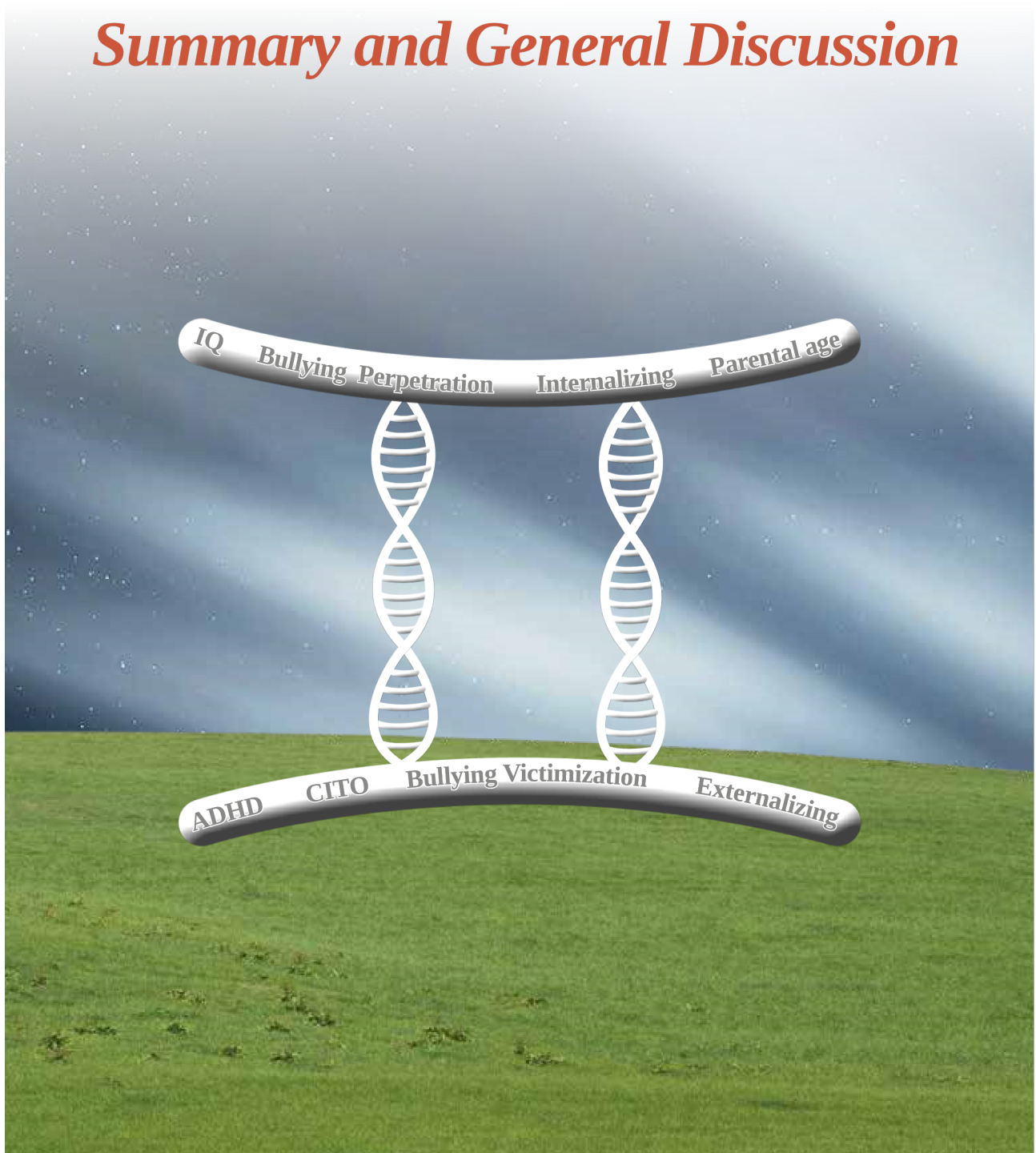# Chapter 6

Summary and General Discussion

Summary

This dissertation focused on 1) bullying in primary school, and 2) the influences of parental age on childhood cognitive development and behavioral and emotional problems. For both domains, I looked at the role of protective and risk factors. With respect to bullying, data of twins were analyzed in two ways. First, in twin data we studied the effect of close companionship on bullying. Second, the classical twin design made it possible to advance knowledge about the etiology of differences between children by estimating the contribution of genetic and environmental factors to bullying. Regarding parental age, the aim was to advance knowledge about the influence of advanced parental age on offspring's externalizing- and internalizing problem behavior, attention problems, and cognitive functioning. For this aim I analyzed data from a large number of children through collaborations with other multiple childhood cohorts in the Netherlands. In this chapter I will first summarize the main findings of the two studies regarding bullying behavior and next of the two studies on the influence of parental age.

