subproject II: Neuromodulation of Lifespan Age Differences in Goal-Directed Behavior

The Neuromodulation of Goal-Directed Behavior subproject investigates age differences in conflict-monitoring mechanisms from childhood to old age. The subproject started in August 2006 and is partially funded by a research unit grant from the German Research Foundation (DFG Forschergruppe 778, Conflicts as Signals in Cognitive Systems).

Mechanisms for monitoring conflicts between one's responses (*response conflicts*) or between actual outcomes and desired goals (*outcome conflicts*) help individuals to dynamically adapt to changes in the environment by regulating and changing their behavioral repertoires. Little is known about how conflict-monitoring mechanisms develop across the lifespan (Li, Hämmerer, Mueller, Hommel, & Lindenberger, in press). Older adults and children perform more slowly and less accurately than younger adults on tasks involving response conflict monitoring and overriding conflicts (Li et al., 2004; Li, Hämmerer et al., in press). These differences are reflected in event-related potentials (ERPs) assessed by electroencephalography (EEG). Generally, ERPs are reduced in amplitude in children and older adults relative to young adults. Age differences in the processing of outcome conflicts have not yet been investigated. In 2008, we completed

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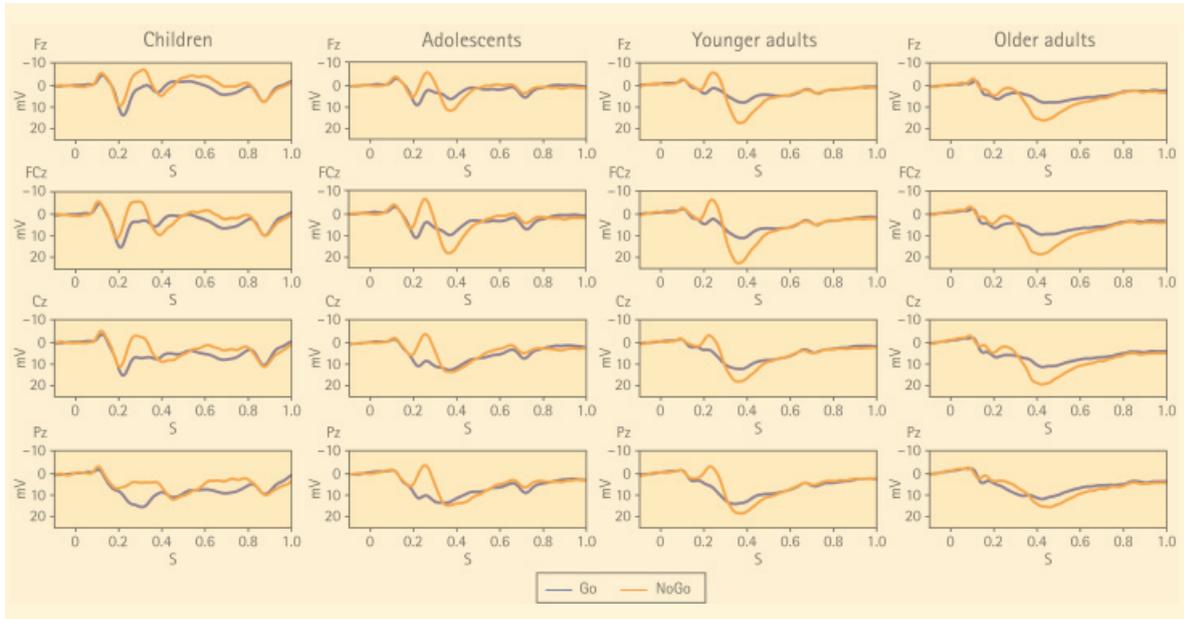
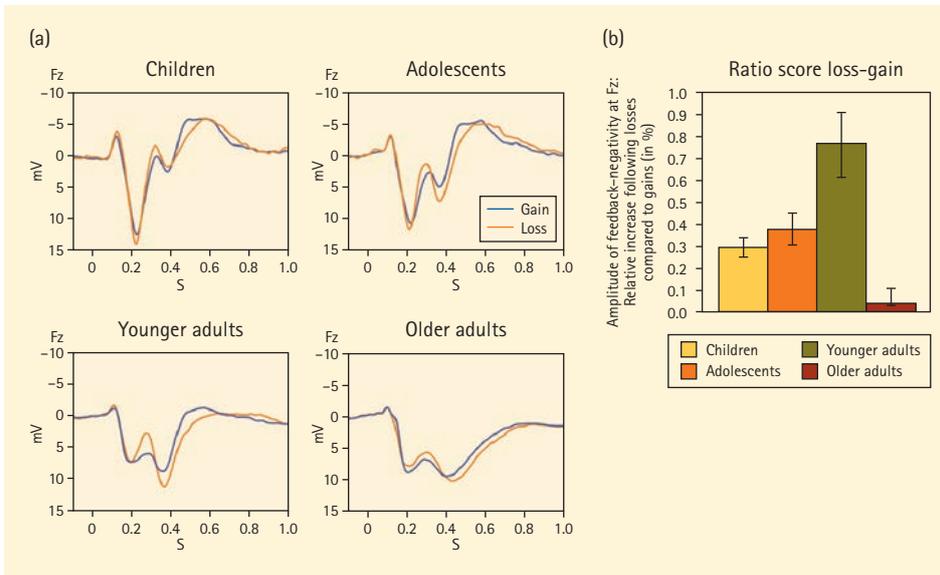


Figure 10. Lifespan age differences in the amplitude difference between Go and NoGo trials for the N2 component of the ERP during a conflict monitoring task. The difference is smaller in older adults than in any of the other three age groups, pointing to aging-induced changes in inhibitory processing (Dissertation Dorothea Hämmerer).

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Figure 11. The distinctiveness of EEG responses to positive and negative outcomes across the lifespan as assessed by a probabilistic reinforcement learning task. (a) The medial-frontal negativity (MFN) component of the ERP for gains and losses in four age groups. (b) The ratio score of losses over gains for the MFN component is less positive in older adults, suggesting that gains and losses are processed less distinctively (Dissertation project Dorothea Hämmerer).



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two experiments that examined lifespan age differences in electrophysiological correlates of response conflict monitoring, investigated with a variant of the continuous performance task known as the AX-CPT task, and in outcome monitoring, investigated with a probabilistic reinforcement learning task (Dissertation project Dorothea Hämmerer). In both cases, ERPs differed markedly between children, adolescents, younger adults, and older adults. For instance, during the AX-CPT task, the difference between Go and NoGo trials for the N2 component of the ERP was smaller in older adults than in any of the other three age groups (Figure 10). Outcome monitoring was assessed with a probabilistic reinforcement learning task. Similar to the results obtained for the conflict-monitoring task, we found that the amplitude differences between the gain-related and the loss-related medial-frontal negativity were smaller in older adults than in the three other groups, suggesting that older adults discriminate less well between gains and losses than children, adolescents, and younger adults (Figure 11). Frontal and midbrain dopaminergic modulation play a central role in conflict-monitoring theories. Hence, the subproject has collected dopamine-relevant genetic information from individuals who participated in the response and outcome conflict-monitoring experiments and is currently investigating possible links between allelic variation and behavioral as well as electrophysiological indicators of conflict monitoring. In the context of a recently funded Bernstein Computational Neuroscience Networks Grant, we will investigate the interactive effects of dopamine and serotonin on adult age differences in goal-directed behavior, with an emphasis on the trade-off between short-term and long-term rewards.

### **Subproject III: Lifespan Differences in Neuromodulation of Perception and Attention**

This recently established subproject examines age differences in the attentional modulation of perceptual processing (Waszak, Schneider, Li, & Hommel, 2009). A first line of work is focusing on EEG and brain-imaging correlates of adult age differences in perceiving temporal characteristics of auditory stimuli (Dissertation project Susanne Passow). A second line of work is investigating the neuromodulation of selective attention in the domain of visual perception, again with an eye on age differences in the effects of genetic differences on performance (Dissertation project Viola Störmer). Here, the focus will be on age differences in the orienting and executive control components of attention and on genes related to the acetylcholine and dopamine neurotransmitter systems.

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## Researchers

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Annette Brose  
Julia Wolff  
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## Research Project 2 Intra-Person Dynamics Across the Lifespan

All is flux; nothing stays still.  
Heraclite, ca. 500 B.C.



### Intra-Person Dynamics: Forms and Functions

Behavioral development comprises both short-term variability and long-term change and is embedded in cultural, environmental, and neuronal contexts. The overarching objective of this project is to explore theories and research designs that articulate behavioral development across timescales, levels of analysis, and functional domains. This emphasis on empirical articulation and conceptual integration requires a drastic increase in observation density within individuals.

In examining relations between short-term variability and long-term age changes or age differences, different forms and functions of variability can be set apart (Li, Huxhold, & Schmiedek, 2004). Specifically, one may distinguish among plasticity, diversity, adaptability, fluctuation, and temporal coupling (see Figure 12). *Plasticity*, in this context, refers to various forms of adaptive performance alterations, such as learning induced by instruction, practice, and training. *Diversity* refers to variations in responses to environmental demands, such as the exploration of behavioral strategies during initial phases of complex skill acquisition. *Adaptability* indicates an individual's ability to regain earlier functional levels after perturbations arising from either internal processing fluctuations (e.g., atten-

tion slips) or changes in the external environment (e.g., more demanding tasks). *Processing fluctuation*, or lack of processing robustness (e.g., Lövdén, Li et al., 2007), reflects stochastic fluctuations around a modal response. Processing fluctuations can be observed more easily when other forms of variability are low, as is often the case for standard reaction-time tasks, or when they have been reduced, as is the case when individuals have consolidated the use of a particular strategy and are operating near maximum levels of functioning. Finally, *temporal coupling* refers to associations between two or more forms of processing within or across domains of functioning, such as concurrent covariation, lead-lag relations, and synchronization, at identical, different, or hierarchically nested timescales.

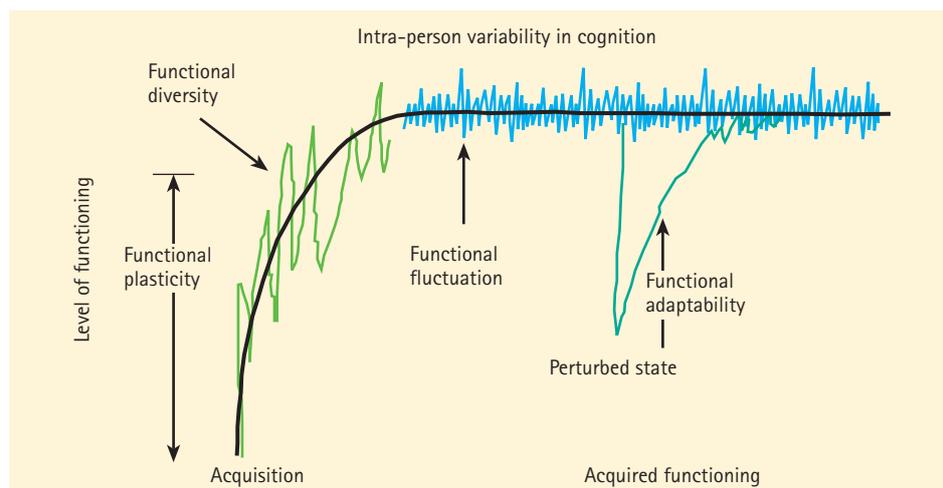


Figure 12. Types of intra-person variability in cognitive functioning (adapted from Li et al., 2004).

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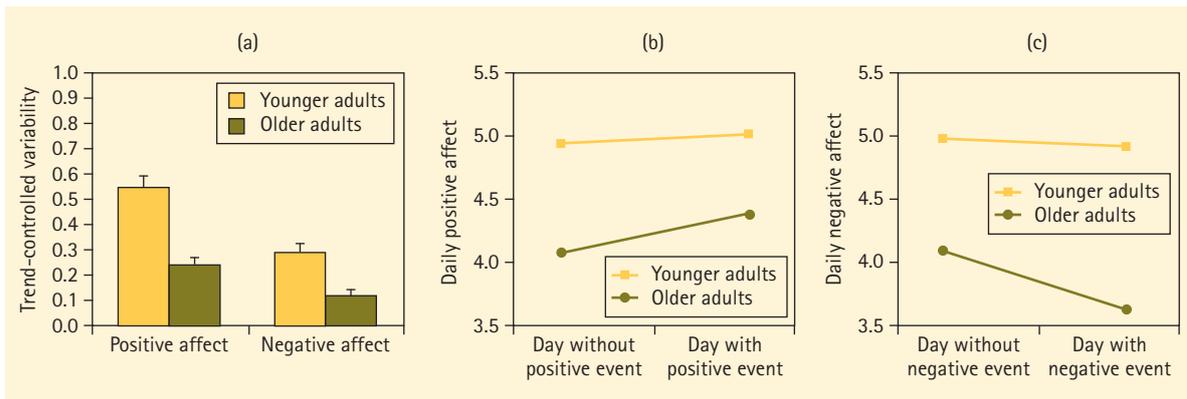


Figure 13. Adult age differences affective variability from day to day. (a) Older adults show less day-to-day fluctuations in both positive and negative affect than younger adults. (b) The moderating effect of age group on the coupling of daily positive affect and exposure to positive events. In younger adults, the coupling is more pronounced than in older adults. (c) The moderating effect of age group on the coupling of daily positive affect and exposure to negative events. Again, the coupling is more pronounced in younger adults than in older adults (adapted from Röcke et al., in press).

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### The DYNAMICS Study

So far, the Intra-Person Dynamics project has completed two rather comprehensive empirical studies to delineate daily fluctuations in intraindividual variability. The DYNAMICS study, completed in November 2005 (senior researchers: Shu-Chen Li, Jacqui Smith, Paul B. Baltes, & Ulman Lindenberger), covered 45 daily measurement occasions to examine adult age differences in intra-person fluctuations in four domains of functioning: postural control, spatial working memory, positive and negative affect, and task-specific motivation. Eighteen young adults aged 20–30 and 19 older adults aged 70–80 years participated in the study for about 9 weeks. Data analysis is still ongoing and has resulted in several publications during the reporting period, some of which are summarized below. Regarding emotional functioning, older adults showed significantly less day-to-day variability in positive and negative affect than younger adults (Figure 13; Röcke, Li, & Smith, in press). This result is consistent with theories predicting improvement in emotion regulation with advancing adult age. However, alternative explanations, such as age-graded differences in everyday environments, identity consolidation, habituation processes, and physiological changes in reactivity, cannot be ruled out. Multilevel analyses also indicated that older

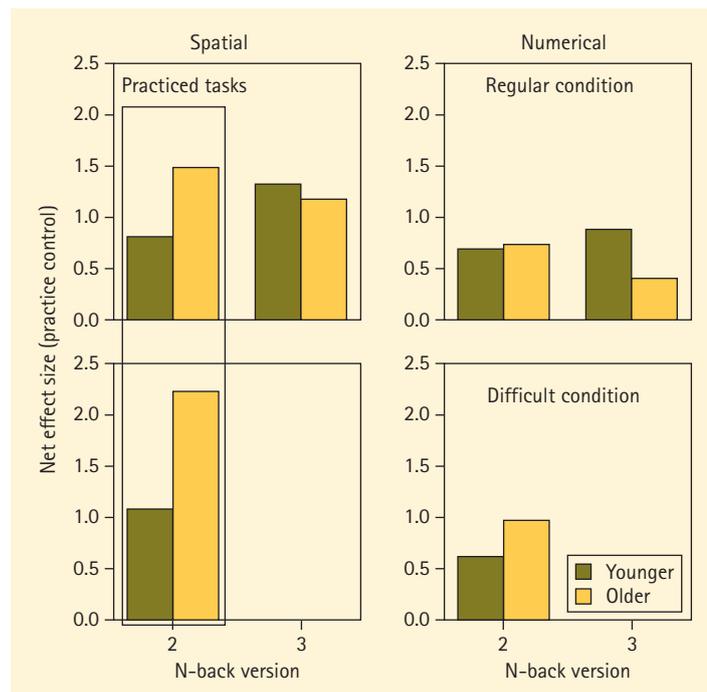


Figure 14. Adult age differences and similarities in working memory plasticity: Practice gains and transfer. Net effect sizes (practice group minus control group) of reaction times for practice gains on regular and difficult versions of a spatial 2-back working memory task and transfer effects in near transfer tasks, that is, a more demanding spatial 3-back task and numerical versions of the 2-back and 3-back tasks. Effect sizes reflect gains in performance speed. Both younger and older adults improved considerably both on practiced tasks and on transfer tasks (adapted from Li, Schmiedek et al., 2008).

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Li, S.-C., Schmiedek, F., Huxhold, O., Röcke, C., Smith, J., & Lindenberger, U. (2008). Working memory plasticity in old age: Practice gain, transfer, and maintenance. *Psychology and Aging*, 23, 731–742.

adults' daily affect was less closely linked to daily positive and daily negative events than younger adults' affect (see Panels [b] and [c] in Figure 13; Röcke et al., in press). This pattern of dampened affective reactivity in older adults may point to mechanisms that result in greater stability in everyday emotional experiences in old age.

Regarding plasticity of cognitive performance due to extensive practice, both younger and older adults showed substantive improvements on practiced tasks as well as transfer to nontrained tasks with similar processing demands but different content or higher difficulty (Li, Schmiedek, Huxhold, Röcke, Smith, & Lindenberger, 2008). These effects were maintained for several months in younger adults but decreased in older adults, pointing to age-related decline in the ability to maintain skilled working memory performance. In a different analysis, we found that older adults were more likely to commit confusion errors in working memory performance than younger adults (Schmiedek, Li, & Lindenberger, 2009).

## The COGITO Study

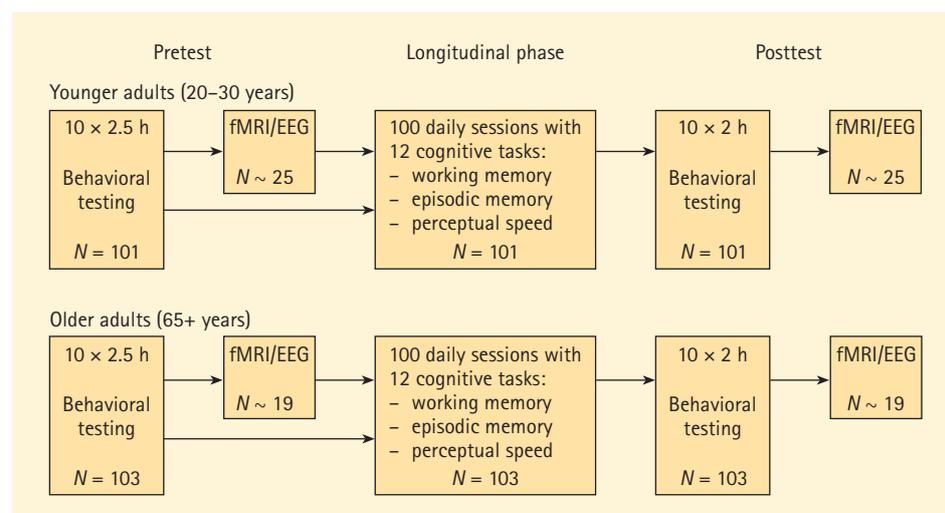
In the reporting period, the Intra-Person Dynamics planned and implemented a second study to more thoroughly investigate the differences and commonalities between covariance structures of intellectual abilities measured across individuals at a given occa-

sion and across occasions within a given individual. Most existing research on intellectual abilities assumes that covariance structures based on interindividual differences generalize to intra-person structures. However, as Raymond B. Cattell, Jacques Lautrey, John Nesselroade, Peter Molenaar, and others have argued for a long time, differences between intra-person and inter-person structures are perfectly possible. Conceptually, the malleability of functional organization at both behavioral and neuronal levels and the diversity of developmental trajectories and life experiences render any strict congruence between intra-person and inter-person structures unlikely.

The main empirical study, labeled the Cognition Ergodicity Study of the MPI for Human Development, or COGITO ERGO SUM, or even shorter, the COGITO study, was started in 2006 and completed toward the end of 2007. One hundred and one younger adults aged 20–31 years and 103 older adults aged 65–80 years participated in 100 daily sessions, working each day on a set of 12 cognitive tasks comprising perceptual speed, episodic memory, and working memory (see Figure 15). Self-report measures of affect, motivation, and mood were also assessed on a daily basis (Dissertation project Annette Brose). In addition, all participants completed comprehensive pretests and posttests with baseline measures of cognitive abilities and transfer

Figure 15. The experimental design of the COGITO study.

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tasks for the practiced abilities. In subsamples of 25 younger and 19 older participants, brain-related measures were taken at pretest and posttest, including structural magnetic resonance imaging, functional magnetic resonance imaging, and electroencephalographic recordings. The study was preceded by extensive pilot work to validate the measures and examine their multivariate structure (e.g., Schmiedek, Hildebrandt, Lövdén, Wilhelm, & Lindenberger, in press).

Data analysis is currently underway to systematically examine differences and commonalities between covariance structures of intellectual abilities measured either (a) across individuals at a given occasion or (b) across occasions within a given individual. Initial results suggest that the degree of congruence between within-person and between-person structures may vary by age. The corresponding analyses will also shed new light on the dedifferentiation hypothesis of old-age intelligence (Lindenberger & Ghisletta, 2009). According to this hypothesis, increasing correlations among cognitive abilities with advancing age reflect the operation of domain-general resource limitations. The critical question here is whether earlier observations of increasing correlations among cognitive abilities with advancing age, when assessed across persons, are matched by increasing correlations among cognitive abilities with advancing age, when assessed within persons across days. Extend-

ing this question to the neuronal level of analysis, we are currently examining whether older individuals who show low levels of average performance and high correlations among different cognitive abilities tend to be those who show diffuse cortical activation patterns relative to older individuals with high average levels of performance and low correlations among cognitive abilities.

In sum, the data of this study provide a full data cube of persons x timepoints x variables as envisioned by Raymond B. Cattell. This will open up new data-analytic approaches and allow new insights into between-person differences in intra-person variability and change.

Furthermore, the COGITO study also provides a unique opportunity to address the question of practice-induced cognitive plasticity because the amount (100 one-hour sessions), breadth (12 different tasks covering a broad range of cognitive abilities and contents), and demand characteristics of the training schedule, when considered in combination, is without precedent. As shown in Figure 18 for older adults, performance on practiced tasks improved continuously across the 100 sessions. To estimate the size of training and transfer effects due to training, age-matched control groups of 44 younger and 41 older adults took part in pretest and posttest measurements separated by a delay comparable to the main study group. Going beyond earlier attempts to determine the

#### Key Reference

Schmiedek, F., Hildebrandt, A., Lövdén, M., Wilhelm, O., & Lindenberger, U. (in press). Complex span versus updating tasks of working memory: The gap is not that deep. *Journal of Experimental Psychology: Learning, Memory, and Cognition*.

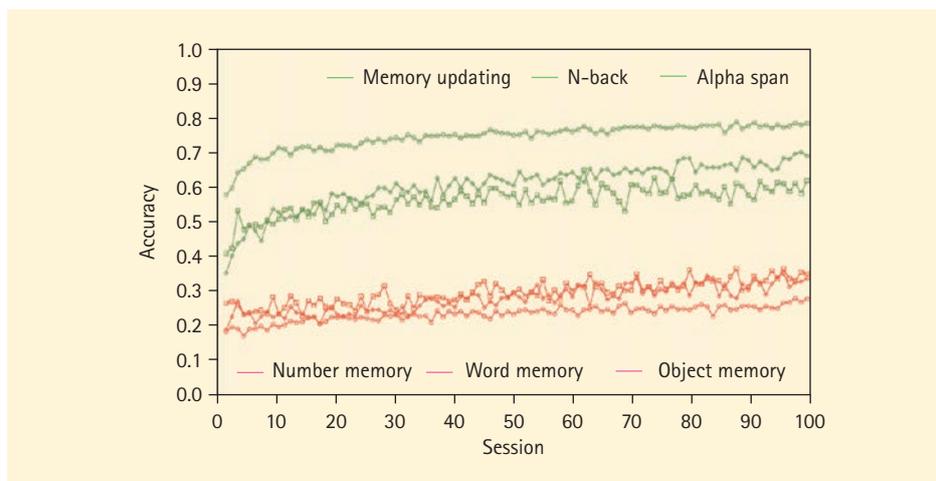
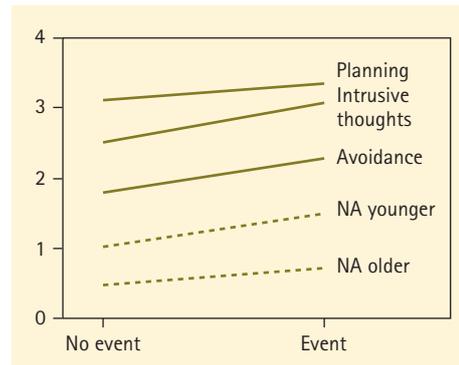


Figure 16. Initial results from the COGITO study. Improvements of older adults' average performance on the working memory tasks (green) and the episodic memory tasks (red) across 100 practice sessions.

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*Figure 17.* Intraindividual daily couplings between negative events and negative affect (NA), intrusive thoughts, avoidance, and planning. The coupling between negative events and negative affects was stronger in younger adults than in older adults. Couplings did not reliably differ in strength between age groups for planning, intrusive thoughts, and avoidance. Results can be interpreted in scale point units (8-point scale, 0–7) (Dissertation project Annette Brose).

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breadth of transfer effects, we included a broad battery of potential transfer tasks, covering different near and far ability constructs. The number and heterogeneity of transfer tasks will allow us to investigate transfer effects at the level of latent factors, which, in our view, is a necessary condition for interpreting positive transfer of training as improvements in cognitive abilities, rather than in task-specific skills.

Another central topic of the COGITO study is the investigation of within-person couplings between daily stressors, negative affect, regulatory activity, as well as cognitive performance. We assume that the exposure to stressors provokes reactions requiring regulatory effort. Whereas such psychological consequences of stress, summarized under the term coping, are described as adaptation processes, they might have detrimental effects on cognitive performance if they draw on attentional resources. Hence, a first research goal was to identify adult age differences in couplings between stressors and different domains of functioning. Initial results, consistent with results from Röcke et al. (in press; see Figure 13), show affective reactivity to daily negative events is particularly reduced in older adults relative to younger adults. Younger and older adults resemble each other in the observed increase in intrusive thoughts, planning, and avoidance on days with events (Figure 17). Thus, coping patterns seem to be rather stable across the adult lifespan. In contrast, initial analyses on the cross-domain couplings between working memory performance and negative events, cognitive interference, and negative

affect point to greater age-group specificity. In younger adults, accuracy of performance was related to these factors, whereas in older adults, reaction times were affected. Furthermore, the link between daily negative events and performance was more pronounced in older adults relative to younger adults. Only younger adults' performance was hampered by negative affect and cognitive interference. Together, daily stress is related to a broad array of psychological outcomes including affect, coping, and cognitive performance. In part, the observed age-group differences may be due to age-related shifts in motivational structures.

Finally, the extensive multimodal imaging protocol administered to a subsample before and after the 100 days of daily cognitive assessment allows for examining the neuronal correlates of both plasticity and variability at different levels of analysis. The functional imaging and EEG protocol allows for investigating brain activity in participants performing working memory, perceptual speed, and episodic memory tasks that were part of the daily assessment. These functional measurements are complemented with structural imaging targeting gray matter structure and diffusion-tensor imaging targeting white matter microstructure. We will link these structural and functional neuronal measures to individual differences in variability over different time scales (e. g., moment-to-moment, day-to-day) and to between-person differences in covariance structures of intellectual abilities. In addition, functional brain correlates of performance improvements and plasticity are being examined.

### **Future Perspectives**

The unique properties of the COGITO study, particularly the number of measurement occasions and the amount of background information on each participant, have paved the way for extending the study into a longitudinal endeavor. First, in collaboration with the *Deutsches Institut für Wirtschaftsforschung*, participants were recruited into the *German Socio-Economic Panel Study* (SOEP). The SOEP is a representative longitudinal study of about 11,000 private households distributed throughout Germany, with yearly interviews being conducted since 25 years. Linking the COGITO study to the SOEP will provide a reference frame for evaluating the representativeness of the COGITO sample and contribute valuable information on socioeconomic

variables, including interviews with all household members and yearly follow-ups.

In addition, a 2-year follow-up of the COGITO main study has begun in January 2009. This follow-up will include a repetition of the whole posttest battery to investigate maintenance of training and transfer effects, and another ten daily sessions to analyze longitudinal changes in day-to-day fluctuations. The follow-up will also include daily measures of objective fitness and cortisol, a comprehensive medical examination, and blood sampling for a whole-genome scan (see also Project 5, The Berlin Aging Studies). Together with data from the SOEP, the extension of the measurement protocol will allow us to relate of social support to objective and subjective indicators of health (Dissertation project Julia Wolff).

## Researchers

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## Research Project 3

### Cognitive and Neuronal Dynamics of Memory Across the Lifespan (CONMEM)

#### Memory Development as the Interplay of Strategic and Associative Components Across Multiple Levels

Information processing in the brain is distributed and carried out in parallel involving several cortical and subcortical regions. Mechanisms related to maturation, learning, and senescence affect different regions of the brain on multiple and interacting levels, dimensions, time-scales, and trajectories. Furthermore, behavioral and neuronal evidence suggests that memory functioning requires oscillatory interactions in a distributed network comprising, among others, prefrontal (PFC), medio-temporal (MTL), and parietal regions.

The overarching objective of the project Cognitive and Neuronal Dynamics of Memory Across the Lifespan (CONMEM) is to provide mechanistic and process-oriented explanations for developmental changes in memory functions. We aim to advance knowledge about the dynamic structure-function dependencies underlying the interplay between memory processes and related neuronal mechanisms. In doing so, the CONMEM project continues and expands on research undertaken together with Shu-Chen Li and Viktor Mueller in the Lifespan Age Differences in Episodic Memory Plasticity subproject of the Intra-Person Dynamics Across the Lifespan project (for more information, see the 2005–2006 Research Report). Also, up to 2007, parts of the research reported below were funded by a research unit grant from the German Research Foundation (DFG Forschergruppe 448, Binding: Functional architecture, neuronal correlates, and ontogeny). The basic conceptual framework of the CONMEM project holds that maturational, experience-dependent, and senescent forces express their influences on the varying contribution of *associative* and *strategic components* during memory encoding, consolidation, and retrieval (cf. Shing, Werkle-Bergner, Li, & Lindenberger, 2008; Werkle-Bergner, Mueller, Li, & Lindenberger, 2006). The associative component of memory refers to mechanisms during encoding, consolidation, and retrieval that bind different aspects of an event into a cohesive memory representation. The associative component can be linked to the functioning of the MTL (especially the hippocampus) and posterior association areas. It is assumed that synchronized activity

within and between neuronal networks acts as a binding mechanism in the service of episodic memory (e. g., Zimmer, Mecklinger, & Lindenberger, 2006).

The strategic component, on the other hand, contributes to memory through selective elaboration, organization, and search for relations among features. Strategic processes may be self-activated spontaneously or elicited by instruction. The functioning of the strategic component is closely related to attentional and control mechanisms mainly supported by PFC regions. As both components rely on partially overlapping and interactive neuronal circuitries, the functioning of both components is highly interdependent, posing an intricate challenge for empirical investigations.

We recently proposed a theory of episodic memory development that predicts a lifespan dissociation between strategic and associative memory components (Shing, Werkle-Bergner et al., 2008; Werkle-Bergner et al., 2006). With respect to childhood, we assume that the protracted maturation of prefrontal regions and associated neural pathways limits the efficiency of the strategic component in children relative to young adults. In contrast, we assume that the associative component, which primarily involves the MTL, is fully functional by middle childhood. For old age, the theory postulates deficiencies in both components relative to early adulthood, reflecting senescent alterations in PFC and MTL regions of the brain and related neuronal circuits. The predicted lifespan dissociation between the two components offers an overarching framework for lifespan studies and provides a starting point for identifying

mechanisms of lifespan changes in various forms of memory, including episodic memory and working memory.

### Neuronal Correlates of Episodic Memory Encoding

This part of the project seeks to closely examine the relative contributions of strategic and associative components to lifespan differences in episodic memory. In an initial study, demands on associative and strategic components were systematically manipulated with an associative recognition memory task in a within-person repeated-measures design (Dissertation Yee Lee Shing and Dissertation project Markus Werkle-Bergner; e.g., Shing, Werkle-Bergner et al., 2008). Forty-three children, 43 teenagers, 42 younger adults, and 42 older adults were presented with lists of word pairs and were subsequently tested for their associative memory. Associative demand was varied by manipulating the type of word pair to be studied (German-German [GG]

versus German-Malay [GM]), and strategic involvement was varied by encoding instructions that either emphasized (a) incidental item encoding, (b) intentional pair encoding, or (c) elaborative strategic encoding. A practice-based follow-up study for the GM condition was conducted to induce further improvements in participants' performance in this condition.

Results of this study are consistent with the two-component model of episodic memory development across the lifespan (see Figure 18). With strategic instruction and practice, children improved more than older adults in forming memory associations, demonstrating their latent potential for associative binding after overcoming their difficulty in implementing and effectively using a mnemonic strategy. This finding is in line with the hypothesis that the associative component of episodic memory matures early in childhood. Older adults, in contrast, did not benefit as much as the children from instruc-

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Werkle-Bergner, M., Mueller, V., Li, S.-C., & Lindenberger, U. (2006). Cortical EEG correlates of successful memory encoding: Implications for lifespan comparisons. *Neuroscience & Biobehavioral Reviews*, 30, 839–854.

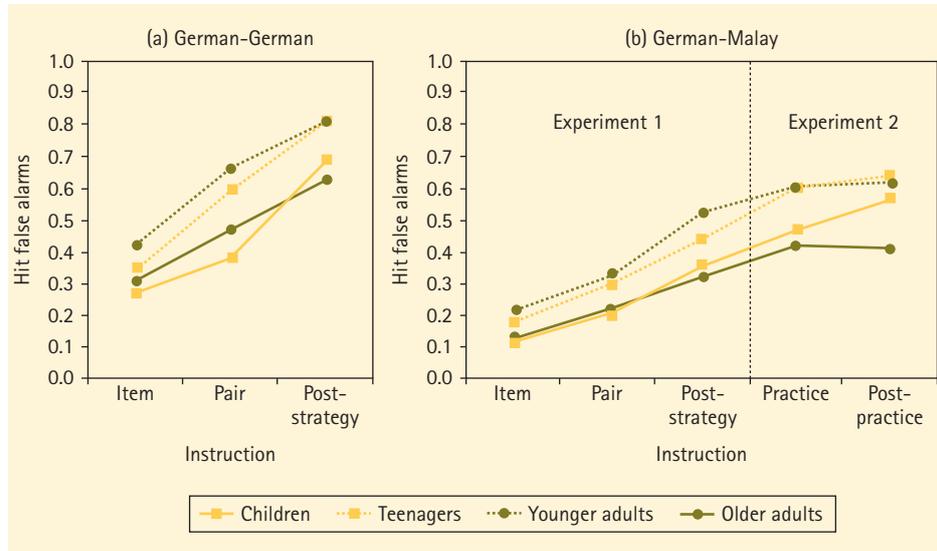


Figure 18. Empirical support for the two-component model of episodic memory development across the lifespan. In two multisession experiments, memory for word pairs was probed with a recognition paradigm. Panel (a) displays data for the associatively less demanding German-German (GG) condition, Panel (b) for the associatively more demanding German-Malay (GM) condition. The strategic component was manipulated by instruction and subsequent practice. Memory performance refers to correctly recognized pairs (hits) minus erroneously recognized lure pairs (false alarms). Here, the lure pairs consist of words that had been separately presented during encoding. As predicted, children overcame their initial strategy deficit through strategic instruction and subsequent practice and eventually surpassed older adults, demonstrating the efficacy of their associative component (Dissertation Yee Lee Shing and Dissertation project Markus Werkle-Bergner; adapted from Shing, Werkle-Bergner et al., 2008).

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### Key Reference

Werkle-Bergner, M., Shing, Y. L., Mueller, V., Li, S.-C., & Lindenberger, U. (in press). EEG gamma band synchronization in visual coding from childhood to old age: Evidence from evoked power and inter-trial phase-locking. *Clinical Neurophysiology*.

tion and practice in the mnemonic strategy. Relative to the other three groups, older adults' performance gains were especially small in the associatively demanding GM condition, supporting the hypothesis that associative binding deteriorates with advancing adult age. Inspired by these promising results, the project has launched a new line of research to directly examine age differences in brain activation patterns of successful memory encoding. This research combines multisession training procedures with functional neuroimaging techniques and is being conducted together with Yvonne Brehmer and Lars Bäckman from the Karolinska Institute at Stockholm. A major goal of this work is to find out whether age-group differences in patterns of brain activation during successful episodic memory formation are consistent with the two-component model. Of special interest is the question whether instruction-related and practice-related changes in neural activation during successful memory encoding differ by age. For instance, we predict that children's brain activation patterns during successful memory encoding may become more similar to those of adolescents in the course of practice.

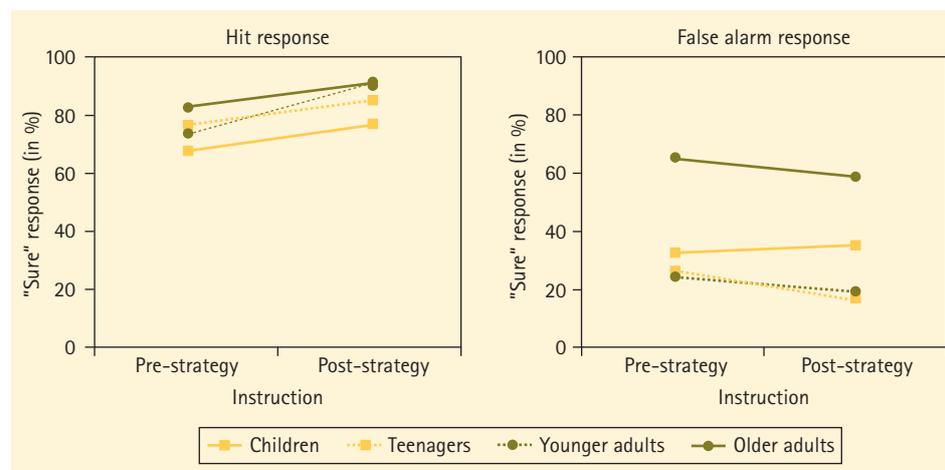
### High-Confidence Errors and Age Differences in Retrieval Processing

The ability to calibrate one's subjective confidence with the accuracy of memory is an important aspect of memory monitoring. In an initial study, we examined lifespan dif-

ferences of confidence calibration in episodic memory, particularly, the susceptibility to high-confidence errors in children, teenagers, younger adults, and older adults (Dissertation Yee Lee Shing and Dissertation project Markus Werkle-Bergner; Shing, Werkle-Bergner, Li, & Lindenberger, 2009). Our results show that participants of all ages show higher confidence following correct responses (hits) than following erroneously recognized lure items (false alarms), demonstrating the ability to calibrate subjective confidence in relation to memory accuracy. However, older adults were disproportionately more likely to indicate high confidence following false alarms to lure pairs than participants of the other three age groups. This difference did not disappear even after strategy instructions and practice. We also observed a remarkable degree of heterogeneity among older adults; some of them always expressed high confidence following false alarms, whereas others always expressed low confidence following false alarms, similar to younger adults, teenagers, and children. We are currently initiating a series of experiments combining structural and functional neuroimaging techniques to further examine the high-confidence error phenomenon. These experiments will address: (a) whether changes in the PFC-MTL-parietal memory retrieval network underlie age differences in false alarms, and, in particular, in false alarms accompanied by high confidence; (b) whether high-confidence false alarms form an integral part of normal cognitive aging, or whether

Figure 19. Relative to other age groups, older adults are more likely to be "sure" about their responses when they erroneously recognize word pairs that had not been presented before (Dissertation Yee Lee Shing and Dissertation project Markus Werkle-Bergner; adapted from Shing, Werkle-Bergner, Li, & Lindenberger, 2009).

