

# A longitudinal study of twins from birth to adulthood

Anne Mari Korbøl Torgersen

*Department of Psychology, University of Oslo, Norway*

Correspondence: a.m.torgersen@psykologi.uio.no

## ABSTRACT

Temperamental variation in infancy was the starting point for this longitudinal study of twins followed from birth to adulthood. The influence of early individuality on later development was a research question in the follow-ups, and by choosing twins as a group, it was possible to uncover the effect of environmental and genetic factors at the different ages. Developmental psychopathology turned out to be a relevant framework, where mental health and well-being are seen as the result of a continuous transaction between genetically-based individuality and a changing and varying environment (Maughan & Rutter, 2008). The twin method was an adequate tool to gain a better understanding of these processes. The overall clear message from the study is that whereas heritability of temperament can be seen from infancy on, environmental factors are of crucial importance for an understanding of mental development and health, but the effect of environmental factors probably varies a great deal in dependency upon the genetic disposition of the person.

This is an open access article distributed under the Creative Commons Attribution Licence, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

## INTRODUCTION

Contrary to most longitudinal twin studies described in today's literature, where a large number of twins are seen by a large number of professionals, this longitudinal twin study examines only one small group of 53 pairs of twins born in 1969 and 1970 and seen mainly by one person (the person who conducted this study and authored this contribution).

Within developmental psychology, as within social sciences in general (Kuhn, 1962), there was a paradigm shift in the late 1960s from linear to transactional explanation models of development. Central, often cited articles at the time claimed that the child's individuality contributes to its own development through transactional processes with the environment (Bell, 1968; Thomas and Chess, 1968). This way of thinking gave rise to new sorts of longitudinal studies where behavioral individuality was focused (Lerner, 2002). Earlier well known longitudinal studies on child development, as conducted by Nancy Bayley, or Arnold Gesell, both started in the 1930s, typically focused on normative development: What is the normal stage of development of a child at each age? The New York Longitudinal Study (NYLS) started by Thomas and Chess and their colleagues in 1956 (Thomas et al, 1963) focused on variation in behavior from infancy on as an input to the transactional processes with the environment throughout development.

Thomas and Chess underlined that already in infancy, the norm was to be different also in behavior, which they initially called "primary reaction pattern" or "initial reactivity". They eventually identified nine different behavior styles along which infants were normally distributed, which they later called "temperament", and by this pioneered the systematic applications of temperament concepts to measurement of children's individuality. Although Thomas and Chess focused on temperamental individuality from infancy,

they did not say anything about the reasons for the variations. Were they inherited?

If temperament was inherited, genetic variation had to be controlled for in developmental studies. The best way to do this would be with the twin method. In fact longitudinal twin studies became very popular from the 1970s on, first to test the genetic hypothesis and then to study environment with a control of genetic factors (Plomin & Rutter, 1989).

Together with the technical and computerized revolutions of the last 30 to 40 years, and the new knowledge within behavior genetics and epigenetics, questions as well as methods have changed considerably within twin research (Rutter, 2006). The presentation of this small-scaled twin study might be of mainly historic interest. However, the details and close-up personal information might give rise to collaboration in forming hypotheses.

Results and specific methods from the different age levels studied will be presented, all embedded in the relevant research questions and the methods available at the time. Only some of the most important results of specific interest for twins or twin research are reported, partly due to lack of space and partly due to the lack of publications. Some important results are mentioned, however, although they were only presented at international conferences.

## GENERAL AIMS OF THIS STUDY

In this longitudinal setting, each age period studied, from infancy through early childhood and adolescence to adulthood, had a different focus. As a starting point, interest centered on observable individual differences in infants' reactivity and behavior. Preventive work in infant-mother health care was in its beginnings in Norway in the 1960s (Bogen et al, 1972). Could we give the mothers advice rather than base our psychological work on repair? But since infants are so different, the











on the subject was finally published with data also from the 30 year follow-up (Torgersen & Janson, 2002).

### Age 30

**Shared and nonshared stress.** Personality differences in adult MZ twin pairs were related to familial stress factors shared by the twins in childhood and early adolescence. Twin pairs, who had shared more stressors at ages 6 to 15, tended to be more different in personality at age 30. These differences were significant for the total difference in the Big Five personality dimensions, as well as for the single personality dimensions Openness, Agreeableness, and Conscientiousness. However, when individual MZ twin-pairs, different in degree of symptoms were scrutinized; only differences in marriage made a significant difference in personality. Case examples illustrate the relationship between stress and personality differences, and provide hypotheses for further studies in larger samples (Torgersen & Janson, 2002).