1. Bullying

The first part of my thesis was about bullying behavior in twins during primary school and addressed two issues: 1) the influences of possible risk factors on the prevalence, and 2) the causes of familial resemblance.

Chapter 2 was about risk factors regarding bullying behavior in twins. Based on previous research, a lot of questions remained regarding bullying in twins. The factors that were investigated in this chapter can be divided into twin specific and non-twin specific factors. For twin specific factors, I investigated whether the risk for bullying perpetration and bullying victimization differed for monozygotic- versus dizygotic twins, same-sex versus opposite-sex twins, and twins attending the same versus separate classrooms. In follow-up analyses, I also investigated two possible interaction effects: 1) whether an effect of classroom sharing differed for monozygotic- and dizygotic twins, and 2) whether an effect of being a same-sex versus an opposite-sex twin pair changed as children age. Regarding non-twin specific factors, I investigated whether the prevalence of perpetration and victimization change as children age and whether the prevalence rate of perpetration and victimization in boys differed from that in girls. In addition, an important question was about whether having a co-twin protected twin-children from bullying or being bullied. This question whether or not close companionship is protective was investigated by comparing the prevalence of perpetration and victimization in twins with the prevalence of their non-twin siblings. By using twins and singleton siblings from the same families, both groups match each other on important family background variables.

All research questions were investigated for both bullying perpetration and bullying victimization in a sample of ~ 8,000 twin children and ~1,400 singleton children. Bullying was rated by their teachers at ages 7, 9-10, and 12. Teachers answered four items about perpetration and four items about victimization. The items for victimization assessed (1) 'how often has the child been victimized in the past couple of months? (in general)', (2) 'how often has the child been teased, laughed at, or called names in the past couple of months? (verbal victimization)', (3) 'how often has the child been physically victimized, such as being hit, kicked, and pushed in the past couple of months? (physical victimization)', and (4) 'how often has the child been excluded by other children, ignored, or have other students spread false rumors? (relational victimization)'. Each item was scored on a five-point scale, from *never, once or twice, two or three times a month, about once a week, and several times a week.* Perpetration was assessed with the same items, but in the active form.

My study showed that close companionship was not protective, based on the finding that twin children are as much involved in bullying as their non-twin siblings. For both twins and singletons, teachers reported that 36% of the children bullied their peers moderately to severely in the last couple of months (i.e., at least once), and 35% of the children suffered moderately to severely from victimization. The twin-specific factors revealed that being fraternal or identical twins, or being part of a same-sex or opposite-sex twin pair does not affect the prevalence rates. The most important twin specific finding, however, is that classroom sharing appeared to be a protective factor regarding victimization. A subsequent analysis showed that this finding was restricted to girl-girl twins. In other words, female twin pairs placed together in the same classroom do, on average, not bully more often, but are less often victimized by others. Based on this finding, we conclude that assigning female twins to the same classroom may act protectively. More general, for girls, this suggests a protective effect of having a close companionship in the same classroom. The non-twin specific factors showed that children around age 10 are at highest risk to be involved in bullying and that boys are more often involved in bullying, either as bully or victim.

After taking into account the general effects on bullying, large individual differences remain. In **Chapter 3**, I addressed the question to what extent these individual differences in the risk of bullying are caused by genetic- and environmental factors. Here I considered these factors as latent concepts containing all genetic and environmental variation between children and estimated the extent to which these factors influence why some children are involved in bullying and others not. This question could be addressed by making use of the classical twin design, that includes mono- and dizygotic twin pairs.

I estimated the relative contribution of genetic and environmental factors on different forms of bullying perpetration, bullying victimization, and their association. Teachers rated ~8,000 twins on their general, physical, verbal and relational bullying behavior by using the same items as in chapter 2.