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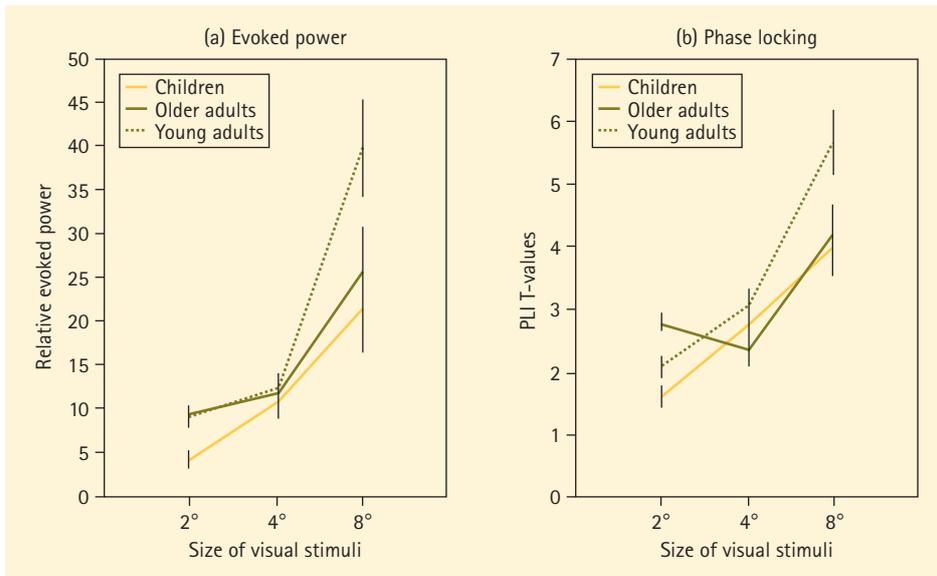


Figure 20. Neuronal correlates of visual perception differ by age. For individually determined gamma frequencies, the figures show the mean of the maximum relative change in evoked power (Panel [a]) and the mean of the maximum post-stimulus T-values of the phase-locking index (Panel [b]) for each age group and size level averaged across parieto-occipital electrodes (Dissertation project Markus Werkle-Bergner; adapted from Werkle-Bergner et al., in press).

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they might qualify as prodromal signs of dementia.

#### Lifespan Age Differences in Neuronal Correlates of Repetition Priming—Implications for Memory Formation

Previous results from our group point to lifespan age differences in the temporal synchronization of neuronal responses during early visual processing (Dissertation project Markus Werkle-Bergner; Werkle-Bergner et al., 2006; Werkle-Bergner, Shing, Mueller, Li, & Lindenberger, in press). In response to varying amounts of visual input, children aged 10.6 to 12.3 years showed lower levels of evoked power and phase locking in the gamma frequency range (> 30 Hz) than younger adults. In contrast, older adults showed smaller changes in evoked power with increasing binding demands, but similar and even higher amounts of phase locking (see Figure 20). These findings point to profound changes in the processing of sensory information from middle childhood to old age (for related results in the auditory domain, see Mueller, Brehmer, von Oertzen, Li, & Lindenberger, 2008). Based on these initial findings, we propose that the visual system of children is less entrained by incoming information, resulting in less synchronized neuronal responses, probably reflecting synaptic overproduction and immature myelination. In contrast, adults

may primarily rely on sparse representations that were formed with experience through temporally synchronized neuronal interactions. In old age, senescent decline in neuronal density and neurotransmitter availability further increase the reliance on temporally synchronized processing, possibly resulting in dedifferentiated representations.

We are currently following up on these initial results by examining age differences in the spatio-temporal characteristics of neuronal interactions during perception and their relation to successful memory formation. Initial pilot studies suggest that repetition-priming paradigms, which allow examining stimulus-specific reductions in neuronal activation due to repeated exposure, may be useful in this regard. Work in this area will be carried out in close collaboration with Hauke R. Heekeren (Independent Junior Research Group, Neurocognition of Decision Making, and Free University Berlin) and Wolfgang Klimesch (Physiological Psychology, University of Salzburg) and is partially funded by a project grant from the German Research Foundation.

#### Mechanisms and Limits of Working Memory Across the Lifespan

Another emphasis of this project is on lifespan age differences in working memory. Working memory is arguably one of the most basic cognitive functions, enabling flexible adaptation to

changing environments. The capacity of working memory is generally assumed to be limited. For example, the capacity of working memory for visuo-spatial information typically refers to the number of visual items an individual can actively hold in mind over short periods of time and has been estimated at about four items for normal adults. Given its capacity limitations, the ability to select relevant and ignore irrelevant information is critical for an individual's range of effective working-memory performance. At present, little is known about age-dependent changes in selective filtering and capacity limits in working memory and associated changes in the large-scale dynamics of neuronal networks. Using EEG methods, we will investigate (a) how age-related and individual differences in selective filtering of information

into working memory relates to differences in working-memory performance and (b) how age differences in selective filtering are related to age differences in oscillatory neuronal dynamics (Dissertation project Myriam Sander; see Figure 21). To this end, and in collaboration with Andreas Brandmaier and Timo von Oertzen (Research Project 8, Formal Methods in Lifespan Psychology), we developed an adaptive testing algorithm that allows researchers to individually determine the presentation time needed to attain a working-memory capacity of 3 to 4 items. It is hoped that the individual adjustment of presentation times and performance ranges will facilitate a processing-speed adjusted lifespan comparison of component processes limiting working-memory capacity in subsequent EEG experiments.

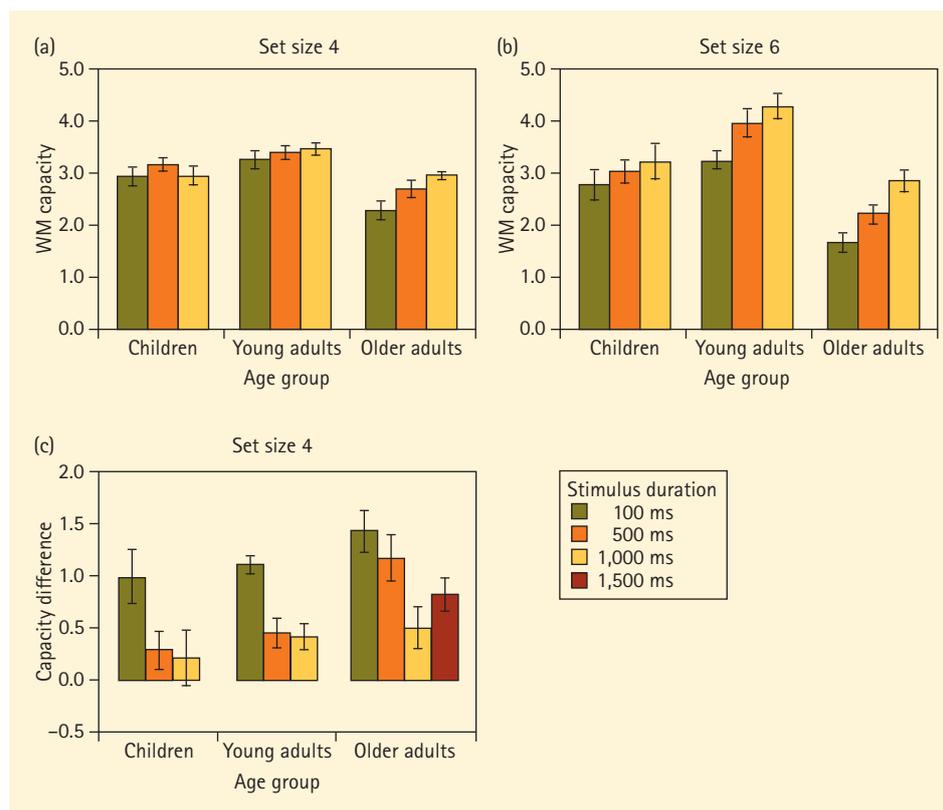


Figure 21. Results from behavioral pilot studies investigating the effects of encoding time on working-memory capacity and filter efficiency in a change-detection paradigm. Panels (a) and (b) show mean estimates of working-memory (WM) capacity for children, younger, and older adults at three different encoding times with displays containing 4 and 6 items, respectively. Panel (c) shows the difference in working-memory capacity estimates for displays without and displays with distractors, based on a memory set of 4 items. Error bars represent the standard error of the mean (Dissertation project Myriam Sander).

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## Research Project 4 Sensorimotor–Cognitive Couplings

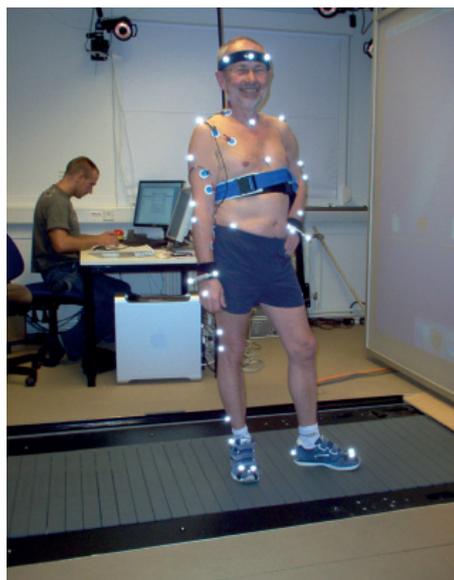
### Conceptual Overview

This project investigates lifespan changes in the interactions between sensorimotor and cognitive aspects of behavior (Schaefer, Huxhold, & Lindenberger, 2006). Everyday life often requires the integration of multiple sensory inputs and concurrent coordination of sensorimotor and cognitive demands. Examples are walking while trying to memorize a shopping list, maintaining one's balance on a bus while trying to read an advertisement, or trying to remember the way to a friend's house while driving in the hectic morning traffic. Everyday observation further suggests that older adults, and young children, need to invest more attention into sensorimotor aspects of their behavior than teenagers and young adults. For example, when facing an obstacle on a narrow path, older adults may tend to stop talking and resume their conversations after the obstacle has been overcome, whereas the same obstacle will affect younger adults' conversation to a lesser extent. How do individuals of different ages adapt to multiple sensorimotor and cognitive demands? How does the interaction between sensorimotor and cognitive dimensions of behavior change across the lifespan? This project seeks to provide answers to these questions by studying sensorimotor and cognitive behavior in multiple-task settings with a high degree of everyday validity. A related goal of the project is to propose and test criteria for effective technological assistance in old age.

Our laboratories are equipped with advanced motion capture systems and integrated synchronized assessments of biosignals, such as EEG and EMG. To visualize the participant's movement, for instance, while walking, markers reflecting infrared light are attached to the participant's body (see Figure 22). Multiple cameras capture the position of the markers, and the positions of the markers are postprocessed offline according to biomechanical models. This procedure allows for visualization of the participant's movement patterns and for the decomposition of these patterns into principal components. Figure 23 shows motion captures of an individual walking on the treadmill while holding a mobile device to assist navigation performance. To investigate locomotion behavior under conditions that more closely approximate everyday behavior, we developed a set of virtual environment paradigms with a walking component. In most cases, a scenery is projected in front of a treadmill and the movement of the treadmill is synchronized to the visual flow of the virtual environment so that participants have the impression of actually walking through the virtual environment (Figure 24). The task for participants might be, for example, to find and remember the way from one place in the virtual environment to another.

### Age-Comparative Dual-Task Studies in the Domains of Walking and Balance

In earlier work, we showed that older adults invest considerable cognitive resources to compensate for the decreased efficiencies of their sensorimotor functions, leading to higher dual-task costs in situations in which walking on a narrow track was combined with the cognitive task of memorizing word lists (Lindenberger, Marsiske, & Baltes, 2000). In



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Julius Verrel  
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fellows)

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Figure 22. An older adult on the treadmill in the motion laboratory. The laboratory is used for studies on dual-task costs in the domain of walking and for examining effects of assistive technology on walking stability and spatial navigation performance.

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Figure 23. Motion captures of an individual walking on the treadmill and holding a mobile device to assist navigation performance. The positions of the reflective markers attached to the body of the participant are captured by several infrared cameras and postprocessed according to biomechanical models to arrive at a dynamic visualization of the participant's movements. The two boxes depict a simultaneously recorded EMG signal from the right arm.

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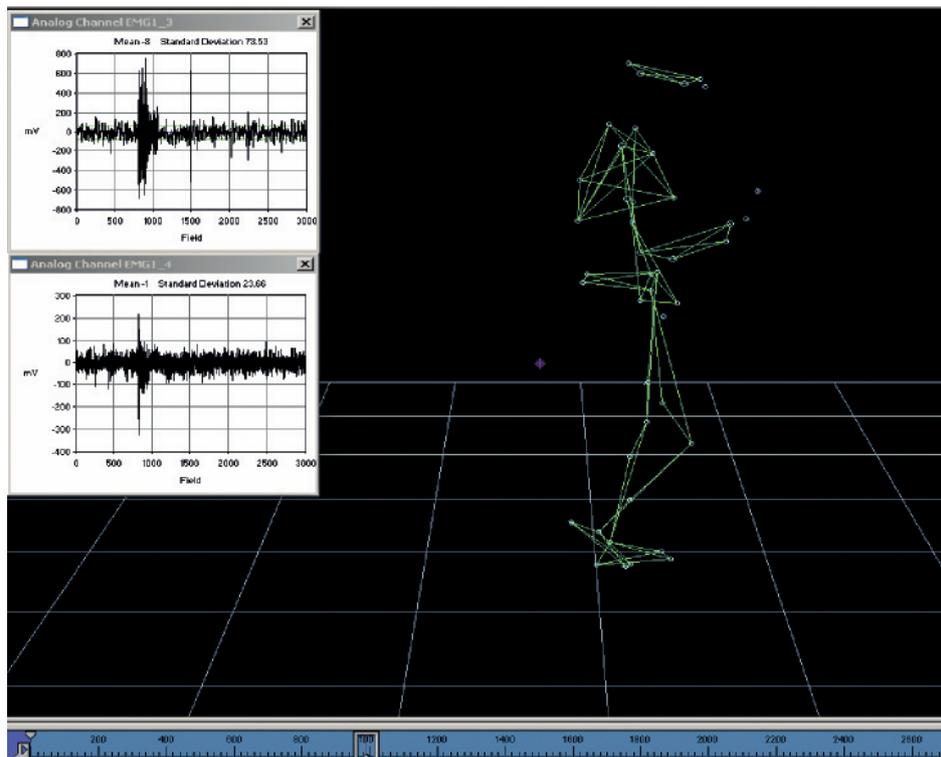
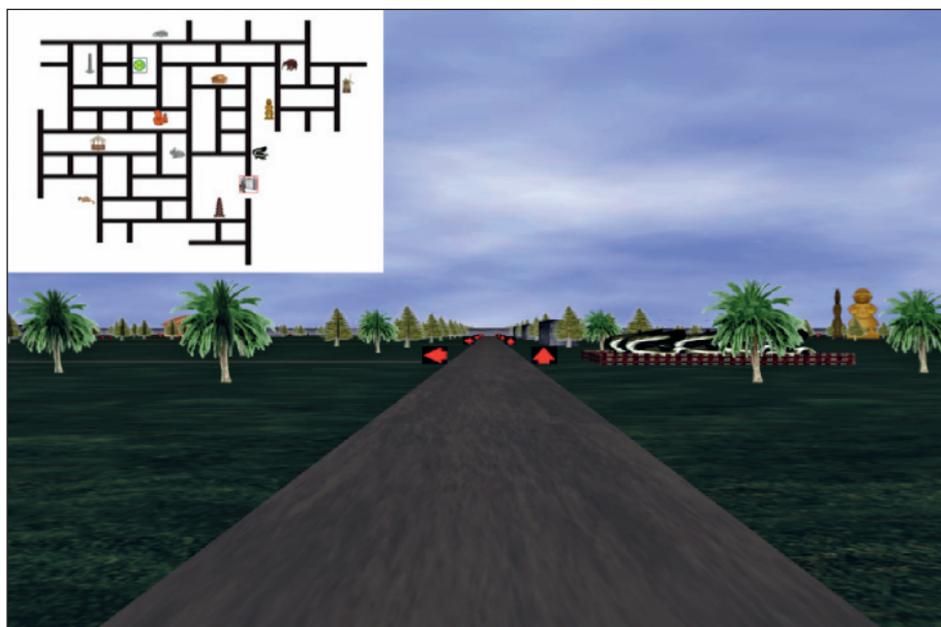


Figure 24. An example of a virtual environment projected onto a large screen in front of the treadmill. The map on the upper left-hand corner is only shown in specific conditions (Dissertation project Michael Schellenbach).

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another study, we found that older men profited from the possibility of holding a handrail while finding their way in a virtual museum, while there was no difference in way-finding

performance for younger men walking with or without support (Lövdén, Schellenbach, Grossman-Hutter, Krüger, & Lindenberger, 2005). In this study, we also found that

walking with navigation load increased older adults', but not younger adults', trunk-angle variability.

These studies point to greater dual-task costs in older adults, presumably due to increased demands of motor control on cognitive control and reductions in cognitive control capacity. However, sensorimotor-cognitive dual-task situations do not always lead to performance reductions. Accumulating evidence points to a U-shaped relationship between motor control and difficulty of concurrent cognitive activities during balance. That is, motor control appears to increase in efficiency relative to motor performance under single-task (motor only) conditions, if an easy cognitive task needs to be performed at the same time, and to decrease again as the cognitive task gets more difficult. Presumably, cognitive activities of lower difficulty promote an external focus of attention that allow the motor system to self-organize and smoothly execute movement. In contrast, higher levels of cognitive task difficulty may hamper motor control performance through cross-domain resource competition, much like those found in the walking studies reported above. The point at which performance improvements due to the first process is surpassed by decrements induced by the second process in a given individual should be predictable by the individual's sensorimotor and cognitive resources, and the demands of motor control on cognitive control (dual-process model of the interactions between cognition and sensorimotor functioning). In an early study investigating the nonmonotonic relation between cognitive load and postural control, published in 2006 in *Brain Research Bulletin*, Huxhold, Li, Schmiedek, and Lindenberger found that older adults showed performance decrements in balance while standing at lower levels of concurrent cognitive task difficulty than young adults who were able to further reduce their body sway while standing even while working on very difficult cognitive tasks. Recently, we extended the validity of the dual-process account proposed by Oliver Huxhold and colleagues to the functional domain of walking (Lövdén, Schaefer, Pohlmeier, & Lindenberger, 2008). We used the n-back

task, a standard measure of working memory that allows for parametric variation in task difficulty, in 32 younger adults (mean age of 25 years) and 32 older adults (mean age of 74 years) who were asked to walk on a treadmill at self-selected speed. Effects of age and age by working-memory load, but not dual-tasking, were found for cognitive performance. Stride-to-stride variability was reduced when participants simultaneously performed an easy working-memory task (1-back), compared to walking without a working-memory task. Further increments in working-memory load (i.e., from 1-back up to 4-back) caused reductions in the variability, but not in the means, of stride time and stride length in younger adults, but not in older adults. In line with these observations, a principal component analysis based on the gait patterns of the two age groups mentioned above and an additional group of older adults between 60 and 70 years of age indicated a U-shaped pattern for residual whole-body variability in the oldest age group (see Figure 25; Dissertation project Julius Verrel; Verrel, Lövdén, Schellenbach, Schaefer, & Lindenberger, 2009). The principal component analysis subtracts the regular from the irregular components of whole-body motion, and the residual variance can be interpreted

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Lövdén, M., Schellenbach, M., Grossman-Hutter, B., Krüger, A., & Lindenberger, U. (2005). Environmental topography and postural control demands shape aging-associated decrements in spatial navigation performance. *Psychology and Aging*, 20, 683–694.

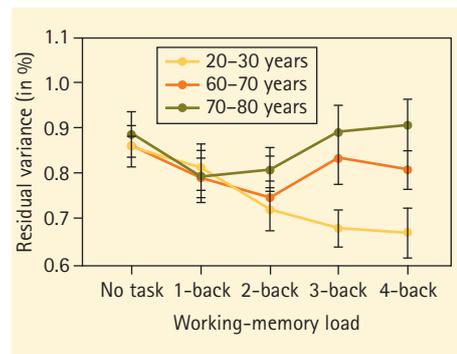


Figure 25. Residual variance of whole-body motion as a function of working-memory load and adult age after accounting for the first six principal components. Whole-body motion variability decreases with low cognitive demands and then increases again. This increase occurs earlier for older adults, pointing to increasing cross-domain resource competition with advancing adult age (Dissertation project Julius Verrel; adapted from Verrel et al., 2009).

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Verrel, J., Lövdén, M., Schellenbach, M., Schaefer, S., & Lindenberger, U. (2009). Interacting effects of cognitive load and adult age on the regularity of whole-body motion during treadmill walking. *Psychology and Aging, 24*, 75–81.

Schaefer, S., Krampe, R. T., Lindenberger, U., & Baltes, P. B. (2008). Age differences between children and young adults in the dynamics of dual-task prioritization: Body (balance) versus mind (memory). *Developmental Psychology, 44*, 747–757.

as an index of gait irregularity. Parametrically increasing working-memory load from 1-back to 4-back led to age-differential effects, with gait patterns becoming more regular in the 20- to 30-year-olds, less regular in the 70- to 80-year-olds, and showing no significant effects in the 60- to 70-year-olds. We conclude that normal aging is associated with alterations in the trade-offs between two continuous control processes involving positive effects of external focus of attention and negative effects of resource competition, respectively.

Our ongoing work on the relation between body movement and cognitive load also includes children. In a recent study, we found that children, similar to older adults, tend to increase their gait variability with increasing working-memory load (Schaefer, Lövdén, Wieckhorst, & Lindenberger, in press). In the cognitive domain, however, both children's and young adults' working-memory performance was actually *higher* when walking than when sitting on a chair, but only when individuals were walking on the treadmill at their preferred speed. Cognitive performance did not improve when the treadmill had a fixed speed of 2.5 km/h, suggesting that the adjustment of one's walking speed to the speed of the treadmill may require attentional resources. Thus, at least in children and young adults, cognitive performance may benefit from periodic forms of body movement, such as continuous walking across a wide range of difficulty levels.

The finding that sensorimotor-cognitive dual-task situations do not always lead to dual-task costs in both task domains has been further supported by a study by Schaefer, Krampe, Lindenberger, and Baltes (2008). In this study, children and young adults balanced on a special balance device, the ankle-disc board, while concurrently memorizing word lists or working on a working-memory task. Balance performance was measured by dynamic posturography on a force platform, which measures participants' stability on the ankle-disc board at any given point in time. Both children and young adults showed performance decrements, that is, dual-task costs, in the cognitive domain, and young

adults also increased their body sway on the ankle-disc board when concurrently working on a demanding cognitive task. In contrast, children swayed less when concurrently performing a cognitive task, resulting in negative dual-task costs or dual-task gains. Children continued to show performance improvements in the balance domain under dual-task conditions even when participants were instructed to focus their attention more strongly on the cognitive task. It is tempting to interpret the children's behavioral patterns in terms of adaptive resource allocation, as it may have helped them to stabilize their body's equilibrium in a situation in which they may be operating closer to their stability boundaries than young adults.

## Developmental Changes in the Structure of Movement Variability

The principal-component analyses of gait regularity performed by Verrel et al. (2009) demonstrate that advanced methods for movement analysis, preferably based on dynamic theories of motor behavior, are crucial for detecting age-related changes in motor behavior as well as their interaction with cognitive demands. In his dissertation project, Julius Verrel is scrutinizing and refining such methods in order to describe and explain age-graded changes in the structure of movement variability. Depending on its organization, movement variability can point to performance flexibility or to poor motor control. In an initial study on manual pointing, Julius Verrel found that older adults make less use of goal-equivalent ("flexible") variability than younger adults. Further studies will investigate interactions between adult age, the structure of movement variability, and the ability to flexibly adapt motor behavior to changing task constraints. Two task environments, manual pointing and treadmill walking, will be used for this purpose. We hope that applying the theory of goal-equivalent versus goal nonequivalent variability to the domain of walking will allow the development of measures of walking efficiency, which, in turn, could be used as covariate or outcome measures in cognitive dual-tasking studies.

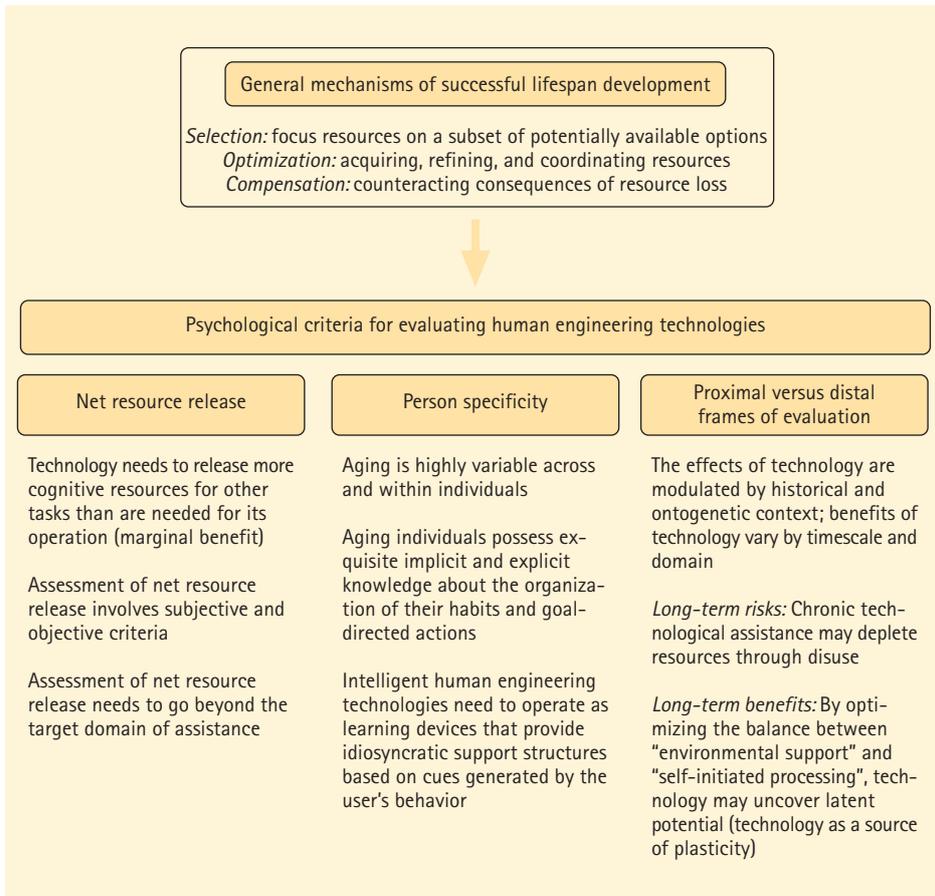


Figure 26. Psychological principles of successful aging technologies (adapted from Lindenberger, Lövdén, Schellenbach, Li, & Krüger, 2008).

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### Assistive Technologies in Old Age

The Sensorimotor-Cognitive Couplings project also investigates assistive technology in adulthood and old age. Figure 26 summarizes the psychological principles of successful aging technologies (Lindenberger, Lövdén, Schellenbach, Li, & Krüger, 2008). In order to be effective, technological devices need to release more cognitive resources for other tasks than are needed for their operation (net resource release). They also need to be person-specific, by taking into consideration the prerequisites of each aging individual, by using cues generated by the individual and by relying on learning algorithms that flexibly adapt the device to the needs and behavioral regularities of the individual. When evaluating assistive technologies, it needs to be assessed whether long-term benefits (e.g., the uncovering of an individual's latent potential) outweighs long-term risks (e.g., the deple-

tion of resources through the chronic use of technological assistance). In his dissertation project, Michael Schellenbach seeks to identify empirical criteria for net resource release by examining the ways in which navigation aids that differ in cognitive demands improve or harm gait stability in younger and older participants who are trying to find their way in a virtual environment while walking on a treadmill (see Figure 24). Currently, three different navigation aid conditions have been implemented and compared: (a) no support; (b) a virtual guide, with participants having to follow a red line that indicates the correct route in the virtual world; and (c) a map showing the structure of the virtual world in the upper left-hand corner of the screen. Preliminary results indicate that the effectiveness of different kinds of navigational assistance varies by context and by the individual's sensorimotor and cognitive resources.

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Lindenberger, U., Lövdén, M., Schellenbach, M., Li, S.-C., & Krüger, A. (2008). Psychological principles of successful aging technologies: A mini-review. *Gerontology, 54*, 59–68.

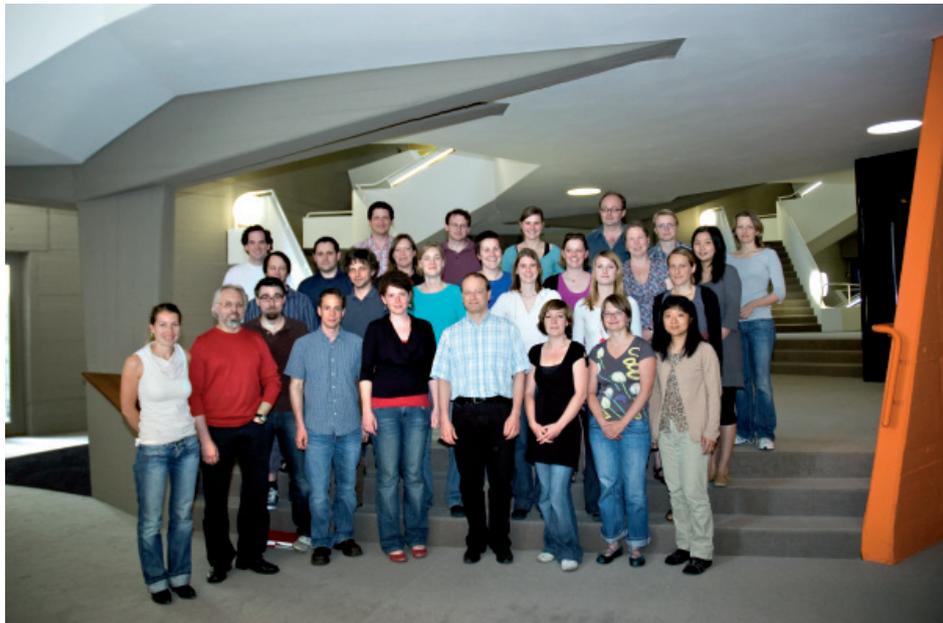
### Future Perspectives

In our ongoing and future work, we will be refining our measures of movement variability and possibly include some movement-related measures in BASE II, a large-scale study on cognition and health in adulthood (see also Project 5). We also plan to develop a treadmill

interface that allows for online control of treadmill speed in response to gait patterns. Finally, lifespan age differences in the relation between motor behavior and cognitive demands will be examined further, with an added emphasis on the influence of arousal and anxiety.

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### The Center for Lifespan Psychology in April 2009



From left to right, first row: Irene Nagel, Viktor Mueller, Markus Werkle-Bergner, Manuel Völkle, Karen Bartling, Ulman Lindenberger, Myriam Sander, Susanne Passow, Shu-Chen Li; middle row: Andreas Brandmaier, Michel Schellenbach, Hannes Noack, Franziska Kopp, Dorothea Hämmerer, Yana Fandakova, Julia Wolff, Imke Kruse, Viola Störmer, Julia Delius, Antje Rauers, Yee Lee Shing; last row: Timo von Oertzen, Florian Schmiedek, Julius Verrel, Cathleen Bache, Nils Bodammer, Sabine Schaefer, Annette Brose.

## Research Project 5 The Berlin Aging Studies (BASE)

During the 20th century, average life expectancy nearly doubled. More and more individuals in current cohorts of older individuals experience additional years of life between the ages of 70 and 100+. What do these added years mean in terms of levels of functional capacity and life quality? What are the constraints on mental and physical capacities in the last years of life? Given the heterogeneity of aging trajectories and outcomes, longitudinal studies of individual development are crucial in providing answers to these questions.

Since 1989, members of the Center of Lifespan Psychology have been investigating age- and death-related changes in psychological functioning from age 70 to 100+ in the context of the Berlin Aging Study (Baltes & Mayer, 1999). Longitudinal data in BASE are now available for eight measurement occasions spanning more than 18 years, and mortality-related information is updated at regular intervals. As of March 2007, 89% ( $n = 459$ ) of the 516 individuals who had participated in the 14-session multidisciplinary assessment at first occasion about 18 years ago were no longer alive.

The BASE project underwent three major changes and extensions during the reporting period. First, an International BASE Research Group was formed (see p. 201). The members of this group, most of whom have worked on BASE for years, meet at irregular intervals, organize symposia on BASE, and oversee the dissemination and archiving of BASE data. Second, the eighth occasion of measurement has been implemented and successfully completed. Third, a new large-scale investigation, tentatively labeled as BASE II, has been initiated.

### Adding A New Measurement Occasion to BASE

The surviving participants of the original BASE sample are of great scientific interest; they have been examined biannually for more than 16 years, and they represent the very old portion of the population, which is steadily increasing in aging societies. Therefore, we decided to add yet another measurement occasion to BASE. Special attention was given to the medical part of the assessment protocol. Varvara Moskiou, a physician, carried out the interview sessions. Kirsten Becker, who had participated in earlier measurement occa-

sions as a research assistant, trained Varvara Moskiou to ensure methodological continuity. Assessment began in May 2008. It was possible to examine 22 BASE participants and to carry out four standardized interviews with close family members of participants who were too ill to take part or had recently died. The Intake Assessment, which includes measures from medicine, psychiatry, psychology, and sociology, the psychological sessions (involving cognition as well as self and personality measures), and the geriatric interview and exams followed the earlier protocols. Due to the advanced age of the participants, it took longer to acquire the data than at earlier measurement occasions. For instance, 11 sessions were needed to examine and interview a 102-year-old participant.

### Data Analyses and Publications

In the 2007–2008 period, ten articles were published in peer-reviewed journals, such as *Psychology and Aging* and *Journals of Gerontology*, and one is currently in press. In line with the major substantive and methodological research foci in BASE, most of these publications addressed one of the following themes: (a) the dynamics of longitudinal change, (b) subjective evaluations in very old age, and (c) the relation between cognitive and sensory aging. In the following, we provide illustrations from each of these domains (but see also Lövdén, Li, Shing, & Lindenberger, 2007; Rapp, Gerstorf, Helmchen, & Smith, 2008).

#### *The Dynamics of Longitudinal Change: Identifying Lead–Lag Relations*

Analysis of BASE data continued to make use of a specific variant of latent growth curve modeling, the multivariate dual-change score model introduced by John J. McArdle

### Researchers

Ulman Lindenberger  
Julia A. M. Delius  
Hauke R. Heekeren  
(BASE II)  
Shu-Chen Li  
Florian Schmiedek  
(BASE II; Adjunct  
researcher, Humboldt  
University Berlin)

### Key Reference

Baltes, P. B., & Mayer, K. U. (Eds.). (1999). *The Berlin Aging Study: Aging from 70 to 100*. New York: Cambridge University Press.

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Gerstorf, D., Ram, N., Röcke, C., Lindenberger, U., & Smith, J. (2008). Decline in life satisfaction in old age: Longitudinal evidence for links to distance-to-death. *Psychology and Aging, 23*, 154–168.

Kleinspehn-Ammerlahn, A., Kotter-Grühn, D., & Smith, J. (2008). Self-perceptions of aging: Do subjective age and satisfaction with aging change during old age? *Journal of Gerontology: Psychological Sciences, 63B*, P377–P385.

and Fumiaki Hamagami, to test dynamic hypotheses about lead–lag relations between and within domains of functioning. Using this method, Gerstorf, Lövdén, Röcke, Smith, and Lindenberger (2007) examined cross-domain associations between perceptual speed and well-being. Reports of well-being were found to influence subsequent decline in perceptual speed. No evidence was found for a directed effect in the other direction. Potential covariates, such as initial health constraints, personality, or social participation, did not account for these differential lead–lag associations. These results suggest that well-being is not only a consequence but also a source of successful cognitive aging.

The extensive use of the dual-change score model in these and other ongoing longitudinal analyses of the BASE data set mandates close attention to the model's statistical properties. Methodological work is currently underway (see Project 8).

### Subjective Evaluations in Very Old Age

Another focus of data analysis has been on various aspects of subjective experience in old age. Gerstorf, Ram, Röcke, Lindenberger, and Smith (2008) explored terminal decline in reported life satisfaction. Life satisfaction as a function of distance to death was associated with greater interindividual differences and steeper average decline than life satisfaction as a function of distance from birth (i.e., chronological age). Furthermore, the authors identified a point about 4 years before death at which decline showed a two-fold increase in steepness relative to the pre-terminal phase. For individuals 85 years and older, they observed a three-fold increase. Established mortality predictors including sex, comorbidities, dementia, and cognition accounted for only small portions of the observed associations between life satisfaction and distance to death. Thus, it appears that late-life changes in subjective well-being are related to mechanisms predicting death (see Figure 27). In the meantime, these results have been replicated in data from the German Socio-Economic Panel Study (Gerstorf, Ram, Estabrook, Schupp, Wagner, & Lindenberger, 2008).

Kleinspehn-Ammerlahn, Kotter-Grühn, and Smith (2008) examined self-perceptions of aging, focusing on subjective aging. Subjective age was measured on two dimensions: distinguishing between *felt age* (psychological age) and the subjective age associated with one's physical appearance (when looking in the mirror). Perceived *physical age* (sometimes called *look age*) was assumed to reflect the self-appraisal of biological aging. Kleinspehn-Ammerlahn et al. (2008) examined these measures and satisfaction with aging over time as well as covariates of this change. They found that individuals' subjective age remained on average about 13 years below their actual age over time, whereas the discrepancy

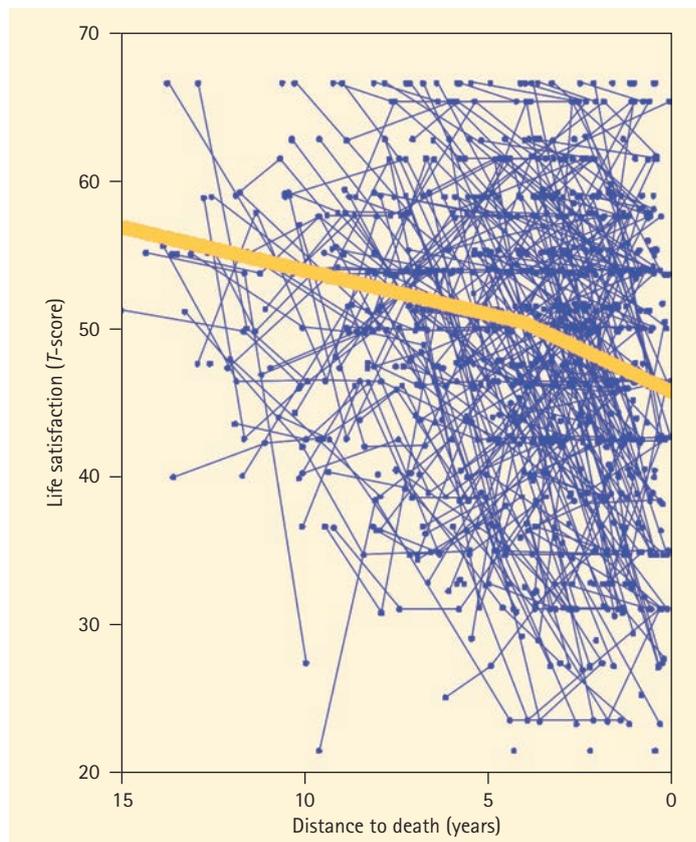


Figure 27. Prototypical (thick line) and individual changes (thin lines) in life satisfaction over distance to death, as revealed by the optimal multiphase growth model with a transition point about 4 years prior to death. This two-phase model described the structure of intraindividual changes in life satisfaction better than a single-phase model covering the complete 15-year period. The prototypical rate of decline steepened from the preterminal phase ( $-0.59$   $T$ -score units per year) to the terminal phase ( $-1.16$   $T$ -score units per year) by a factor of 2 (adapted from Gerstorf, Ram, Röcke et al., 2008).

