The interplay of personal endowments and the social environment in the development of child and adolescent externalizing problems

Joanne Marieke Buil

Reading committee:
prof.dr. C. Schuengel
prof.dr. A. H. N. Cillessen
prof.dr. M. Steketee
prof.dr. P. Prinzie
prof.dr. H. W. Tiemeier

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Joanne Marieke Buil

geboren te Winterswijk

promotoren: prof.dr. P.A.C. van Lier

prof.dr. J.M. Koot

“Give me a child until he is 7 and I will show you the man”

Aristotle, 384–322 BC

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General Introduction

The ‘problem child’ who engages in externalizing behaviors, such as negativistic, oppositional and defiant behavior, in conduct problems such as aggression and serious rule breaking, or in delinquent and illegal acts, was and is a source of fascination for many people in society. In many popular books, films and cartoons ‘problem children’ or ‘troublemakers’ play a major role. Early examples are the adventures of Tom Sawyer and Huckleberry Finn, written in the late 19th century by Mark Twain. In the Netherlands, Pietje Bell, a young boy who often gets into trouble, written in the early 20th century by Chris van Abkoude, became extremely popular. More recently, Dennis the Menace and Bart Simpson are famous examples of children with a penchant for mischief and who rebel against authority. Furthermore, speculations on the origins of externalizing behavior and ‘problem children’ have been a key topic in the early writings of philosophers and scientists (e.g., see Darwin, 1872/1998; Erasmus, 1529/1985; Hobbes, 1647; Rousseau, 1762) and still are for current thinkers. Moreover, the etiology and development of externalizing behavior problems is a topic many researchers in the field of developmental psychology study and is key to most philosophies of human behavior. With time, the opinions on the origins and development of externalizing behavior problems have been upgraded and the assumed paradigms for how we study its development have been reconsidered. That is, while the earlier views stressed either the influence of nature (i.e., innate characteristics that are present prenatally or shortly after birth; Plomin & Rende, 1991; Rousseau, 1762) *or* nurture (i.e., the influences of society; Locke, 1689; Watson, 1924), the current position on the development of externalizing behavior problems is that both nature *and* nurture - and particularly their interplay - are crucial for understanding its etiology and development (see for an overview e.g., Parritz & Troy, 2014).

Studies focused on children’s and adolescents’ behavioral development have discovered a plethora of risk factors within the domains of nature and nurture that are related to the development of externalizing behavior. For example, risk factors within the domain of

innate characteristics that are present prenatally or shortly after birth (i.e., nature), in this thesis referred to as 'biological predispositions' or 'personal endowments', include - among other factors - children's genetic make-up, sex, and temperament and personality (for reviews, see Beaver, Schwartz, & Gajos, 2015; Morizot, 2015; Raine, 2013). Risk factors within the domain of societal influences (i.e., nurture), in this thesis referred to as 'social-environmental factors', include – among other factors – children's home and peer environment (for reviews, see D. Chen, Drabick, & Burgers, 2015; Kerig & Becker, 2015; Pardini, Waller, & Hawes, 2015). In the present thesis we will focus on the abovementioned personal endowments genetic make-up, sex, temperament and personality and children's peer and home environment as the social-environmental factors of interest.

Despite that previous empirical studies have provided plenty of insight in which personal and social-environmental factors are associated with concurrent or later externalizing behaviors, the study of externalizing behavior development is as of yet far from complete. That is, in earlier (but also still in more recent) studies, risk factors for externalizing behavior often have been studied in isolation or as additive risk factors (e.g., see Heron et al., 2013; Moffitt & Caspi, 2001; Moffitt, Caspi, Rutter, & Silva, 2001). Although very insightful, by using this approach these studies cannot provide insight in the *underlying mechanisms* that explain the development of externalizing behavior problems. Furthermore, with this type of study researchers are unable to investigate the potential *interplay* between the risk factors. Investigating the interplay between risk factors enables us to identify potential subgroups of children that may be particularly prone to developing externalizing behavior problems. Hence, although there is a firm knowledge base on which factors predict later externalizing behaviors, far less is known on *how* and *for whom* personal and social-environmental factors may affect its development. In order to understand how certain (possibly innate) personal endowments of children may become expressed in later externalizing problem behavior and which children are

particularly sensitive to (negative or positive) social-environmental influences, we need longitudinal studies that include assessments of multiple (risk) factors from both the domains of nature and nurture (e.g., see Beaver et al., 2015; Frick, 2016). Therefore, in the present thesis we will focus on personal factors within the child, like genetic make-up, sex and temperament and personality traits and study whether these factors – in concert with children's peer and home environment – may explain the development of externalizing behavior.

Previous studies that have investigated the interplay between children's personal endowments and their social environment in explaining externalizing behavior development were generally focused on negative social environments. For instance, traditional as well as recent studies on nature x nature interplay (with the majority focusing on genes as the *nature* factor of interest) have indicated that vulnerable individuals may be at particular risk for developing externalizing behavior problems when they have been exposed to rather severe adverse home environments, such as being maltreated or abused in childhood (Caspi et al., 2002; Kim-Cohen et al., 2006; Ouellet-Morin et al., 2016; Weeland, Overbeek, de Castro, & Matthys, 2015; Windhorst et al., 2016). More recently, studies have started to investigate nature x peer environment interplay. Again, most of these studies focused on the interplay between genetic factors and more severe adverse peer factors, such as affiliation with deviant or aggressive friends (Kretschmer, Vitaro, & Barker, 2014; Lee, 2011; Van Lier, Boivin, et al., 2007) or being victim of bullying (Brendgen et al., 2011; Brendgen et al., 2008; DiLalla, Bersted, & John, 2015).

Despite the importance of such clearly negative factors, subtler social-environmental factors may also influence externalizing behavior development. For instance, whereas bully-victimization is an active process (i.e., children actively bully the victim), social evaluation processes like peer likeability and children's standing in the peer group hierarchy (i.e., social preference) are more passive processes that do not immediately imply a negative effect. That

is, even when children are not liked by many peers in their classroom, this might not be imagined a risk factor at first glance. However, such seemingly subtle social-environmental factors may nonetheless have a significant impact on a child's development because many children are exposed to these environmental influences for a major part of their daily life. This may be of particular importance because such seemingly less negative and perhaps less noticeable relationship factors may easily be overlooked by parents, teachers, clinicians and other professionals as relevant for a child's development and behavioral adjustment. Moreover, whereas factors like bully-victimization can be absent altogether, all children in a classroom will be subjected to social evaluations by their peers. Hence, in addition to research focused on the negative, visible end of the social-environmental spectrum in explaining why certain children and adolescents may develop externalizing behaviors and which subgroups of children are particularly vulnerable to developing such problems, studies that focus on subtler, less explicitly negative social-environmental factors that affected children will encounter on a daily basis may also add to our understanding of externalizing behavior development. Therefore, in the present thesis we will focus on the interplay between children's personal endowments and clearly negative and/or active factors home and peer factors like abusive disciplining, maternal delinquency, maternal depressed mood and affiliation with deviant friends as well as more subtle and/or passive home and peer factors such as parenting stress, poor parental involvement, peer likeability and children's social preference among peers.

In sum, the present thesis is focused on how three key personal endowments of children, namely children's genetic make-up, temperament, personality and sex may - throughout development - become intertwined with two of the most important social-environmental influences in children's and adolescents' lives, namely the daily relationships with their parents and peers. In four observational longitudinal studies and one experimental longitudinal study I address the question how this child – daily environment interplay may predict a broad spectrum

of externalizing behavior problems in children and adolescents, including aggressive behavior and interpersonal violence, theft and vandalism, and illicit drug and alcohol use.

In this general introduction, I will first give a short description of the definition of externalizing behavior problems as used in the present thesis and provide an overview of its prevalence in general population samples in Western countries - including the Netherlands - from a developmental perspective. In this part, I will also review the possible negative consequences of engaging in externalizing behaviors. Second, I will provide an overview of empirical evidence that associates the children's personal endowments (i.e., genetic make-up, temperament, personality, sex) and the social-environmental factors (i.e., parent-child and child-peer relationships) that are focus of this thesis, to the development of externalizing behavior. Third, I will elaborate on the theoretical background and empirical evidence on how these personal endowments and social-environmental factors form the components of an integrative developmental model of externalizing behavior problems. In the final part of this general introduction, I will summarize the research questions that guided my work and present the design and outline of the present dissertation.

GENERAL BACKGROUND

Externalizing behaviors are negative behaviors that are directed toward the external environment. In the present thesis and in accordance with others (e.g., Frick et al., 1993), we refer to externalizing behavior as an umbrella term for a broad spectrum of behavioral problems which includes *oppositionality*, such as being disobedient, stubborn and negativistic, *interpersonal aggression or violence* such as starting fights, threatening and bullying others, *property violations*, such as fire setting, vandalism and theft, and *rule breaking behaviors*, such as illicit substance use (Frick et al., 1993). Although most children and adolescents of the general population do not engage in such externalizing behaviors, a significant amount of youth

does (for prevalence rates of externalizing behavior in Western countries, see e.g., Frick, 1998; Moffitt, 1993; Moffitt, Silva, Lynam, & Henry, 1994). Specific to the Netherlands, the national annual report of youth delinquency showed that a little less than 20% of the Dutch 10 and 11 year old children reported that they had engaged in delinquent acts recently (i.e., in 2015). Of these, minor violent acts were the most prevalent, followed by theft and vandalism. This number increased to 35% for Dutch adolescents aged 12 to 17 years, with interpersonal violence being the most prevalent, followed by theft, acts of vandalism and drug-related crimes (Statistics Netherlands, 2016). Although exact prevalence rates vary between countries, similar trends have been reported in national reports of other Western countries, including the UK (National Statistics, 2015), the United States (Sickmund & Puzzanchera, 2014) and Canada (Statistics Canada, 2015).

