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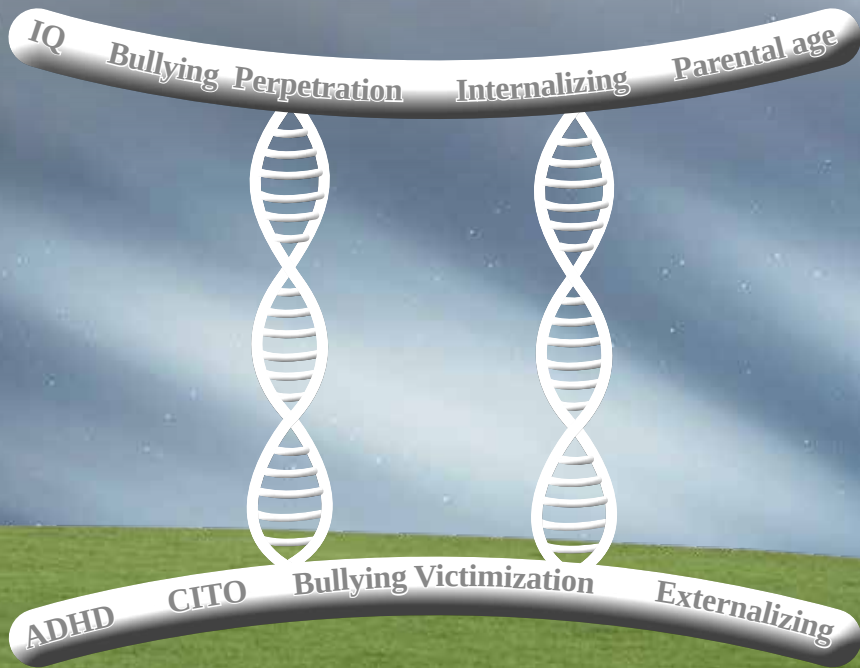
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Chapter 6

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 ($N \sim 38,000$), intelligence ($N \sim 10,000$) and educational achievement ($N \sim 17,500$) 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 offspring 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.

The strength of our study is that we collected, via teachers, data on the brothers and sisters of twins, instead of on unrelated singleton children from different families. That is, we employed a within family design that included twins and their singleton siblings. Within-family analyses are based on a research design that avoids confounding. That is, by comparing twins to their singleton sisters and brothers, we made sure that we controlled for influences of maternal and family characteristics (e.g., the socio-economic environment) that might be related to bullying. For example, Jansen et al. (2012) showed that the prevalence of bullying is influenced by family SES. That is, children with low family SES have an increased risk of being a bully or bully-victim. So, we made sure that both groups match each other on important family background variables. This method of matching important family background information of twins and singletons enabled us to detect true effects. Consequently, we can conclude that there are no differences regarding the bullying prevalence rates of twins and singletons. The implication of this finding is that it is likely that our conclusions based on twin research (like age and gender effects) are therefore generalizable to the population at large.

Classroom Effect

One of the most notable finding of **Chapter 2** is that female twin pairs who attend the same classroom do not bully less or more than separated twins, but they are less victimized. The only previous study that investigated this research question was the study of Lamarche and colleagues (2006). Their result pointed towards a protective effect of sharing a classroom, but their study was possibly too small to reach significance for this finding. Our result, based on a much larger group of twin pairs, is in agreement with the result of Lamarche et al. (2006).

Previous studies found very few harmful or beneficial effects of classroom sharing on other traits, like school performance or problem behavior (van Leeuwen, van den Berg, van Beijsterveldt & Boomsma, 2005). There are also studies showing that separated twins had more internalizing problems and lower reading scores, suggesting that classroom sharing might be beneficial, but we have to take in mind that all these effects were weak (e.g., Lamb, Middeldorp, van Beijsterveldt & Boomsma, 2012; Tully, Moffit, Caspi, Taylor, Kiernan & Andreaou, 2004). In agreement with these results, we found that girl-girl twins attending the same classroom are less often victim of bullying than those in separate classrooms, suggesting that for victimization being together in the same classroom may also act protectively.