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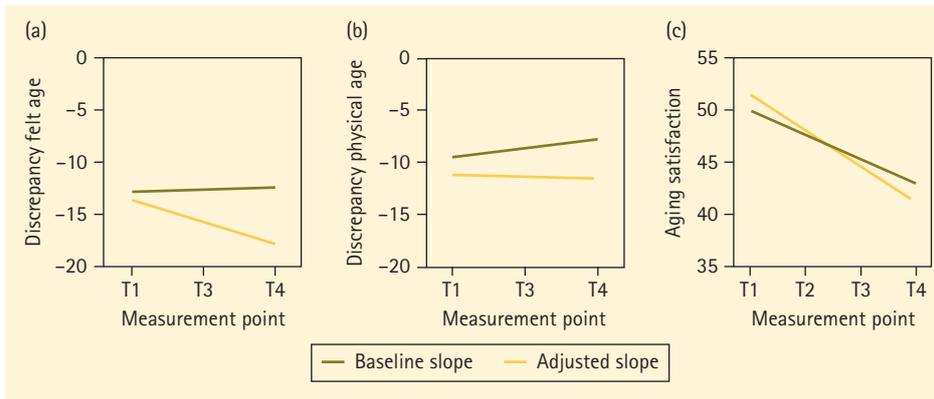


Figure 28. Change over time in the discrepancy between felt age and chronological age in years (Panel [a]), the discrepancy between physical age and chronological age in years (Panel [b]), and aging satisfaction (Panel [c]). For aging satisfaction, a *T*-metric standardized to the BASE sample at T1 ( $n = 516$ ;  $M = 50$ ,  $SD = 10$ ) was used. The green line represents the sample-level trajectory of the baseline model. The yellow line represents the sample-level trajectory after controlling for age, gender, socioeconomic status, number of illnesses, social loneliness, and cognitive functioning (adapted from Kleinspehn-Ammerlahn et al., 2008).

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between physical age and actual age as well as aging satisfaction decreased with advancing age (see Figure 28). The findings suggest that an examination of changes in self-perceptions of aging over time in very old age provides information about the resilience and vitality of the older self.

#### Cognitive and Sensory Declines in Old Age

Lindenberger and Ghisletta (2009) returned to the relation between sensory and cognitive decline in old age, a theme that has played a major role in BASE (Lindenberger & Baltes, 1994). The authors used multivariate random coefficient modeling to examine covariances in longitudinal change for eight cognitive measures assessing four intellectual abilities as well as close visual acuity, distant visual acuity, and hearing. Cognitive declines were highly correlated (see Figure 29), with a single factor accounting for 60% of the variance (65% when controlling for age at first occasion, distance to death, and risk for dementia). Contrary to expectations, correlations between cognitive and sensory declines were only moderate in size. While confirming the need to search for general mechanisms of behavioral senescence, these results also suggest that sensory-cognitive links may be less pronounced when observed longitudinally than when observed cross-sectionally.

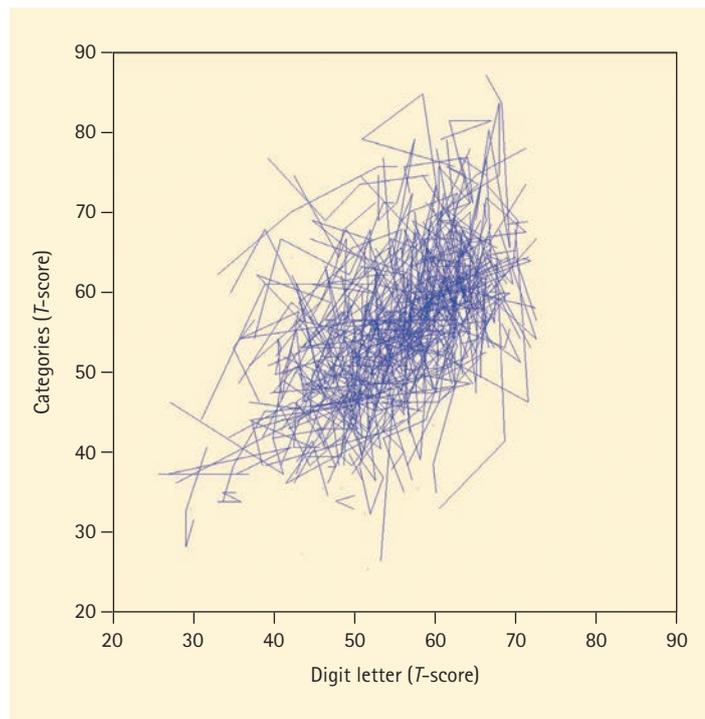


Figure 29. In old age, changes in perceptual speed and verbal fluency are highly correlated. The figure displays performance on the Digit Letter test indexing perceptual speed, and the Categories test indexing verbal fluency. Only individuals assessed at more than one measurement occasion on both tests are represented in the figure. For each individual, lines connect measurement occasions adjacent in time. The average age of the sample is 85 years, and the longitudinal observation period spans up to 13 years. Individual differences in linear change between the two variables are highly correlated ( $r = .80$ ) (adapted from Lindenberger & Ghisletta, 2009).

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- Lindenberger, U., & Baltes, P. B. (1994). Sensory functioning and intelligence in old age: A strong connection. *Psychology and Aging, 9*, 339–355.

Figure 30. From the cover of the Berlin Aging Study monograph.

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#### Key Reference

Lindenberger, U., Smith, J., Mayer, K. U., & Baltes, P. B. (Eds.). (in press). *Die Berliner Altersstudie (3rd ed.)*. Berlin: Akademie Verlag.

#### *Third Edition of the BASE Monograph*

Finally, a partially revised third edition of the German-language monograph on the cross-sectional BASE findings is currently being prepared (Lindenberger, Smith, Mayer, & Baltes, in press). In this revision, two chapters have been added to address the longitudinal extension of BASE. One chapter, written by Jacqui Smith and Julia Delius, reports the longitudinal design, the samples, and the main research questions, whereas the other new chapter, written by Dana Kotter-Grühn, Anna Kleinspehn-Ammerlahn, Christiane Hoppmann, Christina Röcke, Michael Rapp, Denis Gerstorff, and Paolo Ghisletta, summarizes the longitudinal findings that have accrued over the past 18 years.

#### **BASE II: Health and Cognitive Functioning Across the Lifespan**

In the fall of 2008, the Federal Ministry of Education and Research awarded a large grant to BASE (in collaboration with the Deutsche Institut für Wirtschaftsforschung and the Charité's Research Group on Geriatrics), which is currently being used in two ways. First, a whole genome scan of the blood samples taken from the 516 participants of the Berlin Aging Study at the first measurement occasion will be undertaken in collaboration with the Max Planck Institute

for Molecular Genetics in Berlin (BASE I).

Second, a new sample of approximately 2,200 participants aged 20–30 years or 60–70 years has been formed. In addition to an in-depth cognitive assessment, which has already been taking place in Projects 1 or 2 of the Center, socioeconomic, genetic, and health characteristics will also be examined. This new study, tentatively labeled BASE II, is undertaken in collaboration with the Charité's Research Group on Geriatrics and the German Socio-Economic Panel Study, and the MPI for Molecular Genetics, and is hoped to provide a solid foundation for a new longitudinal research effort aiming at uncovering the mechanisms and the malleability of age-graded behavioral changes in adulthood and old age (cf. Hertzog, Kramer, Wilson, & Lindenberger, in press).

### Overview of the Berlin Aging Study I (BASE I)

The multidisciplinary Berlin Aging Study (BASE), initially directed by the late Paul B. Baltes and Karl Ulrich Mayer, was started in 1989 under the sponsorship of the former West Berlin Academy of Sciences and Technology and its Committee on Age and Societal Development. Later, the study came under the auspices of the Berlin-Brandenburg Academy of Sciences. The current BASE core group is headed by Ulman Lindenberger.

As of 2008, the study involves eight measurement occasions spaced over 18 years. In addition, several subsamples have been recruited for intensive study. The distinguishing features of BASE include (1) a focus on the very old (70 to 100+ years); (2) a locally representative sample, stratified by age and sex; and (3) a broad-based interdisciplinarity (involving two research units from the Free University Berlin, Internal Medicine and Psychiatry, and two from this Institute, Sociology and Psychology). In addition to discipline-specific topics, four integrative theoretical orientations guide the study: (1) differential aging, (2) continuity versus discontinuity of aging, (3) range and limits of plasticity and reserve capacity, and (4) aging as a systemic phenomenon.

The initial focus of BASE (1990–1993) was to obtain a heterogeneous sample, stratified by age and sex, of individuals aged 70 to 100+ years who completed a 14-session Intensive Protocol that involved detailed measures from each of the four participating disciplines. The original sample participating in this initial Intensive Protocol consisted of 258 men and 258 women from the western districts of Berlin. Up to 2008, seven longitudinal follow-ups of the survivors from this initial sample involving different depths of assessment have been completed at approximately 2-yearly intervals. A single-session multidisciplinary assessment was collected 1993–1994 ( $N = 359$ ), reduced versions of the Intensive Protocol (six sessions) were collected in the periods 1995–1996 ( $N = 206$ ) and 1997–1998 ( $N = 132$ ), and a repeat of parts of the Psychology Battery together with multidisciplinary outcome variables (e.g., screening for dementia, assessment of well-being) in 2000 ( $N = 82$ ), 2004 ( $N = 46$ ), 2005 ( $N = 37$ ), and 2008 ( $N = 22$ ; with an additional medical focus). In addition, mortality information about the entire BASE sample is updated at regular intervals.

The initial sample of 516 individuals formed the basis of the cross-sectional analyses reported in two monographs (in German: Mayer & Baltes, 1996, 1999; in English: Baltes & Mayer, 1999, 2000). Specific interests of the Psychology Unit of BASE include issues of sample selectivity and representativeness, cognitive aging, subgroup profiles of psychological functioning, the Fourth Age, gender differences, mortality prediction, self-related change, well-being, and models of successful aging, such as selective optimization with compensation.

### International BASE Research Group

Alexandra M. Freund, University of Zurich  
Denis Gerstorf, Pennsylvania State University, University Park, USA  
Paolo Ghisletta, University of Geneva  
Nilam Ram, Pennsylvania State University, University Park, USA  
Jacqui Smith, University of Michigan, Ann Arbor (Co-Speaker)  
Ursula M. Staudinger, Jacobs University Bremen  
Elisabeth Steinhagen-Thiessen, Charité–Universitätsmedizin Berlin  
Gert G. Wagner, German Institute for Economic Research and Max Planck Research Fellow,  
MPI for Human Development (09/2008–2013)  
Julia A. M. Delius, Ulman Lindenberger (Speaker), and Shu-Chen Li

## Researchers

Michaela Riediger  
Sabine Schaefer  
Ulman Lindenberger

Natalie C. Ebner  
(until 2007)  
Antje Rauters (as of  
12/2008)  
(postdoctoral  
research fellows)

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Baltes, P. B., & Baltes, M. M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. In P. B. Baltes & M. M. Baltes (Eds.), *Successful aging: Perspectives from the behavioral sciences* (pp. 1–34). New York: Cambridge University Press.

## Research Project 6

### Developmental Regulation of Affect, Motivation, and Abilities (DRAMA)

The DRAMA project investigates lifespan changes in the regulation of affect, motivation, and abilities. Unique features of the project's research approach are the combination of innovative experience-sampling technologies with psychophysiological monitoring and well-controlled experimental paradigms, aiming at a closer and more process-oriented examination of contextual influences on human development. In 2007 and 2008, the project comprised three main thematic foci.

#### Affect and Motivation in Day-to-Day Life

There is increasing evidence that older adults report higher levels of emotional well-being in their day-to-day lives than younger adults. Little is known about the mechanisms underlying these age-related differences. We investigated the role that day-to-day experiences of motivational conflict may play in this regard. In a first line of research, we examined age-related differences in the implications of motivational-conflict experiences for affective well-being. We found that motivational conflict is indeed associated with lower emotional well-being. With increasing age, the frequency of motivational conflict decreased, while emotional well-being increased. Findings were robust after controlling for age differences in a number of control variables including time use. Based on this cross-sectional evidence, we tentatively conclude that the age-related increments in daily-life motivational conflicts may facilitate emotional well-being in later adulthood (Riediger & Freund, 2008). In collaboration with Alexandra Freund from the University of Zurich, we are currently planning experimental studies to investigate the mechanisms that reduce motivational conflicts in later adulthood.

A second line of research, largely funded by the Federal Ministry for Education, Science, Research, and Technology (grant ID MPI001), has been undertaken in collaboration with the Socio-Economic Panel (SOEP). Gert G. Wagner, German Institute for Economic Research and Max Planck Research Fellow at the Institute, is a co-investigator in this project. To improve the assessment of psychological variables including self-reported affective and motivational states, we started this line of research by developing a mobile-

phone based experience-sampling technology (see Figure 31). In 2007 and 2008, we applied this technology in an experience-sampling study of 378 participants ranging from 14 to 86 years of age. The main goal of this study was to chart everyday life processes of affective self-regulation—their frequency and form, effectiveness, and

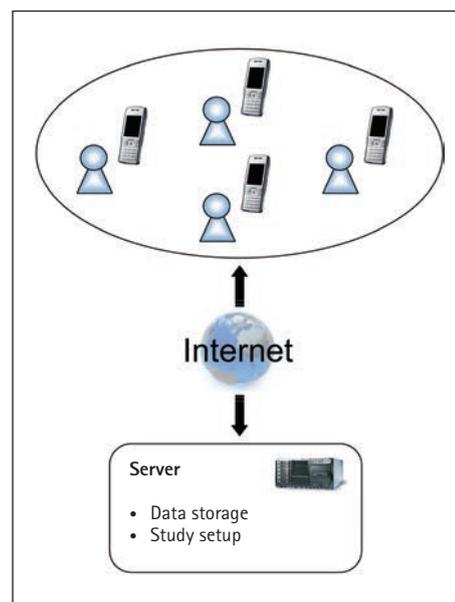


Figure 31. Using mobile phones to sample experiences in day-to-day life. Participants are provided with mobile phones that they carry with them at all times while pursuing their daily routines. On these phones, a testing software is installed that controls the participants' assessment schedule, presents items, and uploads responses to a central server. Several times a day, the mobile phone rings and thus signals the participant to respond to an assessment instrument that refers to his or her momentary experiences and behaviors. Participants navigate and respond to the questionnaire using the phone's joystick and keypad. Responses are immediately uploaded via the internet to a central server that is also used to setup the study design and manage the data collection.

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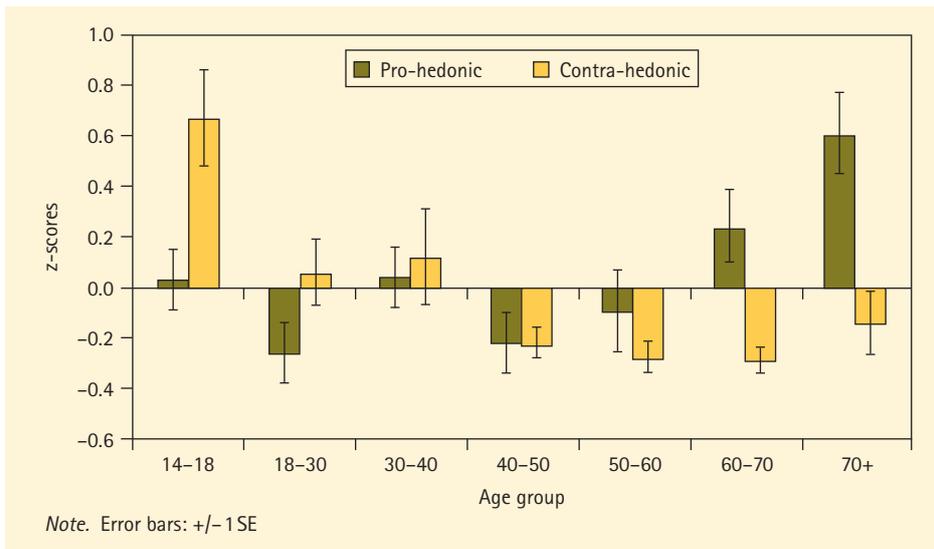


Figure 32. Contra-hedonic motivation is most prevalent among adolescents, whereas pro-hedonic motivation is most prevalent among older adults. Using a mobile-phone based experience-sampling technology in 378 individuals ranging from 14–86 years of age, we investigated age differences in how people want to influence their feelings in their daily lives. Participants carried the phone with them during three experience-sampling periods of at least three consecutive days. On each experience-sampling day, six assessments were distributed throughout a time window of 12 hours, the beginning of which was chosen by the participants.

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attentional requirements. For example, we investigated the motivational processes that precede and shape ways in which people influence the occurrence, experience, and expression of affective states. To date, such affect-regulatory motivational states have rarely been studied, in part because it is often assumed that affect-regulation motivation is inevitably directed at maximizing the individual's emotional well-being (i. e., is inevitably *pro-hedonic*). There are, however, situations in which people may also seek to maintain or enhance negative emotionality. Such *contra-hedonic* motivations can be socially appropriate and instrumental or occur when negative affect is accompanied by positive affect. Our initial findings indicate that contra-hedonic motivations are most prevalent among adolescents, whereas pro-hedonic motivations are most prevalent among older adults (see Figure 32). Consistent with the idea that contra-hedonic motivation is more likely to serve utilitarian rather than hedonic functions, we found contra-hedonic motivation to be less strongly associated with current affect

than pro-hedonic motivation. Furthermore, older participants tailored their pro-hedonic motivations more to their current affect than younger participants. In addition, while contra-hedonic motivation was associated with reduced momentary working-memory performance in younger age groups, it was not associated with momentary working-memory performance in older adults. Overall, these findings support the idea that affect-regulation competence increases with age.

We currently continue this line of research using an ambulatory biomonitring system to investigate *physiological* aspects of affective self-regulation in daily life. This work is carried out in collaboration with Viktor Mueller (see also Project 7). For instance, we followed up a subsample of participants from the study described above, adding a 24-hour ambulatory biomonitring of physical and cardiac activity to the mobile-phone based experience-sampling methodology used before. The data collection of this longitudinal follow-up has been completed in late 2008, and initial data analyses are currently underway.

## Key Reference

Riediger, M. (2007). Interference and facilitation among personal goals: Age differences and associations with well-being and behavior. In B. R. Little, K. Salmela-Aro, & S. D. Philipps (Eds.), *Personal project pursuit: Goals, action, and human flourishing* (pp. 119–143). Mahwah, NJ: Erlbaum.

## Developmental Regulation in Social Contexts

Developmental-regulatory processes unfold in social contexts. Selectivity—the focused investment of limited resources into a subset of developmental options—has been proposed as a central developmental-regulatory mechanism that provides directionality to development. In our earlier work (e.g., Riediger, 2007), we focused on *individual* development and found that motivational selectivity—selectivity as evident in delineating the range of one’s personal goals—is associated with an enhanced involvement in goal pursuit, irrespective of age. More recently, we focused on the role that motivational selectivity plays for the development of *social systems*. In a study carried out from 2003 to 2008, we longitudinally investigated the role of dyadic selectivity for partnership development in 69 initially childless young couples. We found that dyadic selectivity, that is, the extent to which partners perceive themselves as selectively choosing a limited number of joint goals in their partnership, contributed to

improvements in partnership satisfaction over 3 years and went along with an increased likelihood of realizing a wish for a child during the course of 4 years.

In her dissertation project, which was completed in 2008, Antje Rauers examined the role of dyadic knowledge (“common ground”) among younger and older adults. The guiding assumptions motivating this work were (a) that older adults seek to compensate for aging-related losses by collaborating with others and (b) that collaboration may be disproportionately difficult for older adults if its interactive demands are high. Based on these assumptions, Antje Rauers hypothesized that knowledge shared with a familiar person, termed dyadic common ground, will facilitate collaboration, especially in older adults. In a quasi-experimental study based on the interactive game Taboo, 76 younger and 80 older adults were asked to explain target words to their spouses or to unfamiliar interaction partners using as few cue words as possible. Interactions were coded with respect to (a) the number of cue words required and (b) spontaneously used dyadic common-ground cues. Older couples needed more words than younger adults to cue their spouses. However, these age-related differences were reduced when older adults used dyadic common ground in their cueing (see Figure 33). This result supports the idea that dyadic common ground with a familiar partner can enhance collaboration, especially in late adulthood.

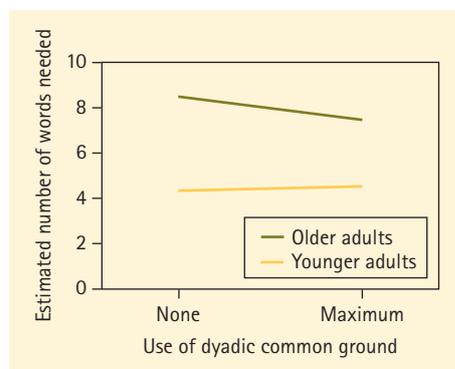
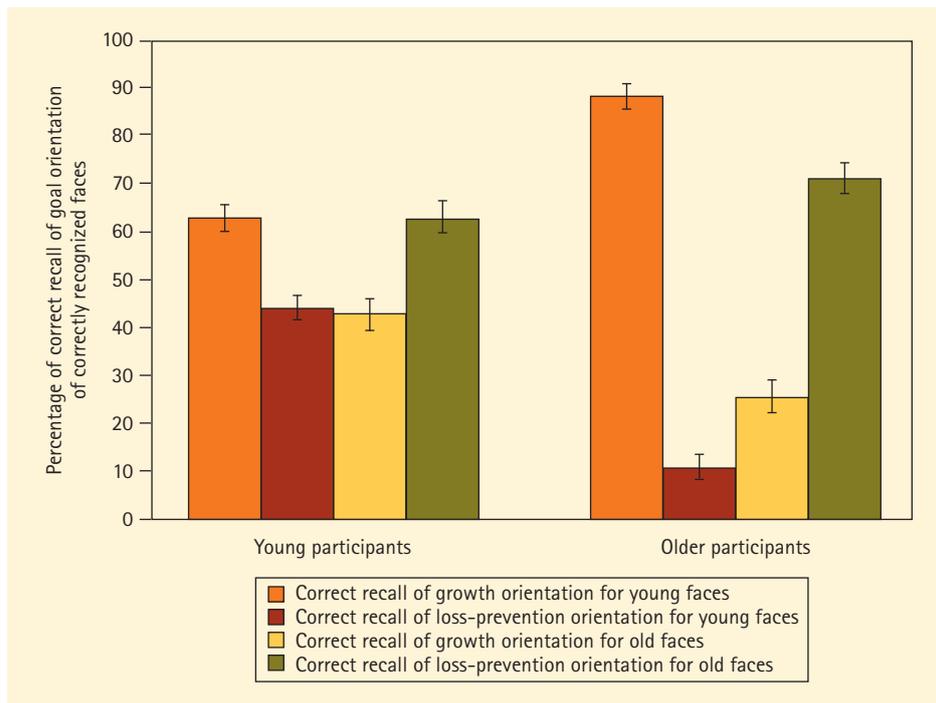


Figure 33. Older, but not younger couples', collaborative performance profits from using dyadic common ground. Younger and older adult couples were asked to explain certain target words (such as bread) to another person, and to do this with as few words as possible, but without using certain taboo words that were the most obvious explanatory cues for the respective target. Among older, but not among younger, spouses, the number of words needed to explain the target was reduced when the spouses referred to dyad-specific knowledge (or common ground) stemming from shared past experiences. This suggests that making use of interactive expertise with particular interaction partners may serve a compensatory function in older adulthood (Dissertation Antje Rauers).

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## Developmental Regulation in Cognitive Processes

There is a widespread belief that individuals are trying to avoid losses when they are old, more so than when they are young. Furthermore, research on adult age differences in episodic memory suggests that older adults may be less able to form, consolidate, and retrieve associations that are at odds with such schematic beliefs. Therefore, they should rely to a greater extent on lifespan schemas when learning and retrieving schema-relevant new associations. This prediction was tested in a series of quasi-experimental studies, conducted in 2006 and 2007. The studies



#### Key Reference

Ebner, N. C., Riediger, M. & Lindenberger, U. (in press). Schema reliance for developmental goals increases from early to late adulthood: Improvement for the young, loss prevention for the old. *Psychology and Aging*.

Figure 34. Schema reliance for developmental goals increases from early to late adulthood: Improvement for the young, loss prevention for the old. People tend to encode and retrieve information in terms of schemata, especially when processing resources are low. We propose that the *lifespan schema about developmental goals* constitutes a generalized expectation about the life course that associates young adults with growth and older adults with loss prevention. Participants were presented with young and old faces, paired with goals, related to growth or to loss prevention. When later asked to recognize the faces and remember goal orientations, participants were more likely to remember young faces with growth and old faces with loss prevention than vice versa. This effect was more pronounced among older adults. We conclude that reliance on lifespan schemata when remembering developmentally relevant information increases with age (adapted from Ebner et al., in press).

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used a recognition-memory paradigm in which participants are presented with adult faces of various ages along with one of two developmental goal orientations, one focusing on growth and the other on loss prevention, and are later asked to recognize the initially presented faces and the developmental goal orientations with which they had been associated. A first study showed that the likelihood to erroneously associate *young* faces with growth during recognition was higher among older than among younger adults, as was the likelihood to erroneously associate *old* faces with loss prevention (Ebner, Riediger, & Lindenberger, in press; see Figure 34). Another line of research, initially funded by the German Research Foundation (Forschergruppe 778; see Project 1) and undertaken together with Sabine Schaefer and Shu-Chen Li,

examined age differences in the monitoring and selection of task difficulties (cf. Riediger, Li, & Lindenberger, 2006). For this purpose, we collected data on children, teenagers, younger adults, and older adults playing a modified version of the BINGO task, in which called-out numbers have to be found on computerized game cards. Overestimating one's performance potential and choosing too many cards reduced the chance to reach a high score (progressive selection margin) just like underestimating one's potential and choosing too few cards (conservative selection margin). As expected, young adults were most accurate in choosing task-difficulty levels that match their capabilities. Children and teenagers fluctuated most in their task-difficulty choices, and many of them occasionally chose difficulty levels that were far too difficult for

Figure 35. A lifespan database of six facial expressions (FACES) – sample photographs. FACES is a lifespan database of emotional expressions. It comprises 2,052 photographs of facial expressions from 171 young, middle-aged, and older men and women. For each depicted person, the database provides two sets of six pictures each showing five emotional and one neutral expression. The unique feature of this database is that it systematically varies emotional expressions within persons stemming from different age groups.

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them. These findings demonstrate lifespan age differences in the abilities to monitor discrepancies between task difficulty and performance potential and to select tasks of adequate difficulty.

the FACES database freely available for use in scientific research. Information on the FACES database and on registration formalities can be obtained from <http://faces.mpib-berlin.mpg.de>.

#### Design of Facial Expression Stimuli

Finally, we also continued our work on FACES, a new database comprising photographs of 2,052 naturalistic faces of young, middle-aged, and older women and men, each displaying six facial expressions (*neutrality, sadness, disgust, fear, anger, happiness*). FACES is unique in providing a large age range of faces with different facial expressions and is therefore well-suited for investigating developmental research questions (see Figure 35). A large-scale rating study in which younger, middle-aged, and older adults rated each of the FACES pictures on various dimensions, including emotional expressions, was completed in 2008 and is currently being analyzed. In collaboration with the eSciDoc project of the Max Planck Digital Library, we currently prepare an online service to make

## Research Project 7 Interactive Brains, Social Minds

In everyday life, people often need to coordinate their actions with each other. Common examples are walking with someone at a set pace, playing collective sports, dancing, playing music in a duet or group as well as a wide range of social bonding behaviors such as eye-gaze coordination between mother and infant or between partners. Despite the undisputed developmental significance of these interpersonally coordinated behaviors, little, if any, is known about their real-time dynamics and about the brain mechanisms that support them. The Interactive Brains, Social Minds project investigates lifespan changes in behavioral and neuronal mechanisms that permit individuals to coordinate their behavior with each other in time and space (see Figure 36). The project is structured into two parts, one focusing on infant development and the other on other parts of the lifespan.

### The Interactive Brains BabyLab

Already in their first year of life, infants perceive others as social partners and learn through imitation, contingency detection, and joint attention. Infants use social cues from others such as eye gaze, facial expression, or

pointing from their first months of life. These cues may facilitate focusing of attention and object processing. Infants' capacity to jointly attend with an adult to an object or event outside the dyad develops from the second half of the first year of life and is known to

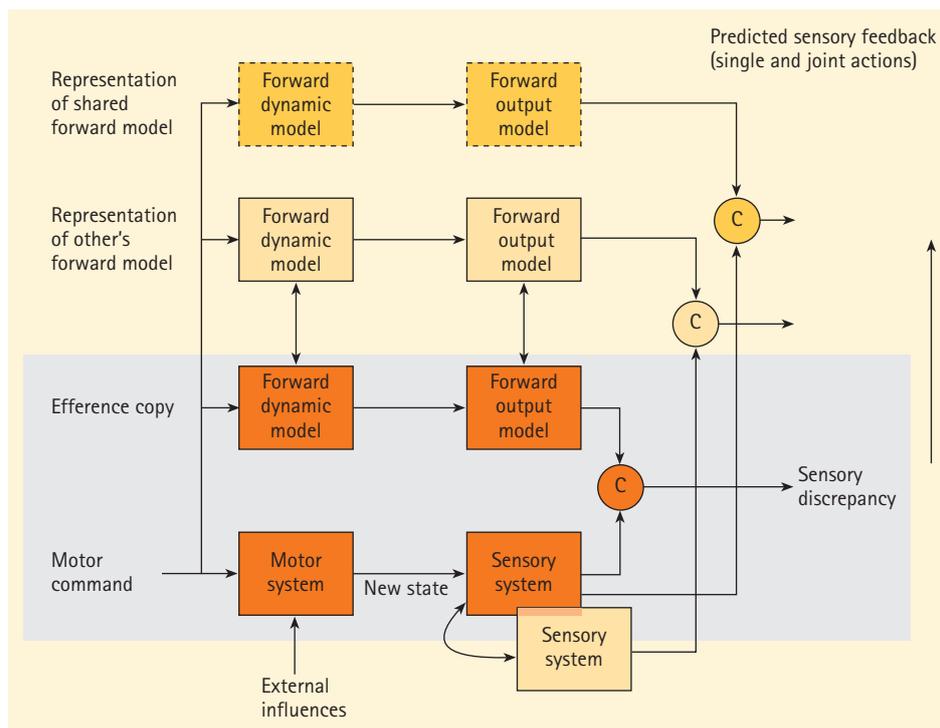
### Researchers

Ulman Lindenberger  
Franziska Kopp  
Viktor Mueller  
Shu-Chen Li

Anna Kleinspehn-Ammerlahn (post-doctoral research fellow)

Karen Bartling (predoctoral research fellow)

Franziska Kopp (principal investigator BabyLab)



### Key Reference

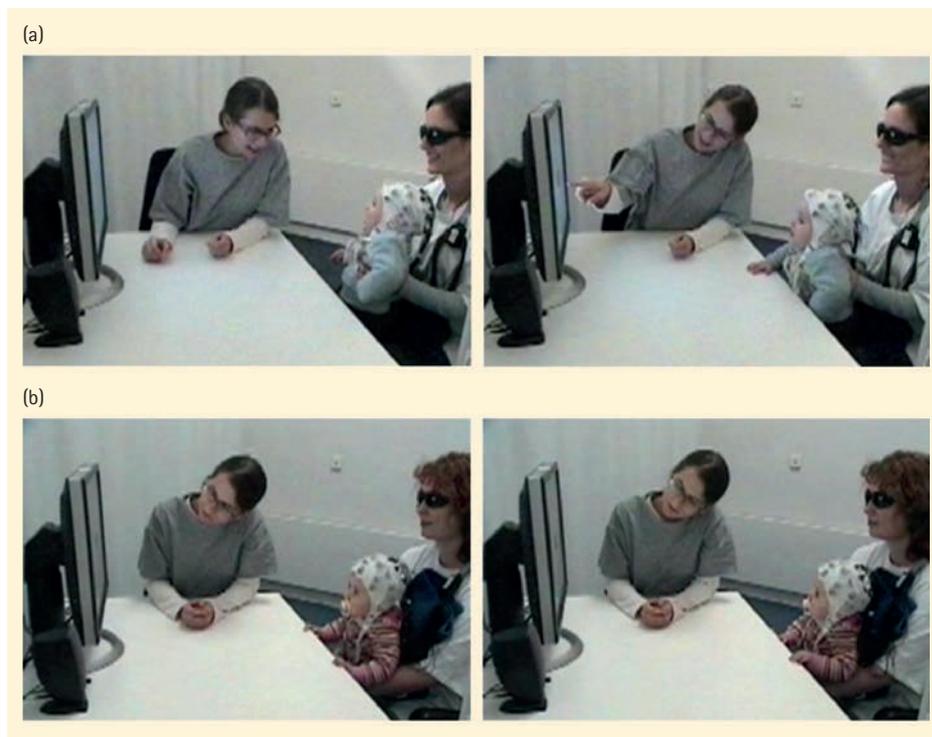
Lindenberger, U., Li, S.-C., Gruber, W., & Mueller, V. (in press). Brains swinging in concert: Cortical phase synchronization while playing guitar. *BMC Neuroscience*.

Figure 36. A forward model of interpersonal action coordination. Drawing on the work of Steve M. Boker, Wolfgang Prinz, Daniel Wolpert, and others, our model assumes that interpersonal action coordination is based on a set of linked representational layers. The single-person layer is shaded in gray. Individuals acting together attempt synchronizing their forward model regarding their own actions with their forward model regarding the other person's actions. Highly skilled individuals, such as dancers or musicians, may represent jointly performed activities as a unified suprapersonal action with a joint forward model and partially joint sensory feedbacks. The various representational layers of the actors are intertwined by sensorimotor feedback loops.

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*Figure 37.* The experimental setup for the study of joint-attention effects in infancy. In both conditions, an attractive object is presented on the computer screen. (a) In the high joint-attention condition, the experimenter is alternating her gaze between the child and the object, speaking to the child about the object, and pointing to it. (b) In the control condition, the experimenter is looking continuously at the object, but never at the infant, and does neither speak nor point. Recordings of infant-directed speech are being presented through loudspeakers.

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facilitate focusing of attention and object processing. In a first study, we investigated the effects of joint attention on long-term memory processes in 4- and 9-month-old infants. Infants were familiarized with two objects in a joint-attention or a nonjoint-attention condition (Figure 37). Electroencephalic (EEG) recordings were taken during recognition of familiarized and novel objects immediately after the familiarization phase and again after 1 week. Currently ongoing analyses suggest that the event-related brain potentials (ERPs) of the 9-month-old infants show significant differences between the joint attention and the nonjoint-attention group at both measurement occasions. Further analyses will focus on comparing the data of the 4-month-old to the 9-month-old infants to delineate developmental changes in mechanisms supporting attention and memory.

In her dissertation project, Karen Bartling has been investigating age-graded differences and longitudinal changes in infants' sensitivity to interpersonal timing, in part in relation to individual differences in maternal affect

attunement. In one study, 80 mother-infant dyads stratified by infant age (5 vs. 7 months) took part in a microlongitudinal assessment with two measurement occasions separated by 2–10 days. The infants interacted with their mothers by means of a double-screen setup (Figure 38), with the mothers' audio-visual presentation being either (a) live, (b) temporally delayed by one second, or (c) replayed from session one. Infants' EEG, electrocardiogram as well as behavioral data of the infants and the mothers were collected. Maternal affect attunement was independently assessed during a face-to-face play of mother and child. The reliability of the coding scheme used for assessing maternal affect attunement had been assessed in an earlier study. Initial results suggest that 7-month-old infants are sensitive to interpersonal timing and are able to differentiate between contingent and non-contingent interactions, as indicated by more smiling and gazing during the contingent (i. e., live) interaction conditions. This behavioral result is supported by corresponding differences in infants' heart rates and heart rate variability. Further analyses will include the

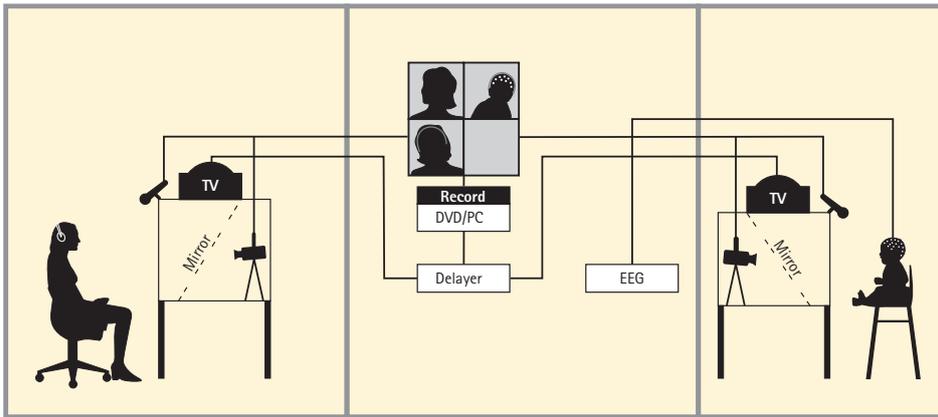


Figure 38. The double-screen setup used to study infants' sensitivity to interpersonal timing. The setup allows manipulating the contingency of maternal audio-visual responses by varying their temporal relation to the infants' behavior (live, delay, replay).

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neurophysiological correlates, the 5-month-old infants, and the relation to individual differences in maternal affect attunement.