Although externalizing behaviors are by definition harmful for the victims of these behaviors, they also pose a significant threat for the perpetrators themselves. That is, children who engage in externalizing behavior in elementary school or during adolescence have been found to be at risk for a broad spectrum of mental health disorders, as well as for academic failure, problematic substance use and substance dependency, criminality, societal dropout and premature mortality including death from reckless behavior and suicide (Fergusson, Boden, & Horwood, 2009; Fergusson, Horwood, & Ridder, 2005; Kim-Cohen et al., 2003; Kretschmer, Hickman, et al., 2014; Maughan, Stafford, Shah, & Kuh, 2014; Moffitt, Caspi, Harrington, & Milne, 2002). Furthermore, externalizing behavior problems were and are among the most common reasons for referrals to child and adolescent mental health clinics in Western countries (Costello & Janiszewski, 1990; Frick, 1998; Kazdin, 1995; Loeber, Burke, Lahey, Winters, & Zera, 2000; Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015), including the Netherlands (Matthys & van de Glind, 2013; Verhulst & Van Der Ende, 1997).

In addition and as indicated above, children who engage in externalizing behavior place a burden on others. That is, children's behavioral problems at home and at school are related to emotional distress in peers (R. D. Duncan, 1999), and to stress, depressive symptoms and burn-out symptoms in parents and teachers (Anderson, 2008; Friedman, 1995; Gartstein & Sheeber, 2004). Furthermore, youth who engage in severe externalizing behaviors are responsible for major societal costs due to vandalism, theft, interpersonal violence and other forms of delinquent and serious rule breaking behaviors such as the illicit use of substances (Miller, Levy, Spicer, & Taylor, 2006; Romeo, Knapp, & Scott, 2006; Statistics Netherlands, 2008). For example, in the Netherlands over 200 million euros are spend yearly on sanctions within the juvenile justice system for youth aged 12 to 18 years (e.g., juvenile detention centers or community services; Statistics Netherlands, 2008). This number does not include costs due to damage to society or people, nor does it include costs for interventions outside the juvenile justice symstem or interventions for youth younger than 12 years of age. Given that more severe externalizing problems, such as delinquency in adolescence, are often preceded by milder externalizing behaviors, such as oppositionality and aggressive behavior in children (for overviews, see Frick, 2016; Tremblay, 2010), it may come as no surprise that externalizing behaviors in children and adolescents are of great concern to parents, teachers and the community at large.

CHILDREN'S PERSONAL ENDOWMENTS AND SOCIAL-ENVIRONMENTAL FACTORS RELATED TO THE DEVELOPMENT OF EXTERNALIZING BEHAVIOR

Factors related to the development of externalizing behavior can broadly be divided in biological predispositions and personal endowments of the child on the one hand and social-environmental factors on the other hand (Bronfenbrenner, 2009). Biological predispositions

and children's personal endowments are innate characteristics that are present prenatally or shortly after birth, commonly known as someone's 'nature', while social-environmental factors are commonly known as someone's 'nurture'. In this section the associations of the personal endowments 'genetic make-up, sex, temperament and personality' and the social-environmental factors 'peer and home context' with externalizing behavior problems are discussed. Note that the factors discussed by no means are an exhaustive overview of all important personal endowments or social environmental factors that may influence the development of externalizing behavior. Other personal factors such as neurocognitive factors and social-environmental factors such as the neighborhoods in which children grow up also play an important role (M. C. Elliott, Dupéré , & Leventhal, 2015; Loeber, Byrd, & Farrington, 2015), but are beyond the scope of the present thesis.

Biological predispositions and personal endowments

A first important biological predisposition predictive of externalizing development is a child's genetic make-up. Behavioral-genetic research has revealed a significant degree of heritability of externalizing behavior. That is, studies have suggested that genes account for approximately 50% of the individual differences in externalizing behavior, such as oppositional defiant behavior, (early childhood) aggression, and behaviors that fall under the broader spectrum of externalizing problems such as involvement in (illicit) substance use by minors (Burt, 2009; Ferguson, 2010; Knopik et al., 2014; Rhee & Waldman, 2002). Moreover, a growing body of genetically informed studies has shown the significance of genetic factors in a wide variety of children's personal characteristics that are thought to play a role in the development, continuation and aggravation of externalizing behaviors, such as temperamental traits (X. Chen & Schmidt, 2015; Saudino, 2005), particularly having a difficult or fussy temperament in early childhood (Micalizzi, Wang, & Saudino, 2017), oppositional defiant

behavior, and early childhood aggression (Burt, 2009; Knopik et al., 2014; Rhee & Waldman, 2002).

A second and perhaps most apparent biological predisposition that is predictive of the development of externalizing behavior problems is the child's sex. In almost every species that populate the earth, males are more aggressive than females and the human race is no exception. Around the time that children are two years old, levels of aggression peak (Tremblay et al., 1999). Even at this early age it is already noticeable that boys show significantly more aggressive behaviors than girls (Baillargeon et al., 2007; Tremblay et al., 1999). From the toddler period onwards, oppositional behavior starts to develop as children begin to say 'no' and start to throw temper tantrums (Granic & Patterson, 2006). Boys show more of these oppositional behaviors than girls (Moffitt et al., 2001; Van Lier, Van der Ende, Koot, & Verhulst, 2007). In middle childhood, conduct problems such as starting fights or destruction of others' belongings generally appear, with again boys engaging more often in these types of behaviors than girls (Moffitt et al., 2001; Van Lier, Van der Ende, et al., 2007). These sex differences in the level of externalizing behaviors remain apparent throughout the later elementary school years and early adolescence (Moffitt et al., 2001; Van Lier, Van der Ende, et al., 2007). Lastly, in later adolescence boys are more prone to engaging in delinquent acts such as interpersonal violence and vandalism (Moffitt et al., 2001; Weerman & Hoeve, 2012). In addition, more boys than girls meet clinical criteria for externalizing behavior disorders, such as conduct disorder (Côté, Tremblay, Nagin, Zoccolillo, & Vitaro, 2002; Maughan, Rowe, Messer, Goodman, & Meltzer, 2004).

Note that sex should not be regarded a risk factor in itself. Sex differences can partially be explained by differences in other biological predispositions between boys and girls, such as inherited vulnerabilities related to temperamental risk factors, prenatal, perinatal and postnatal factors related to impaired neurocognitive functioning and hormonal differences (Azurmendi

et al., 2016; Eme, Beauchaine, & Hinshaw, 2015). Thus, sex differences are apparent from infancy onwards and remain present until the later adolescent years with boys having systematically higher levels of externalizing behaviors than girls, which is at least partially due to differences in biological predispositions related to the child's sex.

Lastly, early childhood temperament and – later on – personality are important and well-studied personal predispositions that may explain individual differences in the development of externalizing behavior. Temperamental traits have been defined as "early emerging basic dispositions in the domains of activity, affectivity, attention, and self-regulation, and these dispositions are the product of complex interactions among genetic, biological and environmental factors across time" (Shiner et al., 2012, p. 437). It represents a child's early inherited personality traits and forms the core for later personality (A. H. Buss & Plomin, 2014; Rothbart, Ahadi, & Evans, 2000). Multiple studies found that individual differences in temperament and personality traits are predictive of a wide range of externalizing behavior problems, including serious rule breaking behaviors (Frick & Morris, 2004), aggression (Burt & Donnellan, 2008), vandalism and theft (Carrasco, Barker, Tremblay, & Vitaro, 2006) and illicit substance use, such as alcohol use by minors and drug use (Dick et al., 2013; Fridberg, Vollmer, O'Donnell, & Skosnik, 2011; Löckenhoff, Terracciano, Costa, Bienvenu, & Crum, 2016).

In sum, the study of individual differences in children's and adolescents' genetic make-up, (biological factors related to) a child's sex, and temperament and personality - as are the focus of the present thesis - may help us understand why certain children and adolescents develop externalizing behaviors and others do not. Of course, the whole story is not covered by children's personal endowments only. Externalizing behaviors also grow out of life experiences, especially with parents and peers. These social-environmental influences are therefore discussed next.

Social-environmental influences

Two major social-environmental domains influencing children's development and that hence are the focus of the present thesis, are the children's daily relationships with their parents and with their peers. The first major domain of potential social-environmental risk involves the child's social relationships with its parents. Within this domain, risk factors can be divided in the subdomains of parenting practices, such as disciplinary styles, parental support and parental control on the one hand, and parental experiences and behaviors, such as the level of parenting stress and depressive symptoms experienced by the parent or the parent's engagement in delinquent behavior, on the other hand.

Within the subdomain of parenting practices, studies found that using abusive disciplining tactics to correct children's behavior is a major risk factor for the development of children's externalizing behavior (Ip et al., 2015; Kerig & Becker, 2015; Keyes et al., 2015; Norman et al., 2012). Abusive disciplining includes parenting strategies such as scolding, threatening or using harsh physical reprimands (e.g., hitting with an object such as a belt) in order to discipline the child. Theoretical considerations propose that the link between abusive disciplining and later externalizing behavior may be explained by, among other things, modeling of the parents' behavior and reinforcement mechanisms. That is, when modeling of the parents' aggression results in compliance of others (e.g., peers or siblings) to the child's wishes and goals, behaving aggressively towards others may be reinforced (Kerig & Becker, 2015).