Together, these findings imply that the placement of twins in the same classroom might be beneficial regarding victimization and is not harmful for other important behavioral and cognitive outcomes. This is very relevant and important to twin families, primary schools, and educational policies, since classroom placement is a malleable factor and teachers and parents can thus have an influence. Although school may have a set policy regarding classroom placement of twins, this protective effect of classroom sharing for girl-girl twins should be taken into account when twins enter primary school.

1.2 Etiology

Only very few studies investigated the causes of individual differences in bullying within a genetics context. Most of them focused on victimization, while perpetration and their association was only investigated once (by Ball et al., 2008). Although we know from earlier studies that bullying behavior comes in different forms, ranging from kicking (physical) and name-calling (verbal) to spreading rumors (relational), all genetically-sensitive studies so far focused on bullying behavior in general. The one exception is the study of Eastman et al. (2018), who investigated the heritability of various forms of victimization. Our data enabled us to investigate the genetic and environmental influences on different types of bullying perpetration, victimization, and their co-occurrence (characterizing bully-victims).

Etiology of the different Forms of Perpetration and Victimization

We found that all forms of bullying perpetration and victimization were substantially heritable. Eastman et al. (2018) investigated self-reported verbal, physical, relational, and property victimization and showed that these heritability estimates ranged from 23% (for attacks on property) to 42% (for physical victimization). Their finding that physical victimization is most heritable is in agreement with our findings. Their study, however, suffered from limited power ($N=306$ pairs) and therefore they could not investigate whether the heritability estimates differed for boys and girls. They also did not investigate different forms of perpetration.

Our large sample ($N \sim 4,500$ twin pairs) and data on both perpetration and victimization enabled us to investigate both remaining research questions. We showed that there were no differences in heritability estimates for boys and girls. Regarding perpetration, we cannot compare our results of the various forms with previous studies, since there are no previous studies. However, as we compare it with the general perpetration heritability Ball et al. (2008) showed, then we see that they are comparable ($\sim 70\%$ in our study, compared to 61% in their study).

Etiology of their Associations

The co-occurrence of perpetration and victimization was mostly due to genetic factors for general, verbal, and physical bullying, but mostly due to environmental factors for relational bullying. The only previous study (Ball et al., 2008) showed a (phenotypic) correlation of .25 between general bullying perpetration and general bullying victimization and they went on to show that this correlation was only due to genetic factors. Although in our study, the correlation for the general item between perpetration and victimization was much higher ($\sim .65$), their finding that this correlation was only due to genetic factors is to a large extent in agreement with our finding. We found that this correlation was mostly caused by genetic factors. However, we also showed that the causes of the associations differed for the various subtypes (i.e., lower influences of genetic factors for the relational form) and therefore we cannot easily compare our results with previous studies that might have combined information of different subtypes into one single measure. For instance, Ball et al. (2008) assessed the construct general victimization with items including verbal, physical and relational victimization.

1.3 Conclusions Regarding Bullying

Together, the results of **Chapter 2** imply that the factors influencing bullying indeed range from individual (like gender) to contextual (like classroom-sharing). Moreover, the results of **Chapter 3** implicate that substantial genetic influences are responsible for the individual differences regarding bullying behavior (for bullies, victims and bully-victims). Teachers, for example, can confirm that some children are more vulnerable for being victimized, especially children that are different based on their appearance or behavior. We know from twin research that most of the physical appearance and behavior is moderately to highly heritable. In addition, a recent study showed that children with a genetic vulnerability for attention-deficit hyperactivity disorder (ADHD), depression, higher BMI and lower IQ, are at a higher risk for exposure to bullying (Schoeler et al., 2019). This genetic vulnerability might explain the genetic influences on bullying. This genetic vulnerability, however does not mean that bullying is not modifiable. There are evidenced-based interventions that reduce school bullying. Interventions have been shown to be most effective when the whole school is involved (e.g. Menesini & Salmivalli, 2017; Vreeman & Carroll, 2007), an example of such a program is the KiVa Anti-Bullying Programm (Salmivalli, Kaukiainen & Voeten, 2005). Positive teacher-child relationships might reduce the vulnerability of children and the detrimental effects victimization has. Teachers that clearly communicate their antibullying attitude to the children in their classroom might be of influence as well (e.g. Menesini & Salmivalli, 2017). Moreover, the findings of Schoeler et al. (2019) implicate that prevention programs should address preexisting vulnerabilities in order to avoid repeated exposure to bullying.