### The Interactive Brains LifespanLab

During the reporting period, the project continued to explore experimental paradigms that may be suitable for the study of behavioral and neuronal mechanisms of interpersonal action coordination. Two such paradigms appeared to be particularly promising and formed the basis of further inquiry. The first paradigm consists of pairs of expert guitarists whose EEGs are being recorded while they are playing the same short tune in unison for a large number of trials (Figure 39; Lindenberger, Li, Gruber, & Mueller, in press). By applying synchronization algorithms to intra- and interbrain analyses, we found that phase synchronization both within and between brains increased significantly during the periods of preparatory metronome tempo setting and coordinated play onset (Figure 40). In addition, phase alignment extracted from within-brain dynamics was related to behavioral play onset asynchrony between guitarists. Our results show that interpersonally coordinated actions are preceded and accompanied by between-brain oscillatory couplings. Presumably, these couplings reflect similarities in the temporal properties of the individuals' percepts and actions. We are currently applying directional coupling measures to this data set and will further refine and expand the experimental paradigm to examine more closely whether

between-brain oscillatory couplings play a causal role in initiating and maintaining interpersonal action coordination. Following the conceptual schema shown in Figure 36, we also will use high-speed video cameras to capture between-person perceptual feedback with sufficiently high temporal resolution. The second paradigm currently used for the study of interpersonal action coordination consists in a dyadic drumming task, in which individuals of different ages are asked to synchronize their drumbeats to a common metrum. In her dissertation, Anna Kleinspehn-Ammerlahn paired participants from four age groups covering early childhood to old age in same- and mixed-age dyads. Participants were instructed to drum in synchrony with their dyad partner at a constant self-chosen tempo. Dyads consisting of adults only showed higher synchronization accuracy than dyads including children. Younger and older adults showed similar levels of interpersonal synchronization accuracy. Furthermore,

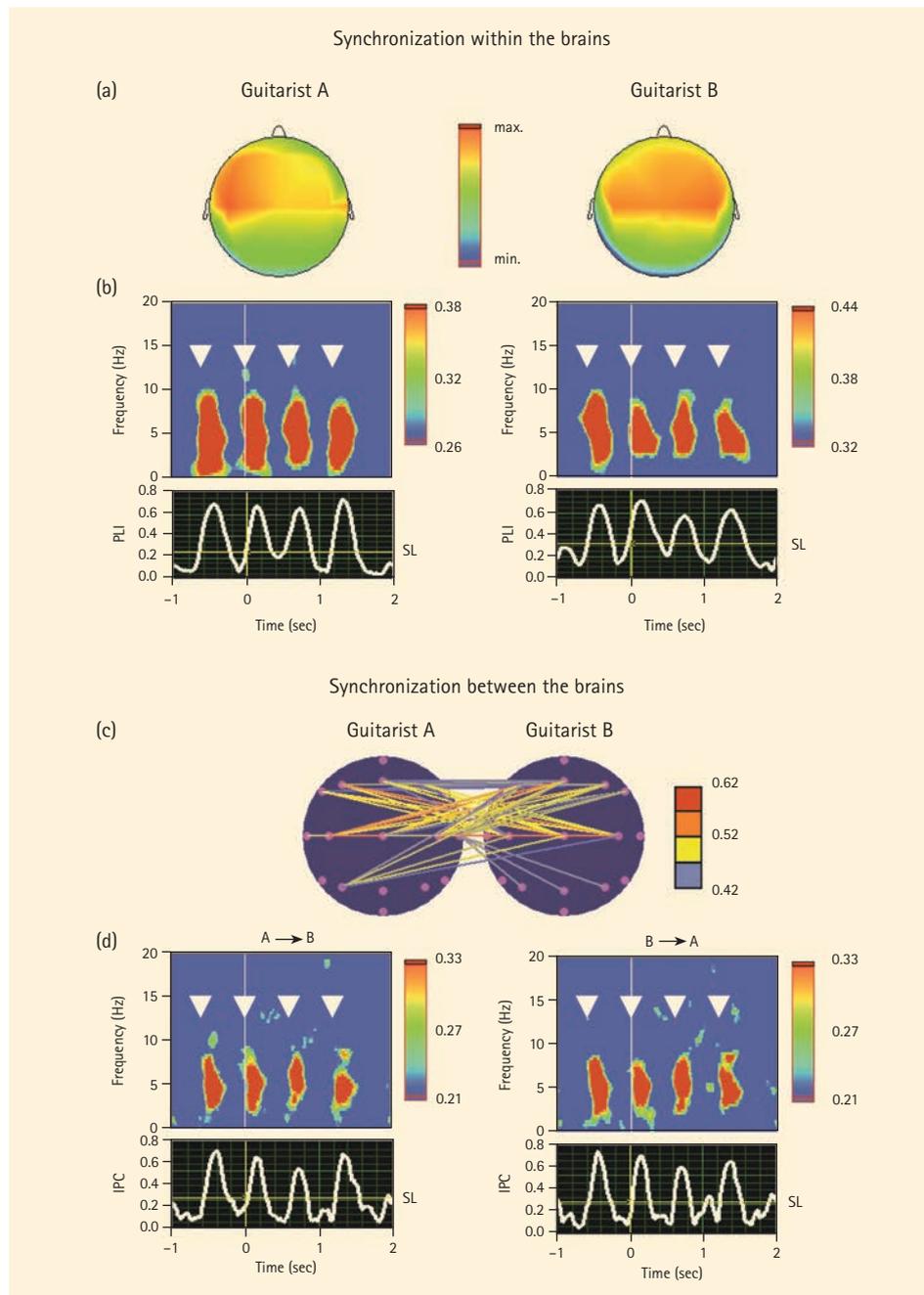
Viktor Mueller  
(principal investigator LifespanLab)



Figure 39. One pair of guitarists with electrode caps during the experimental session.

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Figure 40. See text on next page.



children benefited from synchronizing with more experienced partners, that is, they showed higher synchronization accuracy with older than with same-age partners. Follow-up analyses attempting to delineate the temporal dynamics of these overall lifespan differences are currently underway. Finally, members of the project also investigated age-graded differences in ERP and EEG components across the lifespan using standard single-person experimental

paradigms, such as auditory discrimination (Mueller, Brehmer, von Oertzen, Li, & Lindenberger, 2008; Mueller, Gruber, Klimesch, & Lindenberger, in press). Although this line of work does not speak directly to the issue of neuronal mechanisms supporting interpersonal action coordination, the resulting knowledge about age-graded differences in cortical dynamics aid the design and interpretation of age-comparative studies on cortical correlates of joint action.

#### Key Reference

**Mueller, V., Gruber, W., Klimesch, W., & Lindenberger, U.** (in press). Lifespan differences in cortical dynamics of auditory perception. *Developmental Science*.

*Figure 40.* Phase synchronization within and between brains during the preparatory period of metronome tempo setting. (a) Topological distributions of the phase-locking index (PLI) in a representative pair of guitarists, A and B, at the theta frequency (4.95 Hz) 140 ms after stimulus onset (second metronome beat). Fronto-central maxima of PLI are shown. (b) Time-frequency diagrams of average PLI for guitarists A and B separately. PLI was averaged across six fronto-central electrodes. Only significant PLI values ( $p < 0.01$ ) are highlighted. Time zero is time locked to the second metronome beat. Metronome beats are shown by white arrows. The time course of PLI values at the theta frequency (4.95 Hz) is depicted below the time-frequency diagram. (c) Interbrain synchronization between the two guitarists measured by interbrain phase coherence (IPC) at the theta frequency (4.95 Hz) 140 ms after stimulus onset. Colored lines indicate synchrony between electrode pairs of the two guitarists, corresponding to significant interbrain synchronization. Only IPC values higher than 0.41 are highlighted. (d) Time-frequency diagram of the average IPC averaged across six electrode pairs. In the left diagram (A  $\rightarrow$  B), the selected electrode pairs represent phase coherence between one electrode of guitarist A (Cz) to the six fronto-central electrodes of guitarist B. Conversely, the right diagram (B  $\rightarrow$  A), refers to one electrode of guitarist B and the six fronto-central electrodes of guitarist A. Only significant IPC values ( $p < 0.01$ ) are highlighted. The time course of IPC values at the theta frequency (4.95 Hz) is depicted below the time-frequency diagram. SL = significance level (adapted from Lindenberger, Li, Gruber, & Mueller, in press).

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## Researchers

Timo von Oertzen  
Ulman Lindenberger

Andreas Brandmaier  
(predoctoral research  
fellow)

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von Oertzen, T. (in press). Power equivalence in structural equation modeling. *British Journal of Mathematical and Statistical Psychology*.

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Hertzog, C., Lindenberger, U., Ghisletta, P., & von Oertzen, T. (2006). On the power of multivariate latent growth curve models to detect correlated change. *Psychological Methods*, 11, 244–252.

## Research Project 8 Formal Methods in Lifespan Psychology

Since its foundation by the late Paul B. Baltes in 1981, the Center for Lifespan Psychology has sought to promote conceptual and methodological innovation within developmental psychology and in interdisciplinary context. Over the years, the critical examination of relations among theory, method, and data has evolved into a distinct feature of the Center. The Formal Methods project continues this tradition, with an emphasis on computer algebra and machine learning. Its main goals are to: (a) critically examine the link between theory and data provided by existing statistical methods, (b) refine and develop statistical methods, and (c) equip researchers with means for optimizing the efficiency of data acquisition and data analysis. In the reporting period, the project has primarily focused on the formal analysis of statistical power in structural equation modeling.

### Statistical Power in Structural Equation Modeling of Longitudinal Data

Research on individual development often requires longitudinal studies with relatively large numbers of individuals, variables, and measurement occasions. Designing and implementing such a study is costly. Researchers generally harbor some conception of possible trade-offs among the research design parameters, but lack a metric by which they can compare these parameters in a more formal manner. As a result, there would be difficulties in evaluating whether the loss of one occasion of measurement is offset by the addition of 50 participants.

Statistical power, that is, the probability with which a statistical test refutes a wrong hypothesis, provides a metric for comparing the various design features of empirical studies, including longitudinal studies on behavioral change. Together with Paolo Ghisletta, University of Geneva and Distance Learning University, Switzerland, Christopher Hertzog, Georgia Institute of Technology, Atlanta, and Jack McArdle, University of Southern California, we use formal mathematical analysis and Monte Carlo simulations to investigate statistical power in methods that are widely used in developmental research, such as latent growth curve models. Although such methods are increasingly used, little is known about their statistical power.

To aid the exploration of statistical power and assumptions about developmental change, von Oertzen, Ghisletta, and Lindenberger (in press) developed a simulation engine for finding maximum likelihood estimates in latent

growth curve models, equipped with routines for data generation, data selection, and data analysis (see Figure 41). In the meantime, the efficiency of the engine has been increased further by adding new preprocessing modules (Dissertation project Andreas Brandmaier). On a standard Pentium 4 chip with 2.8 GHz processor speed, the engine needs about one second to perform more than 5,000 repetitions of data creation, data selection, and parameter estimation for a latent growth curve model with 20 measurement occasions.

In earlier work, we used the simulation engine and power approximation methods to investigate the power to detect the covariance of change in two linear change processes (Hertzog, Lindenberger, Ghisletta, & von Oertzen, 2006). Even with large samples ( $N = 200$  or  $500$ ) and several longitudinal occasions (4 or 5), statistical power to detect covariance of slopes was moderate to low unless growth curve reliability at study onset was above .80.

Continuing this line of work, we also examined the power to detect individual differences in the linear slope of latent growth curve models, or the variance of linear change (Hertzog, von Oertzen, Ghisletta, & Lindenberger, 2008). We compared three different standard methods for testing the variance of change against zero. The first method was the *Wald* test, which is commonly used in research practice. In this test, the estimated variance is divided by its estimated standard deviation to produce a statistic that is asymptotically normally distributed. The other two methods were based on likelihood

ratio tests between nested models. In the second method, the nesting is done between a model with free variance and covariance versus a model with both parameters fixed to zero (*generalized test*, here with 2 degrees of freedom). In the third method, the nesting is done between a model with fixed covariance versus a model with both parameters fixed to zero (*specific test*, with 1 degree of freedom). Figure 42 displays the power to detect the variance as a function of the correlation between the slope and the intercept, sample size, and the number of measurement occasions.

The statistical power of the Wald test was always inferior to at least one of the two likelihood ratio tests. Together with Jack McArdle, we also continued to explore the statistical power of the dynamic coupling parameters in the dual-change score model introduced by Jack McArdle and Fumiaki Hamagami. The bivariate dual-change score model combines the benefits of latent growth curves and cross-lagged regressions, as the change in one variable over time is dependent both on its own and the other variable's value at the previous

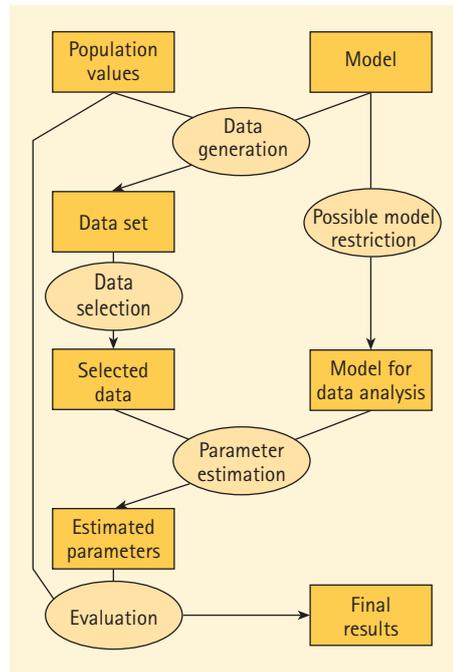


Figure 41. Simulation as a tool to examine the relation between theory, method, and data. A population model together with population parameters is used to generate a data set, which then may be selected by defined selection criteria. By using the selected data and a data analysis model that is nested in the population model, parameters can be estimated and compared to the original population parameters (adapted from von Oertzen et al., in press).

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time point. To comprehensively examine the power to detect the cross-coupling parameters, as a function of different parameters, such as number of occasions, sample size, and

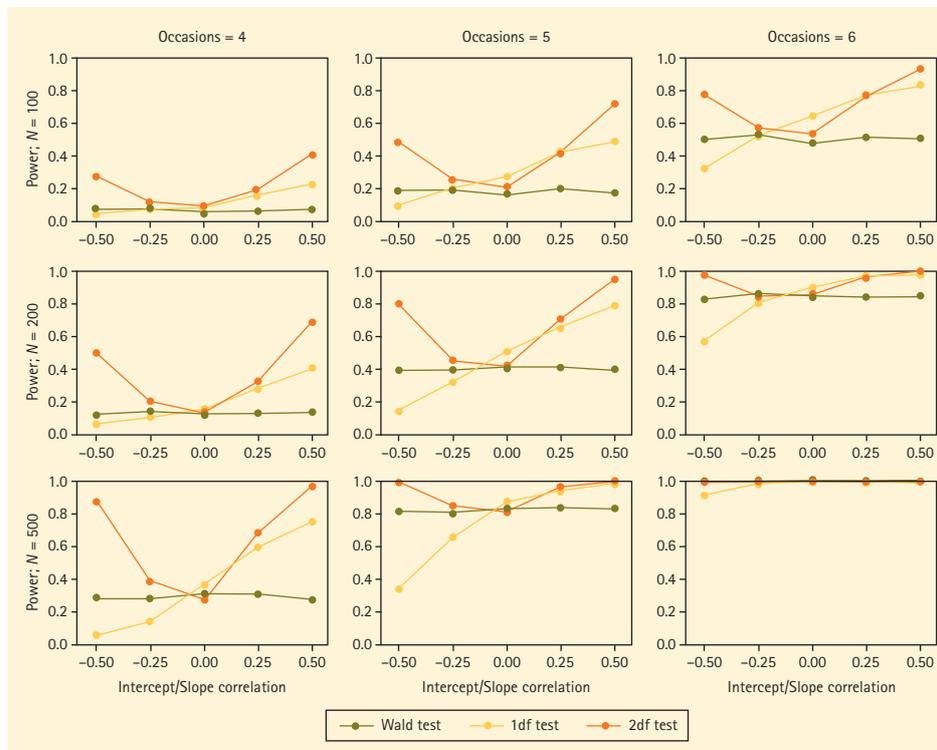


Figure 42. The power to detect individual differences in linear change: Results from a simulation study. Comparison of the statistical power of the Wald test, the generalized variance test (2-df), and the specific variance test (1-df) in rejecting the null hypothesis of zero variance of linear change as a function of the correlation between slope and intercept, sample size ( $N = 100$ ,  $N = 200$ , and  $N = 500$ ), and the number of measurement occasions. The statistical power of the Wald test is always inferior to at least one of the two other tests (adapted from Hertzog et al., 2008).

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reliability, we extended the project's simulation engine to encompass the simulation of dual-change score models as a special case. Ongoing work suggests that the power to detect cross-coupling parameters is influenced by the reliability of the variables.

#### **Toward a General Theory of Power Equivalence**

The most important progress in the efficiency of the simulation engine emerged from Timo von Oertzen's theoretical work on power equivalence. Power equivalence refers to a relation between two structural equation models; two models are designated as power equivalent if their statistical power to detect a given effect is identical. In addition to speeding up simulations by reducing complex models to power-equivalent simple models, the theory of power equivalence has a wide range of implications, such as the design of cost-efficient studies, and comparison between different measurement models indexing the same latent construct. These implications will be explored more fully in the years to come.

As power-equivalent operations allow trading different design features against each other without changing the power, the most cost-efficient design can be chosen among all study designs with identical power that are being considered. As part of his dissertation project, Andreas Brandmaier is currently developing a user-friendly tool to automatically optimize study designs for latent growth curve models of equal power (automated isopower analysis). Furthermore, together with Christopher Hertzog and Paolo Ghisletta, we are currently using the theory of power equivalence to investigate the effect of multiple indicators on assessing individual differences in change.

#### **Brain Signal Analysis**

Together with Oliver Stegle, Cambridge University, we have been using Bayesian independent component analysis to develop methods that would allow researchers to simultaneously identify similar sources of neural activity in two brains. An example for an application would be two individuals playing music together (see Project 5). To test different approaches, a simulation engine was constructed that produces artificial EEG data with a controlled number of sources and, for two data sets, a controlled number of shared sources. At present, the independent component analysis successfully reconstructs shared sources if their commonality is high, but is less successful with lower commonality or with real experimental data. We are currently exploring whether these difficulties can be overcome by preprocessing methods and non-negative matrix factorization.

## Sofja Kovalevskaja Research Group on Plasticity of Brain and Behavior in Adulthood and Old Age

Aging-related reductions in abilities, such as working memory, reasoning, episodic memory, and spatial orientation, begin roughly around the age of 65, but different individuals perform at different levels and change at different rates (de Frias, Lövdén, Lindenberger, & Nilsson, 2007; Lindenberger & Ghisletta, 2009). Epidemiological work suggests that individuals with a lifestyle rich in mental, physical, and social stimulation experience less cognitive decline in old age (Lövdén, Ghisletta, & Lindenberger, 2005). However, we know little about the mechanisms through which experience modulates cognitive aging. For example, we do not know whether the favorable influences of an enriched lifestyle on cognitive change come from direct effects of mental stimulation on cognitive performance or through indirect routes, such as avoidance of negative effects on cognition (e.g., depression, stress, or vascular conditions). The goal of the Sofja Kovalevskaja Research Group on Plasticity of Brain and Behavior in Adulthood and Old Age is to fill this research lacuna (see Table 3).

The group defines plasticity as the capacity for alterations from one possible range of cognitive performance and functioning to another, driven by a mismatch between functional supply and experienced environmental demand.

If experiencing such a mismatch were shown to improve the efficiency of neural processes supporting important cognitive functions, then the hypothesis that an enriched lifestyle may positively influence adult cogni-

### Researcher

Martin Lövdén (for collaborators, see Table 2)

### Key References

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Lövdén, M., Ghisletta, P., & Lindenberger, U. (2005). Social participation attenuates decline in perceptual speed in old and very old age. *Psychology and Aging, 20*, 423–434.

Table 2

### Studies Conducted as a Part of the Sofja Kovalevskaja Research Group on the Plasticity of Brain and Behavior in Adulthood and Old Age

#### SPACE

The study investigates the plasticity of spatial navigation performance and underlying brain structures in younger and older adults. Participants practiced spatial navigation in a virtual zoo equipped with a walking interface every other day for 42 sessions (see Figure 45). Before, after, and 3 months after termination of practice, the participants' brain structure was examined with MRI, DTI, and spectroscopy. Data collection was completed in June 2008.

*Researchers:* Martin Lövdén; Nils Bodammer, Ulman Lindenberger, Sabine Schaefer

*Predoctoral Research Fellow:* Hannes Noack

*Collaborators:* Lars Bäckman (Karolinska Institute, Stockholm), Emrah Düzel (University of Magdeburg), Simone Kühn (University of Ghent)

#### COGITO

In collaboration with the Intra-Person Dynamics project, the study investigates the plasticity of intelligence and underlying brain structures in younger and older adults. One hundred younger and 100 older adults performed perceptual speed, episodic memory, and working-memory tasks for 100 daily sessions. Subsamples underwent MRI, DTI, fMRI, and EEG before and after training (for more information on the COGITO study, see the Intra-Person Dynamics project).

*Researchers:* Florian Schmiedek, Martin Lövdén, Nils Bodammer, Ulman Lindenberger

*Predoctoral Research Fellows:* Annette Brose, Julia Wolff

*Collaborators:* Emrah Düzel (University of Magdeburg), Simone Kühn (University of Ghent), Naftali Raz (Wayne State University)

#### Swedish Military School of Interpreters

Conscript interpreters in the Swedish military learn a new language from scratch to native-like proficiency within a year, which requires extremely intensive and effortful mental activities. During 2008, the interpreters' cognitive performance was assessed before and after their most intensive phase of language training. In 2009, brain structure and function before and after training will be examined with MRI, fMRI, DTI, and EEG.

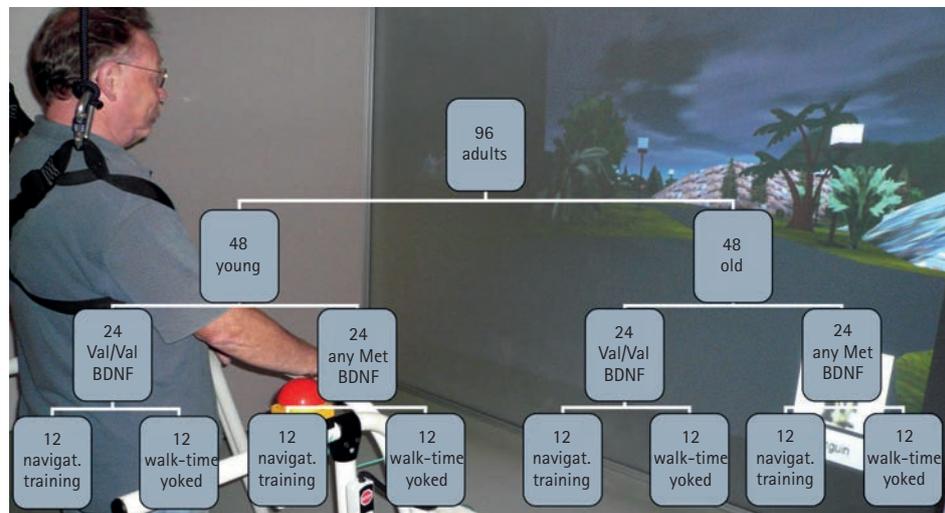
Table 3  
The Sofja Kovalevskaja Award of the Alexander von Humboldt Foundation

**The Sofja Kovalevskaja Award**

In 2006, Martin Lövdén received the Sofja Kovalevskaja Award of the Alexander von Humboldt Foundation. Financed by the Federal Ministry for Education and Research, the one million Euro Award enables young scientists from outside Germany to finance their own research groups at a German university or nonuniversity research institution. The funding period of the Award extends over 4 years (2007–2011).

tive development would be supported. In line with optimistic research agenda, recent evidence suggests that cognitively challenging experience of extensive practice of cognitive laboratory tasks can result in improvements of important cognitive functions, such as fluid intelligence, at least in younger adulthood. Moreover, the acquisition of abstract knowledge can result in alterations of the brain's gray-matter structure in adulthood. Questions central to the group's research agenda include: Can cognitive practice in adulthood and old age improve performance on unpracticed cognitive tasks measuring

the same or different cognitive processes as the trained tasks? Which are the cognitive mechanisms and brain correlates of such performance alterations? Does experience in the form of cognitive practice alter the brain's white- and gray-matter structure in adulthood and old age? What are the biological mechanisms of such structural changes? Which environmental, cognitive, and biological factors determine the nature and magnitude of plastic alterations of brain and behavior in adulthood and old age? We are currently pursuing these questions in three studies (see Table 2). In the COGITO



*Figure 43.* Design of the SPACE study. Younger and older adults stratified on a common valmet genetic polymorphism of the BDNF gene, which is known to influence brain plasticity, practiced spatial navigation in a virtual zoo while walking on a treadmill. The practice period included 42 one-hour sessions administered every other day over a period of about 3.5 months. Control groups walked on a treadmill for a comparable amount of time. Immediately before, after, and 3 months after termination of practice, cognitive performance was assessed during two sessions, and participants underwent magnetic resonance imaging, diffusion tensor imaging, and magnetic resonance spectroscopy. Main research questions are: whether (a) structural alterations in the human hippocampus occur in response to navigation practice, (b) the magnitude of these experience-induced structural changes is reduced in old age, and (c) genetic influences on activity-dependent release of the brain-derived neurotrophic factor (BDNF) moderate these effects.

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study, conducted in collaboration with the Intra-Person Dynamics project, we examine plasticity of intelligence and underlying brain structure and function; for a description of this study, see pages 182–185.

In a second study, we investigate the acquisition of a second language in adulthood and resulting functional and structural brain changes by examining conscript interpreters in the Swedish military. The conscripts learn a new language from scratch to close-to-native proficiency within a year. This rate of improvement requires extremely intensive and effortful mental activities. During 2008, the interpreters' cognitive performance was assessed before and after their most intensive phase of language training. In the course of 2009, brain structure and function before and after training will be examined with structural and functional magnetic resonance imaging (fMRI), diffusion tensor imaging (DTI), and electroencephalography (EEG).

In a third study (SPACE), we investigate plasticity of spatial navigation at behavioral and neural levels of analyses. The main research questions are: (a) whether structural alterations in the human hippocampus occur

in response to navigation practice in younger adulthood and old age, (b) whether the magnitude of these experience-induced structural changes is reduced in old age, and (c) whether genetic influences on activity-dependent release of the brain-derived neurotrophic factor (BDNF) moderate these effects. To this end, younger and older adults stratified on a common valmet genetic polymorphism of the BDNF gene practiced spatial navigation in a virtual zoo while walking on a treadmill (see Figure 43). The practice period included 42 one-hour sessions administered every other day over a period of about 3.5 months. Control groups walked on a treadmill for a comparable amount of time. Immediately before, after, and 3 months after termination of practice, cognitive performance was assessed during two sessions, and participants underwent MRI, DTI, and magnetic resonance spectroscopy. Data collection was completed in June 2008. Preliminary results at the behavioral level show large navigation-related improvements in navigation performance for both younger and older adults (see Figure 44). The analysis of the imaging data is currently underway.

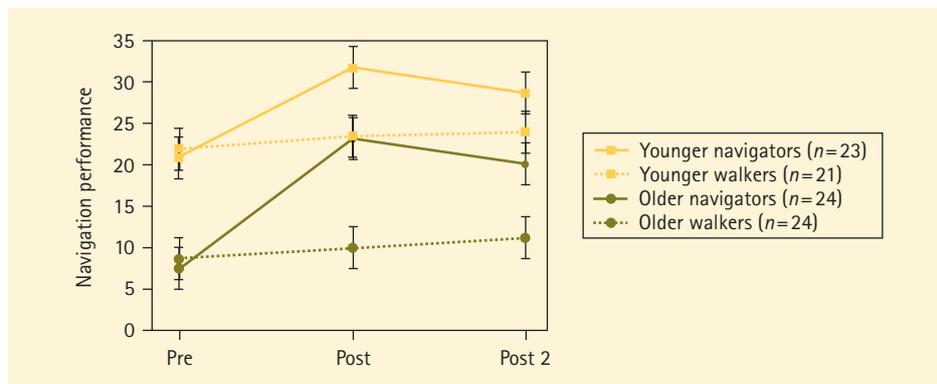


Figure 44. Preliminary results from the SPACE study show large improvements in navigation performance for both younger and older adults from practicing navigation in a virtual environment. The figure depicts mean navigation performance (number of animals found in a virtual zoo within 50 minutes) before (pre) and after (post) practice as well as 3.5 months after termination of practice (post 2). Navigators (thick lines) practiced navigation in a virtual environment equipped with a walking interface for 42 sessions. Walkers (dotted lines) walked for a comparable amount of time. Error bars represent the standard errors of the mean.

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## Publications 2007–2008

(last update: April 2009)

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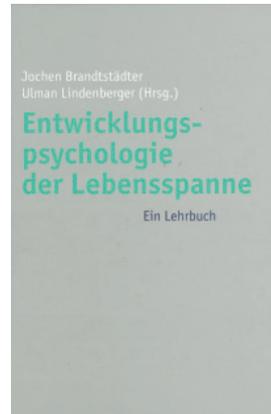
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# Independent Junior Research Group

## Neurocognition of Decision Making

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## Research Agenda: Multimodal Approach to the Neurocognition of Decision Making

Decision making can be defined as the process of choosing a preferred option or course of action from among a set of alternatives. There is a long history of decision-making research in psychology and economics that has resulted in the development of formal models of behavior, which are inspired by behavioral data or the computational demands of a task. An example for the former are sequential sampling models of decision making. An example for the latter are reinforcement learning models for repeated choice tasks. Cognitive functions, such as decision making, can however not be completely understood on the basis of mathematical models and behavioral data alone; we have to investigate how mental (cognitive) and neuronal processes map onto each other. Therefore, a central goal of the Max Planck Research Group "Neurocognition of Decision Making" is to explicitly link brain function and behavior using formal models of decision-making behavior.

In pursuit of this goal, we investigate decision making in different domains. First, at the basis of a number of different decisions we are facing in everyday life stands *perceptual decision making*: the process of translating sensory input into some kind of motor output (cf. Figure 2). Second, many of our decisions are influenced by the potential outcomes associated with different options, hence, *reward-based decision making* is another important topic for our group. Finally, *decision making in social contexts* relies not only on perceptual and reward-related processes but also

includes more complex cognitive processes and emotional aspects and the interaction between the two.

We believe that the investigation of the neurocognition of decision making requires a multimodal methodological approach that integrates information from an array of methods, ranging from cognitive modeling based on behavioral data to simultaneous functional magnetic resonance imaging (fMRI) and encephalographic (EEG) experiments (cf. Figure 1). On the following pages, we briefly describe research in the three topics in more

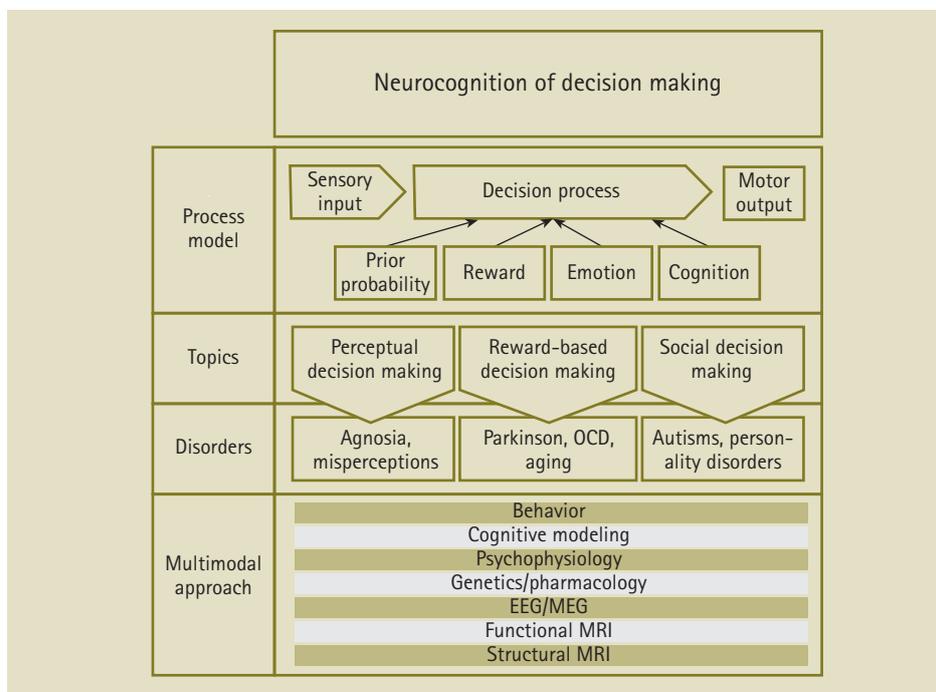


Figure 1. Multimodal approach to neurocognition of decision making.

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**Key Reference**

Heekeren, H. R., Marrett, S., & Ungerleider, L. G. (2008). The neural systems that mediate human perceptual decision making. *Nature Reviews Neuroscience*, 9(6), 467–479.

detail. Each section begins with a brief introduction, which is followed by short descriptions of individual projects.

**Neurocognition of Perceptual Decision Making**

Perceptual decision making is the act of choosing one option or course of action from a set of alternatives based on the available sensory evidence (Heekeren, Marrett, & Ungerleider, 2008). Thus, when we make

decisions, sensory information must be interpreted and translated into behavior. For example, in a motion-direction discrimination task, motion signals need to be interpreted and translated into a saccadic eye movement. In a face-house discrimination task, degraded images of faces and houses have to be interpreted and translated into a button press with the right or the left hand (see Figure 2). Decision-making research has resulted in mathematical models of the assumed

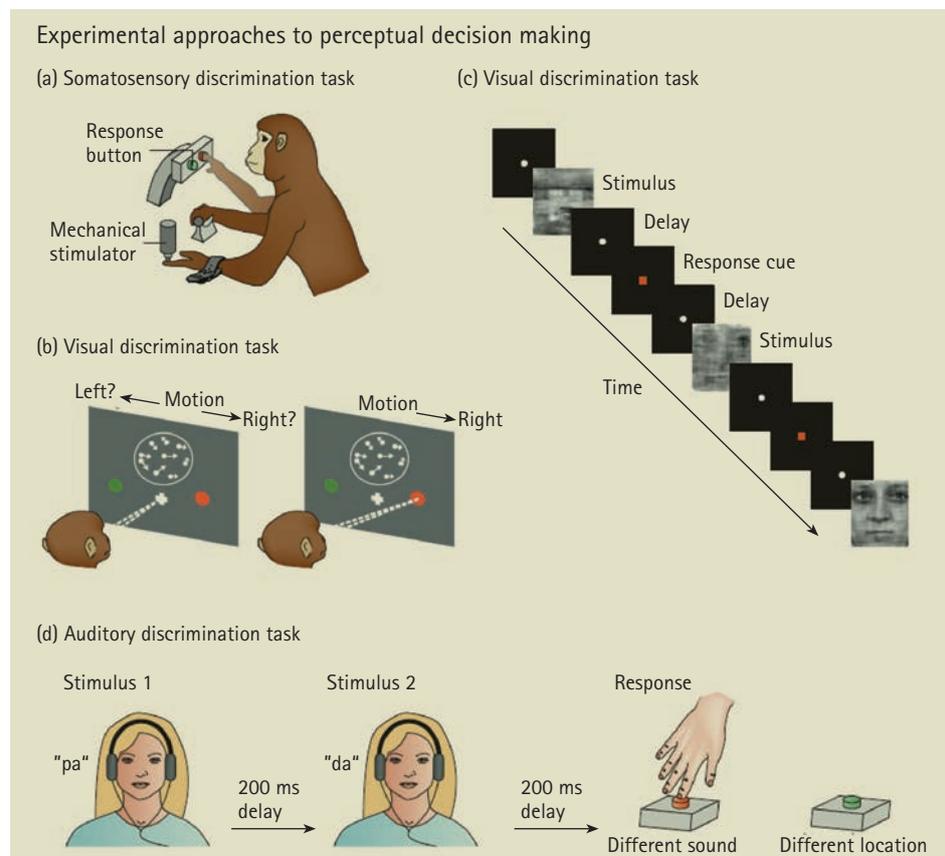


Figure 2. Experimental approaches to perceptual decision making: The general experimental approach to study perceptual decisions is to have subjects perform sensory discriminations, with more or less degraded input. To study perceptual decision making in the somatosensory domain, several studies used a vibrotactile frequency-discrimination task. In this task, subjects had to decide which of two sequentially presented flutter stimuli had a higher frequency (e.g., Preuschhof, 2006, p. 97) (a). To study perceptual decision making in the visual domain, many studies have used a direction-of-motion discrimination task (e.g., Heekeren, 2006, p. 87), in which subjects had to decide whether a noisy field of dots was moving in one direction or its opposite direction (e.g., leftward or rightward) and indicated their choice either with a quick eye movement to the target on the respective side (b) or with a button press (Heekeren, 2006, p. 87). Also in the visual domain, Heekeren et al. (2004) used a face-house categorization task (Heekeren, 2004, p. 127), in which subjects decided whether an image presented on a screen was a face or a house and responded with a button press (c). To investigate perceptual decision making in the auditory domain, Kaiser et al. (2006) used a two-alternative forced-choice task, in which individuals had to decide whether two syllables presented sequentially were: (1) the same or different with respect to identity or (2) the same or different with respect to their perceived location (Kaiser, 2006, p. 146) (d).

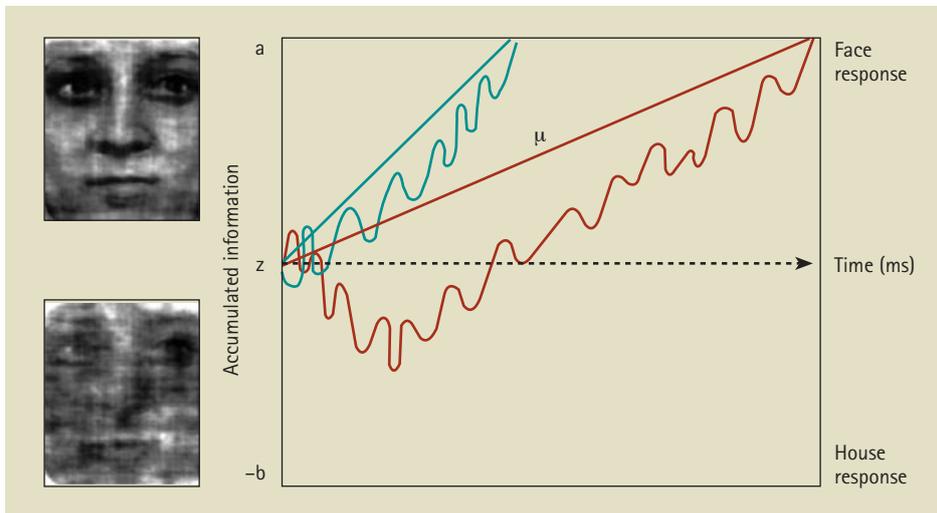
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underlying cognitive processes. Sequential sampling models are particularly successful in explaining response time data and accuracy in two-choice reaction time tasks, such as the ones described above. A prominent version of sequential sampling models are diffusion models, which assume that decisions are formed by continuously accumulating sensory information until one of the two response criteria (a or -b) is reached (cf. Figure 3). Once a boundary is reached, the decision process is concluded and a response is elicited. Moment-by-moment fluctuations in the sample path reflect noise in the decision process. The drift rate ( $\mu$ ) is related to the efficacy of information processing and depends on

the strength of the sensory signal as well as the accumulation rate (the increase in the decision variable that quantifies how much evidence is accumulated per time interval). Clear images of faces contain more sensory evidence than degraded images, therefore, the drift rate is greater for clear images (blue) than for degraded images (red) (see Figure 3). More recent studies in monkeys and humans have begun to model not only psychophysical but also neurophysiological data as a diffusion-to-barrier process (e.g., Philiastides & Sajda, 2007) providing a quantitative link between behavior (decision outcome) and neural activity (decision processing) (Heekeren et al., 2008). In ongoing projects,

#### Key Reference

Philiastides, M. G., & Sajda, P. (2007). EEG-informed fMRI reveals spatiotemporal characteristics of perceptual decision making. *Journal of Neuroscience*, 27, 13082–13091.



