

An Update on Longitudinal Twin and Family Studies

Meike Bartels

Department of Biological Psychology, Vrije Universiteit, Amsterdam, the Netherlands

With the development of large twin-family registers worldwide (see the December 2006 issue of *Twin Research and Human Genetics* for an overview) new options for research projects become feasible, including longitudinal studies. In this special issue on Longitudinal Twin and Family Studies, several aspects of longitudinal research are highlighted and an overview of results is given from European, Australian and United States twin studies. These studies deal with a time span from birth to adulthood and a wide range of phenotypes is covered. Data collection in some studies is age/cohort driven; in others, subjects are followed from different ages at regular time intervals. Most studies are based on data collection in twins, but adoption and parent-offspring data designs are described as well. The overview of results of current longitudinal projects makes this special issue a reference resource for longitudinal research in developmental behavior genetics.

Longitudinal studies provide data about the same individual across the life span. The first obvious application of longitudinal data collected in genetically informative samples is the investigation of the etiology of tracking and stability: to what extent are the same genetic factors expressed across child- and adulthood? Combining techniques developed within the context of structural equation modeling and time series analyses with genetic epidemiology provides the opportunity to disentangle effects of genetic and environmental factors across time. The influence of genetic and nongenetic factors may show distinct developmental patterns, which cannot be distinguished when analyzing data at a phenotypic level solely. For example, the finding that environmental influences on problem behavior throughout childhood act mainly time specifically, while the genetic factors show a transmission pattern, remains unobserved in phenotypic design. Such findings have consequences for both clinical practice as well as research purposes.

In addition to resolving the etiology of covariation across time, longitudinal data allow the study of age-of-onset, direction of causation and the significance of risk and protective factors. Further, large longitudinal database allow the analysis of prospectively collected

data, which are by definition less biased than retrospective data.

The 15 articles in this special issue offer an overview of a wide range of results for different phenotypes assessed in early childhood, adolescence and young adulthood.

Early Childhood

A detailed description of the Early Growth and Development Study is provided by Leve et al. This is a relatively new adoption study which was initiated in 2003, with data collection at 6-month intervals until age 3 years. The focus is on infant/toddler temperament, social behavior, and health, birth and adoptive parent personality characteristics, psychopathology, competence, stress, and substance use, adoptive parenting and marital relations, and prenatal exposure to drugs and maternal stress.

Childhood

Bartels et al. summarize the longitudinal genetic analyses of maternal and paternal ratings of twins' behavior for Aggression (AGG), Attention Problems (AP), Anxious/Depression (ANX) and the two broadband scales, Internalizing behavior (INT) and Externalizing behavior (EXT), using data from the Netherlands Twin Register. They conclude that between ages 3 and 12 genetic factors are the most important cause of individual differences in emotional and behavioral problems.

The influence of temperament, assessed from age 14 to 36 months, on the covariance between INT and EXT, assessed from age 4 to 12 years, is investigated in data from the Colorado Longitudinal Twin Study. In their article Rhee et al. report that in males part of the covariation between internalizing and externalizing behavior was explained by shared environmental influences in common with emotionality and shared environmental influences in common with shyness. In females most of the covariation between INT and EXT was explained by shared environmental influences in common with emotionality.

Address for correspondence: Meike Bartels, Department of Biological Psychology, Vrije Universiteit, van der Boechorststraat 1, 1081 BT, Amsterdam, the Netherlands. E-mail: m.bartels@psy.vu.nl

From Childhood to Adolescence

Several longitudinal studies, as described in this special issue, started data collected in young twins. Since then, continued data collection has provided data from childhood to adolescence. One of those studies is The Twins' Early Development Study (TEDS), which has looked at language, cognitive and academic abilities and behavior problems from multivariate quantitative and molecular genetic perspectives. This special issue contains two articles based on the TEDS sample. The first (Oliver et al.) suggests that, especially in the area of learning abilities and disabilities, genes are generalists and environments are specialists. In a second article Haworth et al. conclude that despite the considerable differences in mathematics curricula from 7 to 9 years the same genetic effects largely operate at the two ages.