2. Parental Age

In the second part of my dissertation, I collaborated with multiple large childhood cohorts in the Netherlands. These cohorts work together within the Consortium on Individual Development (CID). CID is an NWO-funded consortium in which different universities and institutes collaborate, combining expertise of multiple disciplines. This consortium aims to understand the factors that influence individual differences, ranging from child characteristics to environmental factors. Our collaboration within this large consortium turned out to be highly valuable. We wrote two papers together which should be of considerable interest to a large audience. These papers are of great value due to the advanced statistical approach and large datasets and can therefore extend existing knowledge about the influence of parental age on childhood development.

With the unique data of this large collaborative effort, I focused on the influences of parental age on offspring's socio-emotional and cognitive development. The rationale for these two studies was that people in western societies are more and more postponing parenthood and this might have consequences for children's (mental) health. In the Netherlands, for example, the mean age at first birth was 24 in 1970, while nowadays this is much higher, around 30 (CBS, 2019). In Figure 1, it can be seen that the children born to mothers aged 35 years or above were in 1950 mostly the fourth (or subsequent) born child, while in 2015 these children were mostly the first or second born child. In other words, this figure shows that in 1950 and 1975 mothers started a family earlier compared to mothers in 2015.

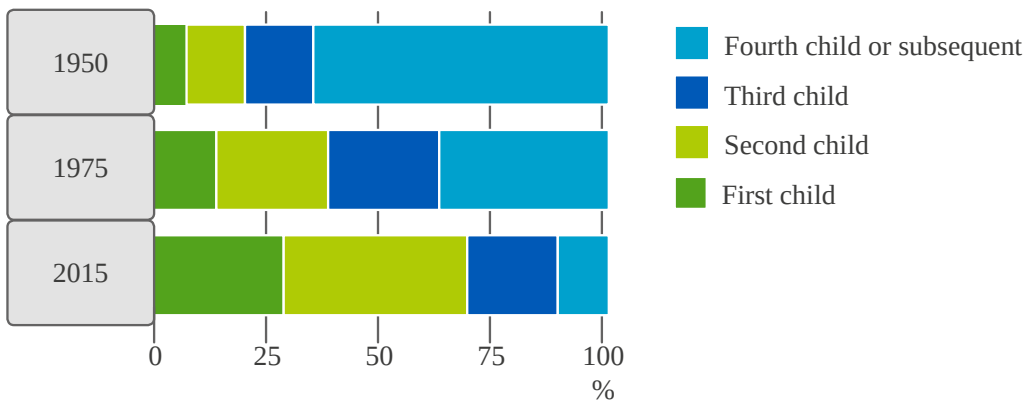


Figure 1. Live births to mothers of 35 years or above, for three different birth cohorts.

In line with Figure 1, Figure 2 also shows that in general people tend to postpone parenthood until later in life. The total number of children born fell rapidly after the widespread availability of contraception around 1970. Regarding the trend of delaying parenthood, for example, the yellow band in Figure 2 demonstrates that the number of mothers of 30-35 years of age has considerably increased. That is, from approximately 25 per 1.000 mothers in 1950 to approximately 50 per 1.000 mothers in 2015. In other words, the number of mothers aged 30-35 has doubled between 1950 and 2015. Figure 2 (bottom blue band) also shows that nowadays there are very few teen mothers (<20 years of age) in the Netherlands. Since in the Netherlands teen mothers barely exist, in the following sections I will focus on the findings and implications for older parents.