**Figure 3.** Decision-making research has led to the development of mathematical models of the assumed underlying cognitive processes. Diffusion models are particularly successful in explaining response time and accuracy data in two-choice reaction-time tasks. These models assume that decisions are formed by continuously accumulating sensory information until one of the two response criteria (a or -b) is reached (see figure). Once a boundary has been reached, the decision process is concluded and a response is elicited. Moment-by-moment fluctuations in the sample path reflect noise in the decision process. The drift rate ( $\mu$ ) is related to the efficacy of information processing and depends on the strength of the sensory signal and on the accumulation rate (i.e., the increase in the decision variable that quantifies how much evidence is accumulated per time interval). Clear images of faces contain more sensory evidence than degraded images, and, therefore, the drift rate is greater for clear images (blue trace in the figure) than for degraded images (red trace). Recent studies have also modeled neurophysiological data as a diffusion process: a dual-diffusion model provides a quantitative account of both the behavior in simple perceptual decision making and the patterns of activity in competing neuron populations. In these studies, monkeys performed a brightness-discrimination task and made saccades to one of two peripheral targets. Task difficulty was manipulated by varying the ratio of black to white pixels. A diffusion model was fitted to the behavioral data. Based on the hypothesis that the neuronal firing rate is linearly related to the accumulated evidence, simulated paths from the model were compared with neural activity. Similar to the behavioral data, the firing rate data showed delayed availability of discriminative information for fast, intermediate, and slow decisions when activity was aligned on the stimulus. By contrast, the firing rate showed very small differences in discriminative information when activity was aligned on the saccade. The first study to link human brain signals with parameters of the diffusion model was that of Philiastides and Sajda (2007). These authors estimated diffusion rates for different noise levels on the basis of behavioral data from a face-car categorization task.

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## Key References

**Heekeren, H. R.,** Marrett, S., Ruff, D. A., Bandettini, P. A., & Ungerleider, L. G. (2006). Involvement of human left dorso-lateral prefrontal cortex in perceptual decision making is independent of response modality. *Proceedings of the National Academy of Sciences of the USA*, *103*, 10023–10028.

**Philiastides, M. G.,** Ratcliff, R. & Sajda, P. (2006). Neural representation of task difficulty and decision making during perceptual categorization: A timing diagram. *Journal of Neuroscience*, *26*, 8965–8975.

we build on our previous work and investigate how the interplay between lower level sensory regions and higher order decision and motor-planning structures leads to decisions regarding ambiguous sensory information. In a first project, using single-trial analysis techniques, we examine how the accumulated sensory evidence is ultimately transformed into a specific action. In a second project, in the somatosensory domain, we investigate how and where in the brain short- and long-term memory representations are maintained and combined with current sensory evidence to make a decision.

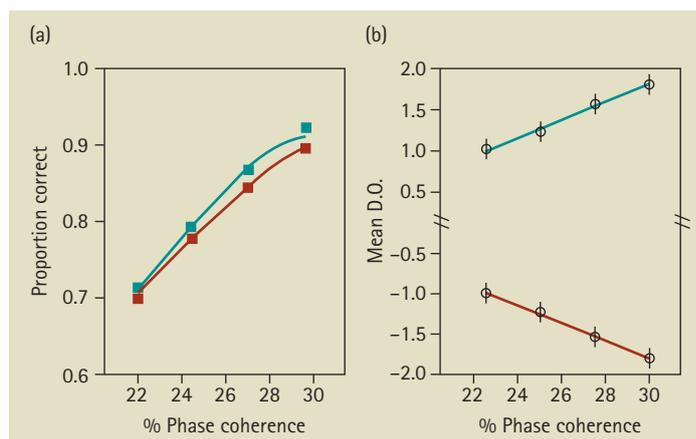
### *Transforming Accumulated Evidence Into Action*

Perceptual decisions are thought to arise after the temporal accumulation of the available sensory evidence leads to a selection of a motor response, which, in turn, determines one's choice (Green & Heekeren, in press; Heekeren et al., 2008; Philiastides & Heekeren, in press). The boundaries between evidence accumulation and selection of the appropriate behavioral response, however, are currently ill defined. In the monkey literature, the problem arises because the areas implicated in evidence accumulation are also the ones that select, plan, and execute motor responses. Therefore, one could conclude from these neurophysiological

studies "to see and decide is, in effect, to plan a motor-response" like Rorie and Newsome wrote in 2005. In contrast, recent human neuroimaging studies identified decision-related activity independent of the response modality used, suggesting that humans might have evolved an abstract decision-making network that allows a flexible link between decision and action (Heekeren, Marrett, Ruff, Bandettini, & Ungerleider, 2006). To investigate if such a flexible link exists, we designed a "face"/"car" categorization task using a novel dynamic stimulus to provide accumulating evidence while simultaneously recording EEG data from 13 subjects. We manipulated the amount of sensory evidence by changing the percentage of phase coherence of our stimuli (cf. Figure 3).

We hypothesize that, once the sensory evidence has been accumulated, it needs to be transformed into a binary choice before the selection of the appropriate motor response can occur. In this sense, evidence "categorization" would provide the link between evidence accumulation and motor output. Furthermore, we hypothesize that, for such a categorization stage to exist, several important requirements must be fulfilled. First, it should appear late in the trial and correlate more with the response than the stimulus (i. e., response-locked activity). Second, it should reflect the strength of the evidence favoring a decision—that is, activity should be higher for easy than hard trials. At the same time, evidence for one category should be interpreted as evidence against the other (i. e., symmetric relationship between the activity from the two categories). Third, activity should not only correlate with behavioral performance but also predict the category of one's choice. Fourth, activity preceding this stage should exhibit evidence accumulation. Finally, the source of the activity should be localized in a region with connections to areas that have been implicated in evidence accumulation as well as those that plan and execute motor responses.

Using a single-trial analysis technique (Philiastides, Ratcliff, & Sajda, 2006), which integrates information across all EEG sensors, we identified a late response-locked component, which correlated with psychophysical



**Figure 4.** (a) Comparing behavioral with neuronal performance from a response-locked EEG component appearing on average 50 ms prior to the response. The average neurometric curve (red) was a good match to the corresponding psychometric function (blue). (b) Component strength as a function of stimulus evidence and image category. Positive values indicate a face trial and negative values a car trial.

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performance (cf. Figure 4a) and responded more for easy than hard trials (cf. Figure 4b). Additionally, this component exhibited a symmetric relationship between face and car trials suggesting that evidence for one category can also be interpreted as evidence against the other (cf. Figure 4b). Time-course analysis of the period preceding this component revealed ramp-like activity consistent with evidence accumulation (cf. Figure 5a). Breaking trials into fast and slow, at each phase coherence level, had an additional effect on the slope of the accumulating activity (cf. Figure 5b). Furthermore, these slopes correlated significantly with mean drift rate in a diffusion model simulation. Most importantly, this component was also a good predictor of the content of a subject's choice. Source localization placed this component in left medial parietal cortex, a region that was shown to communicate with both areas exhibiting accumulator activity as well as premotor and motor cortices. Taken together, these results suggest that human perceptual decision making entails a separate categorization stage, which converts the accumulated evidence into a categorical decision and provides a flexible link between decision and action.

#### *Perceptual Decision Making in the Somatosensory Domain*

Another fundamental process in the formation of a perceptual decision is the contribution of memory. Our sensory experiences—stored in memory and brought online in working memory—are combined with the current sensory inputs to elaborate our perceptual decisions. In the monkey literature, this process has been extensively described by Romo and colleagues using the vibrotactile discrimination task, which allowed the authors to distinguish between working memory, the development of the comparison process (the combination of the memory trace and the current sensory stimulus), and the motor response. Two of our recent projects aimed at elucidating the role of somatosensory memory representations for human vibrotactile decision making.

The role of the primary somatosensory cortex (S1) for the short-term maintenance of sensory

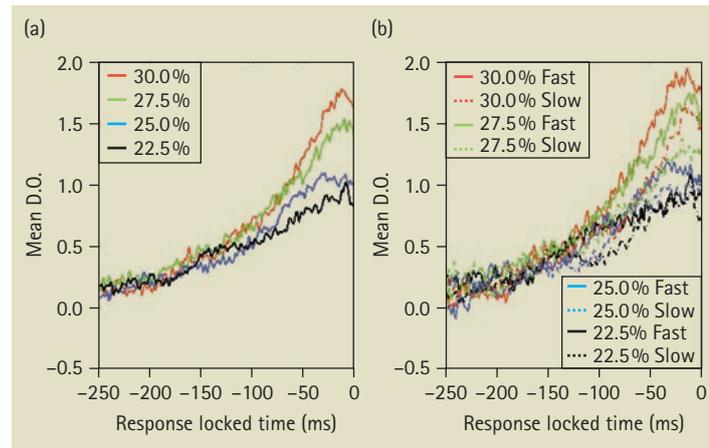


Figure 5. (a) Response-locked activity from the 250 ms preceding the motor response as a function of stimulus evidence. (b) The same activity as in (a) with trials further divided into fast (solid lines) and slow (dotted lines).

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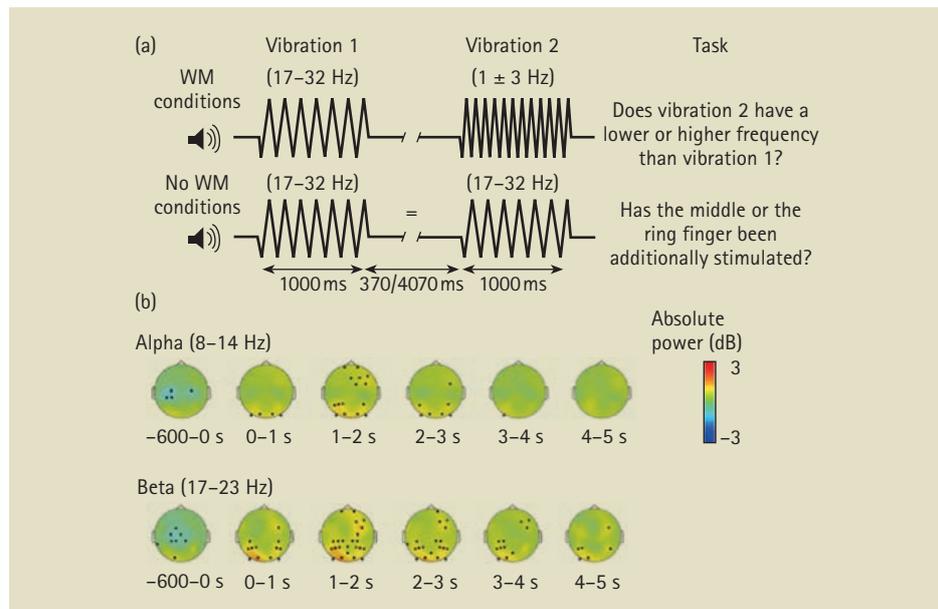
evidence is still under debate. In a previous fMRI study, we have shown that the blood oxygen level dependent (BOLD) signal in human S1 is enhanced during stimulus encoding but not during a 4 s long delay period (Preuschhof, Heekeren, Taskin, Schubert, & Villringer, 2006). It is possible, however, that S1 activity is still enhanced during the early delay period, an effect that cannot be disentangled from encoding activity due to the low temporal resolution of fMRI. Therefore, in a current study, we used the excellent temporal resolution of EEG to investigate the dynamics of the rolandic rhythms which are indicators of S1 activation during the encoding and delay period of a vibrotactile working memory task (cf. Figure 6a). In the pretrial period, the rolandic alpha and beta rhythms over somatosensory sites indicated an increased activity level of S1 in working memory, compared to a control condition. This likely reflects anticipatory attention, but no effect was observed during the delay period (cf. Figure 6b). In contrast to this, frontal and posterior alpha and beta power amplitudes were enhanced during the delay period, which might be related to the functioning of a fronto-parietal attentional network involved in top-down control. Together, our pattern of results suggests that S1 does not maintain the vibrotactile memory trace. The activation level of S1, however, seems to be dynamically adjusted to optimize task performance.

#### Key Reference

Preuschhof, C., Heekeren, H. R., Taskin, B., Schubert, T. & Villringer, A. (2006). Neural correlates of vibrotactile working memory in the human brain. *The Journal of Neuroscience*, 26,13231–13239.

**Key Reference**

**Preuschhof, C.,** Schubert, T. Villringer, A., **Heekeren, H. R.** (in press). Prior information biases stimulus representations during vibrotactile decision making. *Journal of Cognitive Neuroscience*.



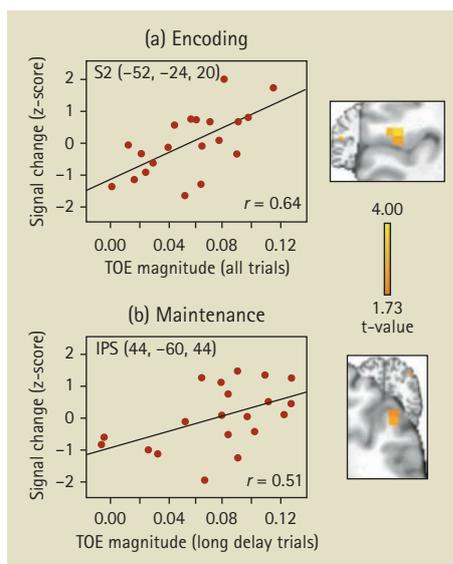
**Figure 6.** (a) Vibrotactile working memory task. (b) Average topographies representing differences in absolute power for the encoding period (0–1 s) and the delay period (1–5 s) for the alpha (8–14 Hz) and the beta frequency band (17–23 Hz). Bold dots indicate electrodes for which absolute power amplitude are significantly larger in the working memory, compared to the control condition ( $p < 0.05$  corrected).

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Another source of information which influences perceptual decision making are long-term representations of stimulus statistics in form of prior information. In a current study, we aimed to identify the brain structures involved in the integration of the current vibrotactile stimulus and prior information

about the average frequency of the stimulus set (Preuschhof, Schubert, Villringer, & Heekeren, in press). Specifically, we investigated whether prior average information already biases vibrotactile decision making during stimulus perception and maintenance, before the actual judgment process. For this purpose, we used a vibrotactile delayed discrimination task and fMRI. To find neural evidence for the integration of prior average information, we used the time-order effect, a psychophysical phenomenon, which has been proposed to result from such a weighting of current sensory evidence provided by the currently presented stimulus and the average of all stimuli presented previously. The BOLD signal in the secondary somatosensory cortex during encoding and the intraparietal sulcus during maintenance mirrored individual differences in the degree to which subjects integrated prior average information. These findings provide strong evidence for a pivotal role of these regions in the integration process (cf. Figure 7) and demonstrate that prior information can influence perceptual decision making already at early processing stages.

**Figure 7.** (a) Encoding activity in S2 is associated with individual differences in the weighing of the prior vibration frequency, (b) while activity in the IPS is associated with the weighting of prior information during maintenance.  $p < 0.05$ . S2: secondary somatosensory cortex; IPS: intraparietal sulcus.



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### **Neurocognition of Reward-Based Decision Making**

Many of our decisions are influenced by the potential outcomes associated with different choice options. For instance, consumers consider positive and negative product attributes prior to purchase, or people use past experience to decide which means of transportation is the best to commute to work. The project Reward-Based Decision Making examines how people use reward-related information to achieve desired outcomes.

To examine reward-based decision making, we abstract basic features from real-life decisions, such as the type of information and feedback available, and implement them in simpler tasks, which are amenable to manipulation in an fMRI environment and to precise modeling. Conducting fMRI experiments allows us to test models and theories by examining decision variables that cannot be measured directly in behavioral experiments. Such variables are the prediction error (PE) in reinforcement learning models, which represents the deviation between expected and actual outcomes, or the decision threshold in sequential sampling models, which determines how much information needs to be collected before a decision is made. Further, neuroimaging techniques allow us to develop theories that describe how the brain implements decision-making mechanisms.

Reward-based decision making has been investigated by different disciplines, which focus on different aspects of decision making. Economics and Machine Learning describe procedures, which aim to maximize the decision maker's outcome. Psychological theories describe how people learn from feedback. Neuroscientific research describes which kind of information is represented in the brain and how it is manipulated to reach a decision. While it is a challenging task to examine behavior across these different levels, we believe that a solid understanding of reward-based decision making has to consider how a decision should be made, the psychological mechanisms that explain coherence with and deviation from maximization, and the neurobiological substrates of those mechanisms. Therefore, to further our understanding

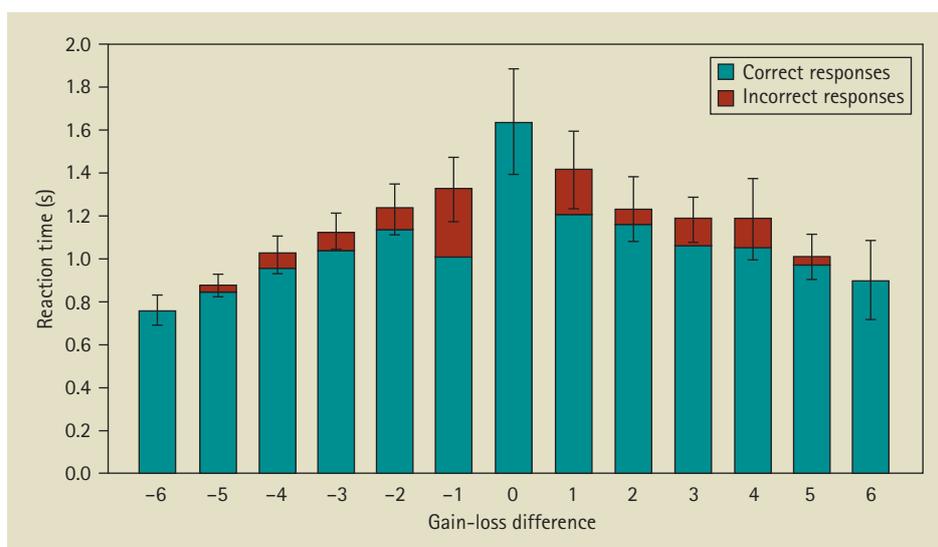
of reward-based decision making, we develop and test simple mathematical models that are derived from adaptive models of decision making and learning. These models are a central tool of our research because they allow to derive predictions for behavioral and neuroimaging data, thereby supporting the development of integrative theories that explain reward-based decision making on different phenomenological levels.

#### *Integration of Possible Gains and Losses During Value-Based Decision Making*

Decisions are often associated with potential positive and negative outcomes. From a standard normative point of view, decision makers would need to weight the possible outcomes by their probability and sum the weighted outcomes to synthesize the final evaluation of a choice option. However, this kind of model often does not describe the outcome of decision processes and is probably not an accurate reflection of the underlying psychological and brain processes. By contrast, sequential sampling models, of which the diffusion model described above is one possible instance, offer a mechanistic account of decision making. These models are traditionally applied to perceptual and memory tasks (e.g., Heekeren et al., 2008), but they can also be applied to describe economic decisions. This project uses fMRI to investigate the neurobiological basis of a diffusion-model type decision process in value-based decision making. In the experiment, participants were asked to accept or reject colored shapes, which were associated with different expected outcomes. Prior to the fMRI experiment, participants learned the associations of different gain and loss magnitudes with different colors and shapes, respectively. In the decision-making experiment, they had to combine these learned values to decide if they wanted to collect the payoff associated with a colored shape or not. This experiment tested the hypothesis that a diffusion process underlies the combination of information about potential gains and losses. From this, we derived the behavioral prediction that difficult decisions (i.e., similar gain and loss magnitudes) should lead to more incorrect decisions and to longer reac-

*Figure 8.* Response time and percentage correct as a function of choice difficulty. The height of the bars represents reaction time. The colors indicate the proportion of correct and incorrect choices. The figure shows that participants responded faster and made fewer errors when the difference between the gain and the loss associated with a colored form was larger.

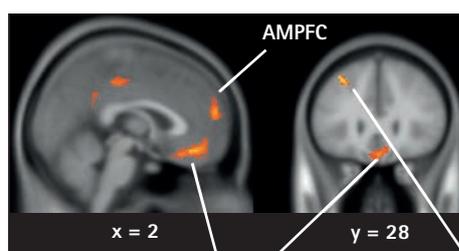
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tion times. On the neurobiological level, we expected a representation of gain and loss information that informs the diffusion process and of decision variables that characterize the diffusion process.

As predicted, Figure 8 shows longer reaction times and more errors when the difference between loss and gain associated with a colored shape was smaller.

For the neurobiological implementation of the diffusion process, we first identified three cortical regions that were modulated by the strength of evidence, the absolute differ-



*Figure 9.* Covariation of BOLD response and strength of evidence. Strength of evidence was operationalized as the absolute difference between the gain and the loss associated with a colored form. The strength of evidence can be thought of as the drift rate in a diffusion model, which is usually defined as the difference of the evidence for one alternative minus the evidence for the other alternative. Increased activity for strength of evidence was observed in the ventromedial prefrontal cortex (VMPFC), anteromedial prefrontal cortex (AMPFC), and right dorsolateral prefrontal cortex (DLPFC).

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ence between gains and losses (see Figure 9). Note that the strength of evidence is a proxy for the drift rate with which information is integrated in the diffusion model. The direction of the decision, accept or reject, was coded in the anterior-most portion of the rostral supracallosal ACC (rACC), which showed stronger activation for positive, compared to negative net outcomes. For a more direct connection of brain and behavioral data, we additionally modeled participants' choices with the diffusion model and examined if individual differences in latent decision variables are associated with different brain activity.

Results of this analysis showed a covariation of participants' decision threshold, which determines how much information they require before settling on a decision, with activation in the ventromedial and anteromedial prefrontal cortex.

Taken together, the behavioral and fMRI results support the hypothesis that the mechanism that underlies the integration of potential gains and losses in reward-based decision making has characteristics of a diffusion process, in which information is sampled and integrated until the collected evidence in favor of one alternative versus the other reaches a decision threshold. This project was realized in collaboration with U. Basten and C. Fiebach (fim lab, University of Heidelberg).

### Neurophysiological Signatures of Valence, Feedback Magnitude, and Prediction Error

The prediction error (PE) is a central variable when organisms learn from experience. It codes the difference between expectations and actual outcome, which is needed to adjust expectations for more accurate prediction. Consequently, the last years showed a strong interest in the neurobiological implementation of the PE. While earlier work focused an important role of mesencephalic dopaminergic neurons for PE signaling, recent research has highlighted the role of a target of these neurons, the anterior cingulate cortex (ACC). While the role of the ACC is undisputed, the details of cortical PE processing are still unclear. In particular, it remains unclear whether the error-related negativity (ERN, a negative reflection that occurs typically 200–250 ms after feedback) codes the valence, the magnitude, or both aspects of the PE. Furthermore, the role of subsequent processes reflected in the positive deflection (P300) that follows the ERN are even less explored.

To address these questions, we designed a simple reinforcement learning task which ensured a wide range of both positive and negative PEs and was conducted while we measured EEG signals. In each trial, participants were presented with two out of three choice options, which differed in their reward probability. The reward probability changed as soon as participants consistently chose the best option. To investigate the mechanisms of cortical PE processing, we related PEs estimated with a reinforcement learning model to EEG data. Specifically, we used a single-trial linear classification technique to discriminate positive and negative PEs (to test for valence) as well as low- versus high-magnitude PEs (to test for size). This procedure resulted in single-trial discriminator amplitudes, which we then correlated with the single-trial PEs estimated by the model.

The results indicate that a centro-frontal component around 220 ms following feedback, consistent with the well-known ERN, is most sensitive to the valence of an action outcome (red line in Figure 10). Contrary to common belief, our results argue against a

role of the ERN in coding the magnitude of the PE (absence of a significant peak around 220 ms for the blue line in Figure 10). An effect of PE valence is also found around 300 ms after feedback, as indicated by the sustained discriminability for the red line in Figure 10. The relevant sensor contributions come from more posterior scalp sites, suggesting a different process than the earlier time window. The effect of PE magnitude is maximal at centro-frontal locations around 300 ms after feedback (blue line in Figure 10). This is also the time window where the size of the PEs correlate positively with the single-trial discriminator amplitudes ( $r > 0.4$ ,  $p < 0.01$ ), suggesting that larger PEs elicit larger physiological responses.

In summary, we show that, within the first 250 ms, the system evaluates mainly along a negative–positive axis. This is followed by two processes (around 300 ms), which happen nearly simultaneously, but appear to have distinct neural generators. While a centro-frontal component codes the valence of an event, a more posterior component evaluates

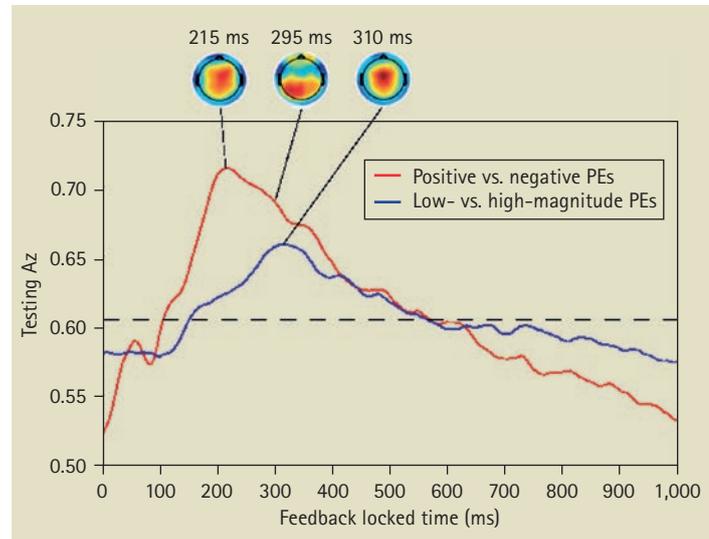


Figure 10. Single-trial EEG discriminator performance. The performance of the classifier is quantified by computing the area under receiver operating characteristics (ROC) curve (Az value) when discriminating between conditions of interest (e.g., positive vs. negative PEs [red] and low vs. high-magnitude PEs [blue]). Scalp maps demonstrate the spatial extent of the discriminating components at the times indicated by the arrows. Data are aligned to the onset of feedback. The dotted line indicates an Az value leading to a significance level of  $p < 0.01$  estimated using a bootstrap procedure.

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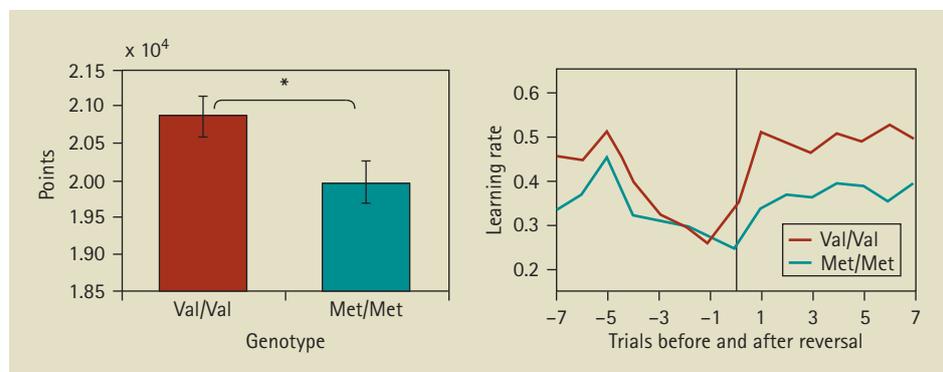
how expected the event was. Both components together provide the PE information required to adjust expectations. Note that, without our single-trial approach, it would have been difficult to differentiate between these two later components, which explains the confusion about the role of the P300 reported in traditional EEG studies.

*Embrace the Change—Ability to Quickly and Flexibly Adapt Decisions to Available Rewards is Influenced by Genetic Variation in Dopaminergic Neuromodulation*

Most theories of associative and instrumental learning assume that learning is driven by the deviation of predicted and experienced outcomes, the PE. Pioneering electrophysiological experiments showed that the PE signal, which is also central to psychological and optimal models of reinforcement learning, originates, amongst others, from dopaminergic cells in the midbrain, which project to the striatum and the prefrontal cortex where learning is implemented. We hypothesized that genetically based variations in dopamine metabolism should also influence performance in instrumental learning tasks. Specifically, we predicted that the uniquely human Val<sup>158</sup>Met polymorphism in the enzyme catechol-O-methyltransferase (COMT), which influences prefrontal and importantly also striatal dopamine availability, should be related to performance differences in instrumental learning. Most studies on performance effects of the COMT genotype emphasize better performance of Met homozygotes due to higher prefrontal dopamine levels. By contrast, we reasoned that the reciprocal relationship of

prefrontal and striatal dopamine levels should lead to a better representation of PEs and, therefore, better performance of Val homozygotes in an instrumental learning task. To test this hypothesis, we conducted an fMRI experiment where Val homozygotes and Met homozygotes performed a reversal learning task. In the task, participants repeatedly chose from four different choice options with different reward probabilities, which changed as soon as participants had learned which option had the highest reward probability (e.g., task reversal). The task had a minimal demand on explicit declarative capacities, yet it afforded constant adaptation to a changing environment. Figure 11 shows, as predicted, that Val homozygotes performed better in the reversal task. To better understand this result, we implemented a reinforcement learning model with an adaptive learning rate that accounts for the requirements of reversal learning in a dynamic environment. According to this model, an increasing difference between expected and actual rewards signal that the adaptation to new reward contingencies is necessary. This is implemented by adapting the learning rate, so that it increases when absolute PEs become larger and decreases when absolute PEs become smaller. The modeling results showed that Val homozygotes had overall higher learning rates and showed a greater increase in the learning rates in the first trials after a reversal (see Figure 11). The fMRI results confirmed that the better learning performance of the Val type is related to a better representation of PEs. First, as Figure 12 shows, the sign of the PE correlated more strongly with the BOLD response of

Figure 11. Left panel: Val homozygotes collected more points than Met homozygotes ( $P = 0.038$ ). Right panel: Adaptive learning rate of Val and Met homozygotes before and after reversal (indicated by vertical line). Val homozygotes show a faster increase of the learning rate in response to a changing environment.



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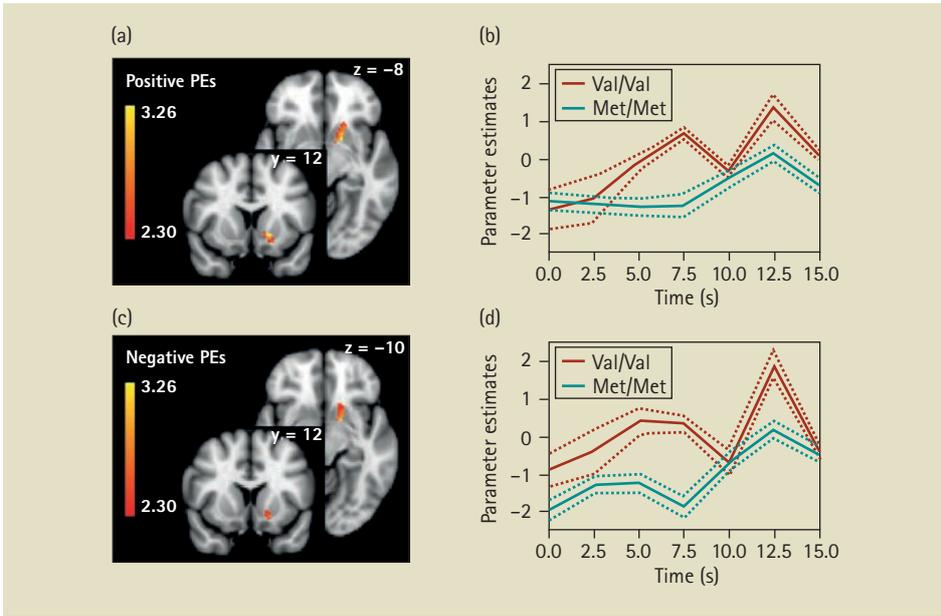


Figure 12. Genotype-related differences in fMRI responses to positive and negative PEs. (a) Greater ventral striatal fMRI responses to positive PEs in Val than in Met homozygotes in the ventral striatum. (b) Averaged time courses (+/-SE) of parameter estimates for voxels within the cluster shown in (a) for Val and Met homozygotes. (c) Greater BOLD responses to negative PEs in Val than in Met homozygotes in the ventral striatum. (d) Averaged time courses of parameter estimates for voxels within the cluster shown in (c) for Val and Met homozygotes.

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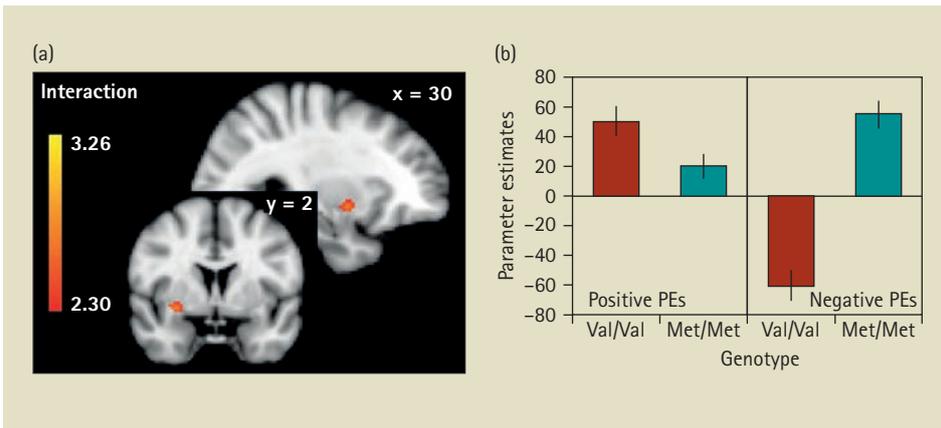


Figure 13. Genotype-related differences in the covariation of fMRI responses with parametric positive and parametric negative PEs. (a) Only Val homozygotes show a positive fMRI signal covariation with positive PEs and negative covariation with negative PEs. (b) Averaged changes in BOLD signal in (+/-SE) in voxels within the cluster shown in (a) for covariation with positive and negative PEs, and for Val and Met homozygotes, separately.

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the Val homozygotes in the ventral striatum, which is known to represent PEs. Second, as depicted in Figure 13, the expected correlation between PE (sign and magnitude) and ventral striatal activity could only be observed for the Val type, which showed increasing BOLD response to increasingly positive PEs and decreasing BOLD response to increasingly negative PEs. In sum, the results of this study show an effect of the COMT genotype on instrumental learning and suggest a mechanistic explanation for this. The better performance of Val homozygotes seems to be mediated on the computational level by a more successful

adaptation of the learning rate and on the neurobiological level by a more effective representation of PEs. Finally, our finding of a functional advantage of Val homozygotes contrasts with prevalent results of an advantage of the Met homozygotes in tasks with higher demands on explicit declarative capacities that more strongly recruit prefrontal brain regions.

#### Parallel Learning Mechanisms for Model-Based and Model-Free Learning

Most reinforcement learning research has focused on model-free learning, where one learns to predict outcomes based on averaged

**Key Reference**

**Biele, G., Erev, I., & Ert, E.** (in press). Learning, risk attitude and hot stoves in restless bandit problems. *Journal of Mathematical Psychology*.

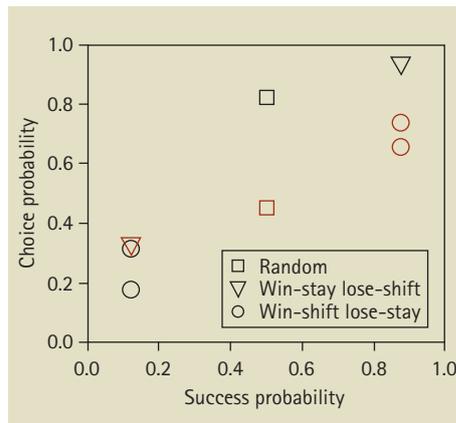


Figure 14. Choice probabilities are adapted to success probabilities. Different symbols forms refer to environments with different reward probabilities. Red symbols depict the probability of being rewarded when repeating a rewarded choice (stay after win). Black symbols depict the probability of being rewarded when not repeating a rewarded choice. In the win-shift lose-stay environment (circles) the probability of success (i.e., a high reward) for repeating an unrewarded choice (red circles) was high and participants frequently repeated y choice after it was not rewarded. The figure also shows that participants learned to stay after a win more easily than to stay after a loss.

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past action outcomes only. In contrast, model-based learning uses an internal representation of the task to predict action outcomes, so that—depending on different states of the world—the same actions can lead to different outcome predictions. For instance, a child might like it when the father offers pizza for lunch for the first time in a week, but dislike it if he or she had pizza for the last 10 days. Our previous research showed that learning in simple dynamic environments where outcomes follow sequential patterns is better explained by a model that assumes that decision makers learn and update an internal model of the payoff governing rules (Biele, Erev, & Ert,

in press). This project tests the hypothesis that model-based and model-free learning work in parallel, so that PEs and expected rewards for the two learning mechanisms are represented separately in the brain.

In the experiment, participants were exposed to two dynamic environments where they had to learn to play either win-stay lose-switch, or win-switch lose-stay, and one static environment without patterns. The behavioral results confirmed sensitivity to reward patterns. Figure 14 shows that participants played win-stay lose-shift in the task where this strategy lead to frequent rewards and learned to play the less intuitive win-shift

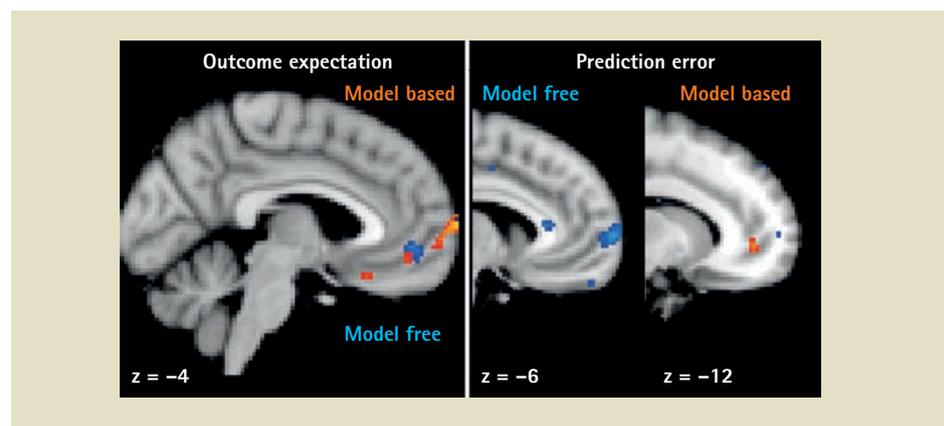


Figure 15. Representation of learning variables for model-free and model-based learning. The left panel shows separate regions in the medial frontal and orbitofrontal cortex that covary with reward expectations from model-free (in blue) and model-based (in yellow/red) learning mechanisms. The right panel shows separate medial frontal and cingulate regions that covary with PEs from model-free (in blue) and model-based (in yellow) learning mechanisms. The learning variables were derived from a learning model that assumes separate parallel learning mechanisms for model-free and model-based learning. While the model-based mechanisms can increasingly determine choices, it is assumed that reward predictions are continuously updated in both mechanisms.

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lose-stay strategy when it led to more frequent rewards.

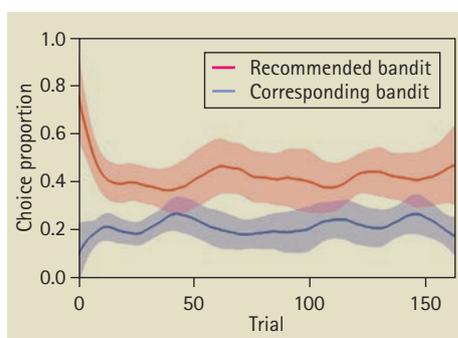
To investigate the neurobiological basis of pattern learning, we tested if the brain represents information about the two parallel learning processes. Participants' behavior was modeled with a new learning model that assumes that the brain updates outcome expectations from model-free and model-based learning in parallel. The fMRI analysis shows that expected payoffs for chosen options as well as PEs predicted by the model were correlated with the BOLD response (see Figure 15). The results showed a separate representation of both expected payoffs and PEs for model-free learning of average payoffs and model-based learning of conditional payoffs in the (medial) prefrontal cortex. These results suggest that instrumental learning does not rely on a single learning mechanism, but that multiple learning mechanism with different sensitivity for patterns in payoff distributions work in parallel to support adaptive choices from experience.