**Adult attachment.** When the within-pair differences of attachment representation in MZ and DZ twins were compared using the AAI, the results showed a clear tendency toward MZ twins to be more concordant than DZ twins, but the within-pair similarity was also high in both zygosity groups. The results suggest, in behavior genetic terms, that heredity as well as shared environment contribute to attachment status in adulthood (Torgersen, Grova & Sommerstad, 2007). This differs from studies of attachment in infancy and early childhood which are reported to be explained mainly by shared environment and only negligible by genetic factors (Bokhorst et al, 2003), but is more in line with results from studies where adult attachment is measured by questionnaires in relation to romantic partner (Brussoni et al, 2000). Adult attachment is however not directly comparable to attachment in infancy, and also vary with methods used (Torgersen, 2013). Furthermore, the results showed that the distribution of the attachment pattern in twins had the same percentage distribution as reported elsewhere for singletons. Consequently, there was no tendency toward more insecure attachment in twins than in singletons despite early experiences of being a twin and sharing one mother.

**The twin relations.** The relations between the two twins in MZ pairs were also looked at developmentally for how it changed from infancy to the age of 15. Dominance in the twin pair was not related to competence in schoolwork or in sports. The conclusion was that Twin 1 (first born) was more often the dominant one from infancy on, but the dominance pattern changed in content and stability from early childhood to adolescence. The most dominant twin at age 15 was also the most Extrovert in personality at the age of 30 years (Torgersen, 2001, Presentation in ECDP-conference, Uppsala).

The twins' attachments to each other, as measured by AAT, had a similar distribution as the AAI catego-

**Figure 1.** Median within-pair differences in temperament in MZ and DZ twins and in nonrelative pairs (NR) presented as percentiles of the distribution of within-pair differences in NR (Torgersen 1987, p148). Since attention span at age 2 months and regularity at age 15 years was not possible to assess reliably, it was excluded from this figure.

same environmental influences create differences rather than similarities among family members, and as such had a Nonshared effect, in behavioral genetical terms. In families with high degree of stress, DZ twins, significant more different in temperament, became more different than MZ twins i.e. they reacted more differently to the same situation (Torgersen, 1987, 1989).

**Contemporary discussions.** Since few studies within behavioral genetics could document the influence of "Shared environment", a common conclusion was that family environment, was of less importance for behavior development (Reiss et al, 2000), while in fact it meant that it was not strong enough to make the same effect in two siblings in the same family. Rather such results tell us something about the importance of a transactional view of development. After the 15 year assessment a paper showing interaction between similar family stress and different outcomes in behavior were published (Torgersen, 1989). The 30 year assessment started with an interest in this topic, and a paper

rizations. The AAT within-pair concordance was significant in MZ twins but not in DZ, i.e. MZ twins had a closer attachment to each other than DZ twins. A tendency for MZ twins to get a dismissing score higher than expected was explained with the special relation to the twin (Torgersen & Grova, 2012).

**Contemporary discussions.** During the last years the quantitative methods of behavioral geneticists, where the twin method have been used to estimate heritability and environment, seems to lose its major interest. Behavioral genetics still aims to identify genetic and environmental influences underlying individual differences in behavior, but many geneticists have turned their interest to molecular methods. These include genetic association and functional analyses to identify the genes and genetic variation responsible for the familial aggregation highlighted by twin and family studies (van Dongen & Boomsma, 2012). Also much more sophisticated and multivariate approaches to twin data continue to yield new insights into the interplay of genetic and environmental influences on human health and behavior (Silventoinen, 2014).

Since behavioral traits are typically heterogeneous and affected by multiple, partly overlapping sets of genes, molecular genetic success is either independent of, or negatively correlated with estimated heritability from twin studies. When a behavior trait is found to be highly heritable when it is studied with the quantitative genetic twin method, it has been difficult to replicate this finding within molecular genetic studies (Bakermans-Kranenburg & van IJzendoorn, 2006). In a developmental perspective explanations gets even more complicated since different genotypes also will have different phenotypes, depending on age and environment, and since a two-way possibility is acknowledged in that environment can affect which alleles might get turned on and off in response to different environmental conditions. Consequently, the obvious, measurable and significant differences in within pair similarities in MZ vs DZ pair of twins, is still of interest in order to understand the psychological implications of genetical variation.