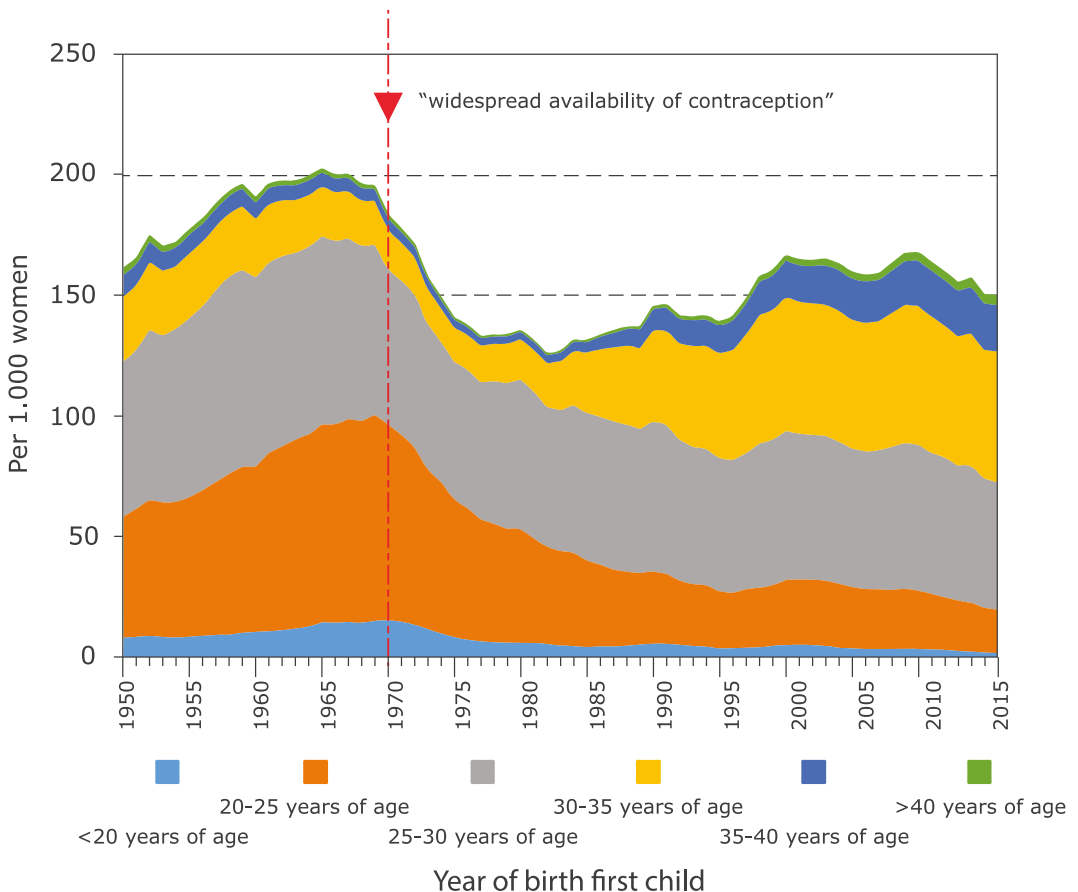


Figure 2. Number of first born children per 1.000 mothers, across maternal age category and year of child birth.

Older parents are disadvantaged from a biological point of view, for example due to a higher number of *de novo* mutations (e.g., Malaspina, 2001). It is well established that children of older parents (especially investigated for older mothers) have an increased risk for rare severe neurodevelopmental disorders, like autism, schizophrenia, and Down Syndrome (e.g., Merkiangas, 2016, 2017). Therefore, concerns are growing about the postponement of starting families. In this part of my thesis, I aimed to investigate whether the adverse effects of advanced parenthood for rare severe disorders extent to the full range of socio-emotional and cognitive skills. Therefore, I investigated externalizing- and internalizing problem behavior in **Chapter 4** and attention problems and cognitive functioning in **Chapter 5**.

2.1 Externalizing and Internalizing Problems

In general, we found that offspring of older parents had fewer externalizing problems. It should however be noted that the results were rater dependent. That is, parents and teachers reported fewer externalizing problems for offspring of older parents. Based on the self-reports of the children no effect was found, but this can be due to the limited ability of 10-year-old children to reliably report their behavior. For teacher-reported data, the positive relation mostly disappeared after including information about the socio-economic status (SES) of the parents. This was not the case for parent-reported problem behavior, meaning that the favorable effect of parental age is rater dependent and not solely due to the socio-economic status of the parents.

Only a number of studies have previously investigated the influence of parental age on externalizing and internalizing problems and showed mixed results (for a review, see Tearne, 2015). In addition, it remained unknown whether the effects of advanced maternal and paternal age were the same. Regarding externalizing problem behavior, most studies reported that offspring of older mothers have fewer problems (for review, see Tearne, 2015), which is in line with our result. We showed that this effect extends to older fathers. Regarding internalizing problems, there was even less known. Since there was little comprehensive evidence from previous studies, we aimed to advance knowledge about the effects of advanced parental age on offspring's externalizing and internalizing problem behavior with our advanced method and large cohorts in order to inform worrying (future) parents about possible harmful effects.