#### *The Influence of Advice on Reinforcement Learning*

The final project in this section makes the link between reward-based decision making and decisions in social contexts. The starting point for this project was a previous finding that people behave as if advice changes the evaluation of decision outcomes (Biele, Rieskamp, Gonzalez, in press; see also Social Rationality section of the ABC group). More specifically, the comparison of various augmented reinforcement learning models showed that people add an advice bonus to outcomes from recommended choices, so that, after follow-

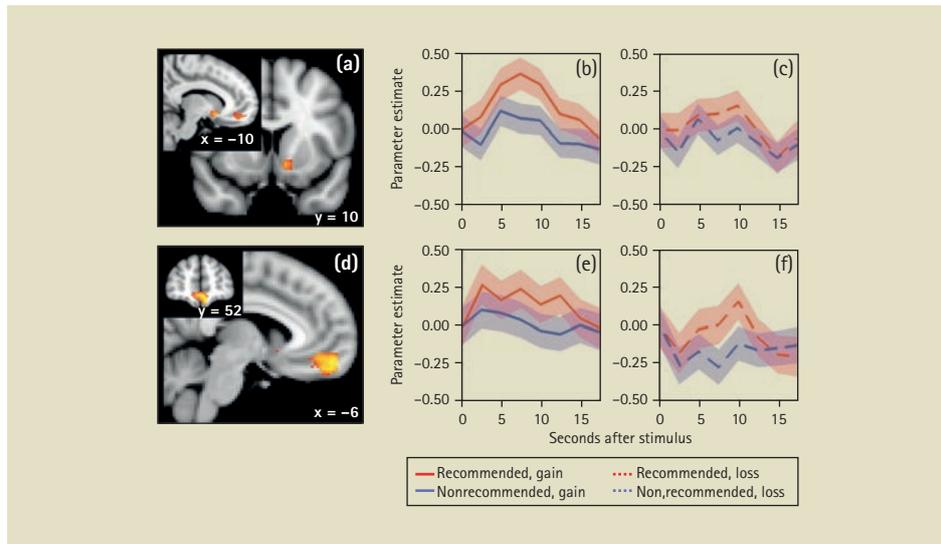
ing advice, positive outcomes are evaluated more positively and negative outcomes less negatively. Even though this explanation can predict the long-lasting influence of advice and a rebound of following advice after initial exploration, it seems to contradict everyday experience. To further test the assertion that following advice influences the evaluation of rewards, we used the fact that reward processing is a well-examined phenomenon in neuroscience. Based on the modeling results, we predicted that reward-representing brain regions should show a greater BOLD response for positive outcomes after following advice than after not following advice. Moreover, these brain regions should signal reward even after a loss, if this loss originates from following advice. To test these hypotheses, participants performed an instrumental learning task in an MRI scanner, after they had received advice from another experienced participant who was motivated to give good advice. Advice indicated which option the advice taker should preferably choose. Consistent with the outcome bonus hypothesis, behavioral results showed again a long-lasting influence of advice on choices, so that recommended options were preferred over nonrecommended options with the same expected rewards (cf. Figure 16).

To investigate the fMRI hypothesis, we focused on the striatum and the medial prefrontal cortex, regions that are known to show increased BOLD response to increased rewards. We first identified reward-sensitive foci within the striatum and the medial prefrontal cortex (see Figure 17). The analysis of the average BOLD time course in the striatum showed an increased BOLD response to gains



*Figure 16.* Preference for recommended choice options. Participants' average choice proportions (running average of 11 trials  $\pm$  2SEM) for the recommended and the nonrecommended corresponding deck. Advice influenced not only the initial choices. In particular, participants also preferred the recommended deck throughout the experiment. The long-lasting influence of advice is easily explained by the outcome bonus model.

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*Figure 17.* Influence of advice on reward representation in the ventral striatum (VST) and the ventromedial prefrontal cortex (VMPFC). (a) Greater BOLD response for positive versus negative feedback in the VST. (b) Peak BOLD response ( $\pm 1$ SD) in the VST for positive feedback was greater after following advice (red) than after not following advice (blue). (c) BOLD response time course in the VST for negative feedback. (d) BOLD response for positive versus negative feedback in the VMPFC. (e) BOLD response time course in the VMPFC for positive feedback. (f) BOLD response time course in the VMPFC for negative feedback was greater after following advice than after not following advice.

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after following advice, compared to after deviation from advice. Moreover, Figure 17 shows that the reward-sensitive medial prefrontal focus signaled rewards even after losses, if losses originated from following advice.

In sum, the behavioral study and the fMRI study suggest that advice influences instrumental learning by changing the evaluation of outcomes. While a simple manipulation of reward perception might superficially appear as a crude implementation of social learning, it can be considered as adaptive because it maintains exploratory behavior and is particularly influential when choice options seem similar.

### Decision Making in Social Contexts

Most of our decisions in everyday life have to be taken in social contexts, and much of our success in life depends on how well we do in interacting with others. Making inferences about the mental states of others, which is referred to as social cognition, is at the core of what enables us to predict the behavior of others. Basic perceptual and cognitive

processes, such as the reading of facial expressions and the decoding of prosodic cues, represent a prerequisite for social cognitive functions. Social decision making, however, is not only the result of perceptual and cognitive operations but also of emotional processes. In fact, in a collaborative project with the Center for Adaptive Behavior (ABC), we recently found that emotional personality characteristics as measured via self-report questionnaires, such as levels of empathic concern, are much stronger predictors for prosocial behavior in economic games, such as the dictator game, than cognitive parameters, such as the ability to take other people's perspective.

Thus, the common goal of our subprojects within the topic of decisions in social contexts is to elucidate the unique as well as combined contributions that these perceptual, cognitive, and emotional processes have on social decision making. Using structural and fMRI as well as psychophysiological measures, such as eye tracking and skin conductance, our group is trying to elucidate how and where in the brain of healthy individuals so-

cial decisions are made. Moreover, to complement our understanding of the “social brain,” we are studying individuals with neuropsychiatric conditions that involve socioemotional impairments, such as autism, borderline personality disorder, and narcissistic personality disorder. Insights from our studies in individuals with and without impairments in social decision making have helped our recent development of the Social Cognition Training Tool (SCOTT), an ecologically valid software targeting socioemotional competence, such as face and prosodic processing as well as more complex mindreading abilities.

*The Bedrock of Social Decision Making: Face Processing*

The study of face processing abilities, such as facial emotion or identity recognition, is of particular importance for social decision making because faces represent a crucial source of social information and their decoding is a precursor for more complex social inferences. Deficits in face processing are among the core features of autism spectrum conditions (ASC) and together with the well-described problems in mindreading they are thought to underlie the defining social impairments of these conditions. Although abnormalities have been reported for a variety of static face processing tasks including visual scanning

and emotion recognition, it is not clear to date if those findings apply to online face processing, that is, face processing during social interaction. Moreover, while, in typically developed individuals, face perception involves a distributed set of brain regions comprising a core system (extrastriate visual cortex, fusiform gyrus) and an extended system (e.g., amygdala, superior temporal sulcus), it is not clear which of these structures are affected in face processing impairments in autism. We are currently addressing these open questions using a multidimensional approach.

Using eye tracking, we are investigating, for the first time in an online naturalistic fashion, fixation patterns of individuals with and without autism using the Virtual Video Interaction (VII) that involves participants in a standardized dialogue situation (cf. Figure 18). The results of the study showed that individuals with autism fixate less on the face and eyes of a dialogue partner than neurotypical control participants. These findings were especially pronounced when individuals were actively engaged in the dialogue, that is, when they were speaking rather than listening to the interacting partner. Those results indicate that, especially under conditions in which attentional resources need to be allocated to different processes, such as during naturalistic social interactions, face processing is

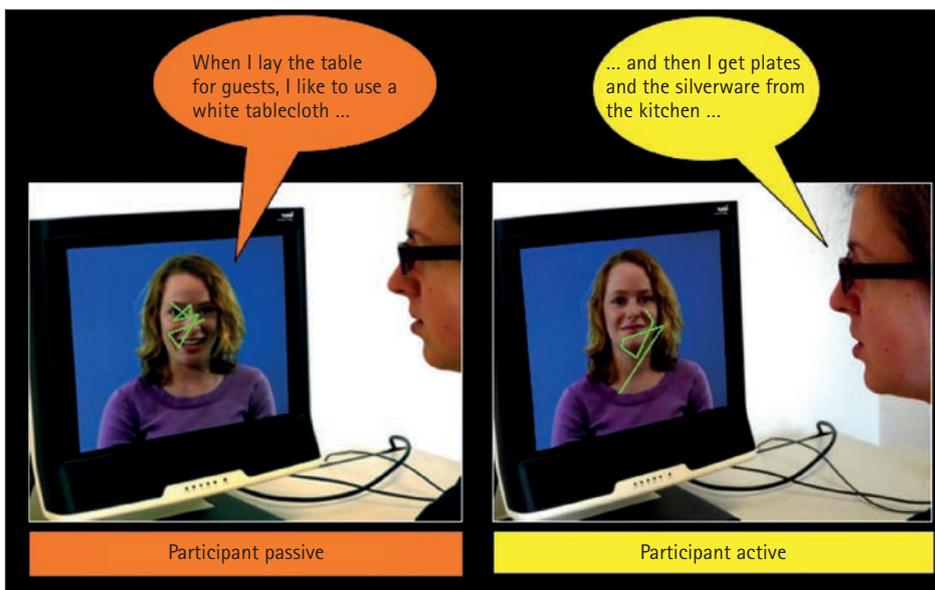
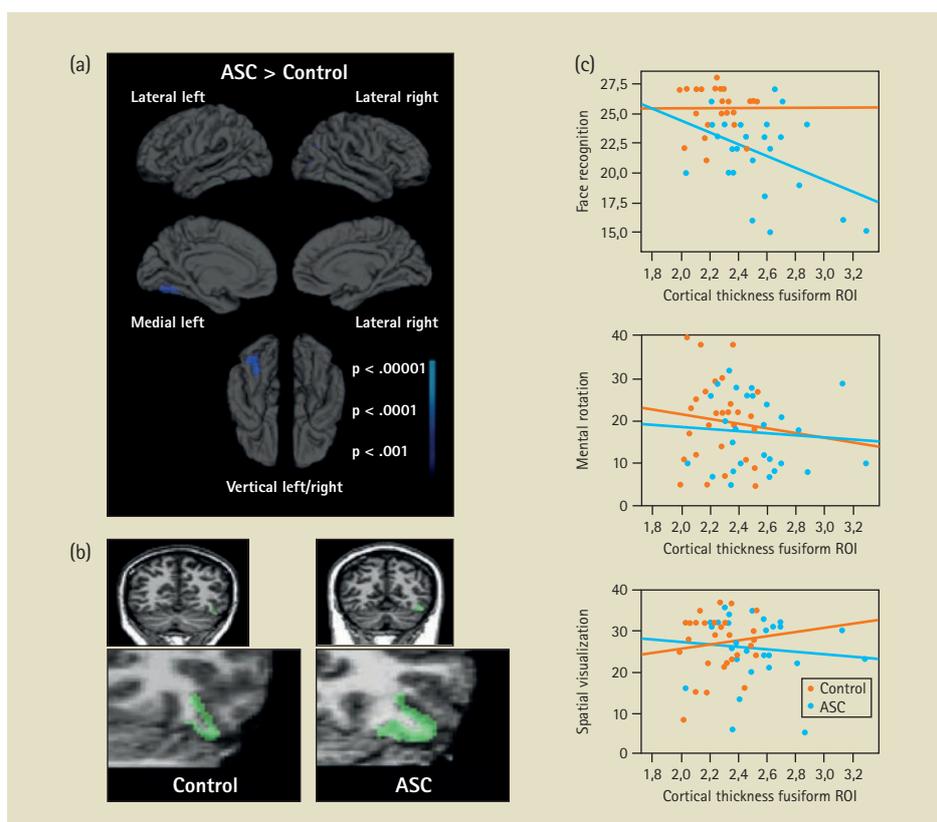


Figure 18. Investigation of gaze patterns using the naturalistic Virtual Video Interaction (VII). Participants are required to watch a 4-minute video on the eye-tracking monitor, facing a virtual dialogue partner, who involves the participant in a conversation about food (passive: participant is listening to dialogue partner; active: participant is speaking).

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**Figure 19.** (a) Cortical regions are thicker in the ASC group than in controls. Statistical map depicting between-group differences in thickness at each vertex on the cortical surface overlaid on the group's average brain. All points meeting a  $p < 0.001$  threshold (uncorrected) are displayed. (b) Coronal section displaying area of significant regional thickening for one control and one ASC participant. (c) Scatter plots of mean cortical thickness of each participant in the left fusiform gyrus ROI plotted versus face recognition, mental rotation, and spatial visualization, respectively, split by diagnostic group.

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impaired in individuals with autism. Moreover, in the autism group, fixations on face and eyes were strong negative predictors for social symptomatology as measured with autism diagnostic interviews and tests of social cognition performance: Those individuals that fixated more on the face and eyes of a dialogue partner showed less severe social impairments and better performance in recognizing emotions from faces. Applying structural and fMRI, we are currently seeking to elucidate the neuronal correlates of face processing in individuals with and without ASC. In a first morphometric study, carried out in collaboration with the Center for Brain Health, New York University (Antonio Convit), we applied an automated measurement to estimate fusiform gyrus cortical thickness and a manual tracing method to obtain amygdala volumes in 27 adults with ASC and 29 well-matched typically developed controls. Anatomical connectivity was estimated by analyzing volumetric covariance among those brain regions. We found specific

local increases in cortical thickness of the fusiform gyrus and associated impairments in face processing in individuals with autism (cf. Figure 19). Amygdala volumes further predicted face reading (dys)functionality in all study participants. Anatomical covariance between amygdala and fusiform gyrus local thickness increase was significantly smaller in the ASC group. As such, our data provide the first anatomical evidence for an abnormal amygdala-fusiform axis and its behavioral relevance for face processing deficits in ASC. While autism has been theorized as a condition of reduced connectivity in higher order association cortices, our findings extend this conception to lower level perceptual systems involving subcortical regions, suggesting dis-connectivity to be a more universal correlate of ASC brain dysfunction. In an fMRI study, we are currently following up on our findings from eye tracking and structural MRI studies in ASC (Dziobek, Rogers, Fleck, Wolf, & Convit, 2006b), seeking to identify whether differential involvement

of amygdalar subregions may account for the specific gaze behavior and face processing impairments observed in autism. Specifically, a two-component model for autism gaze behavior with specific amygdalar activation patterns recently proposed that a failure to actively orient to the eyes, as observed in patients with amygdala lesions, coexists with an aversion to directly fixate the eyes. To validate and potentially expand on this model, we developed, in collaboration with the University of Hamburg (Christian Büchel), a new facial emotion discrimination task, which targets (a) the effect of aversion when focusing on the eye region and (b) the effect of attentional capture by the eyes when directed to focus on the mouth region.

*Differentiating Empathy in Psychopathology*  
Empathy builds on more basic social perceptual functions and enables us to infer the mental states of others and to share emotional experiences, both of which are essential for the formation of close bonds. Thus, as a socioemotional construct, empathy entails cognitive (understanding others' mental states, social cognition) and affective (emotional reaction to the observed experiences of others) components. Our Multifaceted Empathy Test (MET; Dziobek et al., 2008) gives us an objective test for this multidimensional conception for the first time by simultaneously assessing cognitive and affective components while study participants process social picture stimuli. An important goal of our work is to make it applicable for *clinical* cognitive neuroscience questions. In pursuit of this goal, we are investigating empathic abilities in clinical populations, such as autism and borderline and narcissistic personality disorder, in collaboration with the Department of Psychiatry and Psychotherapy of the Charité—University Medicine, Campus Benjamin Franklin in Berlin (Isabella Heuser, Stefan Röpke). Despite the lack of research, deficient empathy is considered a central characteristic of autism. Using the MET, we have recently shown that, while individuals with autism have impairments in inferring others' mental states (cognitive empathy), they are as empathically concerned for others (emotional

empathy) as control individuals (Dziobek et al., 2008). In a next step, we sought to elucidate the brain underpinnings of cognitive and emotional empathy and its differential representation in individuals with and without autism. To this end, we developed an fMRI compatible adaptation of the MET and contrasted brain activations of 20 individuals with autism and 18 controls. The results showed that both groups activated similar networks for cognitive as well as emotional empathy (Figure 20). When contrasting cognitive empathy between groups, individuals with ASC showed more activation in an emotional network encompassing the right amygdala, anterior insula, and orbitofrontal cortex (Figure 21), possibly reflecting a mechanism by which deficient cognitive empathy is compensated for in individuals with ASC. During the emotional empathy condition, however, the autistic individuals showed reduced activity in a region of the inferior frontal gyrus, which has been equated with the human mirror neuron system. In a recent study, we also found that, in contrast to individuals with autism, patients with borderline personality disorder (BPD) show deficits in both cognitive and emotional empathy. BPD is a psychiatric disorder characterized by unstable relationships, impulsivity, and affective dysregulation. Results of our first behavioral study showed that the level of comorbid posttraumatic stress disorder and a history of childhood sexual

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Dziobek, I., Rogers, K., Fleck, S., Bahnemann, M., Heekeren, H. R., Wolf, O. T., & Convit, A. (2008). Dissociation of cognitive and emotional empathy in adults with Asperger syndrome using the Multifaceted Empathy Test (MET). *Journal of Autism and Developmental Disorders*, 38(3), 464–473.

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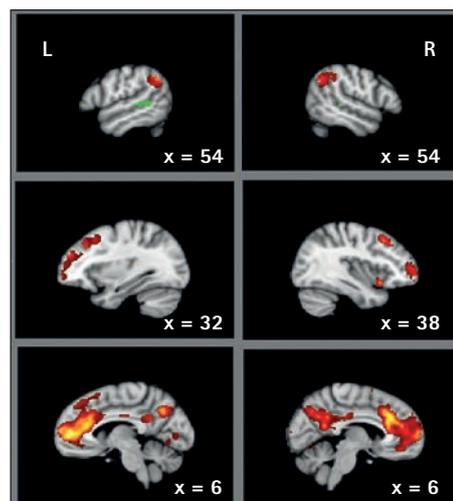
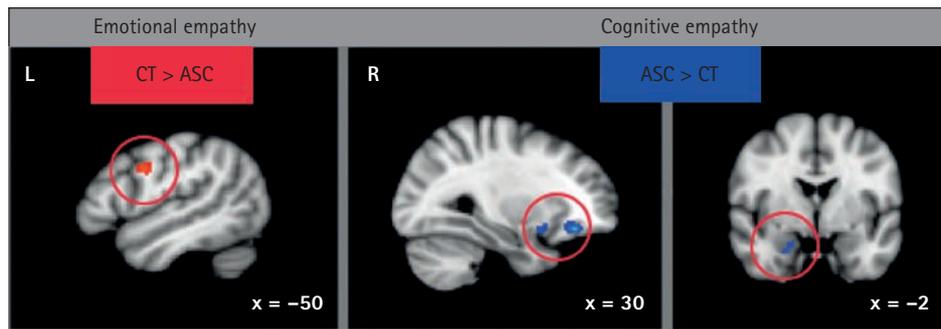


Figure 20. Conjunction analysis (ASC group and neurotypical controls) for the contrasts emotional > cognitive (red-yellow) and cognitive > emotional empathy (green;  $p = 0.001$ , uncorrected).

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Figure 21. Contrasts between ASC group and neurotypical controls for emotional and cognitive empathy ( $p = 0.001$ , uncorrected).

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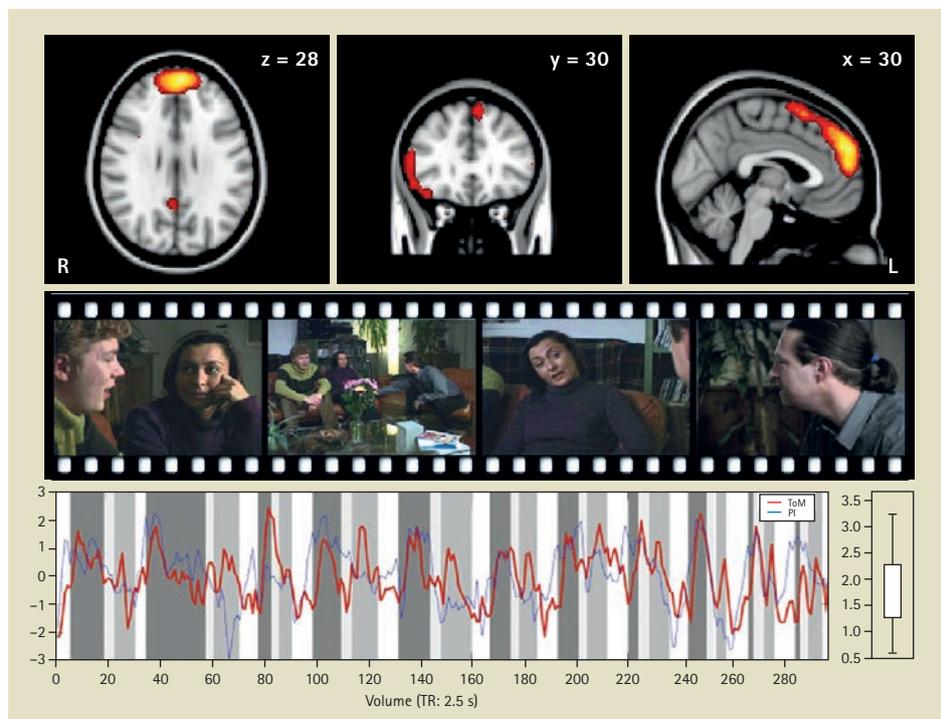


and physical abuse were strong predictors for the deficits in cognitive empathy, pointing to the importance of psychosocial factors in the etiology of BPD. In a subsequent fMRI study contrasting cognitive and emotional empathy using an adaptation of the MET in 30 patients with BPD and 30 controls, we confirmed the traumatic experiences as crucial predictors for the ability to infer mental states of others: Patients with BPD showed reduced activation in the superior temporal sulcus (STS) during cognitive empathy, where this reduced activation was highly correlated with levels of intrusive symptomatology in the BPD group. Thus, in BPD, the involvement of the STS-

gion as a key mediator for cognitive empathy might be adversely affected early in development by childhood trauma that leads to the intrusive symptoms seen in adult patients. Individuals with narcissistic personality disorder (NPD) are characterized in the DSM-IV by an inflated sense of self-importance, need for admiration, extreme self-involvement, and lack of empathy for others. In an effort to validate the DSM-IV criterion of lack of empathy for the first time empirically in affected individuals, we recently conducted a study using the MET and the Movie for the Assessment of Social Cognition (MASC; Dziobek et al., 2006a). The results showed that, while NPD

Figure 22. Upper panel: T-PICA results showing a functional network including dorsomedial prefrontal cortex, inferior frontal gyrus and precuneus activation during social decoding of naturalistic scenes (middle panel). The associated time course (lower panel) indicates the component's sensitivity during social processing.

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involves impairments in emotional empathy, cognitive empathy is generally well preserved, which represents a mirror image pattern of the empathic abilities found in autism. We are currently using fMRI and the MET to identify brain correlates of this double dissociation between cognitive and emotional empathy by contrasting brain activation of individuals with autism and NPD.

According to recent conceptions, social cognition entails both decoding of visual-perceptive socioemotional cues and reasoning about mental states. Using social cognition tests, such as the video-based MASC (Dziobek et al., 2006a), we are currently investigating those processes and their neural underpinnings in close to naturalistic settings. We used an fMRI adaptation of the MASC that allows separate analysis of decoding fast-changing perceptual cues as demanded in naturalistic settings versus social reasoning. Imaging data were analyzed by means of both a standard General Linear Model (GLM) approach and a tensorial probabilistic independent component analysis (T-PICA), a novel model-free approach that allows for the fine-grained analysis of specific neuronal activations and functional connectivity between brain regions. Interestingly, while results of the GLM approach identified a set of brain regions known to be part of the social brain, such as the superior temporal sulcus, temporo-parietal junction, medial prefrontal cortex, and precuneus as important for social reasoning,

the T-PICA showed that those regions are not represented in a functionally connected network. Instead, T-PICA results seem to indicate that more circumscribed and smaller networks, such as the medial prefrontal cortex and parts of the frontal operculum (cf. Figure 22), might mediate differential aspects of social cognition, such as self-referential mental activity.

Our previous research has shown that individuals with autism have relatively more accentuated impairments in the decoding of social cues than in the reasoning about mental states (Dziobek et al., 2006a). Moreover, in eye-tracking studies using adaptations of MASC and MET, we recently found evidence that, already at the level of social attention, autism seems to involve an attenuated orienting response to socially salient features of a scene. Based on those observations, we have developed the Social Cognition Training Tool (SCOTT), a computer-based intervention for the improvement of socioemotional competencies. SCOTT uses lifelike video-based stimuli to increase the understanding of 40 simple and complex emotions and is composed of four training modules of varying complexity, each targeting specific aspects of socioemotional attention, perception, and cognition (for an example cf. to Figure 23). As a core element, SCOTT's Emotion Library includes 40 emotions, which users will encounter in the different training modules (cf. Figure 24). Communicative

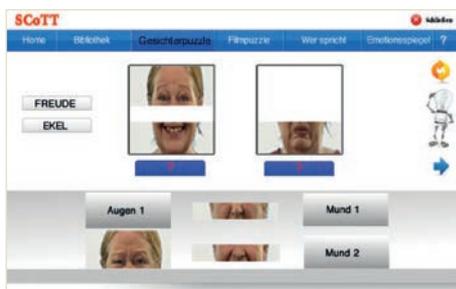


Figure 23. The SCOTT's module Face Puzzle. The stimuli of this module are made up of video sequences of different emotional facial expressions of the same person, which were cut into several parts. The parts are shuffled and presented simultaneously to the user whose task it is to match the emotion congruent pieces to holistic faces.

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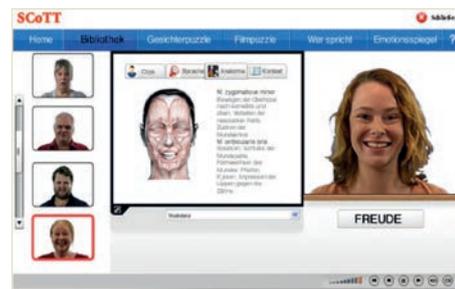


Figure 24. The SCOTT's Emotion Library. Each of a set of 40 emotions is explained at semantic, audio-visual, and physiological levels by using verbal definitions, video and audio excerpts of the emotional expression, and educational maps of emotion-specific psychophysiological correlates, respectively.

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relevance was the most important criterion when deciding on the emotions to be included in the software. However, given the lack of emotion taxonomies allowing for communicative relevance, we conducted a survey with 100 participants who were specifically asked to rate the frequency with which 60 different emotions are encountered in everyday life. Of

those 60 emotions, the 40 most communicatively relevant ones were chosen for SCOTT. We expect this specific emotion selection to increase the relevance and generalization of effects of SCOTT. In a 3-month intervention study, we seek to evaluate the effectiveness of SCOTT in improving social attention and cognition at the behavioral and neuronal level.

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#### The Independent Junior Research Group in February 2009



From left to right: Marios G. Philiastides, Holger Gerhardt, Nikos Green, Soyoung Park, Helen Blank, Isabel Dziobek, Peter N. C. Mohr, Anja Marwitz, Flavia Filimon, Niki Vavatzanidid, Claudia Preuschhof, Dorit Kliemann, Sandra Preißler, Niels Kloostermann, Rosa Steimke, Agnieszka Zofia Burzynska, Hauke R. Heekeren.

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# Service Units

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**Research and Professional Staff (2007–2008)**

**Library and Research Information:** Nicole Engelhardt, Ursula Flitner

**Information Processing Center:** Wolfgang Assmann

## Library and Research Information

Rapid access to printed and digital information is a decisive prerequisite for successful studies and for internationally renowned research.

The Library and Research Information Unit of the Max Planck Institute for Human Development aims to anticipate, determine, and respond to the Institute's needs for information in the areas of education, history, sociology, psychology, and neighboring disciplines. To support the research, teaching, and publishing activities of the Institute's researchers, the Library seeks to provide an environment and facilities conducive to efficient and independent use and dissemination of information.

The Library's collection currently comprises around 200,000 volumes, 530 printed periodicals, several thousand electronic journals, and an extensive selection of electronic resources. It offers fast and easy access to our own materials and information worldwide. Comprehensive intranet services include online access to major bibliographic, abstract, and full-text databases, to portals and e-books, to document delivery services, and listings of new acquisitions. In 2007 and 2008, the range of electronic full texts available within the context of the Max Planck Society's basic provision (*Grundversorgung*) was expanded to include a total of more than 16,000 journals on all fields of science, thus offering a sound basis for interdisciplinary research.

The collection of centrally and locally licenced electronic resources, accessible from every office desk in the Institute, is growing steadily. Among the new electronic resources added to the Library's services are:

- *Historical Abstracts*, covering the history of the world (excluding the United States and Canada) from 1450 to the present, including military history, women's history, history of education, and more. The database provides indexing of more than 1,700 academic historical journals reaching back to 1955.
- *America: History and Life*, a bibliography covering the history and culture of the United States and Canada, from prehistory to the present, with indexing for 1,700 journals from 1964 to present.
- *Historische Bibliographie Online*, covering German monographs, dissertations, habilitations, journal articles, and book chapters

in the field of history from prehistory to modern times, published since 1990.

- *Project MUSE Premium Collection*. This is a collaboration between libraries and publishers providing full-text online access to over 350 high-quality humanities and social sciences journals from over 60 scholarly publishers.
- *The IEEE All Society Periodicals Package* provides access to the IEEE's core collection of periodicals (120 journals with backfiles until 1998).
- 2.3 million dissertations and theses, of which more than 925,000 papers can be downloaded in PDF format.
- Various collections of *e-books*, both online reference works and monographs, were added, searchable in a separate e-book catalog.

In addition, the Institute profits from the National Licences, a program financed by



Figure 1. The atrium of the Library during reconstruction.

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Figure 2. For the installation of the air conditioning system the stacks had to be completely sealed.

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the German Research Foundation (DFG), offering free access on a national level to a vast number of databases, digital full-text collections, and e-journals. Thus, for example, all "Nature" backfiles (starting 1869) have become available recently as well as all journals (approx. 75) published by Karger. The staff of the Library offer regular training in the use of databases.

Satisfying the information requirements of the new Research Center "History of Emo-

tions" has been an exciting challenge. We are building up a solid base of current and classical historical literature that has not been systematically collected by the Library so far. To this end, new business relations were built up with providers of historical resources and suppliers of Indian literature.

To enhance the visibility of the Institute's scientific output, the Library introduced RSS-feeds. Anyone interested worldwide can subscribe to this service and automatically receive notifications of the latest publications by the Institute's researchers.

One important element of the reconstruction of the Institute's building in Lentzeallee was the complete refurbishment of the Library. In this context, it was finally possible to install full air conditioning for optimal humidity in the stacks. Despite the temporary move to a different building, all Library services were maintained at the usual standard.

Last, but not least, the Library continues training apprentices in Library and Information Science.

## Information Processing Center

The Information Processing Center supports projects and other service units in the Institute through its central facilities. Central servers are installed with Windows 2000/2003 or Linux for dedicated purposes: internet/intranet servers, software server, and so forth. Seven Windows cluster systems with large RAID storage installations provide the capacity (more than 10 TByte) for the central data management. Several powerful terminal servers establish a CITRIX server farm. They allow the user to run programs (SPSS, SAS, MAT-Lab, EQS, etc.) on the server CPUs from their own workstations (Windows or Apple PC) or the Internet. "Server-based computing" helps to overcome the constraints of the different workstations concerning CPU power and local storage. There has been a paradigm shift from the classical RAID system to a Storage Area Network/SAN solution on the central servers in 2005. Thereby, 80 TByte has been created in the last years.

The decentralized personal computing capacity comprises about 300 Intel PCs and 150 Apple computers. The Apple computers are running MacOS X and the Intel PCs are operating on Microsoft Windows XP. A central backup service is provided for all data on cluster and SAN disks. A wide array of software is available for the desktop systems.

To provide the necessary security, a Cisco-PIX firewall system was installed which allows for the failure of certain modules without causing a complete breakdown. Central virus scanner software—continuously updated via the internet—monitor all Intel and Apple workstations to avoid data loss caused by viruses.

The Local Area Network (LAN) integration of all desktop computers provides access to central resources and cluster capacity. At the end of 2004, the previous "fiber-to-desktop" solution of 10 Mbit/s was replaced by the "fiber-to-office" concept. Each office is now connected with 1,000 Mbit/s, and here the changeover from fiber to four copper ports takes place by using a small Gigabit Ethernet Switch.

To provide notebook users with a wireless connection to the internet, the Institute has installed WLAN.

The Institute's connectivity to Wide Area Networks (internet, etc.) is provided via the Research Network (WIN) of German Telekom and the German Research Network Association (Deutsches Forschungsnetz [DFN]). Late in the year 2000, the GIGA-WIN (1 Gbit/s) was installed, allowing the Institute to increase the use of high-speed connectivity.

The Center's services include:

- operating, optimizing, and developing the devices of the central cluster and network equipment;
- maintenance and updating Windows 2000, XP, and Linux operating systems;
- centralized printing capacity, including high-speed and color printers;
- LAN integration of desktop computers, and the continuous enhancement of LAN facilities;
- national and international connectivity (Wide Area Network);
- internet services: E-mail, WWW, NEWS, FTP, and Telnet;
- maintenance tasks of the Institute's internet and intranet servers;
- security measures;
- management of the central telephone system, including the voice-mail server;
- user support and trouble-shooting for Intel PCs and Apple computers;
- coordination and technical support for desktop computers and software;
- software acquisition.



Figure 3. Central server room.

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Figure 4. Storage area network (SAN).

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The Center provides:

- general design and coordination of the Institute's information technology equipment;
- the documentation of data concerning the existing computer and network equipment;
- an overview of market developments;
- advice for the Institute's boards and departments;
- the promotion of new concepts for state-of-the-art computer equipment.