The teachers reported that 34% of these children were involved as a bully, victim, or both. The heritability of perpetration was ~70%, for victimization the heritability was ~65%, similar for boys and girls, yet both were somewhat lower for the relational form. More specifically, for both boys and girls the heritability estimate of general perpetration was 72%, for verbal perpetration the heritability was 73%, for physical perpetration 71%, and for relational perpetration 68%. For victimization these estimates were respectively 62%, 64%, 70%, and 55%. Shared environmental influences for perpetration and victimization were modest (ranged from 2%-18%) and were more pronounced among girls. Bullying perpetration and bullying victimization were highly correlated.
The correlations in our sample ranged from .59 (for the relational form) to .85 (for the physical form).

The association between being a bully and being a victim was mostly explained by shared genetic factors for the general (~65%), verbal (~71%) and physical (~77%) forms and mostly by environmental factors for the relational form (~60%). This translates into genetic correlations of .50 for general bullying, .62 for verbal bullying, .86 for physical bullying, and .26 for relational bullying.

2. Parental Age

The second part of my thesis was about the influences of parental age on two important aspects of child development: 1) externalizing and internalizing problem behavior, and 2) attention problems and cognitive functioning.

In the literature, the effects of advanced parenthood on neurodevelopmental disorders, like autism and schizophrenia, are well established (Merikangas, 2016; 2017). That is, offspring of older parents are more at risk to develop these disorders. However, for other child characteristics less is known about the effect of advanced parenthood. **Chapter 4** reported on the influence of parental age on offspring internalizing and externalizing problems. Based on previous studies regarding neurodevelopmental disorders, our expectation was that the adverse effects of older parents might extend to offspring problem behavior. We analyzed the influence of advanced mother- and fatherhood within four large Dutch population-based cohorts, with a total sample of ~33,000 10-12 aged children.

The cohorts that contributed to this study were the Netherlands Twin Register (NTR, see van Beijsterveldt et al., 2013; from all regions in the Netherlands), Generation R (Gen-R, see Kooijman et al., 2016; city of Rotterdam in the Netherlands), the Research on Adolescent Development and Relationships-Young cohort (RADAR-Y, see Crocetti et al., 2017; province of Utrecht and four large cities in the mid-west of the Netherlands), and the Tracking Adolescents' Individual Lives Survey (TRAILS, see Oldehinkel et al., 2015; the Northern regions of the Netherlands). Externalizing and internalizing problems were rated by multiple informants: mothers, fathers, teachers and the children themselves. Each cohort had data available for at least one informant. Both outcomes were assessed with the ASEBA questionnaires, which include standardized instruments for child self-reports, parent reports, and teacher reports. We executed cross-validation analyses by using the first random half of the data for generating hypotheses and by using the other half of the data for testing these hypotheses. Cutting the whole dataset of each cohort into two independent datasets avoids "double dipping". That is, in this way the informative hypotheses are not generated and evaluated by the same dataset. The exploratory results of the various cohorts showed that it might be possible that 1) age had a negative linear effect and no quadratic effect, or 2) that age has a negative linear effect with a positive quadratic effect. Hypotheses representing "no effect" and "all other effects than specified in the informative hypotheses" were also tested in the confirmatory phase. Each cohort evaluated this same set of hypotheses. Bayesian evidence synthesis was applied to summarize the results of the multiple cohorts.

Based on the confirmatory results, we can state that there was evidence of a robust (i.e., "over cohorts") negative linear relation between parental age and externalizing problems when the analyses were based on parent reports, indicating that children from older parents show less externalizing problems. In teacher-reports, this relation was largely explained by socio-economic status. Child-reported data showed no effect with parental age. Parental age had limited to no association with internalizing problems. These results indicate that there is no harmful effect of advanced parenthood on offspring's externalizing and internalizing problem behavior. For externalizing problem behavior, there even is a beneficial effect, both before and after including SES.

The method we applied in this study thus contained four steps: 1) creating exploratory and confirmatory datasets, 2) generating informative hypotheses using the exploratory dataset, 3) evaluating these informative hypotheses using Bayesian hypothesis evaluation, and 4) using Bayesian evidence synthesis to summarize all results of the multiple cohorts into an overall "robust" result.