Children's experienced levels of parental support and control (often referred to as 'parental involvement') are two other important factors within the subdomain of parenting practices that are related to the development of externalizing behavior. Cross-sectional and longitudinal studies have indicated that externalizing behavior problems are more likely among children who perceive lower levels of parental support and control (for an overview, see Pardini

et al., 2015). Parental support refers to the extent to which children perceive their parents to be loving, affectionate, warm, supportive, and involved (Gerlsma, Van der Lubbe, & Van Nieuwenhuizen, 1992; Hale, Raaijmakers, Gerlsma, & Meeus, 2007). Children's experienced parental support may act as a protective factor for engagement in externalizing problem behavior, potentially because of its modeling effects or by setting a comfortable context in which other teaching efforts by the parent might prove successful (Dodge & Pettit, 2003). Parental control refers to the active effort by parents to set limits on their child's behavior. It includes the extent to which parents require their child to obtain permission before engaging in certain activities (such as going out) and insist on being informed about their children's whereabouts, activities and friends (Fletcher, Steinberg, & Williams-Wheeler, 2004). Requiring youth to obtain permission before going out and ensuring that activities outside of the home are sufficiently monitored by other adults may protect children against developing externalizing behavior (Pardini et al., 2015).

Within the subdomain of parental experiences and behavior, mothers' experienced stress from parenting and maternal psychopathology, most notably engagement in delinquent behavior and experiencing symptoms of depression, have been put forward as important risk factors involved in the development of externalizing behaviors. Regarding parenting stress, experiencing at least some amount of stress from parenting is the rule rather than the exception (Crnic & Greenberg, 1990; Morgan, Robinson, & Aldridge, 2002). However, although relatively normative, heightened levels of parenting stress in mothers have been linked to the development of externalizing problems in their children (Pardini et al., 2015). This association may be explained by, among other factors, the negative effect that parenting stress has on children's self-regulation and coping competence (Choe, Olson, & Sameroff, 2013; Moreland, Felton, Hanson, Jackson, & Dumas, 2016).

Regarding parental behavior, a history of delinquent behavior of parents has been related to a variety of externalizing problems in children, including (serious) delinquent behaviors (Pardini et al., 2015). Furthermore, it is well known that delinquent behavior runs in families (Savage, Palmer, & Martin, 2014). Although the mechanisms explaining why parental delinquent behavior predicts children's externalizing behavior remain to be investigated, initial evidence indicates that this link may partially be explained by absence of the parent due to incarceration, hostile parenting practices and monitoring of the parent's behaviors (J. Murray, Loeber, & Pardini, 2012; Sellers et al., 2014). Furthermore, multiple studies have related maternal symptoms of depressed mood to the development of externalizing problems in their children (for an overview, see Pardini et al., 2015). This association may be due to, among other factors, increased mother-child aggression (Villodas, Bagner, & Thompson, 2015) and the negative effects that maternal depressive symptoms have on children's neurocognitive functioning (Roman, Ensor, & Hughes, 2016) and self-regulation (Choe et al., 2013).

The second major domain of potential social-environmental risk involves the child's (emergent) relationships with peers. Around the fourth year of life, almost all children around the world enter formal schooling, which is a major change in their social environment. Not only do children need to adjust their behaviors according to classroom rules, functioning among peers and cooperating with classmates becomes more and more important. From the start of early elementary school onwards, being liked and accepted by the peer group is a crucial developmental task (Rubin, Bukowski, & Parker, 2006; Sroufe, Egeland, Carlson, & Collins, 2009). For example, in tandem with the development of theory of mind, which starts around this age (Perner & Lang, 1999), children may become aware of the fact that other children may not like them and become more vulnerable to social comparisons and the social hierarchies that are naturally formed in peer groups (Granic & Patterson, 2006).

When children enter formal schooling and move into classrooms, they are subjected to a social evaluation process by their age-matched peers. As a consequence of this process, some children may become liked and others may become disliked by their peers. Previous studies revealed that being liked among peers protects children against developing externalizing behavior, particularly for children who are already vulnerable (Menting, Koot, & van Lier, 2014; Menting, Van Lier, & Koot, 2011). A slightly different, albeit related, construct that reflects children's appraisal among peers is a child's place in the social hierarchy, also known as child's 'social preference' (Coie, Dodge, & Coppotelli, 1982). Social preference refers to the extent of how well a child is liked, relative to being disliked among peers (Coie et al., 1982). Hence, high social preference levels indicate that a certain child is liked among many and disliked by only a few of its peers, while the opposite is true for children who are poorly preferred. Poor social preference is an important risk factor for the development, continuation and aggravation of externalizing behavior (Gooren, van Lier, Stegge, Terwogt, & Koot, 2011; Lansford, Malone, Dodge, Pettit, & Bates, 2010; Reijntjes et al., 2011; Van Lier & Koot, 2010; Vitaro, Pedersen, & Brendgen, 2007). The link between poor social preference and subsequent externalizing behaviors may be explained by the fact that poorly preferred children have fewer opportunities to develop adaptive social skills, may retaliate against their peers, or may show aggressive coping styles and maladaptive social information processing (Dodge et al., 2003; Sandstrom, 2004). This may lead to further and more chronic poor preference among peers, ultimately feeding the development of externalizing behavior problems (Van Lier & Koot, 2010).

During the later elementary school years, the direct influence of children's peers on antisocial behavior grows via affiliation with deviant friends. An early study on criminal offenses found that the grand majority of all recorded delinquent acts by adolescents were committed within groups rather than by sole individuals (Aultman, 1980). Furthermore,

children who affiliate with deviant friends are at high risk of engaging in externalizing behaviors themselves, a finding that has been replicated multiple times for severe as well as minor rule breaking and antisocial behaviors, as well as for associated outcomes such as illicit substance use (Keijsers et al., 2012; Melde & Esbensen, 2013; Van Lier, Wanner, & Vitaro, 2007; Vitaro, Pedersen, & Brendgen, 2007; Weerman, Lovegrove, & Thornberry, 2015). Children's deviant friends may provide role models for externalizing behavior and may support and stimulate antisocial and rule-breaking activities by deviancy training and coercive interactions (Granic & Patterson, 2006; Vitaro, Tremblay, & Bukowski, 2001). Thus, by the time a child reaches early adolescence, the amount of time a child spends with deviant peers may be an additional important explanatory factor underlying externalizing behavior development. Indeed, several prospective studies (e.g., Keenan, Loeber, Zhang, Stouthamer-Loeber, & Van Kammen, 1995; Vitaro et al., 2007) provided empirical support for the increasing influence of associating with deviant peers in the development of adolescent externalizing behavior.

In sum, previous empirical evidence has found support for a broad spectrum of child-personal and social-environmental risk factors that predict concurrent and later externalizing behavior. The next part of this general introduction will elaborate on how these factors may operate in conjunct, thereby explaining the development of externalizing behaviors.

BIO-SOCIAL MODELS OF EXTERNALIZING BEHAVIOR DEVELOPMENT

In the last three decades, the focus of research on externalizing behavior development has shifted from studies that investigated autonomous risk factors for developing externalizing behavior, towards the development of integrative developmental models that aim to incorporate factors within and between various domains (i.e., personal endowments and social-environmental factors) and how these factors might operate together. Several integrative

models have since been developed, amongst which the 'biopsychosocial model of chronic conduct problems' of Dodge and Pettit (Dodge & Pettit, 2003) and the 'dynamic systems approach of antisocial development' of Granic and Patterson (Granic & Patterson, 2006) are highly influential. These models have in common that they warrant the importance of investigating dynamic processes that encompass complex interactive elements in order to understand how externalizing behaviors develop. Specifically, these models posit that certain (adverse) biological predispositions or personal endowments place children at risk for externalizing behavior development early in life, and that this initial risk may become expressed or aggravated via complex mediating and moderating mechanisms involving the social environment. The following part of this general introduction will focus on how children's genetic make-up, sex and temperament or personality, in conjunction with their parent and peer environment, may explain the development of externalizing behavior in childhood and adolescence.

How may children's personal endowments become expressed in later externalizing behavior?

The question *how* children's biological predispositions and personal endowments are prospectively associated with later externalizing behavior can be answered by the study of developmental pathways or cascades (Masten & Cicchetti, 2010). Developmental pathway or cascade models indicate that personal endowments may become manifested in later externalizing behavior via their prospective association with social-environmental factors, also known as *indirect* or *mediation* pathways (Edwards & Lambert, 2007; Holmbeck, 1997).

Three processes that may link the children's and adolescents' personal endowments and social-environmental factors in this regard are 'environmental elicitation', 'environmental selection', and 'social comparison' processes, and these were investigated in the present thesis. The first process - environmental elicitation - entails that children may evoke certain responses

from their environment because of their personal endowments. For example, children's genetic make-up may predispose them to encounter certain environments, also known as evocative gene-environment correlation (Plomin, DeFries, & Loehlin, 1977). Specifically, children with certain genetic characteristics potentially underlying their risk status for developing externalizing behavior may evoke (negative) responses from their environment like being poorly preferred or being the victim of bullying (Boivin et al., 2013). Similar findings have been reported for childhood temperament and children's sex. For example, children's temperamental difficulties may evoke peer victimization and poor preference among peers (De Bolle & Tackett, 2013). In addition, it has been found that boys may evoke more abusive disciplining tactics from their parents and may be more prone to experiencing poor appraisal from their peers than girls (Moffitt et al., 2001).