The Wisconsin Twin Panel (Goldsmith et al.) uses the resources of state birth records to study the etiology and developmental course of early emotions, temperament, childhood anxiety and impulsivity, the autism spectrum, and related psychobiological and behavioral phenotypes. Longitudinal results are expected shortly.

Adolescence

The second article to use an adoption design describes a longitudinal study on problem behavior among international adoptees (Huizing et al.). In line with findings from twin studies they report that both INT (r s ranging from .34 to .58) and EXT (r s ranging from .47 to .69) were rather stable over time and that both genetic as well as shared environmental factors account for this stability.

Middelberg et al. analyze data on plasma high-density lipoprotein and low-density lipoprotein cholesterol, total cholesterol and triglycerides data from 965 Australian twin pairs and their siblings, when they were 12, 14 and 16 years of age. Their results suggest that there are developmental changes in the genes affecting plasma lipid concentrations across adolescence.

From Childhood to Early Adulthood

The Cardiff Study of All Wales and North West of England Twins (CaStANET; Van den Bree et al.), has followed children and adolescents over time into early adulthood. So far, four waves of data collection have taken place focusing on depression and anxiety, chronic fatigue, attention-deficit/hyperactivity disorder, conduct problems and prosocial behavior. The fourth wave of data collection gave information on substance use and problem use as well as associated risk factors in the twins and their families (including the relations between family members). A summary of results is provided.

Another large-scale longitudinal study spanning childhood to early adulthood is The Swedish Twin study of CHild and Adolescent Development (TCHAD). Lichtenstein et al. provide an overview of results. Focusing on antisocial behavior, criminality,

and psychopathic personality, they found, for instance, that continuity in aggressive behavior from childhood to early adolescence was largely mediated by genetic influences, whereas continuity in non-aggressive behavior was mediated both by the shared environment and genetic influences.

Adolescence to Adulthood

Five studies in this special issue describe stability and change in the period from adolescence to adulthood. Significance of early adolescent problem behavior for risk of adult psychopathology is described by Keys et al., using data from the Minnesota Twin Family Study (MTFS). Data from Fintwin16–25 are used to estimate genetic and environmental influences on the stability of alcohol problems across development and the genetic and environmental contributions to predictive correlations between adolescent personality and later alcohol-related behavior problems (Vikken et al.). Another study focusing on genetic and environmental influences on stability of personality deserves special attention, as it is conducted on a sample of Croatian twins (Bratko and Butkovic). During a 4-year period from adolescence to young adulthood genetic factors contribute mainly to stability, while environmental factors contribute mainly to change in personality.

Most longitudinal projects described in this special issue started their study in order to estimate the relative contribution of genes and environment to individual differences of many phenotypes. In contrast, the Nonshared Environment in Adolescent Development (NEAD) project is a longitudinal study of twins/siblings and parents, as described in this issue by Neiderhiser et al., to identify the nonshared environmental influences. Although systematic sources of nonshared environmental influences were not found in NEAD, significant findings of genetic influences on family relationship, relationships outside the family and adolescent adjustment are found.

A final article from in the Virginia Twin Study of Adolescent Behavior Development and its Young Adult Follow shows how intergenerational stability and influences from parents on their children can be investigated in a parent–offspring design. Significant heritability is found for conduct disorder, which is slightly increased by assortative mating. In the offspring, significant effects of primarily nonparental shared environment are seen.

To summarize, this special issue brings together longitudinal research in the field of behavior genetics covering early childhood to adulthood. Genetic and environmental influences on a wide range of phenotypes, including problem behavior, personality and lipid levels are described. All participants to this special issue doubtless agree that in order to conduct longitudinal research we largely depend on the continuous willingness of our subjects to participate in our research. Continuation of most longitudinal database is expected, increasing the value of their longitudinal characteristics.