# Appendix





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## 1. Research Colloquia 2007–2008

### Dietrich Albert

University of Graz  
Modeling Developmental Paths  
July 9

### David M. Almeida

Pennsylvania State University  
Does Daily Living Wear You Out? Capturing Multiple  
Sources of Variation Between Daily Stressors,  
Diurnal Cortisol, and Health  
July 4

### Leora Auslander

University of Chicago/American Academy Berlin  
Changing Hearts and Minds: The Division of Labor  
Between Emotion and Reason in Revolutionary  
Transformation  
November 4

### Hannelore Bauhaus-Lötzke

Humboldt University Berlin  
Aradhana  
May 6

### Anton Beguin

CITO, Arnhem  
Item Response Theory: Modeling, Applications, and  
Designs  
May 28–29

### Georg Berkemer

Humboldt University Berlin  
Rasa Theorie  
November 18

### Frank Biess

University of San Diego/University of Göttingen  
Angstregime und Subjektkulturen: Die Geschichte  
der Bundesrepublik als Angstgeschichte  
November 11

### Felix Blankenburg

Bernstein Center for Computational Neuroscience,  
Berlin  
Integration of Transcranial Magnetic Stimulation  
(TMS) and Functional Magnetic Resonance Imaging  
(fMRI)  
April 9

### Monika Boehm-Tettelbach

University of Heidelberg  
Welche Gefühle für welche Schicht? Quellen-  
kritische Überlegungen anhand des Befundes aus  
dem höfischen Milieu Nordindiens  
June 24

### Rafal Bogacz

University of Bristol  
The Subthalamic Nucleus and Optimal Decision  
Making  
December 16

### Michael Bosnjak

Free University Bozen  
Why Meta-Analytic Evidence is Anything Else Than  
"Rock Solid": The Case of Environmental Tobacco  
Smoke  
November 5

### Joanna Bourke

Birkbeck Collage, London  
Why and How to Write a History of Fear  
May 27

### Franz-Josef Brüggemeier

University of Freiburg  
... und sie küssten sich. Gefühle, Sport und Männer  
(und Frauen)  
May 13

### Katherine Butler Brown

University of Leeds  
Sense and Sensibility: The Cultivation of the Emo-  
tions and the Place of Music in Mughal India  
October 21

### Bhismadev Chakrabarti

Autism Research Centre, Cambridge, UK  
The Role of the Cannabinoid Receptor (CNR1) Gene  
in Emotion Perception and Empathy  
December 1

### Antonio Convit

Episodic Memory Across the Life Span: An Applica-  
tion of Latent Growth Curve Model  
September 8  
New York University School of Medicine  
Brain Correlates of Type 2 Diabetes and Insulin  
Resistance in Adults and Children  
July 16

### Belinda Davis

Rutgers University, New Jersey  
An Emotional History of the West German  
"New Left"?  
April 29

### Adele Diederich

Jacobs University Bremen  
Decision Field Theory for Multiattribute Choice  
Alternatives  
May 20

### Jean-Claude Dreher

Centre de Neurosciences Cognitives, Bron, France  
Neuroimaging Studies on Reward Processing and  
Decision Making  
May 16

### Eva-Maria Engelen

University of Konstanz  
Schuldgefühle in der Literatur der Überlebenden  
July 8

### Heide Fehrenbach

Northern Illinois University/American Academy  
Berlin  
International Adoption and the Emotional Logic of  
Family Construction  
December 2

### Yuval Feldman

Bar-Ilan University, Israel  
Are All Legal Probabilities Created Equal?  
October 23

### Mark Fenton-O'Creevy

Open University Business School, UK  
Interests—Financial Decision Making and Expertise  
(e. g., stock traders)  
December 5

### Jenny Fischer

MPI für Molekulare Genetik, Berlin  
Regulatory Networks of Gene Expression in Heart  
and Skeletal Muscle Cells  
April 28

2008

- Etienne Francois**  
Free University Berlin  
Nation, Emotion, Gedächtnis  
October 14
- Michael J. Frank**  
University of Arizona  
Frontal-Subthalamic Interactions in High Conflict  
Decisions and Response Inhibition  
July 18
- Alexandra Freund**  
University of Zurich  
The Role of the Cannabinoid Receptor (CNR1) Gene  
in Emotion Perception and Empathy  
December 1
- Ute Frevert**  
MPIB, Center for the History of Emotions, Berlin  
Opening Lecture of the Research Center History of  
Emotions  
January 22
- Darya Gaysina**  
King's College, London  
Bipolar Association Case Control Study (BACCS):  
Focus on "Schizophrenia" Candidate Genes  
April 2
- Ansgar Gerhardus**  
University of Bielefeld  
Tell Someone: Evidence-Based Public Health in  
Times of Mass Vaccination Against Some Types of  
Human Papillomavirus  
December 17
- Sandra Gordon-Salant**  
New York University School of Medicine  
Auditory Temporal Processing Deficits in Older  
Listeners and Their Implications for Speech  
Communication  
July 16
- Anja Göritz**  
University of Würzburg  
Incentives in Web-Based Surveys  
July 17
- Thomas D. Griffin**  
University of Illinois, Chicago  
Emotion-Based Beliefs: Intellectual Values, Ac-  
ceptance of Scientific Ideas, and Comprehension of  
Belief-Relevant Information  
October 29
- Beatrix Hauser**  
Martin Luther University Halle-Wittenberg  
Selbstaufgabe statt Selbstdarstellung: Zur Gestalt-  
barkeit der Gottesliebe im indischen Ritualtheater  
October 28
- Derek Isaacowitz**  
Brandeis University, Waltham, MA  
Positive Preferences in Gaze: Who, What, When,  
Why, and so What?  
January 8
- Monica Juneja**  
Emory University Atlanta  
Beyond Likeness: Portraying the Self in Visual Prac-  
tice of the North Indian Courts  
July 22
- Gideon Keren**  
Technical University Eindhoven  
The Magic Number Two (+/- one): A Critical Evalua-  
tion of 2-System Theories  
October 15
- Andrew King**  
University College London  
Decision Making in Baboons  
October 6
- Olaf Köller**  
Humboldt University Berlin/Institute for Educa-  
tional Progress, Berlin  
High School and Beyond: Academic Achievement  
and Academic Learning In and Out of School  
November 28
- Daniel Koretz**  
Harvard Graduate School of Education, Cambridge  
Developments of the International Project for the  
Study of Educational Accountability  
March 19–20
- Gyula Kovacs**  
University of Regensburg/Budapest University of  
Technology and Economics  
Perceptual Judgments on Moving Surfaces  
January 23
- Florian Krauß**  
Hochschule für Film und Fernsehen (HFF), Potsdam-  
Babelsberg  
Hum Aapke Hain Kaun ...!  
June 17
- Jon Krosnick**  
Stanford University  
Do Lab Experiments Replicate on Representative  
Samples?  
September 11  
Satisficing When Answering Questions  
September 10
- Ruth Leys**  
John Hopkins University Baltimore/Wissen-  
schaftskolleg Berlin  
How Did Fear Become a Scientific Entity and What  
Kind of Entity Is It?  
June 10
- Andrea Lopez**  
Sao Paulo University  
Volunteer Work and Aging: A Comparative Study  
Among American and Brazilian Seniors  
July 30
- Rochona Majumdar**  
University of Chicago  
Women, Property, and Affect in the Hindu Code Bill:  
A Historical Genealogy  
November 25
- Richard Markovits**  
University of Texas  
Two Distortion-Analysis Approaches to Economic-  
Efficiency Analysis: A Third-Best Economically  
Efficient Response to the General Theory of Second  
Best  
May 14
- Jutta Mata**  
Health Literacy: A Representative Study in Nine  
European Countries  
July 21
- Winfried Menninghaus**  
Free University Berlin  
License to Kill? Über Beziehungen von ästhetischer  
Lust und tödlicher Gewalt  
April 15

- Andreas Meyer-Lindenberg**  
Central Institute of Mental Health, Mannheim  
Genetic Dissection of the Human Social Brain  
April 1
- Randolph Nesse**  
Wissenschaftskolleg Berlin  
Runaway Social Selection for Displays of Partner  
Value and Altruism  
January 30
- Karl Newell**  
Pennsylvania State University  
Intra-Individual Variability and Aging: Clues From  
the Motor System  
February 12
- Klaus Oberauer**  
University of Bristol  
Modelling Working Memory  
December 2
- Diemut Ophardt**  
Technical University Berlin  
Klassenmanagement als Kernbereich der Profes-  
sionalität von Lehrkräften an Haupt- und Realschulen:  
Rekonstruktion von Orientierungen und Gestal-  
tungsleistungen  
April 23
- Francesca Orsini**  
School of Oriental and African Studies (SOAS),  
University of London  
Literary Repertoires, Layered Histories and Problem-  
atic Performances: Love in South Asia  
December 16
- Thorsten Pachur**  
University of Basel  
Cognitive Processes in Risky Choice  
April 30
- Gyburg Radke**  
Free University Berlin  
Rational Intuition From a Historical Perspective  
April 9
- Daniel Read**  
London School of Economics  
When You're 64, in Ten Years, on June 1st 2018: The  
Framing of Time and Outcomes in Intertemporal  
Choice  
April 16
- Brent Roberts**  
University of Illinois, Urbana-Champaign  
Contextualizing Personality  
July 17
- Paul Sajda**  
Columbia University, New York  
Integrating EEG and fMRI for Inferring Cortical  
Networks Underlying Rapid Decision Making  
May 22
- Gavriel Salomon**  
University of Haifa  
Education and Technology: Is the Marriage  
Doomed?  
October 16
- Pamela Sammons**  
The School of Education, University of Nottingham  
The Influence of School & Teacher Quality on  
Children's Cognitive and Social Behavioural  
Progress in Primary School: Recent Results From  
EPPE3-11  
April 15
- Michaela Schantl**  
University of Graz  
Knowledge Competence Spaces Underlying Risk  
Comprehension  
September 23
- Michael Schied**  
Film & Television Academy Potsdam-Babelsberg  
Bobby  
May 20  
Mother India  
April 22
- Lisa Schwartz & Steven Woloshin**  
Dartmouth Medical School  
Drug Facts Box  
October 14
- Natalie Sebanz**  
University of Birmingham, UK  
Understanding The Mind Through Joint Action  
January 14
- Vidya Shah**  
Musician, New Delhi  
Concert  
October 10  
Experimental Workshop "Emotions and Music"  
October 7
- Vernon L. Smith**  
George Mason University, Arlington, VA  
Rationality: Constructivist and Ecological Forms  
July 8
- Masanori Takezawa**  
Tilburg University, NL  
Reasons for Fairness: Children's Group Decision  
Making in the Dictator and the Ultimatum Games  
May 28
- Oliver Vitouch**  
University of Klagenfurt  
3% + 3% = 6%? Inducing Cognitive Fallacies in  
Investment Contexts  
October 22
- Allan Wigfield**  
University of Maryland, College Park  
Concept-Oriented Reading Instruction: Improving  
Reading Motivation and Competence  
September 29
- Andreas Wilke**  
Indiana University  
Is the Hot Hand Phenomenon a Cognitive Adapta-  
tion for Clumped Resources?  
May 29
- John Wixted**  
University of California, San Diego  
Scaling Memory  
July 4
- Ludger Wößmann**  
Ludwig Maximilians University Munich  
Was Weber Wrong? A Human Capital Theory of  
Protestant Economic History  
November 25  
Was Weber Wrong? A Human Capital Theory of  
Protestant Economic History  
October 8

- Dietrich Albert**  
University of Graz  
The Competence-Based Knowledge Space Theory  
and Some Considerations on Modelling Judgements  
and Choices  
November 21
- David M. Almeida**  
Pennsylvania State University  
Does Daily Living Wear You Out? Capturing Multiple  
Sources of Variation Between Daily Stressors,  
Diurnal Cortisol, and Health  
July 5
- Morris Altman**  
University of Saskatchewan  
Efficiency Wage Idealism: Does Reciprocity and  
Altruistic Punishment Yield Fair and High Wages?  
December 13
- Aron Barbey**  
Emory University, Atlanta  
Learning Causal Structure From Reasoning  
August 15
- Ellen Bialystok**  
York University, Toronto  
Lifespan Consequences of Bilingualism: Effects on  
Lexical Retrieval and Executive Control  
June 5
- Milo Bianchi**  
Stockholm School of Economics  
Speculative Bubbles Without Stupid Investors  
March 30
- Michael Birnbaum**  
University of California, Fullerton  
Critical Properties for Testing Lexicographic Semi-  
order Models (Including the Priority Heuristic)  
May 21
- Rafal Bogacz**  
University of Bristol  
Models of Optimal Decision Making  
December 12
- Jochen Brandtstädter**  
University of Trier  
Rationality, Wisdom, and Awareness of Life's  
Finitude  
January 12
- Joshua W. Brown**  
Indiana University  
The Role of Medial Prefrontal Cortex in Learned Risk  
Prediction and Aversion  
September 5
- Christian Büchel**  
University Medical Center Hamburg-Eppendorf  
Values, Predictions, and Prediction Errors in the  
Human Brain  
April 25
- Terry Burnham**  
Harvard University  
Caveman Economics: How Charles Darwin Will Help  
Adam Smith  
July 25
- Peter Carruthers**  
University of Maryland, College Park  
An Architecture for Dual Reasoning  
May 7
- Laura Carstensen**  
Stanford University  
The Influence of Shifting Temporal Horizons on  
Human Aging  
November 9  
Life-Span Developmental Trajectories of Motion,  
Emotion, and Cognition  
January 12
- Bernd Ctordecka**  
Max-Planck-Innovation GmbH, Munich  
Connecting Science and Business. Technology  
Transfer: Inventions, Patents, Software, Licences  
November 6
- Ben Eppinger**  
University of Saarbrücken  
A Life-Span View on Learning and Error Processing  
July 16
- Helmut Fend**  
University of Zurich  
Am Anfang standen die Gesamtschule und Reval ...  
December 13
- Julia Fischer**  
University of Göttingen  
Perspectives on Primate Communication  
March 26
- Bruce Fischl**  
Harvard Medical School  
Building Anatomical Model and Linking Micro- and  
Macrostructure With MRI  
May 21
- Alexandra Freund**  
University of Zurich  
Regulating the Incompleteness and Imperfection of  
Life: An Emerging Theory on Sehnsucht  
January 12
- David Funder**  
University of California, Riverside  
Process and Moderators of Accurate Personality  
Judgment  
March 14
- Hans-Peter Füssel**  
Deutsches Institut für Internationale Pädagogische  
Forschung (DIPF), Berlin  
Schulpflicht für alle—ein Abschied in Raten?  
December 13
- Fred Fwu-Tyano Ho**  
National Academy for Educational Research Prepa-  
ratory Office, Taiwan  
Introduction to the Work of the Taiwanese National  
Academy for Educational Preparatory Office (NEAR)  
October 1
- Rocio Garcia-Retamaro**  
Universidad de Granada  
How to Learn Good Cue Orders: When Social Learn-  
ing Benefits Simple Heuristics  
February 14
- Herbert Gintis**  
University of Massachusetts  
Unification of the Behavioral Sciences  
June 4  
Santa Fe Institute  
Altruistic Punishment and Prosocial Emotions  
April 6

**Wayne Gray**

Rensselaer Polytechnic Institute, Troy, NY  
The Soft Constraints Hypothesis: A Rational Analysis Approach to Resource Allocation for Interactive Behavior  
October 24

**Rainer Greifeneder**

University of Mannheim  
Maximizing Versus Satisfying Strategies: Investigating Underlying Processes  
September 4

**Werner Greve**

University of Hildesheim  
The Adaptivity of Adaptability: Adaptation, as Acquired Through Adaptation, is an Adaptation  
July 19  
Erziehung durch Strafe? Probleme und Befunde der Untersuchung von Entwicklungsfolgen von Jugendhaft  
June 12

The Adaptivity of Adaptability: Adaptation, as Acquired Through Adaptation, is an Adaptation  
May 16

**Tobias Großmann**

Birkbeck College, London  
Social Perception in the Infant Brain: Gamma Oscillatory Activity in Response to Eye Gaze  
May 10

**Nathan Hall**

University of California, Irvine  
Control Striving and Development in Higher Education  
May 9–11

**Haim Harari**

Weizmann Institute of Science, Israel  
Education in the Age of Science and Technology: A Crucial Ingredient for Economic Success  
April 12

**Brian Hare**

MPI for Evolutionary Anthropology, Leipzig  
From Non-Human to Human Mind: What Changed and Why?  
February 28

**Hartmut von Hentig**

Laborschule Bielefeld  
Im Gespräch mit Jürgen Baumert  
December 13

**Christopher Hertzog**

Georgia Institute of Technology, Atlanta  
Older Adults' Delayed Retrieval Shift in the Noun-Pair Task: An Associative Deficit, and Much More  
June 20

**Sheena S. Iyengar**

London Business School  
Choice Overload: Consequences, Causes, and Remedies  
March 5

**Ole Jensen**

F. C. Donders Centre for Cognitive Neuroimaging, Nijmegen  
The Role of Occipital Gamma Activity in Humans: From Work Memory to Consolidation  
November 20

**Kristen Kennedy**

Wayne State University, Detroit  
Aging of Brain Structure Across the Adult Lifespan and the Impact on Cognition  
November 22

**Eckhard Klieme**

Deutsches Institut für Internationale Pädagogische Forschung (DIPF), Frankfurt a. M.  
Veränderungen messen und erklären: Schulentwicklung im Längsschnitt  
December 13

**Eric Klinger**

University of Minnesota  
Motivational Structure: Goal Pursuit as Organizational Core for Cognition, Emotion, and Action, and Differences With Age  
February 6

**Jürgen Kocka**

Wissenschaftszentrum Berlin für Sozialforschung  
Chancen und Probleme alternder Gesellschaften  
January 12

**Arthur Kramer**

University of Illinois, Urbana-Champaign  
Cognitive Aging Research: In and Out of the Laboratory  
March 16

**Hermann Lange**

Hamburg, Staatsrat a. D.  
Vom Messen zum Handeln: "Empirische Wende" in der Bildungspolitik?  
December 13

**Hedda Lausberg**

Technical University Dresden  
When We Speak, We Gesture: How Gesture Reflects and Affects Individual and Interactive Cognitive Processes  
May 7

**Stephen Lea**

University of Exeter  
One-Reason Decision-Making in Pigeons?  
June 20

**Jonathan Leland**

National Science Foundation, VA  
Equilibrium Selection, Similarity Judgments and the Nothing to Gain/Nothing to Lose Effect  
June 27

**Richard Lerner**

Tufts University, MA  
Developmental Systems' Theory, Plasticity, and the Promotion of Positive Development Among Adolescents: Recent Findings From the 4-H Study of Positive Youth Development  
August 21

**Volker Lippens**

University of Bielefeld  
Smart Balance Performance Does Facilitate Supra-postural Activity!?  
March 28

**Jennifer Maggs**

Pennsylvania State University  
Assessing Developmental and Situational (Co)Variation in Alcohol Use and Sexual Behavior Across University Using a Measurement Burst Design  
July 4

- Yasumi Matsumoto**  
Waseda University, Tokyo  
Seeking a Realistic Way of Individual Decision Making  
December 7
- Ulrich Mayr**  
University of Oregon  
Neural Responses to Taxation and Voluntary Giving Reveal Motives for Charitable Donations  
September 24
- Gail McKoon**  
Ohio State University  
Aging, IQ, and the Diffusion Model  
June 19
- Marco Monti**  
Bocconi University, Milan  
Cognitive Aspects in the Customer-Financial Advisor Relationships: The Heuristics Value in Banking  
July 26
- Moshe Naveh-Benjamin**  
University of Missouri  
Binding of Memories: An Update on the Associative Deficit Hypothesis of Age-Related Episodic Memory Decline  
March 15
- John Nesselroade**  
University of Virginia  
Another Look at Factorial Invariance and Developmental Change Measurement  
January 12
- Hakan Nilsson**  
Uppsala University  
Why Linda is Not a Bearded Lady Living at the Fringe of Reality: An Ecological Explanation of the Conjunction Fallacy  
December 19
- Elinor Ostrom**  
Indiana University  
The Evolution of Social Norms  
April 6  
The Evolution of Social Norms  
June 4
- Marios Philiastides**  
Columbia University, New York  
Perceptual Decision Making in the Human Brain: From High-Temporal to High-Spatial Characterization  
March 1
- Ype E. Poortinga**  
Tilburg University/University of Leuven  
On the Psychological Organization of Culture  
October 30
- Nilam Ram**  
Pennsylvania State University  
Examining Developmental and Experimental Change: Attempts to Match Method to Theory  
June 13
- Roger Ratcliff**  
Ohio State University  
Diffusion Model Seminar  
June 20
- Tenko Raykov**  
Michigan State University  
A Test for Stability of Measure Specificity in Multi-wave, Multiple-Indicator Models  
October 30
- Naftali Raz**  
Wayne State University, Detroit  
Differential Aging of the Brain: Patterns, Cognitive Correlates and Modifiers  
August 28
- Michel Regenwetter**  
University of Illinois, Urbana-Champaign  
Intransitivity of Preferences  
May 30
- Vincent Reid**  
Durham University  
The Directed Attention Hypothesis of Infant Social Cognition  
August 20
- Karen M. Rodrigue**  
Wayne State University, Detroit  
Aging and Vascular Effects on the Brain in Healthy Adults  
November 21
- Larry Samuelson**  
University of Wisconsin  
The Evolution of Intertemporal Preferences  
June 5
- Hersh Shefrin**  
Santa Clara University, CA  
Lessons From Smart Organizations: Combining Insights From Academia and Practice to Achieve High Performance  
May 16
- Tania Singer**  
University of Zurich  
The Study of Empathy Through the Lense of Neuroscience  
October 30
- Ursula M. Staudinger**  
Jacobs Center on Lifelong Learning and Institutional Development, Bremen  
Persönlichkeitsentwicklung im Erwachsenenalter und Alter: Anpassung und/oder Wachstum?  
February 20
- Niels Taatgen**  
University of Groningen  
The Minimal Control Principle: Fast and Frugal Cognitive Control  
September 27
- Kusumi Takashi**  
Kyoto University  
Adaptive Function of Regret  
August 29
- Masanori Takezawa**  
Tilburg University  
Revisiting the Evolution of Reciprocity in Sizeable Groups  
June 13
- Heinz-Elmar Tenorth**  
Humboldt University Berlin  
Bildungsforschung und Bildungsreform: Illusionen der Nützlichkeit?  
December 13
- Nicolaus Tideman**  
Virginia Tech  
An Economist's Thoughts on Explaining Human Behavior  
March 21

**J. D. Trout**

Loyola University Chicago  
Trading Robustness for Utility: Epistemological  
Aspects of Fast and Frugal Heuristics  
July 25

**Diemo Urbig**

Max Planck Institute for Neurological Research,  
Cologne  
Functional Neuroanatomy of Human Performance  
Monitoring  
November 29  
Humboldt University Berlin  
Entrepreneurial Overconfidence, Optimism, and  
Pessimism: What Enhances Our Profits?  
April 18

**Kirsten Volz**

Max Planck Institute for Neurological Research,  
Cologne  
What Neuroscience Can Contribute to an Under-  
standing of Heuristic Decisional Processes  
January 31

**Jan-Eric Wagenmakers**

University of Amsterdam  
A Diffusion Model Account of the Worst Perfor-  
mance Rule, the Law of Practice, and the Accessory  
Stimulus Effect  
November 26

**Oliver Wolf**

University of Bielefeld  
Stress, Memory, and Aging: Evidence From  
Behavioral and Neuroimaging Studies  
February 21

**Hubert Zimmer**

University of Saarbrücken  
Processing Information Bound in Object and  
Episodic Memory Token  
January 25

## 2. Visiting Researchers 2007–2008

- Kaaren Anstey**  
Australian National University  
July 2008
- Lars Bäckman**  
Karolinska Institute, Stockholm  
February, April, May, June, September, November  
and December 2008
- Boris Baltes**  
Wayne State University, Detroit  
July 2008
- Anton Beguin**  
CITO, Arnhem  
May 2008
- Horst Biedermann**  
University of Fribourg, Switzerland  
February–June 2008
- Fredda Blanchard-Fields**  
Georgia Institute of Technology, Atlanta  
January and June–July 2008
- Steve Boker**  
University of Virginia, Charlottesville  
July 2008
- Yvonne Brehmer**  
Karolinska Institute, Stockholm  
June and December 2008
- Natalie Ebner**  
Yale University  
July 2008
- Peter Federolf**  
University of Calgary  
December 2008
- Michael J. Frank**  
University of Arizona  
July 2008
- Alexandra Freund**  
University of Zurich  
September 2008–January 2009
- Denis Gerstorff**  
Pennsylvania State University  
June–August 2008
- Paolo Ghisletta**  
University of Geneva  
January and October 2008
- Sandra Gordon-Salant**  
University of Maryland, College Park  
July 2008
- Adam Hahn**  
University of Colorado, Boulder  
June–July 2008
- Christopher Hertzog**  
Georgia Institute of Technology, Atlanta  
June–July 2008
- Ingmar Hosenfeld**  
University of Landau  
March 2008
- Derek Isaakovitz**  
Brandeis University, Waltham  
January 2008
- Torkel Klingberg**  
Karolinska Institute, Stockholm  
January 2008
- Karen Li**  
Concordia University, Montreal  
July 2008
- Mary Lunn**  
Oxford University  
January and October 2008
- Claudia Mähler**  
University of Hildesheim  
January 2008
- Rochona Majumdar**  
University of Chicago  
October–December 2008
- Herbert W. Marsh**  
Oxford University  
July–August 2008
- Jack McArdle**  
University of Southern California  
September 2008
- Karl Newell**  
Pennsylvania State University  
February 2008
- Philipp Nielsen**  
Yale University  
October 2008–January 2009
- Klaus Oberauer**  
University of Bristol  
September 2008–January 2009
- Fritz Oser**  
University of Fribourg, Switzerland  
April 2008
- Ann Pearman**  
Georgia Institute of Technology, Atlanta  
July 2008
- Patrick Rabbitt**  
Oxford University  
January and October 2008
- Nilam Ram**  
Pennsylvania State University  
June–August 2008
- Hermann Rampacher**  
Wissenschaftszentrum Bonn  
November 2008
- Naftali Raz**  
Wayne State University, Detroit  
February, June–August, September, December 2008
- Michel Regenwetter**  
University of Illinois, Urbana-Champaign  
August 2008–August 2009
- Brent Roberts**  
University of Illinois, Urbana-Champaign  
July 2008
- Pamela Sammons**  
The School of Education, University of Nottingham  
April 2008
- Susanne Scheibe**  
Stanford University  
January 2008
- Richard Shavelson**  
Stanford University  
January–February 2008
- Hester Vaizey**  
University of Cambridge  
October 2008–February 2009
- Helena Westerberg**  
Cogmed, Sweden  
January 2008

**Allan Wigfield**  
University of Maryland, College Park  
September 2008  
**Andreas Wilke**  
Indiana University  
May–December 2008

**Marjorie Woollacott**  
University of Oregon  
May, July and September 2008

2008

**David Almeida**  
Pennsylvania State University  
July 2007  
**Lars Bäckman**  
Karolinska Institute, Stockholm  
July, November and December 2007  
**Franz Baeriswyl**  
University of Fribourg, Switzerland  
April 2007  
**Boris Baltes**  
Wayne State University, Detroit  
May 2007  
**Ellen Bialystok**  
York University, Toronto  
June 2007  
**Fredda Blanchard-Fields**  
Georgia Institute of Technology, Atlanta  
July–August 2007  
**Yvonne Brehmer**  
Karolinska Institute, Stockholm  
May 2007  
**Steve Boker**  
University of Virginia, Charlottesville  
June 2007  
**Ruth Butler**  
Hebrew University of Jerusalem, School of  
Education  
August 2007  
**Peter Federolf**  
University of Calgary  
March and May 2007  
**Fred Fwu-Tyano Ho**  
National Academy for Educational Research  
Preparatory Office, Taipei  
October 2007  
**Denis Gerstorff**  
Pennsylvania State University  
March–April and May–July 2007  
**Paolo Ghisletta**  
University of Geneva  
June 2007  
**Richard Gonzalez**  
University of Michigan, Ann Arbor  
August 2007  
**Werner Greve**  
University of Hildesheim  
April–August 2007  
**Nathan C. Hall**  
University of California, Irvine  
May 2007  
**Christopher Hertzog**  
Georgia Institute of Technology, Atlanta  
June–July 2007  
**Kristin Kennedy**  
Wayne State University, Detroit  
November 2007

**Daniel Koretz**  
Harvard Graduate School of Education, Cambridge  
July 2007  
**Arthur Kramer**  
University of Illinois, Urbana-Champaign  
March 2007  
**Richard Lerner**  
Tufts University, MA  
August 2007  
**Jennifer Maggs**  
Pennsylvania State University  
July 2007  
**Herbert W. Marsh**  
Oxford University  
June–July and November–December 2007  
**Andrew Martin**  
University of Sydney  
November 2007  
**Jack McArdle**  
University of Southern California  
August–September 2007  
**Gail McKoon**  
Ohio State University  
June 2007  
**Jens Möller**  
University of Kiel  
November 2007  
**Benno Nigg**  
University of Calgary  
March 2007  
**Alois Niggli**  
Pädagogische Hochschule Fribourg, Switzerland  
June 2007  
**Denise Park**  
University of Illinois, Urbana-Champaign  
April–May 2007  
**Ann Pearman**  
Georgia Institute of Technology, Atlanta  
June 2007  
**Ype H. Poortinga**  
Tilburg University/University of Leuven  
October 2007  
**Nilam Ram**  
Pennsylvania State University  
January–July 2007  
**Roger Ratcliff**  
Ohio State University  
June 07  
**Tenko Raykov**  
Michigan State University  
October 2007  
**Naftali Raz**  
Wayne State University, Detroit  
February and June–August 2007  
**Michel Regenwetter**  
University of Illinois, Urbana-Champaign  
May–June 2007

2007

2007

**Karen Rodrigue**  
Wayne State University, Detroit  
November 2007

**Tania Singer**  
University of Zurich  
October 2007

**Jacqui Smith**  
University of Michigan  
May 2007

**Ursula M. Staudinger**  
Jacobs University Bremen  
February 2007

**Elliot Tucker-Drob**  
University of Virginia, Charlottesville  
May–July 2007

**Jürgen Wiechmann**  
University of Koblenz–Landau  
January 2007

**Andreas Wilke**  
Indiana University  
May 2007

**Hubert Zimmer**  
Saarland University  
January 2007

### 3. Other Professional Activities 2007–2008

- Jürgen Baumert**
- Max Planck Society (Vice-President, Human Sciences Section).
  - Jacobs Foundation, Zurich, Switzerland (Member of Board of Trustees).
  - Institute for Educational Progress, Humboldt University Berlin (Member of Board of Trustees).
  - Research Program "Professional Minds of Teachers: On the Development of Standards for Vocational Teachers," University of Fribourg, Switzerland (Member of Advisory Board).
  - Quality Agency of the State Institute of School Education and Educational Research (ISB), Munich (Member of Board of Scientific Advisers).
  - University of Twente, Institute for Behavioral Research (IBR) (Member of Board of Trustees).
  - Action Program "New Paths in Teacher Training," Founders' Association of German Science, Bonn (Member of Board of Scientific Advisers).
  - Leibniz Association (Member of Senate and Evaluation Committee).
  - Internationale Grundschul-Lese-Untersuchung (IGLU)/Progress in International Reading Literacy Study (PIRLS) (Member of Advisory Board).
  - Center for Research on Learning and Instruction, University of Erfurt (Member of Advisory Board).
  - Psychologie in Erziehung und Unterricht (Member of Advisory Board).
  - Schweizerische Zeitschrift für Bildungswissenschaften (Member of Advisory Board).
  - Zeitschrift für Erziehungswissenschaft (Coeditor).
  - Zeitschrift für Pädagogische Psychologie (Member of Advisory Board).
  - Center for School Research and Questions of Teacher Education, Martin Luther University Halle-Wittenberg (Member of Advisory Board).
  - Waxmann Verlag, Reihe Pädagogische Psychologie und Entwicklungspsychologie (Member of Advisory Board).
  - Zeitschrift für Unterrichtswissenschaft (Coeditor).
  - Jacobs Center on Lifelong Learning and Institutional Development (JCLL), Jacobs University Bremen (Member of Advisory Board).
  - European Science Foundation, Strasbourg (Member of Pedagogical and Educational Research Expert Panel).
  - University of Kassel (Member of University Council).
  - "Bürger Netzwerk Bildung" (Member of Advisory Board).
  - State Institute for School Quality in Berlin und Brandenburg (ISQ) (Member of Advisory Board).
  - Expert Committee to Assess Teacher Training in North Rhine-Westphalia (Chair).
  - International Academy of Education (Fellow).
  - Carnegie Foundation for the Advancement of Teaching (Member of Board of Trustees).
  - "Haus der kleinen Forscher" (McKinsey) (Member of Advisory Board).
  - "School Reform and Beyond" (David L. Featherman) (Member of Advisory Board).
  - Dahlem Conferences (Member of Advisory Board).
- Nathan Berg**
- Journal of Socio-Economics (Editorial Board).
  - Global Business Economics Review (Member of Advisory Board).
  - Society for the Advancement of Behavioral Economics (Member of Board).
  - European Science Foundation (Member of Program Review Committee).
- Henry Brighton**
- The First Conference on Artificial General Intelligence (AGI-08) (Member of Program Committee).
- Wolfgang Edelstein**
- Institut für angewandte Familien-, Kindheits- und Jugendforschung e. V., Potsdam (Member of Board of Scientific Advisers).
  - Irmgard-Coninx-Stiftung (Member of Advisory Council).
  - Yehudi Menuhin Stiftung Deutschland (Member of Board of Trustees).
  - Deutsche Gesellschaft für Demokratiepädagogik (German Association for Democratic Education) (President).
  - Akademie für Bildungsreform (Member).
  - Buddy e. V. (Member of Board of Advisers).
  - New Directions for Youth Development, New York (Member of Editorial Board).
  - Entwicklungswissenschaft. Biopsychosoziale Forschung und Anwendung (Member of Board of Advisers).

- Ursula Flitner**
- German Special Library Association (ASpB), Section 5 of the German Library Association (DBV) (Deputy Chair).
  - Member of the Board of "Bibliothek & Information Deutschland" (BID), the Umbrella Organization of the Library Institutional and Personnel Associations, the Information Science Societies, F3 Central Bodies for the Promotion of Cultural Affairs in Germany.
- Ute Frevert**
- Akademie der Naturforscher Leopoldina, Sektion Kulturwissenschaften (Advisory Board).
  - Arbeitskreis für moderne Sozialgeschichte (Advisory Board).
  - Dahlem Conferences (Advisory Board).
  - Einstein Forum (Advisory Board).
  - European Studies Review (Editorial Board).
  - Free University Berlin (Honorary Professor of History).
  - Geschichte und Gesellschaft (Managing Director and Member of the Editorial Board).
  - International Institute of Social History, Amsterdam (Advisory Board).
  - Institut für die Wissenschaften vom Menschen, Vienna (Advisory Board).
  - Jacobs University Bremen (Advisory Board).
  - Journal of Contemporary History (Editorial Board).
  - Journal of Modern History (Editorial Board).
  - Kurt-A.-Körber-Stiftung–Geschichtswettbewerb des Bundespräsidenten (Advisory Board).
  - Zentrum für Interdisziplinäre Forschung, University of Bielefeld (Advisory Board).
  - Zentrum für Zeithistorische Forschung, Potsdam (Advisory Board).
  - Zukunftskolleg University of Konstanz (Advisory Board).
- Gerd Gigerenzer**
- Berlin-Brandenburgische Akademie der Wissenschaften (Member).
  - Deutsche Akademie der Naturforscher Leopoldina (Fellow).
  - Theory and Psychology (Coeditor).
  - Journal of Behavioral Decision Making (Editorial Board).
  - Evolution and Human Behavior (Editorial Board).
  - Summer Institute on Bounded Rationality in Psychology and Economics (Codirector).
  - British Medical Journal (Member of Advisory Committee).
  - Organizational Behavior and Human Decision Process (Editorial Board).
  - Bundesinstitut für Risikobewertung, Germany (Advisory Board).
  - European Society for Philosophy and Psychology (ESPP) (Advisory Board).
  - Psychological Inquiry (Editorial Board).
  - Frankfurt Institute for Advanced Studies Forum (Advisory Board).
- Axinja Hachfeld (Kalusche)**
- Max Planck PhDNet (Section Representative of the Humanities).
- Hauke R. Heekeren**
- Acta Neuropsychiatrica (Editorial Board).
  - Frontiers in Human Neuroscience (Editorial Board).
  - Max Planck Society (Speaker of the section's IJRG leaders).
- Konstantinos V. Katsikopoulos**
- IEEE Transactions on Systems, Man, and Cybernetics (Associate Editor).
- Monika Keller**
- Erwägen, Wissen, Ethik (Editorial Board).
  - European Developmental Science (Editorial Board).
  - Jean Piaget Society (Ex-Officio Member of Board of Directors).
- Shu-Chen Li**
- Neuroscience and Biobehavioral Reviews (Board of Consulting Editors).
  - Psychology and Aging (Board of Consulting Editors).
  - Brain Research Center, School of Computer Science, National Chiao-Tung University, Taiwan (International Collaborative Faculty).
  - International Max Planck Research Network on Aging (Deputy Director).
  - Max Planck Society (Institute Scientific Staff Representative in the Human Sciences Section).

Ulman Lindenberger	<ul style="list-style-type: none"> <li>- European Journal of Developmental Science (Member of Editorial Board).</li> <li>- Centre for Population Studies (CPS), Umea University, Sweden (Member of the Board of Ageing and Living Conditions Programme, ALC).</li> <li>- Margret M. and Paul B. Baltes Foundation for the Advancement of Research in Developmental Psychology and Gerontology (Member of the Board).</li> <li>- Nordic Centre in Cognitive Control (Member of the Scientific Advisory Board).</li> <li>- Gerontological Society of America (Fellow).</li> <li>- Wilhelm-Wundt-Gesellschaft (Member).</li> <li>- Alexander-von-Humboldt-Stiftung (Member and Selection Committee for Humboldt Research Awards).</li> <li>- German Academy of Sciences Leopoldina (Member of Section 26 "Psychology and Cognitive Sciences").</li> <li>- Akademiengruppe Altern: Opportunities and Problems of an Aging Society: The World of Work and Lifelong Learning, launched together by the German Academy of Sciences Leopoldina and acatech-Council for Engineering Sciences at the Union of the German Academies of Science and Humanities (Member of Working Group on Aging).</li> <li>- Psychology and Aging (Member of Editorial Board).</li> <li>- Aging, Neuropsychology, and Cognition (Member of Editorial Board).</li> <li>- International Journal of Behavioral Development (Member of Editorial Board).</li> <li>- Gerontology: Regenerative and Technological Science Section (Member of Editorial Board).</li> <li>- GeroPsych – The Journal of Gerontopsychology and Geriatric Psychiatry (Member of Editorial Board).</li> <li>- German Research Foundation (DFG), Review Board (Fachkollegium) 110 "Psychology," Sub-Division 110-02 "Developmental Psychology and Educational Psychology" (Member of Review Board).</li> <li>- International Society for the Study of Behavioural Development (ISSBD) (Member of Executive Committee).</li> <li>- Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie (Member of Advisory Board).</li> <li>- German Institute for International Educational Research (DIPF), Frankfurt a.M. (Member of Scientific Advisory Board).</li> <li>- Interdisciplinary Wolfgang Köhler Research Centre on Conflicts in Intelligent Systems, Humboldt University Berlin (Member of Scientific Board).</li> <li>- Rotman Research Institute, Toronto, Canada (Member of External Review Team).</li> <li>- Ontario Brain Initiative, Toronto, Canada (Member of the International Scientific Advisory Board).</li> </ul>
Nele McElvany	<ul style="list-style-type: none"> <li>- European Conference on Reading (Member of Program and Organization Committee).</li> <li>- German Society for Reading and Writing (Member of Management Board).</li> </ul>
Margrit Pernau	<ul style="list-style-type: none"> <li>- Concepta (International Research School in Conceptual History and Political Thought) (Advisory Board).</li> <li>- Geschichte und Gesellschaft, Journal of History Social Sciences (Editorial Board).</li> </ul>
Lael J. Schooler	<ul style="list-style-type: none"> <li>- 19th International Congress of Psychology. Organizing a series of controversial debates for the ICP (Member of Scientific Committee).</li> <li>- Frankfurt Institute for Advanced Studies Forum (Member of Program Advisory Committee).</li> <li>- Berlin Graduate School of Mind and Brain (Member of Curriculum Committee).</li> <li>- International Conference on Cognitive Modeling (Member of Program Committee).</li> </ul>

## 4. Academic Degrees 2007–2008

### Habilitations

Hardy, I. (2007). Die Bedeutung der kognitiven Strukturierung von Lernumgebungen für die Förderung mathematisch-naturwissenschaftlicher Verständnisprozesse. Free University Berlin.

Kunter, M. (2008). Motivation als Teil professioneller Kompetenz von Lehrkräften. Free University Berlin.

Lüdtko, O. (2007). Methodische und statistische Aspekte der Erfassung von schulischen Kontextmerkmalen: Grundlagen und Anwendungen. Free University Berlin.

Maaz, K. (2008). Soziale Ungleichheit im Bildungssystem: Die Analyse von Bildungsentscheidungen vor dem Hintergrund individueller Entscheidungsmechanismen und struktureller Rahmenbedingungen des Bildungssystems. Free University Berlin.

Pernau, M. (2007). Bürger mit Turban: Muslime in Delhi im 19. Jahrhundert. University of Bielefeld.

### Doctoral Dissertations

Barton, A. (2008). Probabilities in the Everett interpretation of quantum mechanics. Paris 1 Panthéon-Sorbonne.

Becker, M. (2008). Kognitive Leistungsentwicklung in differenziellen Lernumwelten: Effekte des gegliederten Sekundarschulsystems in Deutschland. Free University Berlin.

Gaissmaier, W. (2007). The mnemonic decision maker: How search in memory shapes decision making. Free University Berlin.

von Helversen, B. (2008). Quantitative estimation from multiple cues: Test and application of a new cognitive model. Humboldt University Berlin.

Husemann, N. (2007). Stability and change in life goals in the transition from school to work: Selection, environmental fit, and socialization processes. Free University Berlin.

Huxhold, O. (2007). Processing fluctuations in postural control: Relations to adult age and fluctuations in cognition. Free University Berlin.

Kleinspehn-Ammerlahn, A. (2008). Goal-directed interpersonal action synchronization across the lifespan: A dyadic drumming study. Free University Berlin.

Klusmann, U. (2008). Berufliches Beanspruchungserleben und Unterrichtsverhalten von Lehrkräften: Zur Rolle persönlicher und institutioneller Ressourcen. Free University Berlin.

Köllner, M. (2008). Konstruktion und Implementierung von Schulprogrammen: Ein triangulativer Forschungsansatz. Humboldt University Berlin.

Kotter-Grühn, D. (2008). Development and functionality of life longings: The case of involuntary childlessness. Free University Berlin.

Kuhl, P. (2008). Family matters: A longitudinal study on within-family associations between family context and adjustment in adolescence. Free University Berlin.

Mata, J. (2008). Healthy food choice: How environment and cognition determine what we eat. Humboldt University Berlin.

Mériaux, K. (2007). The influence of individual differences on neural correlates of emotional and cognitive information process. Humboldt University Berlin.

Müller, A. G. (2007). Aspekte schulbezogener Sprache als Barriere für schulischen Erfolg von Schülerinnen und Schülern deutscher und nichtdeutscher Herkunftssprache. Free University Berlin.

Neumeyer-Gromen, A. (2008). Historical cohort study about Diesel motor emissions and lung cancer mortality in potash mining: Second follow-up and validation study. University of Bielefeld.

Prehn, K. (2008). Interaction of cognition and emotion in information processing in social contexts with special consideration given to moral judgment. Humboldt University Berlin.

Preuschhof, C. (2008). The neural correlates of human vibrotactile working memory: Converging evidence from functional magnetic resonance imaging, electroencephalographic and behavioral studies. Humboldt University Berlin.

Rauers, A. (2008). Interactive expertise and dyadic common ground in younger and older couples. Free University Berlin.

Scheibehenne, B. (2008). The effect of having too much choice. Humboldt University Berlin.

Shing, Y. L. (2008). Dynamics of episodic memory: interaction between associative and strategic components. Humboldt University Berlin.

Tsai, Y.-M. (2008). Motivation in context: Intraindividual variability in day-to-day classroom learning. Humboldt University Berlin.

Wegwarth, O. (2007). Deciding the fast and frugal way on the application of pharmacodiagnostic tests in cancer care? A comparative study of oncologists', pathologists', and cancer patients' decision making in Germany and the USA. Humboldt University Berlin.

## Master's and Diploma Theses

Bache, C. (2008). The role of maternal affect attunement in triadic communication. Humboldt University Berlin.