Our findings implicate that there were thus no harmful effects of older parents on offspring's externalizing and internalizing problem behavior. Having older parents might even be beneficial regarding externalizing problems.



2.2 Attention Problems and Cognitions

Overall, we showed that offspring of older parents tended to have offspring with fewer attention problems. For cognitive functioning, offspring of older mothers had on average higher IQ and educational achievement scores. Regarding paternal age, offspring of older fathers tended to have higher educational achievement scores, but this effect attenuated with older age (i.e., curvilinear plateau). Offspring of both older and younger fathers had lower IQ scores. Most of these relations, however, disappeared when taking the socio-economic status of the parents into account.

Previous studies regarding children's neurodevelopment showed mixed results. For instance regarding the effects of paternal age on offspring ADHD. Children of older fathers have been found to have a higher risk for ADHD in the study of D'Onofrio et al. (2014), equal risk in the study of Mikkelsen et al. (2016), and reduced risk in the study Chudal et al. (2015). These mixed findings were mirrored in the literature regarding the effects of parental age on cognitive function. All these previous studies used different methods, analytical strategies and/or control variables, which hampers drawing conclusions. Our method, on the other hand, enabled us to combine evidence from four large cohorts and hence obtain robust results, even though cohorts differed in type of measure. This study enabled us to expand the message for worrying (future) parents in Chapter 4 with information about the effects of advanced parental age on aspects of childhood development beyond rare neurodevelopmental disorders.

Our findings implicate that there were no harmful effects of older parents on offspring's attention and educational achievement. Only for IQ possible harmful effects of advanced fatherhood were found. For offspring's attention and educational achievement, the effects of older parenthood might even be beneficial. Taken together, this chapter showed us that advanced parental age is hardly disadvantageous, and mostly advantageous, with respect to attention problems, educational achievement and IQ.

2.3 Conclusions Regarding Parental Age

In the two discussed studies (Chapter 4 and Chapter 5), we reported that offspring of older parents fare better, but importantly, most effects disappeared after correcting for SES of the parents. This suggests that these positive effects are due the interplay between the genetic and environmental effects in SES that are transmitted from parents to their children. SES reflect the family's economic position (i.e., income and education) and is associated with different characteristics of the parents, like the parent's attention, cognitive abilities, and occupational level.



We know that in general most older parents have a higher SES and are highly educated. This implies that the beneficial effect of advanced parenthood seems especially driven by parental educational level.


The influence of SES might be explained in two ways. The first way is that SES might influence parental age, which in turn influences the offspring outcomes, meaning that people of low SES start families earlier which indirectly influences childhood outcomes. For instance regarding ADHD, parents with ADHD have a tendency for lower SES and their more risky behavior might result in early pregnancies. The children of these younger parents have lower family income (SES) and a parental history of ADHD, which both make them on average more likely to develop ADHD compared to other children. Russell, Ford, Williams and Russell (2016) indeed showed that family income and parental history of ADHD are strong predictors of the prevalence of ADHD in the offspring generation. Parental age is thus a mediator between parental SES and offspring outcomes. That is, ADHD in offspring is not due to the age of the parents, but due to the transmitted environmental and genetic liability. Secondly, SES may reflect a more general liability that influences both age at which people start families and offspring outcomes, without causality between parental age and offspring outcomes. This general liability could reflect both the genetic- and environmental transmission from parents to offspring.

Regarding the environment, parents of higher SES obviously have more resources to provide their children with a more stimulating environment. For instance van Bergen et al. (2017) showed that parental level of education, a measure that is highly correlated with SES, and the number of books in the home are moderately correlated ($r=.45$). So, highly educated parents tend to provide a more stimulating home environment, and transmit more genetic variants to their children that are associated with higher educational attainment. This phenomenon is referred to as “passive” gene-environment correlation; the genes that are transmitted from parents to offspring are not independent from the environments that these same parents provide to their offspring. In fact, the effect of the number of books in the home on children’s reading ability mostly disappeared after controlling for genetic influences, leaving little room for genuine environmental effects (van Bergen et al., 2017). This is in line with the finding that parent-child resemblance for reading ability seems to be due to genetic rather than cultural transmission (Swagerman et al., 2017).