## GENERAL DISCUSSION AND CONCLUSIONS

Each of the follow-ups in this study was set at ages with large developmental spurts or changes in social situation: in infancy huge changes occur from week to week; at six years the toddler change into a school child; at 15 years pubertal influence change the child into an adolescent; and at 30 years great variability occur at the entrance into adulthood.

In periods with large individual variation, developmental tasks typical for the age period is easier to see, and vulnerability is more specific. Children who tend to be genetically different (as DZ twins) in these periods will be more different, and genetically more similar individuals (as MZ twins) will be more similar,

if genetic variance are of importance, the question of heritability will be clearer. High or low heritability at one age might tell us something of importance from that age.

Twins and their situation, their similarities and peculiarities, have for me become a central interest in addition to heritability and temperament. Experiences from all the home-visits from infancy to adolescence gave the inspiration to write a book for twins and their parents about twins and their relation to each other from infancy to adolescence (Torgersen, 2004). These experiences together with my clinical expertise have also made it possible for me to be an adviser at the twin parent club in Oslo on a regular basis. During the last 20 years this practice have been performed by answering questions in their magazine (Tvillingnytt), giving lectures for parents or health personnel, and offering guidance as a clinical psychologist to twin parents, but also to adult twins, taking place on average once or twice a month.

Environmental influence, as it may be measured as differences within MZ twin pairs, are today studied mainly through molecular genetic studies, and epigenetics. Narrow specters of hidden details are discovered. In a small scaled study as the present, the narrowness and the details are of another kind. A small group of people rather than groups of several thousand, introspection and qualitative data rather than microscopic measurements and statistical expertise are used. The type of data is different, but in both cases it is a tiny specter of genetic research information picked out of a total real existence, giving a huge amount of data, and as such might show different roads to better understandings on how environmental risk factors may operate.

## THE 45 YEAR STUDY AND BEYOND

In 2015 the twins reached the age of 45 years. A questionnaire has been developed where the relation to the other twin is in focus, as well as descriptions of physical nearness and emotional closeness. Some single individuals are seen to go even more in depth of how the twin-ship may be experienced, and how some of this can be related to early experiences in the childhood, and from the time they grew up. So far only about half of the twins have answered, relatively often only one of the twins in a pair.

It is too early to refer any results, but a preliminary look seems to reveal that when it comes to more serious psychological problems in life, it is the large environmental burdens from early childhood that make severe damage of the life quality for decades. Several stress factors lasting for a long time seem to be much more decisive than temperament or personality, but individual differences might tell us something about type of symptoms that most probably will develop dependent of individuality.