In traditional null hypothesis significant testing it is not possible to quantify the support for the null-hypothesis, which appeared an important hypothesis in our study. In our study the generated informative hypotheses are evaluated to this traditional null-hypothesis and the alternative hypothesis. Consequently, this Bayesian method should increase the credibility of our results. Since our method is based on quantifying support for each informative hypothesis instead of rejected or not-rejecting the null-hypotheses, it should also reduce publication bias. Classical meta-analyses are biased since a lot of studies with null-findings are not published. Another important strength of Bayesian evidence synthesis over classical meta-analyses is that our method enabled us to combine the results of the multiple cohorts into robust overall results, even when the multiple cohorts used different measurement instruments for the same concepts.

Chapter 5 investigated the effects of parental age on neurodevelopmental outcomes that are more common than autism and schizophrenia, like attention problems and cognitive functioning. Here, child-, father-, mother- and teacher-rated attention problems (N ~ 38,000), intelligence (N ~ 10,000) and educational achievement (N ~ 17,500) were analyzed for children from NTR, Gen-R, TRAILS, and RADAR-Y. Data for attention problems and intelligence (IQ) were available for each cohort. Standardized educational achievement data, measured by the "CITO-test" (Citogroep, 2019), were available for two cohorts. The "CITO-test" is a 3-day nation-wide standardized test for children at the end of primary school (around age 12). Around 75 per cent of schools in the Netherlands took part. For attention problems, each cohort had data available for at least one informant. The method we applied to analyze these data was the same as applied in chapter 4. That is, first informative hypotheses were generated based on the exploratory part of the data, after which these hypotheses were evaluated based on the confirmatory part of the data. The random first half of the data discovered that age 1) might have a negative linear relation and no quadratic relation, 2) might have a negative linear relation and a positive quadratic relation, or 3) might have a positive quadratic relation, but no linear relation. The hypotheses for cognitive functioning were the reverse. These informative hypotheses were tested in the confirmatory phase. Based on Bayesian evidence synthesis, the confirmatory analyses showed that older parents have offspring with fewer attention problems and younger parents have offspring with more attention problems. For IQ and educational achievement, the age of the mother also showed a positively and linearly effect. For fathers, however, their age had an attenuating positive relation with educational achievement, and an inverted U-shaped relation with IQ. This inverted U-shaped effect means that younger and older fathers are disadvantaged.

We thus conclude that, in general, there were hardly any disadvantages for off-spring of older parents with respect to the neurodevelopmental conditions attention problems, IQ, and educational achievement. We even showed that advanced parental age is mostly advantageous for attention problems and educational achievement. These associations mostly disappeared after including SES, indicating that SES had an important role in the relation between parental age and offspring neurodevelopmental outcomes.

General Discussion

As an overall aim of my dissertation I wondered which influences make some children vulnerable to face developmental difficulties and make others resilient. The aim of this thesis was to expand knowledge about two issues regarding child development: 1) bullying during primary school, and 2) influences of parental age on child development.

1. Bullying
In this part of my thesis, I investigated risk factors for bullying in **Chapter 2** and genetic and environmental influences on bullying in **Chapter 3**.

1.1   Risk Factors
The body of literature regarding bullying mostly addressed the effects of general factors, ranging from individual (e.g., age and gender) to contextual (e.g., parenting). Not many studies were done to investigate twin specific risk factors or to compare twins with singletons, even though twin children constitute 1/40 of all children. I will highlight and discuss the two most interesting and remarkable findings regarding risk factors for bullying in twins, which are about twin-singleton differences and the protective effect of classroom-sharing.

Twin-singleton differences
The first key finding of **Chapter 2** is that twin children are as much involved in bullying as their singleton, i.e., non-twin, siblings. Previous studies that tried to answer this "twin-singleton" question showed mixed results *(singletons at higher risk:* Barnes & Boutwell, 2013; no effect: Oshima et al., 2010; *twins at higher risk:* Weissenberg et al., 2007). These studies, however, were all based on unrelated singletons. Important related family factors in these unrelated singletons could have differed from that in the twin group, which hampers the twin-singletons comparisons of previous studies. This means that previous studies were thus not able to distinguish between real effects or effects caused by differences in important background characteristics of the twins and singletons.