The second process – environmental selection – entails that children may actively select a specific (peer) environment based on similarities in their personal characteristics. For example, children with certain genetic characteristics may affiliate with (deviant) friends that 'fit' their genetic make-up (Vitaro et al., 2016), a process also named active gene-environment correlation (Plomin et al., 1977). In the same way, children with certain temperament and personality traits may like to affiliate with friends that engage in risky and externalizing behaviors (Steca, Alessandri, Vecchio, & Caprara, 2007). Lastly, boys tend to affiliate more with deviant friends than girls do (Moffitt et al., 2001), which may indicate that boys tend to select peers that engage in externalizing behaviors more so than girls do.

The third process – social comparison – indicates that personal endowments may influence how children evaluate themselves by comparing themselves to others, which in turn may influence the development of externalizing behavior. For example, children with certain temperament traits may be prone to overestimating their social standing in the peer group, compared to their actual social standing in the peer group (Scholtens, Diamantopoulou,

Tillman, & Rydell, 2012). That is, these children may believe that they are more liked and popular among their peers than they actually are. When these believes are challenged (i.e., when confronted with the discrepancy between their own believes and the actual evaluation by others), these children may become frustrated or angry, which may ultimately lead to externalizing problems (Lynch, Kistner, Stephens, & David-Ferdon, 2016; Orobio de Castro, Brendgen, Van Boxtel, Vitaro, & Schaepers, 2007; Stephens, Lynch, & Kistner, 2015).

Previous empirical evidence has suggested that the environmental elicitation, environmental selection and social comparison processes may be interrelated as well. For example, at-risk children may initially elicit poor appraisal among peers, which may then place them at risk of affiliation with deviant friends (Van Lier & Koot, 2010; Vitaro et al., 2007). In addition, an overestimated social self-perception may influence children's actual standing among peers (Brendgen, Vitaro, Turgeon, Poulin, & Wanner, 2004; MacDonald & Cohen, 1995; Stephens et al., 2015). Regardless of whether effects run via elicitation, selection, social comparison or a combination of these processes, the essential premises of developmental pathways or cascade models is that it are these elicitation, selection and comparison processes that explain *how* the initially benign risk of the child becomes expressed and eventually manifested in the development, continuation and aggravation of externalizing problems.

For which children do personal endowments become manifested in later externalizing behavior?

The question for which children specific biological predispositions and personal endowments become manifested in later externalizing behavior can be answered by studying moderator variables that may modify the association between children's personal endowments and later externalizing problems. This modification, also known as moderation, occurs when the effect of a predictor variable on an outcome variable varies according to the level of a third variable, under the condition that the third variable is conceptually and/or statistically

independent of the predictive variable (Edwards & Lambert, 2007; Holmbeck, 1997; Kraemer, Stice, Kazdin, Offord, & Kupfer, 2001). In this regard, children's social environment may act as a moderator in the association between children's personal endowments and later externalizing behavior. That is, certain initial dispositions may become manifested in later externalizing behavior problems, because a negative or less positive social environment aggravates its influence.

Studies using various designs have found support for the idea that the influence that personal endowments potentially have on the development of externalizing problems, can be altered by their social environment. An example of such studies are gene-environment interaction studies. Gene-environment interaction entails that genetic influences on externalizing development may become apparent only (or more so) under the condition of particular environmental experiences, or vice versa. Indeed, since the turn of the century the number of studies that found that genetic characteristics interact with (adverse) social-environmental experiences in explaining the development of externalizing behavior has been growing exponentially (for overviews, see Dodge, 2009; Moffitt, 2005; Weeland et al., 2015).

Similar findings have been reported for temperament and personality traits and for children's sex. That is, studies indicated that potentially disadvantageous temperamental and personality traits may become manifested in externalizing behavior only under particular environmental conditions (e.g., see overview by X. Chen & Schmidt, 2015). For example, difficult temperamental traits may be strongly related to externalizing behaviors for children who experience negative parenting practices (Belsky, Hsieh, & Crnic, 1998). However, when children with a difficult temperament receive high levels of parental support and other favorable parent-child relationship factors, this may buffer the negative impact of a child's difficult temperament, thereby impeding the development of externalizing problems (X. Chen & Schmidt, 2015). With regard to the interplay between children's sex and the social

environment, it is found that boys and girls may differ in the effect that social-environmental experiences may have on their development. For example, for boys certain risk factors, such as experiencing poor preference among peers, may have a higher predictive value for externalizing behavior development than for girls (Moffitt et al., 2001).

Note that the above mentioned examples are all illustrations of cross-domain (i.e., nature x nurture) interactions. However, within-domain interactions (i.e., nature x nature or nurture x nurture) are also possible. For example, having a difficult temperament may be a particular risk factor for the development of externalizing behavior for boys, and less so for girls (nature x nature; Moffitt et al., 2001). Furthermore, children from an at-risk home environment, for example children who experience abusive disciplining, may be particularly influenced by negative experiences with peers with regard to developing externalizing behaviors (nurture x nurture; Criss, Pettit, Bates, Dodge, & Lapp, 2002). These types of interactions will therefore also be addressed in this thesis.

THE PRESENT THESIS

The present thesis aimed to add to the existing knowledge on how and for whom children's biological predispositions and personal endowments are related to the development of later externalizing behavior problems. In answering this question, I focused in particular on how children's daily experiences with their parents and peers may explain (i.e., mediate) and aggrevate or buffer against (i.e., moderate) the effects of their personal vulnerabilities on the development of externalizing behavior in childhood and adolescence. Specifically, the studies presented in the present thesis aimed to clarify how differences in youth's genetic make-up, temperament, personality and sex as well as their daily home and peer context work together in explaining why some children (start to) engage in interpersonal violence, theft, vandalism and illicit drug and alchohol use, while others do not. The studies presented in this thesis were

characterized by multi-informant, longitudinal observational and longitudinal experimental research designs in which children were followed from the start of formal schooling, throughout elementary school, into adolesence. The specific research aims and questions were as follows:

1) Environmental mediation: The first research aim was to understand to what extent children's daily experiences with peers may - through environmental selection, elicitation and/or social comparison processes - explain (a) how children's personal endowments may be associated with later externalizing problems and (b) how children's existing externalizing problems may further aggravate into more severe externalizing problems. In other words, to what extent are children's daily experiences with peers relevant for understanding how their personal endowments may become expressed in externalizing behavior and to what extent can daily experiences with peers explain the continuation and aggravation of externalizing problems over time? These questions will be addressed in chapter 2 and chapter 3.
2) Environmental moderation: The second research aim was to understand to what extent children's daily home and peer experiences may explain why certain at-risk children may develop externalizing problems, while others do not. In other words, to what extent do children's negative daily home and peer environments determine whether children who are potentially at risk for developing externalizing problems due to their personal endowments, actually develop externalizing problems? And vice versa, to what extent may a positive daily home and peer environment buffer against the development of externalizing behavior for children at risk due to their personal endowments? These questions will be addressed in chapters 4 and 5.
3) The third research aim was to understand whether positive peer experiences could make up for what the familial environment fails to provide. More specifically, to what

extent can the facilitation of children's positive peer experiences through a preventive intervention program protect children against developing externalizing problems, dependent upon their at-risk home environment? This question will be addressed in chapter 6.

Although not a specific research question, sex differences in developmental pathways and interaction patterns were explored.

DESIGN

To answer these research questions, five different datasets - retrieved from four different study samples - were used. These datasets are described below and study characteristics per sample are presented in Table 1.1.

1. Canadian child to adolescent sample (chapter 2)

The participants from the *Canadian child to adolescent* sample came from a multi-informant, longitudinal population-based cohort study aimed at contributing to the understanding of the development of adjustment problems in children and youth. Participants in the sample described in the present thesis were 411 children (n = 214 boys, 52%) who came from five mainstream elementary schools in Quebec, Canada. Participants were on average 6.30 years (SD = 0.47) at the initiation of this study (at the end of kindergarten) and were followed over ten years, until age 15 (at the end of grade 10). The majority of the children (> 90%) had a French-Canadian background. Data was collected once per year via mother-reports, teacher-reports, peer-nominations, and self-reports.

2. Dutch adolescent sample (chapter 4)

The *Dutch adolescent sample* (entitled: Research on Adolescent Development and Relationships, young cohort; RADAR-y) is a multi-informant, longitudinal population-based cohort study aimed at understanding the interplay between adolescents' relationships with

family and friends and various developmental outcomes. In the RADAR-y study adolescents are followed from age 12 to 18 years. Participants in the sample described in the present thesis were 444 adolescents who came from the province of Utrecht and the cities of Amsterdam, Rotterdam, The Hague and Almere, in the Netherlands. The adolescents in the sample used in the present thesis had a mean age of 13 years (*SD* = .05) at baseline and were followed over three years (ages 13 to 15 years). All children included in the study were of Dutch origin. Data was collected via self-reports.

3. Dutch late elementary school sample (chapter 5)

The *Dutch late elementary school sample* is a combined sample of two multi-informant, longitudinal population-based studies, focused on children's social, emotional and behavioral development. Participants were 405 (49% boys) children attending 48 different mainstream elementary schools in the Netherlands. In the first project (also described below, sample 4), 30 schools were recruited in two urban areas and one rural area in the Netherlands. In the second project, eighteen schools from the northern and the eastern part of the Netherlands were recruited via municipal health services. Children in this sample were followed annually throughout third to sixth grade of elementary school (ages 9 to 12 years). At age 13, children provided saliva samples for genotyping. The majority of the sample (87%) had a Dutch/Caucasian background. Data was collected via teacher-reports, peer-nominations and saliva.