## REFERENCES

- Ainsworth MDS, Blehar MC, Waters E, Wall S (1978). *Patterns of attachment*. Hillsdale, NJ: Erlbaum.
- Bakermans-Kranenburg MJ, van IJzendoorn MH (2006). Gene-environment interaction of the dopamine D4 receptor (DRD4) and observed maternal insensitivity predicting externalizing behavior in preschoolers. *Wiley Periodicals*, **48**, 406-409.
- Bell RQ (1968). A reinterpretation of the direction of effects in studies of socialization. *Psychol Rev* **75**: 81-95.
- Bogen B, Solum L, Storvik O, Sommerschild H (1972). *Helsestasjonen i støpeskjeen: nye muligheter for psykisk forebyggende arbeid*. Oslo: Universitetsforlaget.
- Bokhorst CL, Bakermans-Kranenburg MJ, Fearon P, van IJzendoorn MH, Fonagy P, Schuengel C (2003). The importance of shared environment in mother-infant attachment security: A behavioral genetic study. *Child Dev*, **74**, 1769-1782.
- Brennan KA, Clark CL, Schaver PR (1998). Self-report measurement of adult romantic attachment: An integrative overview. In: J A Simpson, WS Rholes (eds.): *Attachment theory and close relationships*. New York: Guilford Press: 46-76.
- Brussoni MJ, Jang KL, Livesley WJ, MacBeth TM (2000). Genetic and environmental influences on adult attachment styles. *Personal Relationships*, **7**, 283-289.
- Caspi A, Shiner R (2008). Temperament and personality. In: M Rutter, D Bishop, D Pine, S Scott, J Stevenson, E Taylor, A Thapar (eds.): *Rutter's child and adolescent psychiatry*, 5<sup>th</sup> edn. Oxford: Blackwell: 182-198.
- Chess S, Thomas A (1984). *Origins and evolution of behavior disorders*. New York: Brunner/Mazel.
- Costa PT, McCrae RR (1992) *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) professional manual*. Odessa, FL: Psychological Assessment Resources.
- Diener E, Emmons RA, Larsen RJ, Griffin S (1985). The Satisfaction With Life Scale. *J Pers Assess*, **49**, 1, 71-75.
- Goldsmith HH (1989). Behavior-genetic approaches to temperament. In: GA Kohnstamm, JA Bates, MK Rothbart (eds.): *Temperament in childhood*. John Wiley & Sons: 111-132.
- Hesse E. (1999). The Adult Attachment Interview: Historical and current perspectives. In: J Cassidy, PR Shaver (eds.): *Handbook of Attachment: Theory, research, and clinical applications*. New York: Guilford Press: 395-433.
- Jang KL, Livesley WJ, Vernon PA (1996). Heritability of the big five personality dimensions and their facets: a twin study. *J Pers*, **64**: 577-591.
- Kagan J, Reznick JS, Snidman N (1987). The physiology and psychology of behavior inhibition in children. *Child Dev*, **58**, 1459-1473.
- Kandel DB, Davies M (1982). Epidemiology of depressive mood in adolescents. An empirical study. *Arch Gen Psychiatry*, **39** (10): 1205-1212.
- Kuhn TS (1962). *The Structure of Scientific Revolutions. International Encyclopedia of Unified Science*. Chicago: The University of Chicago Press.
- Lerner R (2002). *Concepts and theories of human development*, 3<sup>rd</sup> edn. London: Lawrence Erlbaum Associates.
- Maughan B, Rutter M (2008). Development and psychopathology: A life course perspective. In: M Rutter, D Bishop, D Pine, S Scott, J Stevenson, E Taylor, A Thapar (eds.): *Rutter's child and adolescent psychiatry*, 5<sup>th</sup> edn. Massachusetts: Blackwell Publishing: 160-181.
- Millon T (1996). *Disorders of personality, DSM-IV and beyond*. New York: John Wiley & Sons.
- Plomin R (1986). *Development, genetics, and psychology*. Hillsdale, NJ: Lawrence Erlbaum.
- Plomin R, Rutter M (1989). Quantitative genetics and developmental psychopathology. In: D Cicchetti (ed.): *The emergence of a discipline: Rochester Symposium on Developmental Psychopathology*. London: Lawrence Erlbaum Associate Publishers.
- Reiss D, Neiderhiser E, Hetherington EM, Plomin R (eds.) (2000). *The relationship code: Deciphering genetic and social influences on adolescent development*. Cambridge: Harvard University Press.
- Rothbart MK, Bates J (2006). Temperament. In: W Damon, RM Lerner, N Eisenberg (eds.): *Handbook of Child Psychology, Vol 3. Social, Emotional, and personality development*, 6<sup>th</sup> edn. New York: Wiley: 99-166.
- Rutter M, Tizard J, Yule W, Graham P, Whitmore K (1976). Research report: The Isle of Wight Studies 1964-1974. *Psychol Med*, **6**: 313-332.
- Rutter M (2006). *Genes and behaviour. Nature-nurture interplay explained*. Blackwell Publishing.
- Silventoinen K, Volanen SM, Vuoksima E, Rose RJ, Suominen S, Kaprio J (2014). A supportive family environment in childhood enhances the level and heritability of sense of coherence in early adulthood. *Soc Psychiatry Psychiatr Epidemiol*, **49** (12): 1951-1960.
- Stern C (1972). *Principles of Human Genetics*. San Francisco: Freeman.
- Suomi SJ (1987). Anxiety-like disorders in young nonhuman primates. In R Gittelman (ed.): *Anxiety disorders of childhood*. New York: Guilford Press.
- Thomas A, Chess S, Birch HG, Hertzog ME, Korn S (1963). *Behavioral individuality in early childhood*. Oxford, UK: New York University Press.