The phenomenon of a passive gene-environment correlation may also apply to other traits: for example, parents with ADHD have an increased risk of impulsive behavior and unplanned early pregnancies (Ostergaard, Dalsgaard, Faraone, Munk-Olsen & Laursen, 2017).

These parents transmit their genetic vulnerability for ADHD to their offspring as well as a more chaotic and unstructured environment. More offspring of younger than of older parents may thus have a genetic predisposition to develop ADHD.

Although we do not exactly know which factors cause the beneficial effects of parental age that I found in my PhD research, we can say that it seems that advantages of advanced parenthood might outweigh the biologically disadvantages of advanced parenthood. Based on beneficial effects of parental age, people may think that future parents (especially highly educated people) do not need to worry about the development of their offspring and that it might be better to start a family at a later age. However, one should keep in mind that these results are *general effects* (i.e., in the population at large). I do not want to state that advanced parenthood is always “better”, since the biology of ageing still seems to put older parents in an unfavorable position with regard to their offspring’s physical and mental health (e.g., Malaspina, 2001). It is well established that offspring of older parents are at higher risk for serious neurodevelopmental disorders, like autism (Merikangas, 2016; 2017) even though the mechanisms that underly the association are still debated. It is also important to mention that the older parents in our (and comparable) studies were indeed parents; some people who postpone parenthood remain involuntary childless (te Velde, Habbema, Leridon & Eijkemans, 2012), which can have a big psychological impact (Lechner, Bolman & van Dalen, 2006). In Figure 3, taken from the study of te Velde et al. (2012), it can be seen that permanent involuntary childlessness (PIC) in Europe approximately doubled since the 1970’s. In the Netherlands, this percentage increased from approximately 2.5% in 1970 to approximately 6.5% in 2007.



My aim was to investigate whether the well-established adverse effects of advanced parenthood for severe neurodevelopmental disorders also would extend to more common neurodevelopmental problems. Based on **Chapter 4** and **Chapter 5**, it is clear that there were hardly any harmful effects of advanced parental age on internalizing and externalizing problem behavior, attention problems, IQ, and educational achievement. Stated differently, offspring of older parents do, on average, equally well or better than offspring of younger parents. The finding that offspring of older parents perform better was mostly found before taking the SES of the parents into account. The finding that there is no effect of parental age was mostly found after taking the SES information into account. Both findings, however, imply that there is no harmful effect for postponing parenthood for the socio-emotional and cognitive development of children and thus parents that started their family at a later age do not have to worry regarding these childhood outcomes.

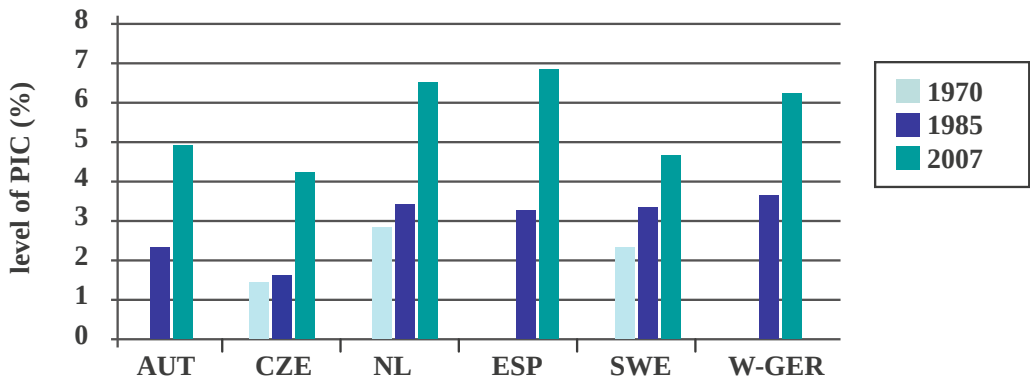


Figure 3. The effect of postponement of first childbirth on permanent involuntary childlessness (PIC in %) for different European countries. AUT = Austria, CZE = the Czech Republic, NL = the Netherlands, ESP = Spain, SWE = Sweden, and W-GER = West Germany. (This figure is taken from the study of *te Velde, Habbema, Leriodon & Eijkemans, 2012*).