Blumensath, S. (2007). Modulation of gamma-band activity by stimulus size in the EEG of children and young adults: An age-comparative study. Free University Berlin.

Böhnke, A. (2008). Prozesse erfolgreicher Partnerschaftsentwicklung: Kinderwunsch und dyadische Zielrealisierung im Kontext des SOK-Modells. Free University Berlin.

Fandakova, Y. (2008). Associative and strategic components of episodic memory across the lifespan: An application of latent growth models. Humboldt University Berlin.

Graef, S. (2008). The role of dopamine in reward based learning. University of Freiburg.

Graf, J. (2008). Autonomy and well-being in Korea and Germany: A cross-cultural comparison of middle school students. Humboldt University Berlin.

Kortenbruck, M. (2007). Development of reading literacy: Effects of motivation and gender. Free University Berlin.

Krauskopf, K. (2008). Surface and deeper level characteristics of instruction: Influence of nonverbally expressive teaching and content importance on motivation and performance. Humboldt University Berlin.

Meisdrock, C. (2007). Studienverlaufsanalysen des Abiturjahrgangs 2002: Der Einfluss der sozialen Herkunft auf den Studienabbruch unter Berücksichtigung der Studiendauer. University of Potsdam.

Milek, A. (2008). Referenzgruppeneffekte beim Übergang von der Grundschule in die Sekundarstufe I: Eine mehrbenenanalytische Untersuchung. Free University Berlin.

Pannier, V. (2007). Selbstaufmerksamkeit bei Lehrkräften: Ressource oder Risikofaktor im Kontext des beruflichen Beanspruchungserlebens? Free University Berlin.

Rjosk, C. (2007). Teachers' diagnostic competencies: Judgments of basic reading skills in students with and without immigrant background. Free University Berlin.

Sander, M. (2007). Binding deficits in visual processing in older adults: An investigation of gamma band modulation. Humboldt University Berlin.

Wolff, J. (2007). Mood and mood fluctuation of younger and older adults. Friedrich Schiller University Jena.

## 5. Research and Professional Staff 2007–2008

**Anders (Grabbe), Yvonne** (Diploma in Psychology, 2001, University of Münster; Dr. phil. in Psychology, 2003, University of Münster): Research in instruction and learning; teacher-based assessment of student achievement; effective preschool education and educational outcomes; job demands and stress of teachers.

**Assmann, Wolfgang** (Head of Information Processing Center): Service management in research institutions; information technology in the social and behavioral sciences.

**Baumert, Jürgen** (State Examination for Teachers, 1968, Hamburg; Dr. phil., 1968, University of Tübingen; Habilitation in Educational Sciences, 1982, Free University Berlin; Fellow of the Max Planck Society; Co-director of the Institute; Professor of Educational Sciences, Free University Berlin and Humboldt University Berlin; Vice President of the Max Planck Society): Research in teaching and learning; cultural comparisons, large-scale assessment, cognitive and motivational development in adolescence.

**Baumgarten, Jürgen** (Dr. phil. in German Language and Literature, 1973, Free University Berlin; Former Head of Editorial and Public Relations Department): Prehistory of the Middle East; neolithization; nomadic cultures.

**Becker, Michael** (Diploma in Psychology, 2004, Free University Berlin; Dr. phil. in Psychology, 2008, Free University Berlin): Cognitive development; changes in educational systems; quantitative methods in social sciences.

**Berg, Nathan** (B.A. in American Studies, 1995, University of Kansas; M.A. in Mathematics, 2001, University of Kansas; PhD in Economics, 2001, University of Kansas): Behavioral economics; demographic economics; less-is-more effects in decision making and estimation; social heuristics.

**Bodammer, Nils** (Dr. rer. nat. in Physics, 2005, University of Magdeburg): Quantitative magnetic resonance imaging of the human brain; functional magnetic resonance imaging; development of algorithms for MRI data processing.

**Brighton, Henry** (B.Sc. [Hons] in Artificial Intelligence and Computer Science, 1996, University of Edinburgh, UK; M.Sc. in Cognitive Science, 1997, University of Edinburgh, UK; PhD in Cognitive Science, 2003, University of Edinburgh, UK): Cognitive-ecological approaches to artificial intelligence; inductive inference in humans and machines; evolutionary linguistics.

**Czienskowski, Uwe** (Dr. phil. in Psychology, 1995, Free University Berlin; Scientific Programmer): Scientific software development (resource distribution in social networks; feature-pattern-analysis; computer-based scientific research); modeling and simulation; self-reference effect; meta-analysis; experimental design and analysis; philosophy of psychology (mind & consciousness).

**Delius, Julia A. M.** (Dr. med. in Medicine, 1993, University of Frankfurt a.M.): Interdisciplinary gerontology in the context of the Berlin Aging Study (BASE); BASE Website design and management; editorial projects.

**Eitler, Pascal** (M.A. in History, 2001, University of Bielefeld and EHESS Paris): Human-animal relationship in modern history; body history of the 19th and 20th century; history of religion in West Germany.

**Elsner, Jürgen** (Diploma in Mathematics, 1966, Georgia Augusta University, Göttingen; Dr. rer. nat. in Mathematics, 1969, Georgia Augusta University, Göttingen; Habilitation in Mathematics, 1977, Christian Albrecht University Kiel): Cultural comparisons in mathematics with students and teachers.

**Engelhardt, Nicole** (M.A. in Cultural Anthropology, 2001, University of Cologne; Wissenschaftliche Dokumentarin/Information Specialist, Fachhochschule Potsdam, 2003; Subject Librarian): Scientific electronic information systems, classification, bibliometrics.

**Fific, Mario** (Joint PhD in Cognitive Psychology and Cognitive Science, with Certificate in Mathematical Modeling): Development of a general information processing model of human cognition; memory and visual search, classification, and judgment and decision making; computational modeling of reaction time and choice probabilities.

**Flitner, Ursula** (M.A. in American Studies and German Literature, 1991, Free University Berlin; State Examination in Library and Information Science, 1995, Senatsverwaltung für Kulturelle Angelegenheiten Berlin/Cologne; Head of the Library and Research Information Unit): Information management; electronic resources and networked information systems; human resources development.

**Fox-Kuchenbecker, Petra** (Dr. rer. nat. in Biology, 1995, Humboldt University Berlin; Public Relations Specialist, 2003, PR Kolleg Berlin; Head of Public Relations Department): Integrated communications; scientific communication with the media and the lay public.

**Frevert, Ute** (Dr. phil. in History, 1982, University of Bielefeld; Habilitation in Modern History, 1989, University of Bielefeld; Scientific Member of the Max Planck Society; Co-director of the Institute; Hon. Professor of History, Free University Berlin): Social and cultural history of modern times; gender history; political history.

**Gaissmaier, Wolfgang** (Diploma in Psychology, 2002, Free University Berlin): Memory-based decision making; modeling and predicting voting behavior; simple heuristics underlying intuitions; medical decision making.

**Galesic, Mirta** (PhD in Psychology, 2004, University of Zagreb; M.Sc. in Survey Methodology, 2005, Joint Program in Survey Methodology, University of Maryland/University of Michigan): Judgment and decision

making; sampling approaches to cognition; risk communication; survey methodology.

**Gammerl, Benno** (M.A. in Cultural History, 2000, University of London; M.A. in History, 2003, Free University Berlin; PhD in Modern History, 2008, Free University Berlin): Imperial history; citizenship and nationality; contemporary history of homosexuality in Germany.

**Gigerenzer, Gerd** (Dr. phil. in Psychology, 1977, University of Munich; Habilitation in Psychology, 1982, University of Munich; Fellow of the Max Planck Society; Co-director of the Institute; Professor of Psychology, Free University Berlin): Models of bounded rationality; social intelligence; ecological rationality; heuristics of scientific discovery; philosophy, history, and methodology of social sciences.

**Hardy, Ilonca** (PhD in Educational Psychology, 1998, University of Iowa; Habilitation in Psychology, 2007, Free University Berlin): Learning environments incorporating the social character of cognition (emphasis: collaborative learning); the role of language in problem solving; effects and uses of external representations.

**Heekeren, Hauke R.** (Dr. Med., 2000, Humboldt University Berlin; License for the practice of medicine, 2000; Head of Independent Junior Research Group, 2005; Professor of Affective Neuroscience and Psychology of Emotion, Free University Berlin, 2009): Neurobiology of perceptual decision making; motivation and affect in decision making; cognitive and affective components in normal and disturbed social cognition; multimodal neuroimaging.

**Hitzer, Bettina** (First State Examination in History and French, 1999, Free University Berlin; Dr. phil. in History 2004, University of Bielefeld): Body and fear: A 20th century obsession; history of emotions, history of migration, history of religion, history of medicine.

**Husemann, Nicole** (Diploma in Psychology, 2004, University of Bielefeld; Dr. phil. in Psychology, 2007, Free University Berlin): Research in teaching and education; personal goals; academic cheating.

**Katsikopoulos, Konstantinos V.** (PhD in Industrial Engineering, 1999, University of Massachusetts, Amherst): Theory: Mathematical models of bounded and ecological rationality. Applications: Business decision making, behavioral economics, engineering design.

**Keller, Monika** (Dr. phil. in Psychology, 1974, University of Heidelberg; Habilitation in Psychology, 1996, Free University Berlin; Professor of Psychology, Free University Berlin): Understanding of relationships, moral development, and moral emotions in cultural context; social rationality: interconnecting moral psychology with behavioral game theory; social perspective taking, theory of mind, and domains of social and moral reasoning; social and moral competence in education.

**Klusmann, Uta** (Diploma in Psychology, 2004, Free University Berlin; Dr. phil. in Psychology, Free University Berlin): Research in teachers' occupational

well-being and health; teacher education; research in instruction and learning.

**Krauss, Stefan** (First State Examination in Mathematics and Physics, 1995, University of Erlangen-Nuremberg; Dr. phil. in Psychology, 2001, Free University Berlin): Research on teaching and learning; didactics of mathematics, especially didactics of statistics; probabilistic reasoning (Bayesian inferences).

**Kruse, Imke** (Dr. phil. in Political Science, 2005, Free University Berlin; Research Manager, Center for Lifespan Psychology; LIFE Program Manager): Aging policy for elderly migrants in Europe; asylum and migration policies.

**Kunter, Mareike** (Diploma in Psychology, 1999, Julius Maximilians University Würzburg; Dr. phil. in Psychology, 2004, Free University Berlin; Habilitation in Psychology, 2008, Free University Berlin): Research in instruction and learning; teacher research; multiple educational objectives; motivational processes in the classroom; assessment of instructional processes.

**Kurz-Milcke, Elke M.** (PhD in Psychology, 1997, Bowling Green State University, Ohio).

**Li, Shu-Chen** (PhD in Psychology, 1994, University of Oklahoma; Habilitation in Psychology, 2006, Free University Berlin; Professor of Psychology, 2008, Free University Berlin): Behavioral and neurocognitive development across the lifespan; neuromodulation of cognition; neurocomputational and formal modeling of lifespan cognition; ontogeny of brain-body-world interactive dynamics; neuroeconomics and aging; biocultural co-construction of development.

**Lindenberger, Ulman** (Dr. phil. in Psychology, 1990, Free University Berlin; Habilitation in Psychology, 1998, Free University Berlin; Fellow of the Max Planck Society; Co-director of the Institute; Professor of Psychology, Saarland University; Professor of Psychology, Free University Berlin; Professor of Psychology, Humboldt University Berlin): Lifespan psychology: theories and methods; behavioral plasticity and its neural correlates in childhood and old age; sensorimotor and cognitive development; multivariate measurement of change and variability.

**Lövdén, Martin** (B.A. in Psychology, 1998, Lund University; PhD in Psychology, 2002, Stockholm University): Lifespan development; cognitive neuroscience of aging; behavioral and neural plasticity; cognitive control; episodic memory; spatial navigation; sensorimotor-cognition couplings; methods for studying individual change.

**Lüdtke, Oliver** (Diploma in Psychology, 2000, Free University Berlin; Dr. phil. in Psychology, 2004, Free University Berlin; Habilitation in Psychology, 2007, Free University Berlin): Research in teaching and learning; quantitative methods in empirical research; personal goals.

**Maaz, Kai** (Diploma in Education [FH], 1998, Catholic University of Applied Sciences Berlin; Diploma in Social Sciences, 2002, Humboldt University Berlin; Dr. phil. in Educational Science, 2006, Free University

- Berlin; Habilitation in Educational Science, 2008, Free University Berlin): Transition from school to university and work; social background and educational and vocational chances; social inequality and educational decisions.
- McElvany, Nele** (Diploma in Psychology, 2001, Free University Berlin; Dr. phil. in Psychology, 2006, Free University Berlin): Research in instruction and learning; reading literacy; teacher research; influences of family background on achievement.
- Michl, Susanne** (M.A. in Neuere Geschichte, University of Tübingen, 2002; Maîtrise, Histoire, Université de Provence, Aix-en-Provence, 2002; Dr. phil. in Neuere Geschichte, University of Tübingen, 2006): History of medicine; war and medicine; colonial history.
- Mueller, Viktor** (Dr. rer. soc., 1996, University of Tübingen): Lifespan psychology and aging mechanisms; psychophysiology of social interactions; complexity and brain dynamics; cortical synchronization: local and global networks.
- Nagy, Gabriel** (Diploma in Psychology, 2002, Free University Berlin; Dr. phil. in Psychology, 2006, Free University Berlin): Transition from school to university and work; determinants of success in tertiary education; cognitive and motivational development; measurement and assessment; quantitative research methods.
- Nelson, Jonathan D.** (B.A. in Cognitive Science and Statistics, 1998, Wheaton College; M.S. in Cognitive Science, 2002, University of California, San Diego; PhD in Cognitive Science, University of California, San Diego, 2005): Statistical foundations of active visual perception: eye movements as hypothesis testing (eye movement experiments); neural bases of the value of information for categorization (fMRI experiments); use of optimal experimental design principles to design informative behavioral experiments, to characterize the intuitive value of information; communicative pragmatics of biases (base rate neglect, conservatism) in Bayesian inference; effective communication of probabilities using experience-based learning and natural sampling; characterization of helpful and unhelpful strategies for teaching by examples; Bayesian modeling of learning on probabilistic and deterministic categorization tasks.
- von Oertzen, Timo** (Diploma in Computer Science, 1999, Saarland University; PhD in Computer Science, 2003, Saarland University): Mathematical psychology; algorithms in psychology; statistical modeling; formal modeling.
- Olsson, Henrik** (PhD in Psychology, 2000, Uppsala University): Computational modeling; judgment and decision making; categorization, estimation, and causal learning; adaptiveness of cognitive mechanisms to environmental structures; working memory capacity.
- Pernau, Margrit** (Dr. phil. in Modern History, 1991, University of Heidelberg; Habilitation, 2007, University of Bielefeld): Indian history, 18th–20th centuries; history of modern Islam; historical semantics, comparative studies, and translation studies.
- Plamper, Jan** (B.A. in History, 1992, Brandeis University; PhD in History, 2001, University of California, Berkeley; Dilthey Fellow [Fritz Thyssen Foundation], 11/2008–11/2012): Russian history, 19th–20th centuries.
- Riediger, Michaela** (Diploma in Psychology, 1997, Humboldt University Berlin; PhD in Psychology, 2001, Free University Berlin): Lifespan changes in the interplay of motivation, affect, and social cognition; future-orientation, motivation, and volition; emotion and emotion regulation; social aspects of motivational and affective processes.
- Rieskamp, Jörg** (Diploma in Psychology, 1998, Technical University Berlin; Dr. phil. in Psychology, 2001, Free University Berlin): Cognitive modeling of judgment and decision making; the role of learning in decision making; experimental examinations and evolutionary simulations of simple strategies for social interactions.
- Scheer, Monique** (B.A. in History, 1989, Stanford University; M.A. in Empirischer Kulturwissenschaft und Religionswissenschaft, 2000, University of Tübingen; Dr. rer. soc. in Empirischer Kulturwissenschaft, 2005, University of Tübingen): Emotions and religious experience; Catholic piety, vision cults; history of anthropology; history of perception, experience.
- Schmidt, Anne** (PhD in Modern History, 2004, University of Bielefeld): History of advertising and marketing.
- Schmiedek, Florian** (Diploma in Psychology, 2000, University of Mannheim; PhD in Psychology, 2003, Free University Berlin): Cognitive lifespan psychology; intraindividual variability; model-based analyses of reaction time distributions; multivariate modeling of cognitive developmental processes; typical intellectual engagement; structural equation modeling, latent growth modeling, time series analysis; item response theory.
- Schooler, Lael, J.** (PhD in Cognitive Psychology, 1993, Carnegie Mellon University): Adaptation of human memory to the statistical structure of past and present environments; computational models of human memory; memory's role in judgment and prediction tasks.
- Schroeder, Sascha** (M.A. in Musicology, 2002, University of Cologne; Diploma in Psychology, 2006, University of Cologne; PhD in Psychology, 2008, University of Cologne): Cognitive processes in language and text comprehension; reading literacy: assessment of micro- and macrostructural reading skills; research in instruction and learning; quantitative and qualitative methods in empirical research.
- Stevens, Jeffrey R.** (PhD in Ecology, Evolution, and Behavior, 2002, University of Minnesota): Cognitive constraints on cooperative behavior; evolution of decision making (particularly temporal discounting); comparative aspects of decision making in humans and nonhuman animals; the role of ecological and social context on choice.
- Trautwein, Ulrich** (Diploma in Psychology, 1999, University of Göttingen; Dr. phil. in Psychology, 2002, Free

University Berlin; Habilitation in Psychology, 2005, Free University Berlin): Development of self-related cognitions in educational settings; school development and management; effects of homework assignment on academic achievement.

**Verheyen, Nina** (M.A. in History, 2002, Free University Berlin; PhD in Modern History, 2008, Free University Berlin): Modern social and cultural history, especially: history of emotions, family history, history of masculinities, history of face to face communication; German and Indian history in a transnational perspective

**Völkle, Manuel** (Dr. rer. soc., 2008, University of Mannheim): Longitudinal research methods; structural equation models; learning and skill acquisition; various aspects of differential psychology; evaluation research.

### Emeritus Members of the Max Planck Society

**Edelstein, Wolfgang** (Dr. phil. in Medieval Studies, 1962, University of Heidelberg; Fellow of the Max Planck Society; until 1997 Co-director of the Institute; Honorary Doctorate in Social Science, University of Iceland; Honorary Professor of Educational Science, Free University Berlin and University of Potsdam): Development and socialization; social-cognitive and moral development and education; democratic competences and citizenship learning; conditions of successful school transformation.

**Wagner, Gert G.** (Diploma in Economics, 1978, University of Frankfurt; Dr. rer. oec. in Economics, 1984, Technical University Berlin; Habilitation in Economics, 1992, Technical University Berlin): Research on survey-statistic; research on social risk management; policy advice; teaching of economics.

**Wegwarth, Odette** (Diploma in Psychology, 2003, University of Potsdam; Dr. rer. nat. in Psychology, 2007, Humboldt University Berlin): Medical decision making; risk communication and understanding of risk and the role of ecological and social context; moralism and risky health behavior.

### Postdoctoral Research Fellows

**Bailey, Christian** (B.A. in Modern History, 2002, University of Oxford; M.A. in Intellectual History and the History of Political Thought, 2003, University of Sussex; M.A., M.Phil. in History, 2006, Yale University; PhD in History, 2008, Yale University): Intellectual history; history of europeanization; history of honors systems.

**Bauer, Markus** (Diploma in Psychology, 2002, Humboldt University Berlin; PhD research, F. C. Donders Centre for Cognitive Neuroimaging): Neuronal mechanisms of perceptual decision processes; functional relevance of synchronized oscillatory neural activity; methods of human electrophysiology.

**Biele, Guido** (Diploma in Psychology, 1999, Free University Berlin; Dr. phil. in Psychology, 2006, Free University Berlin): Reward-based decision making; computational modeling; neural correlate of reinforcement learning models.

**Chiang, Yen-Sheng** (PhD in Sociology, 2008, University of Washington): Social networks; mechanisms of prosocial behaviors; group decision making; simulation modeling.

**Chicherio, Christian** (PhD in Psychology, 2006, University of Geneva): Developmental and differential approaches to the study of cognitive aging; working memory, executive functioning, and attentional resources across the lifespan; individual differences and variability; gene-behavior interactions; age-related

**Roeder, Peter M.** (Dr. phil., 1960, University of Marburg; Habilitation in Educational Science, 1966, University of Marburg; Fellow of the Max Planck Society; until 1995 Co-director of the Institute; Special Professor of Educational Science, Free University Berlin): Educational science; school research; history of educational science.

changes in brain functioning (plasticity/reorganization) using SPECT/PET, EEG, and fMRI; connectivity and dynamics in brain functioning; linking behavioral performance to cerebral signal; multivariate methodology.

**Cokely, Edward T.** (PhD in Cognitive Psychology, 2007, Florida State University): Mechanisms of adaptive and superior performance; judgment and decision making; memory and metacognition; expertise and individual differences; experimental philosophy and philosophy of mind.

**Conlin, Juliet** (PhD in Psychology, 2006, University of Durham): Working memory and "executive" processes; decision making across the lifespan; navigational heuristics.

**Dziobek, Isabel** (Diploma in Psychology, 2000, Ruhr University Bochum; PhD in Psychology, 2006, University of Bielefeld): Social cognitive neuroscience; autism spectrum conditions; neuroanatomy.

**Ebner, Natalie C.** (Diploma in Psychology, 2001, Free University Berlin; Dr. phil. in Psychology, 2005, Free University Berlin): Development and interplay of motivational, emotional, and cognitive processes across the lifespan; goal selection and goal pursuit as processes of developmental regulation; approach and avoidance orientation in adulthood; lifespan changes in cognitive processing of age-associated motivational and emotional information; age-related differences

in perception of, attention to, and memory for human faces.

**Filimon, Flavia** (PhD in Cognitive Science, 2008, University of California, San Diego): Functional neuroimaging; perceptual decision making; sensorimotor representations; perception for action; brain connectivity.

**Freunberger, Roman** (Dr. phil. in Developmental Psychology, 2008, University of Salzburg): Investigation of cortical oscillations like alpha and gamma rhythms and their functional meaning to attention, memory, and object recognition; relationship between ERP components, especially the P1 component, and ongoing alpha oscillations.

**Furtak, Erin** (B.A. in Environmental, Population, and Organismic Biology, 1999, University of Colorado, Boulder; M.A. in Education, 2001, University of Denver; PhD in Curriculum and Teacher Education, 2006, Stanford University): Secondary science education, preparing teachers for the demands and realities of daily middle and high school science teaching.

**von Helversen, Bettina** (Diploma in Developmental Psychology, 2004, University of Erlangen-Nuremberg; Dr. rer. nat., 2008, Humboldt University Berlin): Categorization and estimation strategies; ontogenetic development of heuristic strategies; adaptiveness of basic cognitive capacities to environmental structures; legal decision making.

**Karlsson, Linnea** (PhD in Psychology, 2008, Umea University Sweden): Cognitive mechanisms of strategy shifts; causal inferences; models of judgment in relation to neural activity in the brain.

**Kleinspehn-Ammerlahn, Anna** (Diploma in Psychology, 2004, Free University Berlin): Development of emotional and self-related processes across the lifespan; age differences in cooperative behavior; individual differences and context covariates underlying interpersonal interactions; subjective experience of own aging.

**Kopp, Franziska** (Diploma in Psychology, 1999, University of Leipzig; Dr. rer. nat. in Psychology, 2006, University of Leipzig): Cognitive and social development during infancy; synchronized brain activity during cognition in infants and adults.

**Kotter-Grühn, Dana** (Diploma in Psychology, 2004, Technical University Dresden; PhD in Psychology, 2008, Free University Berlin): Developmental psychology of life-longing (Sehnsucht); self-regulation and subjective well-being over the lifespan; self-perceptions of aging; personality and social relations in middle and old adulthood.

**Le Lec, Fabrice** (PhD in Economics, 2007, GREQAM, University of Aix-Marseille): Behavioral/experimental economics; behavioral game theory; bounded rationality; economics and philosophy.

**Marewski, Julian N.** (Diploma in Psychology, 2005, Free University Berlin): The use and ecological rationality of recognition and ease of retrieval in decision

making; adaptive memory; process models of decision making under uncertainty; eye-movements and decision making under uncertainty; ecological rationality in political environments.

**Mata, Jutta** (Diploma in Psychology, 2004, Humboldt University Berlin; PhD in Psychology, 2008, Humboldt University Berlin): Food choice (decision rules, developmental aspects); preference prediction; development of prosocial behavior (behavioral game experiments).

**Meder, Björn** (Diploma in Psychology, 2003, University of Göttingen; PhD [Dr. rer. nat.], 2006, University of Göttingen): causality and causal cognition, categorization, and judgment and decision making; computational modeling.

**Monti, Marco** (PhD in Economics, Bocconi University, Milan): Behavioral finance and experimental economics; risk communication and representation of risk; cognitive sciences and decision making; information technology.

**Neth, Hansjörg** (PhD in Psychology, 2004, Cardiff University, UK): Stopping rules; multitasking and task switching; interactive behavior; problem solving and learning; cognitive engineering; computational modeling.

**Neumeier-Gromen, Angela** (Licence to practice medicine [MD], 1998, Humboldt University/Free University Berlin; Master of Public Health [MPH], 2002, Technical University Berlin; Doctor of Public Health [DrPH], 2008, University of Bielefeld): Harding Center for Risk Literacy; risk communication in public health; risk literacy; statistical literacy; medical decision making; evidence-based medicine and public health.

**Persson, Magnus** (PhD in Psychology, 2003, Uppsala University Sweden): Memory-based decision making; cognitive modeling; computer go.

**Philiastides, Marios G.** (PhD in Biomedical Engineering, 2007, Columbia University, New York): Neural correlates of perceptual and reward-based decision making; methods in human electrophysiology; computational modeling.

**Preuschhof, Claudia** (Diploma in Psychology, 2003, Humboldt University Berlin; PhD in Psychology, 2008, Humboldt University Berlin): Perceptual decision making; somatosensory system.

**Quesada, José** (PhD in Psychology; 2003, University of Granada, Spain): Computational modeling of semantics; problem solving; judgment and decision making; analogy; contextual diversity; mental number line.

**Quian, Jing** (B.Sc. in Economics and Business, 2001, Beijing Foreign Studies University, China; PhD in Cognitive Psychology, 2005, University of Warwick, UK): Economic psychophysics; statistical structure of magnitudes distributions (e.g., income, price, probabilities); distribution of wealth and its impact on individual and societal well-being; information search algorithms; exemplar memory; communication and dynamic social networks; evolutionary game theory and adaptive strategies.

**Rauers, Antje** (Diploma in Psychology, 2005, Free University Berlin): Regulation of social and cognitive lifespan development; age trajectories of collaborative cognition; intrapersonal and interpersonal knowledge organization.

**Schaefer, Sabine** (Diploma in Psychology, 2001, Free University Berlin; Dr. phil. in Psychology, 2005, Free University Berlin): Cognitive-sensorimotor coordination across the lifespan; age differences in the regulation of sequential action; spatial navigation; behavioral and neural plasticity; ontogenetic changes in behavior regulation.

**Scheibe, Susanne** (Diploma in Psychology, 2001, Humboldt University Berlin; Dr. phil. in Psychology, 2005, Free University Berlin): Strategies of life management and successful development across the lifespan; developmental psychology of Sehnsucht (lifelongings); emotions and emotion regulation across the lifespan; the role of interindividual differences in psychopathology; structural equation modeling and questionnaire development.

**Scheibehenne, Benjamin** (Diploma in Psychology, 2004, Humboldt University Berlin; PhD in Psychology, 2008, Humboldt University Berlin): Cognitive modeling of preferential choice; effects of having too much choice; food choice.

### Predocctoral Research Fellows

**Artinger, Florian** (M.Sc. in Economics and Management, 2006, Humboldt University Berlin): Behavioral game theory; emotions; theory of mind.

**Bahnemann, Markus** (Cand. med., University of Witten/Herdecke): Decision making in social contexts.

**Bartling, Karen** (Drs. in Psychology, 2006, University of Maastricht): Social development in early childhood (especially mother-child interaction); neural correlates of early interaction; EEG methods. (LIFE)

**Barton, Adrien** (Master of Physics, 2000, ENS Lyon; Master of Philosophy of Science, 2004, Sorbonne University; PhD in Philosophy, 2008, Sorbonne University): Philosophy of probability; philosophy of quantum mechanics; psychology of probability and risk communication.

**Besser, Michael** (First State Examination in Mathematics and German, 2007, University of Kassel): Research on "teacher expertise"; content knowledge and pedagogical content knowledge of mathematics teachers.

**Brandmaier, Andreas** (Dipl.-Inform., 2008, Technical University Munich): Machine learning and data mining; analysis of multidimensional time-series and synchronicity; statistical modeling; computer algorithms in psychology.

**Brose, Annette** (Diploma in Psychology, 2006, Free University Berlin): The interaction of emotion, situational influences (events), and cognition within

**Shing, Yee Lee** (Dr. rer. nat. in Psychology, 2007, Humboldt University Berlin): Lifespan and developmental psychology theories; the development and plasticity of basic cognitive mechanics and intellectual functioning over the lifespan; multivariate analyses of dynamical developmental and change processes; neural correlates of cognitive developmental and aging processes.

**Simsek, Özgür** (M.S. in Industrial Engineering and Operations Research, 1997, University of Massachusetts, Amherst; M.S. in Computer Science, 2004, University of Massachusetts, Amherst; PhD in Computer Science, 2008, University of Massachusetts, Amherst): Machine learning; artificial intelligence; complex networks.

**Tsai, Yi-Miau** (M.Sc. in Psychology, 2003, National Taiwan University; Dr. rer. nat. in Psychology, Humboldt University Berlin): Research in learning and instruction; achievement motivation and goals; context and cultural effects on motivation.

**Zhu, Wei** (PhD in Urban Planning, 2008, Eindhoven University of Technology): Econometric models of human decision making; choice of decision strategies; pedestrian behavior in urban environments.

and across individuals across the lifespan; emotion regulation and its developmental trajectories; the study of intraindividual variability and its relation to developmental change. (LIFE)

**Burzynska, Agnieszka Zofia** (B.Sc. in Biotechnology, 2005, University of Gdansk/University of Perugia; M.Sc. in Neuroscience, 2007, University of Göttingen): White matter integrity and connectivity in aging brain (diffusion MRI); correlations with cognitive performance and genetic background. (LIFE)

**Diao, Linan** (Diploma in Management, 2002, Jilin University, P.R. China): Agent-based computational economics; simulation in financial markets.

**Eckhardt (Müller), Andrea G.** (M.A. in Sociology, 2000, University of Iowa; M.A. in Educational Science/Sociology, 2002, Martin Luther University Halle-Wittenberg; Dr. phil. in Educational Science, 2007, Free University Berlin): Conditions of immigrant students' school success; bilingual education and second language acquisition; everyday school-related communication skills.

**Engster, Bettina** (M.A. in Literature, History and Educational Sciences, 2007, University of Bielefeld): Emotions and their representation in Indian mainstream cinema.

**Fandakova, Yana** (Diploma in Psychology, 2008, Humboldt University Berlin): Memory development and its neuronal correlates; age differences in episodic memory.

**Fleischhut, Nadine** (M.A. in Analytical Philosophy, 2006, Humboldt University Berlin/Free University

- Berlin): Cognitive processes of moral decision making; heuristic principles of "mind-reading," and the role of (shared) rational norms for the attribution of intention and beliefs in predicting the behavior of others.
- Freier, Monika** (M.A. in Indian Studies/German Literature, 2005, University of Hamburg): Advice and travel literature in Hindi; social history of emotions; intercultural studies.
- Green, Nikos** (B.Sc. in Cognitive Science, 2004, University of Osnabrück; M.Sc. in Cognitive Science, Track: Brain, Behavior, and Cognition, 2006, University of Amsterdam): Cognitive science; cognitive neuroscience; computational and cognitive modeling; developmental neuroscience; decision making.
- Gresch (Hausen), Cornelia** (Diploma in Social Sciences, 2004, University of Mannheim): Social origin and educational career decisions; ethnic disparities. (LIFE)
- Hachfeld (Kalusche), Axinja** (Diploma in Psychology, 2006, Free University Berlin): Attitudes of teachers; attitudes toward cultural heterogeneity in the classroom.
- Hämmerer, Dorothea** (Diploma in Psychology, 2005, University of Freiburg): Cognitive models of neuro-modulation.
- Huxhold, Oliver** (Diploma in Psychology, 2002, Free University Berlin; Dr. phil., 2007, Free University Berlin): Lifespan cognitive development and cognitive aging; intraindividual and interindividual variability in cognitive performance; cognitive processes contributing to balance control.
- Jonkmann, Kathrin** (Diploma in Psychology, 2005, Humboldt University Berlin): Social interactions and relationships in the classroom; social dominance in adolescence; educational measurement. (LIFE)
- Kliemann, Dorit** (Diploma in Psychology, 2008, University of Bremen): Cognitive neuroscience; social decision making in healthy controls and individuals on the autism spectrum; functional and structural neuroimaging.
- Köller, Michaela** (Diploma in Psychology, 1992, University of Kiel; Dr. phil. in Educational Science, 2008, Humboldt University Berlin): Educational effectiveness; implementation of innovations in school.
- Krugel, Lea Katharina** (Cand. med., Charité Universitätsmedizin Berlin): Neurobiology of reward-based decision making; neuroimaging.
- Mell, Thomas** (M. D., 2005, Humboldt University Berlin): Neurobiology of reward-based decision making; neuroimaging.
- Mériaux, Katja** (Diploma in Psychology, 2003, Humboldt University Berlin): Cognitive neuroscience; emotions and decision making.
- Mohr, Peter N. C.** (M.Sc. in Business Administration, 2006, University of Münster): Economic decision making; risk perception. (LIFE)
- Morais, Ana Sofia** (Licenciatura in Psychology, 2004, University of Lisbon): Memory-based decision making; cognitive aging, and the use of decision strategies; the role of attention in learning. (LIFE)
- Nagel, Irene E.** (Diploma in Psychology, 2005, Maastricht University): Age-related changes in human cognition and behavior; age-related changes in the human brain (structure, functional activation, dopamine system); using fMRI (functional magnetic resonance imaging) to examine the interplay of increasing age, genetic predisposition, brain structure, and task-specific brain activation patterns, and their relation to cognitive decline in the elderly. (LIFE)
- Neumann, Marko** (M.A. in Educational Sciences, 2006, Humboldt University Berlin): National and international school achievement research; impact of institutional opportunity structures on the development of scholastic abilities; school effectiveness research; quality assurance and quality improvement in the educational system.
- Noack, Hannes** (Diploma in Psychology, 2007, University of Potsdam): Behavioral and brain plasticity.
- Park, Soyoun** (B.A. in German Language and Literature, 2006, Korea University, Seoul; Diploma in Psychology, 2008, Technical University Berlin; PhD Student at the Berlin School of Mind and Brain, 2008, Humboldt Graduate School): Neuroscience; reward based decision making; neural mechanisms of reinforcement learning; functional and structural neuroimaging.
- Passow, Susanne** (Diploma in Psychology, 2008, University of Freiburg): Neuropsychology in aging; neurodegenerative diseases.
- Pieper, Swantje** (Diploma in Psychology, 2006, University of Münster): National and international school achievement research; quality assurance and quality improvement in the educational system; effects of homework assignment on academic achievement.
- Prehn, Kristin** (Diploma in Psychology, 2003, Humboldt University Berlin; PhD, 2008, Humboldt University Berlin): Interaction of cognition and emotion; moral decision making; emotion regulation.
- Preißler, Sandra** (Diploma in Psychology, 2006, University of Jena): Cognitive neuroscience; social decision making; personality and personality disorders.
- Richter, Dirk** (M.A. in Quantitative Research, Evaluation and Measurement in Education, 2005, Ohio State University; M.A. in Education, 2006, Technical University Dresden): Teacher education; teacher testing; development of novice teachers; statistical modeling. (LIFE)

**Sajjad, Mohammad** (M.Phil in History, Jamia Millia Islamia, New Delhi): Religion, society and culture in the 18th and early 19th century India, Sufism in India: thoughts and practices, the Muslim community in the late Mughal and early colonial India, Muslim revivalist and traditionalist movements in India.

**Sander, Myriam** (Diploma in Psychology, 2007, Humboldt University Berlin): Development of perception and memory across the lifespan; neural correlates of developmental change and brain plasticity; EEG methods.

**Scheibe, Christina** (Diploma in Psychology, 2004, Humboldt University Berlin): Perceptual decision making; influence of prior probability.

**Schellenbach, Michael** (Diploma in Computer Science, 2004, Saarland University): Spatial navigation; pedestrian navigation systems; virtual reality.

**Schleyer, Maritta** (M.A. in Indian Studies [classic and modern] & Ethnology, 2008, University of Heidelberg): Islam and Sufism in South Asia, Hinduism, Bhakti; Urdu, Hindi and Sanskrit literature.

**Shah, Nadeem** (M.Phil., 2004, Centre for Historical Studies, Jawaharlal Nehru University): Sufi orders, medieval and early modern Urdu and Persian texts, medieval and early modern Indian socio-political issues.

**Störmer, Viola** (M.A. in Psychology, 2008, Humboldt University Berlin): Genetic and age effects on neuro-modulation of selective attention and perceptual processing. (LIFE)

**Straubinger, Nils** (Diploma in Psychology, 2006, University of Münster): Thinking, problem solving, and judgment and decision making; lifespan cognitive development (focus on probabilistic thinking); the

role of external representations (e.g., diagrams) in probabilistic thinking.

**Timm, Franziska** (M.A. Educational Science, 2007, University of Potsdam): Philosophy of education and history of education; sociology; history of emotions.

**Verrel, Julius** (D.E.A. in Mathematics, 2001, Jussieu, Paris; M.Sc. in Cognitive Neuroscience, 2006, Radboud University, Nijmegen): Motor development and aging; interaction of sensorimotor and cognitive skills. (LIFE)

**Volstorf, Jenny** (Diploma in Psychology, 2006, Technical University Chemnitz): Conditions for the emergence of cooperation in short interactions; simulations; evolutionary approach; prisoner's dilemma game.

**Voss (Dubberke), Thamar** (Diploma in Psychology, 2006, Philipps University Marburg): Research on instruction and learning; teacher research; teacher beliefs.

**Wenzlaff, Hermine** (Diploma in Biology, 2005, University of Tübingen): Neurobiology of perceptual decision making; electrophysiological recordings (EEG, MEG); cognitive modeling; correlation of neurophysiological components with modeled parameters.

**Werkle-Bergner, Markus** (Diploma in Psychology, 2004, Saarland University): Lifespan development of memory and cognitive control functions; neuronal correlates of lifespan plasticity and change; EEG methods in lifespan research; multivariate statistical models of variability and change.

**Wolff, Julia** (Diploma in Psychology, 2008, Friedrich Schiller University Jena): The interplay of well-being, health, and health behavior in younger and older adults; intraindividual variability and its development over the lifespan.

# Research Report 2007–2008



The Max Planck Institute for Human Development, founded in 1963, is a multidisciplinary research establishment dedicated to the study of human development and education. Its inquiries are broadly defined, and concentrate on the evolutionary, social, historical, and institutional contexts of human development. The disciplines of education, psychology, and history reflect the current directors' backgrounds, but the Institute's scholarly spectrum is enriched by the work of colleagues from such fields as behavioral developmental neuroscience, sociology of education, mathematics, economics, computer science, evolutionary biology, and the humanities.

The Institute for Human Development is one of about 80 research facilities financed by the Max Planck Society for the Advancement of Science (Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V.), the core support for which is provided by the Federal Republic of Germany and its 16 states.

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