4. Dutch early elementary school sample (chapter 3 and chapter 6)

The *Dutch early elementary school sample* is a multi-informant, longitudinal population-based study focused on children's social, emotional and behavioral development. The samples used in the present thesis include 759 participants (50.3% boys; for chapter 3) and 554 participants (51% boys; for chapter 6), respectively. These children came from 47 classrooms of 30 mainstream elementary schools that were located in two urban areas and one rural area

in the Netherlands. Children were followed over first to fourth grade of elementary school (ages 7 to 10 years, chapter 3) and from kindergarten to second grade (ages 6 to 8 years, chapter 6). The sample was ethnically diverse, depending on the actual sample used in the chapters (*N*=759 or *N*=554) 58-64% of the children were from a Dutch/Caucasian background, 11% were Moroccan, 9-10% were Turkish, 4-7% were Surinamese, 4-5% were from the Netherlands Antilles, and 8-9% were from other ethnical backgrounds. Approximately two-thirds of the children had received a classroom-based preventive intervention targeting peer relationships and problem behavior (Good Behavior Game; Barrish, Saunders, & Wolf, 1969), with the remaining children serving as controls. The Good behavior Game was implemented in first and second grade of elementary school. Data was collected via teacher-reports and peer-nominations (chapter 3) and via teacher-reports, mother-reports, and peer-nominations (chapter 6).

Table 1.1

Study Characteristics per Chapter

Chapter	*N*	Age	Design	Personal endowments	Social-environmental factors	Outcome
2	411	6-15 years	Longitudinal, observational	Childhood temperament	Social preference among peers Affiliation with deviant friends Overestimated social self-perception	Overt antisocial behavior Covert antisocial behavior Substance use
3	759	7-10 years	Longitudinal, observational	Sex	Social preference among peers	Conduct problems Oppositional defiant behavior
4	444	13-15 years	Longitudinal, observational	Adolescent personality traits	Parental support Parental control	Early onset of cannabis use
5	405	9-12 years	Longitudinal, observational	Dopamine Receptor D4 gene	Social preference among peers	Conduct problems Prosocial behavior
6	554	6-8 years	Longitudinal, RCT	None	Acceptance among peers Maternal delinquent behavior Maternal depressive symptoms Parenting stress Abusive disciplining	Conduct problems

Note. RCT = Randomized Controlled Trial

2

Developmental Pathways Linking Childhood Temperament with Antisocial Behavior and Substance Use in Adolescence: Explanatory Mechanisms in the Peer Environment

J. Marieke Buil

Pol A.C. van Lier

Mara R. Brendgen

Hans M. Koot

Frank Vitaro

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Abstract

This study investigated three developmental pathways involving the peer environment that may explain how certain temperamental dispositions in childhood may become manifested in later antisocial behavior and substance use. A total of 411 (52% boys) Canadian children were followed annually from ages 6 to 15 years. The study tested whether the temperamental traits approach, negative reactivity and attention (assessed at ages 6-7 years), were associated with overt antisocial behavior, covert antisocial behavior and illicit substance use (assessed at ages 14-15 years), via poor social preference among peers, inflated social self-perception and antisocial behavior of peer-group affiliates (assessed throughout ages 8-13 years). Results indicated that negative reactivity was indirectly associated with overt antisocial behavior and substance use via poor social preference. Specifically, negative reactivity in earlier childhood predicted poor social preference in later childhood and early adolescence. This poor social standing among peers, in turn, predicted more engagement in overt antisocial behavior but less substance use in later adolescence. Over and above the influence of social preference, negative reactivity predicted engagement in all three outcomes via children's antisocial behavior in childhood and early adolescence. Inflated social self-perception and antisocial behavior of peer-group affiliates did not mediate the link between temperament and the outcomes under scrutiny. No sex differences in developmental pathways from temperament to the outcomes were found. To further our understanding of the developmental link between childhood temperament and later antisocial behavior and substance use, we need to recognize the role of peer environmental factors, specifically poor preference among peers.

The study of childhood temperament has been put forth as a promising avenue for understanding the etiology of behavioral problems within the externalizing spectrum, including overt antisocial behavior, covert antisocial behavior and illicit substance use (for overviews, see De Pauw & Mervielde, 2010; Nigg, 2006; Shiner & Caspi, 2003). A key question in this area of research is *how* temperamental traits may lead to these problematic and undesirable behaviors. In the present study, we studied a sample of 411 Canadian children who were followed annually from age 6 to 15 years, to test whether childhood temperamental traits were associated with children's difficulties with mastering three key developmental tasks that involve the peer environment, namely 1) establishing a positive position in the peer-group, 2) forming a realistic social self-perception, and 3) affiliating with a group of friends that encourages healthy behavioral adjustment (Masten & Coatsworth, 1998; Sroufe et al., 2009). We tested whether difficulties in mastering these key tasks may explain the link between children's temperament and later engagement in antisocial behavior and illicit substance use.

Childhood Temperament and Pathways to Overt Antisocial Behavior, Covert Antisocial Behavior and Illicit Substance Use

Temperament refers to "early emerging basic dispositions in the domains of activity, affectivity, attention and self-regulation, and these dispositions are the product of complex interactions among genetic, biological and environmental factors across time" (Shiner et al., 2012, p. 437). Individual differences in temperament are organized in a hierarchical way. That is, certain temperamental traits (i.e., lower-order traits) show covariance which is explained by broader underlying dimensions of temperament (i.e., higher-order dimensions; Shiner et al., 2012). Although there is still debate on which dimensions best describe children's temperamental characteristics, researchers generally agree that the vast majority of temperamental characteristics in childhood is captured by the three higher-order dimensions 'effortful control', 'positive emotionality/surgency', and 'negative emotionality' (Rothbart,

2007; Shiner et al., 2012). Effortful control refers to children's ability to focus their attention and detect errors, plan their course of action, show inhibitory control and derive pleasure from low-intensity activities. This construct includes lower-order traits like task persistence, attentional focus and ability to suppress inappropriate responses. Positive emotionality/surgency reflects children's affinity with engaging with others, their sociability, activity level and pleasure derived from high-intensity activities. This construct includes lower-order traits such as the tendency to approach novel situations and unfamiliar people (also known as behavioral disinhibition), the tendency to be attracted to adventurous activities and the tendency to easily smile and laugh. Lastly, negative emotionality refers to the tendency to experience frustration, fear, discomfort and sadness, as well as being hard to sooth. This construct includes lower-order traits like the tendency to express negative reactivity to sensory stimuli such as pain, light, texture or sounds and the intensity of this negative reaction, the tendency to experience unease, worry or nervousness, the tendency to show lowered mood when exposed to suffering or disappointment and having difficulties with recovering from distress or general arousal (Coplan & Bullock, 2012; Rothbart, 2007; Shiner et al., 2012).

In the present study we investigated differences in the temperamental traits 'attention span', 'approach', and ' negative reactivity', which comprise part of the aforementioned higher-order dimensions 'effortful control', 'positive emotionality/surgency' and 'negative emotionality', respectively (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006; Goldsmith, Rieser-Danner, & Briggs, 1991; Rothbart, 2007). Differences in these temperamental traits have been related to various distinct - although related - behavioral problems within the externalizing spectrum, including antisocial behavior and substance use (for an overview of studies addressing the comorbid nature of antisocial behavior and substance use, see e.g., Clark, 2005; Krueger, Markon, Patrick, Benning, & Kramer, 2007; McGue, Irons, & Iacono, 2014). Specifically, differences in effortful control, positive emotionality/surgency and negative

emotionality have been associated with overt forms of antisocial behavior, like aggression (Becht, Prinzie, Deković, Van den Akker, & Shiner, 2015; Burt & Donnellan, 2008; Wang, Chassin, Eisenberg, & Spinrad, 2015), covert forms of antisocial behavior, like vandalism and theft (Becht et al., 2015; Carrasco et al., 2006) and illicit substance use, like drug use and alcohol use by minors (Burt & Donnellan, 2008; Dick et al., 2013).

Several authors have theorized about the pathways through which temperamental traits may lead to later antisocial problems and substance use (X. Chen & Schmidt, 2015; Nigg, 2006; Shiner & Caspi, 2003). According to the vulnerability model, certain temperamental traits may set in motion a cascade of negative processes, eventually putting children at risk for developing antisocial behavior and illicit substance use (De Bolle, Beyers, De Clercq, & De Fruyt, 2012; Nigg, 2006). According to this viewpoint, the interplay between temperament and the daily environment that children encounter is key. For instance, temperament may influence how children learn from, elicit reactions from, interpret, compare themselves with, select and manipulate their social environment (for overviews, see Hasenfratz, Benish-Weisman, Steinberg, & Knafo-Noam, 2015; Shiner & Caspi, 2003). In the present study we focused on three of these processes, namely environmental elicitation, social comparison and environmental selection, with regard to one of the most important contexts for behavioral development for school-aged children, that is, the world of peers (Rubin, Bukowski, & Bowker, 2015; Rubin et al., 2006).

The process of *environmental elicitation* indicates that children's temperament may shape the responses of their peers (Shiner & Caspi, 2003), which in turn may influence the development of antisocial behavior and substance use. As said, establishing a positive position within the peer-group is an important developmental task for school-aged children (Hasenfratz et al., 2015; Sroufe et al., 2009). Temperamental traits may influence how children are perceived by their peers, thereby influencing these children's position within the peer-group

through the process of environmental elicitation. Indeed, empirical findings indicate that temperamental traits reflective of or related to negative reactivity, low attention and low approach are linked to poor social preference among peers and related constructs (for an overview, see Coplan & Bullock, 2012). Poor social preference (i.e., a sociometric measure that captures how much a child is disliked relative to being liked by peers; Coie et al., 1982) has been found to be a robust predictor of subsequent behavioral problems within the externalizing spectrum (Ladd, 2006; Sturaro, Van Lier, Cuijpers, & Koot, 2011), possibly because of the missed opportunities for positive socialization by normative peers or the resentment that follows peer rejection.