The strength of the last two empirical chapters of my thesis is its methodological approach which employed a method to estimate robust effects by using Bayesian synthesis evidence. With the different measures from the four cohort studies, a meta-analysis approach which often requires to have the same measurement method in different studies would have been less optimal. In contrast, the Bayesian method enabled us to estimate robust effects, even though some child characteristics might have been assessed with different measures. Another strength was the large sample sizes of the four different cohorts. Thus, we contribute to the knowledge about parental age effects on childhood development by using a strong methodological approach.

3. General Conclusion

The overall question of my thesis was: which influences make some children vulnerable to face developmental difficulties and make others resilient? Within this overarching question, I aimed to expand knowledge about bullying in primary school and influences of parental age. For bullying, I conclude that there are general risk factors which make some children more vulnerable to be involved, like being a boy. Besides, I also found protective factors, like classroom sharing for girl-girl twins and I take the close bond that twins can have as a model for the protective effects of ‘close companionships’. Even after accounting for these general effects, large individual differences remained, which we showed to be mostly caused by genetic differences between children.

In the second part of my thesis, I showed that offspring of older parents tend to have fewer behavioral- and neurodevelopmental problems and higher cognitive functioning. This effect was mostly due to the SES of their parents. In other words, also characteristics of parents, like their age at which they start families and education, influence multiple aspects of their offspring development.

To situate these results within the Consortium for Individual Development (see Figure 4), we can indeed say that children's biological predisposition, children's characteristics and children's rearing environment influence why some children face more difficulties during their development than others.

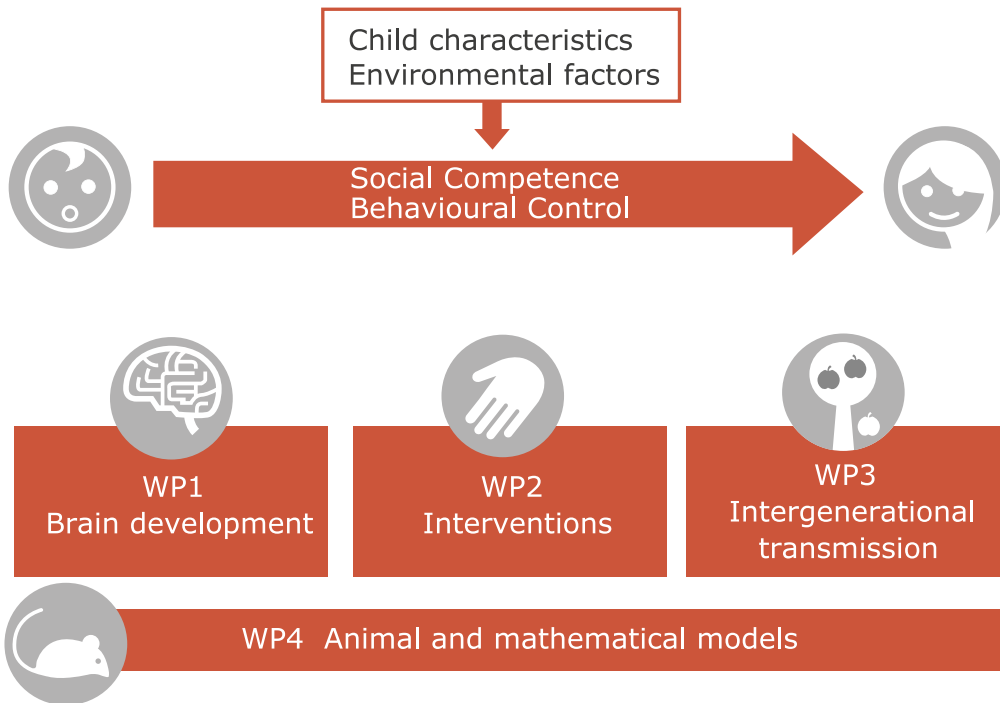


Figure 4. The overview of the CID consortium.

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