- Thomas A, Chess S, Birch HG (1968). *Temperament and Behavior Disorders in Children*. New York: New York University Press.
- Thomas A, Chess S (1977). *Temperament and development*. New York: Brunner/Mazel Publishers.
- Thomas A, Chess S (1980). *The dynamics of psychological development*. New York: Brunner/Mazel Publishers.
- Torgersen AM (1973). Temperamentsforskjeller hos spedbarn. Deres årsaker, belyst gjennom en tvillingundersøkelse (Master's thesis, in Norwegian). University of Oslo, ISBN 82-569-0099-7.
- Torgersen AM, Kringlen E (1978). Genetic aspects of temperamental differences in infants. *J Am Acad Child Psychiatry*, **17**, 433-444.
- Torgersen AM (1981a). Genetic factors in temperamental individuality. *J Am Acad Child Psychiatry*, **20**, 701-711.
- Torgersen AM (1981b). Genetic aspects of temperamental development: A follow-up study of twins from infancy to six years of age. In: L Gedda, P Parisi, WE Nance (eds.): *Twin Research 3: Intelligence, Personality and Development*. Alan R. Liss: 261-268.
- Torgersen AM (1982). Influence of genetic factors on temperament development in early childhood. In: R Porter, GM Collins (eds.): *Temperament differences in infants and young children*. Ciba Foundation Symposium No. 89. London: Pitman Books: 141-154.
- Torgersen AM (1985). Temperamental Differences in infants and 6-years old children: A follow-up study of twins. In: J Strelau, FH Farley, E Gale (eds.): *The biological bases of personality and behavior*. Washington: Hemisphere Publishing Corporation.
- Torgersen AM (1987). Longitudinal research on temperament in twins. *Acta Genetic Med Gemellol*, **36**, 145-154.
- Torgersen AM (1989). Genetic and environmental influences on temperamental development: A longitudinal study of twins from infancy to adolescence. In S Doxiadis (ed.): *Early influences shaping the individual*. New York: Plenum: 269-281.
- Torgersen AM (1990). Temperament som utviklings-psykologisk begrep. Utvikling av en forskertradisjon. *Tidsskrift for Norsk Psykologforening*, **27**, 889-911 (In Norwegian).
- Torgersen AM (1991a). *Genetic and environmental influence on temperamental behavior. A longitudinal study of twins from infancy to adolescence* (dissertation). University of Bergen, Norway.
- Torgersen AM (1991b). Assessing temperamental individuality with the DOTS-R among adolescents. In: AM Torgersen (ed). *Genetic and environmental influence on temperamental behavior. A longitudinal study of twins from infancy to adolescence* (dissertation) University of Bergen, Norway.
- Torgersen AM (2001). Twin relationship in a developmental perspective. Paper presented at: IXth European Conference on Developmental Psychology, Uppsala, Sweden.
- Torgersen AM, Janson H (2002). Why do twins differ in personality: Shared environment reconsidered. *Twin research*, **5**, 44-52. Also published in Malykh SB, Torgersen AM (eds.) (2008): *Gene. Brain. Behavior*. Moscow: Russian Panorama Press.
- Torgersen AMK (2004). *Tvillinger og forholdet mellom dem*. Oslo: Cappelen Akademisk forlag (In Norwegian).
- Torgersen AMK (2006). Tvillinger i puberteten. *Tidsskrift for ungdomsforskning*, **6** (1): 25-45 (In Norwegian).
- Torgersen AM, Grova B, Sommerstad R (2007). A pilot study of attachment patterns in adult twins. *Attach Hum Dev*, **9**, 127-138.
- Torgersen AM (2013). Forklaringer på individuelle forskjeller i tilknytningsmønstre hos barn og voksne. *Tidsskrift for Norsk Psykologforening*, **50**, 16-22 (In Norwegian).
- Torgersen AM, Grova B (2012). Twins' relationship in retrospect: Does zygosity matter? Abstracts for The 14<sup>th</sup> International congress on twin studies and The 2<sup>nd</sup> world congress on twin pregnancy (ISTS). Florence, Italy. In: *Twin Res Hum Genet*, **15**, 2, 170-261.
- van Dongen J, Slagboom PE, Draisma HHM, Martin NG, Boomsma DI (2012). The continuing value of twin studies in the omics era. *Nature Rev Genet*, **13**, 640-653.
- Wilson R (1983). The Louisville Twin-study: developmental synchronies in behavior. *Child Dev*, **54**, 298-316.
- Windle M, Lerner R (1986). Reassessing the dimensions of temperamental individuality across life span: The revised dimensions of temperament survey (DOTS-R). *J Adolesc Res*, **1**, 213-230.