The process of *social comparison* indicates that temperament may shape the way children evaluate themselves relative to others (Shiner & Caspi, 2003), thereby potentially influencing the development of problematic behaviors. Indeed, there is some (indirect) evidence supporting the hypothesis that children's temperament may influence whether they exhibit a more congruent or an inflated self-perception. For example, it has been found that higher levels of inattention are associated with a positive illusory bias of children's social acceptance among peers (Scholtens et al., 2012). In turn, various studies have found that children who have an overly positive self-perception of their social status, meaning that they overestimate their social standing relative to their actual social standing among peers, may be at risk for engaging in overt antisocial behavior (Lynch et al., 2016; Orobio de Castro et al., 2007; Stephens et al., 2015). Although the processes through which an overly positive self-perception of one's social standing may lead to future antisocial behavior remain to be investigated, one possibility is that children who hold biased perceptions may retaliate against peers who challenge these perceptions by acting in aggressive ways (Lynch et al., 2016).

The process of *environmental selection* suggests that temperament may shape children's choices about their day-to-day environment, including choices about with whom

they do and do not (want to) affiliate (Shiner & Caspi, 2003). This, in turn, may influence antisocial behavior development and substance use. For example, children may want to affiliate with peers who are like them, potentially because they have similar (negative) temperamental characteristics. Indeed, in a study of adolescents, Steca and colleagues (2007) found that adolescents with an undercontrolled temperament (which included temperamental traits reflective of – in part – high negative reactivity, low attention and high approach) as well as children with an overcontrolled temperament (characterized by – in part – low approach, low attention and high negative reactivity) both had more friends who engaged in antisocial behavior and substance use, compared to resilient, well-adjusted children (which included temperamental traits reflective of low negative reactivity, high attention and high approach). Thus in this study, negative reactivity and low attention were associated with affiliation with deviant peers. More recently, low attention has also been associated with antisocial peer-group affiliation in adolescence, as well as in young adulthood (Kendler, Myers, & Dick, 2015; Li, Newman, Li, & Zhang, 2016). For the temperamental trait approach the results are more inconsistent. That is, both high and low levels of this trait have been associated with affiliation with antisocial peers (Kendler et al., 2015; Li et al., 2016; Steca et al., 2007). Multiple studies have indicated that affiliation with antisocial peers is a salient risk factor for engaging in antisocial behavior and using illicit substances (Forgatch, Patterson, Degarmo, & Beldavs, 2009; Keijsers et al., 2012). This link is potentially explained by modeling of deviant behaviors, coercive interactions such as interacting in an aggressive way, and deviancy training such as talking about, rehearsing and receiving positive social evaluation of deviant acts (Dishion, Kim, & Tein, 2015; Salazar et al., 2015).

Furthermore, previous studies have shown that indicators of environmental elicitation, social comparison and environmental selection may relate differently to various distinct, although related, forms of externalizing behaviors. For instance, poor social preference and

related constructs have been associated with overt antisocial behavior such as aggression, but seem less strongly associated with covert antisocial behavior such as vandalism and theft (Barnow, Lucht, & Freyberger, 2005; McEachern & Snyder, 2012). Inflated social self-perception has been linked to overt antisocial behavior in particular (Lynch et al., 2016; Orobio de Castro et al., 2007; Stephens et al., 2015), while affiliation with an antisocial peer-group may be more strongly linked to covert antisocial behavior, than to overt antisocial behavior (Barnow et al., 2005; Dick et al., 2013; Slattery & Meyers, 2014).

Studies reporting on predictors of illicit substance use have been more inconsistent. These studies generally agree that affiliation with antisocial peers is related to substance use (Dick et al., 2013; Dishion, Capaldi, & Yoerger, 1999). However, regarding poor social preference, some studies indicated that poor preference and related constructs increase risk for substance use (Dishion et al., 1999; Kelly et al., 2015), while others reported that being well-liked instead of being disliked increases this risk (Allen, Porter, McFarland, Marsh, & McElhaney, 2005; Tucker et al., 2011; Van Ryzin, DeLay, & Dishion, 2016), and still others found no association between social preference and substance use (Kaplow, Curran, & Dodge, 2002). To the best of our knowledge, no developmental links have as of yet been reported between an inflated social self-perception and substance use. In this case, it may be possible that an overly positive social self-perception is not directly linked to substance use. However, given that previous studies have found that an inflated self-perception positively influenced children's actual social preference (e.g., see Brendgen et al., 2004), the link between inflated social self-perception and substance use could be indirect, that is, mediated by social preference.

In sum, evidence from prior studies suggests that the developmental link between childhood temperament and later engagement in problematic behaviors may be explained by environmental elicitation, social comparison and environmental selection processes. Although

informative, these studies were hampered by various limitations. First, our literature search provided no examples of studies that investigated the hypothesized developmental pathways in their entirety. That is, the results of prior studies provide evidence in support of segments of the developmental pathways, but to our knowledge no previous studies have investigated the full pathways testing whether links between temperament and antisocial behavior or substance use indeed run via the hypothesized peer processes.

Second, although many of the more recent studies do, some previous studies (e.g., Kendler et al., 2015; Li et al., 2016; Stephens et al., 2015; Sterry et al., 2010) have not accounted for children's existing antisocial behavior. This is of importance because empirical evidence suggests that peer-environmental factors may no longer add to the prediction of antisocial behavior or substance use when concurrent behavioral problems are accounted for (Lynch et al., 2016; Woodward & Fergusson, 1999). Thus, temperament could be linked to antisocial behavior or substance use through individual characteristics of the child (i.e., concurrent antisocial behavior) with little or no contribution of social experiences with peers. This actually could be seen as an alternative fourth pathway: the *externalizing psychopathology pathway*. This pathway suggests that certain adverse temperamental traits in childhood may be linked to behavioral problems in adolescence because of a shared underlying factor, in this case: externalizing psychopathology (Krueger et al., 2007). According to this viewpoint, also known as the spectrum or 'shared factor' model, certain temperamental traits may be regarded as 'mild' or 'normative' manifestations of behaviors of a more problematic nature and - even more extreme - behavioral disorders, rather than temperament being distinct from psychopathology (Nigg, 2006). Hence, in order to ascertain that the hypothesized intermediate peer-factors may truly add to the development of antisocial behaviors or substance use, that is, above and beyond behavioral problems, these behavioral problems should be taken into account.

Third, the processes of environmental elicitation, social comparison and environmental selection have been described as independent developmental pathways that may operate in parallel (e.g., Shiner & Caspi, 2003). However, at the empirical level, studies have found evidence for an interplay between these social processes. For example, previous studies have indicated that poor social preference and related constructs were correlated with affiliation with antisocial peers (D. Chen et al., 2015; Ettekal & Ladd, 2015). Likewise, disparities between self-ratings and peer-ratings of peer acceptance have previously been found to be associated with actual peer acceptance (Brendgen et al., 2004; MacDonald & Cohen, 1995; Stephens et al., 2015). In addition, the environmental elicitation, social comparison and environmental selection processes may influence each other over time. For instance, children who are rejected by their normative peers may later on in their development affiliate with friends who engage in antisocial behavior (for an overview, see D. Chen et al., 2015). Our literature search provided no examples of previous studies that investigated the unique contribution of environmental elicitation, social comparison and environmental selection to the development of antisocial behavior or substance use, when all three processes are investigated together. In the present study we took potential overlap into account in order to determine the respective contribution of each individual process and their possible interplay.

Fourth, previous research often neglected to include multiple aspects of behavioral problems within the externalizing spectrum. This may be a serious omission, given that the use of a broad and heterogeneous constructs like ‘externalizing behavior’ or ‘behavioral problems’ may obscure more specific associations between particular risk factors and different kinds of problems (Burt, 2012; Moffitt, 1993), as we have outlined above.

Lastly, when studying explanatory mechanisms that link temperament with the development of antisocial behavior and illicit substance use, potential sex-differences in developmental pathways should be investigated. For example, several studies found that

children's sex may be a moderator in de association between temperament and peer relationships. That is, this association was found to be stronger for boys than for girls (Coplan, Prakash, O'Neil, & Armer, 2004; Sterry et al., 2010). In addition, sex-differences have been found in the associations between peer-factors and the outcomes under scrutiny. For example, results from cross-sectional studies imply that the association between poor social preference and behavioral problems within the externalizing spectrum is stronger for boys (Moffitt et al., 2001). Furthermore, the correlation between affiliation with antisocial peers and these outcomes also seems stronger for boys (Van Lier, Vitaro, Wanner, Vuijk, & Crijnen, 2005). However, not all studies found such sex-differences for poor social preference (Coie, Terry, Lenox, Lochman, & Hyman, 1995; Dodge et al., 2003; Van Lier et al., 2005) and affiliation with deviant peers (Moffitt et al., 2001; Simons, Johnson, Beaman, Conger, & Whitbeck, 1996). Regarding the link between an inflated social self-perception and antisocial behavior and substance use, previous studies have generally found no sex-differences (Brendgen et al., 2004; Jan N. Hughes, Cavell, & Prasad-Gaur, 2001). Nevertheless, closer attention to potential sex-differences would further enhance our understanding of developmental pathways that link temperament to later problematic behaviors.

The Present Study

In the present study, we tested three developmental pathways that may link childhood temperamental traits to overt antisocial behavior, covert antisocial behavior and illicit substance use, using a sample of 411 children from the general population followed from age 6 until age 15. We added to existing knowledge in three ways. First, we investigated the developmental pathways that potentially link temperament to these problematic behaviors via three peer environmental factors that may contribute in a negative way to the behavioral development of elementary school children and adolescents, namely: difficulties in establishing a positive position in the peer-group, difficulties in developing a congruent and

realistic social self-perception and difficulties in affiliating with a group of friends that encourages healthy behavioral adjustment. These developmental pathways were studied while accounting for children's concurrent antisocial behavioral problems. Second, we not only tested for parallel links between temperament, intermediate processes and our outcomes under scrutiny (i.e., the environmental elicitation, social comparison and environmental selection processes as individual pathways that don't influence each other), but also investigated sequential and transactional pathways between these intermediate processes that account for the influence of one process on another process (e.g., environmental elicitation may subsequently predict environmental selection). Third, we took into account three different although related subtypes of problematic behavior, namely overt antisocial behavior, covert antisocial behavior and illicit substance use.

Based on previous studies we formulated three hypotheses. First, we expected that childhood temperament would be associated with later antisocial behavior and substance us, via poor social preference, overly positive social self-perception and affiliation with antisocial peers (hypothesis 1). More specifically, we predicted that higher levels of negative reactivity, lower levels of attention and lower levels of approach would be prospectively associated with poor social preference among peers (Coplan & Bullock, 2012; Ilmarinen, Vainikainen, Verkasalo, & Lönnqvist, 2015; Sterry et al., 2010). In addition, we predicted that these temperamental traits would be related to subsequent affiliation with peers who engage in antisocial behavior (Kendler et al., 2015; Li et al., 2016; Sterry et al., 2010). Lastly, we predicted that low levels of attention would be associated with an inflated social self-perception (Scholtens et al., 2012). We expected that the intermediate peer-processes, in turn, would be prospectively associated with antisocial behavior or substance use (see, e.g., D. Chen et al., 2015; Lynch et al., 2016).

Second, we explored parallel, sequential and transactional effects between the intermediate processes (hypothesis 2). More specifically, poor social preference could predict subsequent overly positive self-perceptions and affiliation with antisocial peers (see e.g., D. Chen et al., 2015; Stephens et al., 2015). However, poor social preference and affiliation with antisocial peers could also operate independently (i.e., in parallel; D. Chen et al., 2015; Ettekal & Ladd, 2015). Reversed patterns are also possible. For example, overly positive self-perceptions could positively influence social preference among peers (Brendgen et al., 2004). In sum, parallel, sequential and transactional links between the three intermediate processes were deemed possible.

Third, we expected differential links between the intermediate processes and the outcomes (hypothesis 3). More specifically, we predicted that poor social preference would be more associated with overt than with covert antisocial behavior (Barnow et al., 2005; McEachern & Snyder, 2012). In addition, we predicted that overly positive social self-perception would be specifically related to overt antisocial behavior (Lynch et al., 2016; Stephens et al., 2015). Lastly, we expected that affiliation with antisocial peers would be associated more with covert antisocial behavior and substance use than with overt antisocial behavior (Dick et al., 2013; Slattery & Meyers, 2014).

Method

Participants and procedure

Participants were 411 children (n = 214 boys, 52%) from five mainstream elementary schools in Quebec, Canada. Whole classrooms were included (note that the classroom composition in Canada changes from one year to the next). This study was approved by the University of Montreal ethics board (protocol # 410-95-1129; Study title: Behavior problems, peer relations and psychosocial adjustment), as well as by each participating school. Informed written consent was obtained from parents of all participants, whereas informed verbal assent

was obtained from all participating children. Participants were on average 6.30 years (*SD* = 0.47) at the initiation of this study (i.e., at the end of kindergarten) and were followed annually over ten years, until age 15 (i.e., at the end of grade 10). The majority of the children (> 90%) had a French-Canadian background. Participants' average socioeconomic status (*M* = 42.81, *SD* = 9.43) was representative of the socioeconomic status of the general Canadian population (*M* = 42.74, *SD* = 13.28; Blishen, Carroll, & Moore, 1987).

Each spring (in April or May), participants spent two hours of classroom time, divided by a 20-min break, answering questionnaires. After the children were informed about the purpose of the study, they were told that all of their answers would be confidential and that they did not have to answer any of the questions if they did not want to. The children were encouraged to keep their answers confidential and not to talk with classmates about their answers. Trained research-assistants administered and collected the questionnaires. Teachers were asked to leave the classroom during the assessment time to emphasize that participants' answers would not be revealed to their teachers. Teachers also completed questionnaires during this period.

Only children whose data was present on each of the study variables for at least one annual assessment wave within two out of four age periods were included in the present study. The four age periods were 1) ages 6 and 7 years; 2) ages 8 to 10 years; 3) ages 11 to 13 years; and 4) ages 14 and 15 (see Figure 2.1). These age periods were chosen for two main reasons. Conceptually, we chose these age periods because our constructs under scrutiny are of particular importance during these specific developmental stages. That is, in middle childhood and adolescence peer-relationships become particularly important for children's development (Sroufe et al., 2009), with certain aspects of the peer-world having the strongest influence in the earlier childhood years (e.g., social preference) and other aspects having the strongest influence in later childhood and early adolescent years (e.g., affiliation with antisocial peers;

Vitaro et al., 2007). Furthermore, engagement in overt antisocial behavior, covert antisocial behavior and the use of illicit substances tends to significantly increase in the middle adolescent years (e.g., see DeLisi, 2015; Liu, 2015; Loeber et al., 2012), which makes this the ideal period to assess these types of behavioral problems. Methodologically, we chose to average our data across two or three assessments for reasons of parsimony and to increase the reliability of the developmental model.

The 411 participants were part of an initial sample of 469 children who represented 92.5% of all French-speaking kindergarten children of a small community in northwestern Quebec, Canada (population 30,000). Each year, children that entered a participating classroom were included in the sample, which resulted in a total sample of 680 children after 10 years of follow-up. Of the final sample (N = 411), 287 children (70%) had information on all study variables for at least three age periods. Attrition during the study-period was due to a lack of parental permission, moving out of the school district, or absence on the day of data collection.

Children who were included in the present study had higher levels of attention compared to excluded children at age 7 (F (1, 381) = 4.45, $p < .05$, $\eta^2 = .01$). At ages 8 to 10 years, included children were on average more preferred (F (1, 582) = 19.29, $p < .001$, $\eta^2 = .03$) and had lower levels of antisocial behavior themselves (F (1, 495) = 14.99, $p < .001$, $\eta^2 = .03$). At ages 11 to 13 years, included children were on average again more preferred than excluded children (F (1, 521) = 6.78, $p < .01$, $\eta^2 = .01$). Note that the effect sizes of these differences were always small. None of the other variables differed between included and excluded children.

Measures

Temperament. Childhood temperament was measured by the Dimensions of Temperament Survey (DOTS; Lerner, Marion, Avron, & R., 1982), rated by mothers when children were 6 and 7 years old. The DOTS is a 34-item, factor-analytically developed

questionnaire that measures five temperamental traits of which three were used. Attention (11 items, e.g., “child was able to persist at a task”, “child was not distracted when involved in a task”), approach (6 items, e.g., “child moved towards new situations”, “child moved towards unfamiliar persons”) and negative reactivity (6 items, e.g., “child reacted intensely to pain”, “sunlight bothered child’s eyes”). Items could be answered with yes (1) or no (0). Items scores were averaged over ages 6 and 7 years, which were subsequently used as indicators of their latent factors (attention, negative reactivity and approach; see Figure 2.1). Confirmatory factor analysis (CFA) indicated that a correlated three-factor model fitted the data sufficiently (CFI = .89, RMSEA = .06). Correlations for similar dimensions measured at ages 6 and age 7 varied between r = .49 and r = .65, all ps < .01. Internal consistency coefficients (Cronbach’s alpha) for the three traits varied between .61 and .80 for the assessments, which is comparable to levels found in previous studies (Lerner et al., 1982). Moderate convergent and discriminant validity of the DOTS subscales with other measures of temperament have been reported (Goldsmith et al., 1991; Hubert, Wachs, Peters-Martin, & Gandour, 1982).

The DOTS rhythmicity (7 items that refer to sleep and eating habits, e.g., “child woke up from naps at different time than yesterday”, “child ate same amount of food as yesterday”) and activity (3 items that refer to activity during bed-time, e.g., “today my child moved a lot in bed”) scales were omitted because they did not map on the three higher-order dimensions effortful control, positive emotionality/surgency and negative emotionality and are often not included in current empirical and conceptual trait taxonomies of temperament (e.g., see De Pauw & Mervielde, 2010).

Poor social preference was used as an indicator of environmental elicitation. It was assessed annually throughout ages 8 to 13 by asking children to nominate three children in their class whom they liked least and three children whom they liked most (Coie et al., 1982). Separately for each year, the total number of received positive nominations was calculated for

each participant and z-standardized within the classroom to create a total liked-most score. The total number of received negative nominations was calculated for each participant and z-standardized within the classroom to create a total liked-least score. The liked-most score was then subtracted from the liked-least score, resulting in a score where high values indicate a poor social preference score (Coie et al., 1982). Poor social preference scores were averaged for ages 8 to 10 (*r*s between ages all ≥ .51, $p < .001$) and ages 11 to 13 years (*r*s between ages all ≥ .51, $p <$. 001).

Inflated social self-perception was used as an indicator of social comparison. It was operationalized by calculating discrepancy scores between children's actual social preference among peers and their self-perceived social competence. Self-perceived social competence was measured over ages 9 to 13 years using the Social Competence subscale (6 items, e.g. "it's hard to make friends") of the Self-Perception Profile for Children (Harter, 1982). Items were scored from 1 to 4, with higher scores reflecting more positive self-perception. Cronbach's alpha's ranged from .67 to .80 throughout the assessments.

Inflated social self-perception was then operationalized by computing a standardized residual score by regressing children's self-perceived social competence on their peer-perceived social preference score. Standardized residuals above zero represent a more positive evaluation of social competence from a child's own perspective than would be expected based on his or her peer-perceived social preference. Residual scores below zero were recoded into zero to create a variable that ranged from no overestimation to high overestimation. Scores for overestimation were averaged across ages 9 and 10 years ($r = .47$, $p < .001$) and across ages 11 to 13 years (*r*s ≥ .44, $p < .001$).

Antisocial behavior of peer-group affiliates was used as an indicator of environmental selection of friends who engage in antisocial behavior and was measured annually over ages 9 to 12 years. Each year, children were asked to nominate up to four friends

in their classroom. Membership in a clique was established using the program Kliquefinder (Frank, 1995, 1996). Cliques are groups of friends, determined on the basis of friendship nominations within the classroom. Kliquefinder identifies cohesive cliques based on these friendship nominations. Clique-membership was conceptualized as having a minimum of two (un)reciprocated friendship nominations with other members of the clique. Children with reciprocated friendships are children who have nominated each other as a friend. Unreciprocated friends are peers who a certain child has nominated as a friend, but these peers have not nominated this particular child back as a friend. Clique-sizes varied between 3 and 12 members at age 9, between 3 and 10 members at age 10, between 3 and 11 members at age 11, and between 3 and 9 members at age 12. More detailed information on how clique-membership was obtained and on the characteristics of clique-members is provided elsewhere (Witvliet, Brendgen, van Lier, Koot & Vitaro, 2010; Witvliet, van Lier, Brendgen, Koot & Vitaro, 2010).

For members of a clique, the level of antisocial behavior within that clique was determined by summing peer-nominated antisocial behavior scores (e.g., “starts fights”) retrieved from the Pupil Evaluation Inventory (PEI; Pekarik, Prinz, Liebert, Weintraub, & Neale, 1976) of all members of a clique, minus the score of the target child. This way, the target child’s own level of antisocial behavior is not confounded with the clique’s level of antisocial behavior. Given that children who were not part of a clique at a given year (i.e., isolates) by definition did not affiliate with an antisocial peer-group, they received a score of zero for that particular year. Scores were averaged for ages 9 and 10 ($r = .13$, $p < .05$) and for ages 11 and 12 years ($r = .13$, $p < .05$). Note that the magnitude of these correlations is moderately high given that classroom compositions in Canada change from one year to the next.

Overt antisocial behavior, covert antisocial behavior and illicit substance use at ages 14 and 15 years was assessed using the Self-Reported Delinquency Questionnaire (SRDQ; LeBlanc & Frechette, 1989). Items of the violence subscale (6 items, e.g., “engaged in a

fistfight") were used as indicators of overt antisocial behavior. Items of the theft (10 items, e.g., "stole from a store") and vandalism (6 items, e.g., "purposely destroyed school equipment") subscales were used as indicators of covert antisocial behavior. Items from the subscale drug-alcohol (3 items, e.g., "used alcohol") were used to indicate illicit substance use. Participants reported annually how frequently they had engaged in each act (1 = never, 2 = rarely, 3 = sometimes, or 4 = often) in the past 12 months. Because of very few responses in the extreme ends of the response scales of overt and covert antisocial behavior, we recoded mean item scores of these scales into binary item scores (0 = never, 1 = rarely to often). Items scores were averaged over age 14 and 15 years.

In our study sample, 45.6% of participants had not engaged in overt antisocial behavior at all at age 14 and 15; 26.2% of participants had engaged in at least some form of overt antisocial behavior at one point in time (either at age 14 or at age 15 years), and 28.3% of participants had engaged in at least some form of overt antisocial behavior at both measurement times (i.e., both at age 14 and age 15 years). These percentages were 26.6%, 18.6% and 54.9%, respectively, for covert antisocial behavior. Illicit substances were used by the grand majority of our sample (> 90%). Of these adolescents, 49.4% reported they used illicit substances rarely, 31.5% reported they used illicit substances sometimes and 12.3% reported they used illicit substances often, when they were 14 or 15 years old.

Item scores were used as indicators of their latent factors (overt antisocial behavior, covert antisocial behavior and substance use; see Figure 2.1). A three-factor model fitted the data well (CFI = .95; RMSEA = .04). Correlations for similar dimensions measured at age 14 and age 15 varied between r = .46 and r = .73, all ps < .01. Internal consistency coefficients (Cronbach's alpha) for the three traits in the current sample varied between .68 and .87 for the assessments. Satisfactory internal consistency, test–retest reliability, as well as convergent,

discriminant and predictive validity of the SRDQ have been reported (LeBlanc & McDuff, 1991).

Control variables

Children's own antisocial behavior was measured annually throughout ages 9 to 13 years through peer-nominations using the Pupil Evaluation Inventory (PEI; Pekarik et al., 1976). Children nominated classmates whom they believed fitted descriptions for behaving in an antisocial manner (8 items, e.g., ''starts fights"). Scores were z-standardized within each classroom (see also Vitaro, Tremblay, Kerr, Pagani, & Bukowski, 1997), and averaged for ages 9 and 10 (r = .76, p < .01) and ages 11 to 13 years (rs ≥ .65, p <. 01). Cronbach's alphas ranged from .91 to .93 across the data points. Evidence for reliability, construct and predictive validity of the PEI has been reported (Pekarik et al., 1976).

Socioeconomic status (SES) was obtained through mother-reported parental occupation(s) using the Blishen and colleagues' (1987) occupational prestige scale. Scores are based on the average income and average education level associated with occupations in Canada. Scores were first averaged across the two parents and then across the first 8 years of data collection (rs ranged between .62 and .79). Information on SES was not available when children were 14 and 15 years of age. The SES variable is a continuous scale, which in our sample ranged from 21.37 to 86.41. On average, participants had a mean SES score of 42.81 (SD = 9.43).

Statistical Analyses

Analyses were performed in Mplus version 7.31 (L. K. Muthén & Muthén, 1998-2015). Because some of our measures were binary, we used the robust weighted least squares mean and variance adjusted (WLSMV) estimator to fit our models, which is the recommended estimator for analyzing skewed (partially) categorical data. Missing data was handled according to the default options of Mplus when using the WLSMV estimator (L. K. Muthén &

Muthén, 1998-2015). Model fit was determined via the Comparative Fit Index (CFI; ≥ .95 indicates good fit; between .95 and .90 indicates acceptable fit; Hu & Bentler, 1999) and the Root Mean Squared Error of Approximation (RMSEA; ≤ 05 indicates close approximate fit; between .05 and .08 indicates reasonable error of approximation; ≥ 1.00 indicates poor fit; Browne & Cudeck, 1993). Nested model comparisons were assessed using robust chi-square difference testing using the DIFFTEST function available in Mplus (L. K. Muthén & Muthén, 1998-2015). We used 50.000 bootstrap resamples with replacement and bias-corrected 95% confidence intervals (95% CI; Preacher & Hayes, 2004) to estimate the significance of indirect effects. (In)equality of the indirect pathways was estimated using the DIFFTEST option in Mplus (L. K. Muthén & Muthén, 1998-2015). Estimates were controlled for children's own antisocial behavior between ages 8 and 13 years. Furthermore, all estimates were controlled for household SES.

Figure 2.1 provides an illustration of the tested model. Latent early childhood temperamental traits (indicators were measured at ages 6 and 7 years) were used to predict middle childhood peer factors (ages 8 to 10 years), which, in turn, predicted their consecutive scores at ages 11 to age 13 years. In addition to these autoregressive (i.e., parallel) paths, cross-lagged (i.e., sequential/transactional) paths were estimated. The peer factors at ages 11 to 13 years were used to predict adolescents' outcomes.

In order to find the most parsimonious model that represented the data adequately, an iteration process was utilized in which the full models were trimmed of paths with significance levels of two-sided $p > .10$. We used this most parsimonious model to examine the significance of indirect pathways linking temperament to later problems behaviors via the three intermediate processes (hypothesis 1); to test whether the intermediate processes influenced each other over time (hypothesis 2); and to test for differential links between the intermediate processes and overt antisocial behavior, covert antisocial behavior and illicit substance use (hypothesis 3).

Sex-differences were explored using multiple-group nested model testing (boys versus girls) using the Wald chi-square test of parameter constraints (Muthén & Muthén, 1998-2015). To this end, a model in which all developmental paths and cross-sectional residual error correlations between boys and girls were freely estimated, was compared to a model in which developmental paths and residual error correlations were constrained to be equal for boys and girls. Note that before measures between boys and girls can be meaningfully compared, the constructs under scrutiny should be measurement invariant (i.e., similarly measured in boys and girls; Knight & Zerr, 2010). Therefore, we first tested whether our latent constructs (i.e., temperament and problem behavior) were invariant across sex. Results for measurement invariance testing are in the section ‘supplementary material chapter 2’.

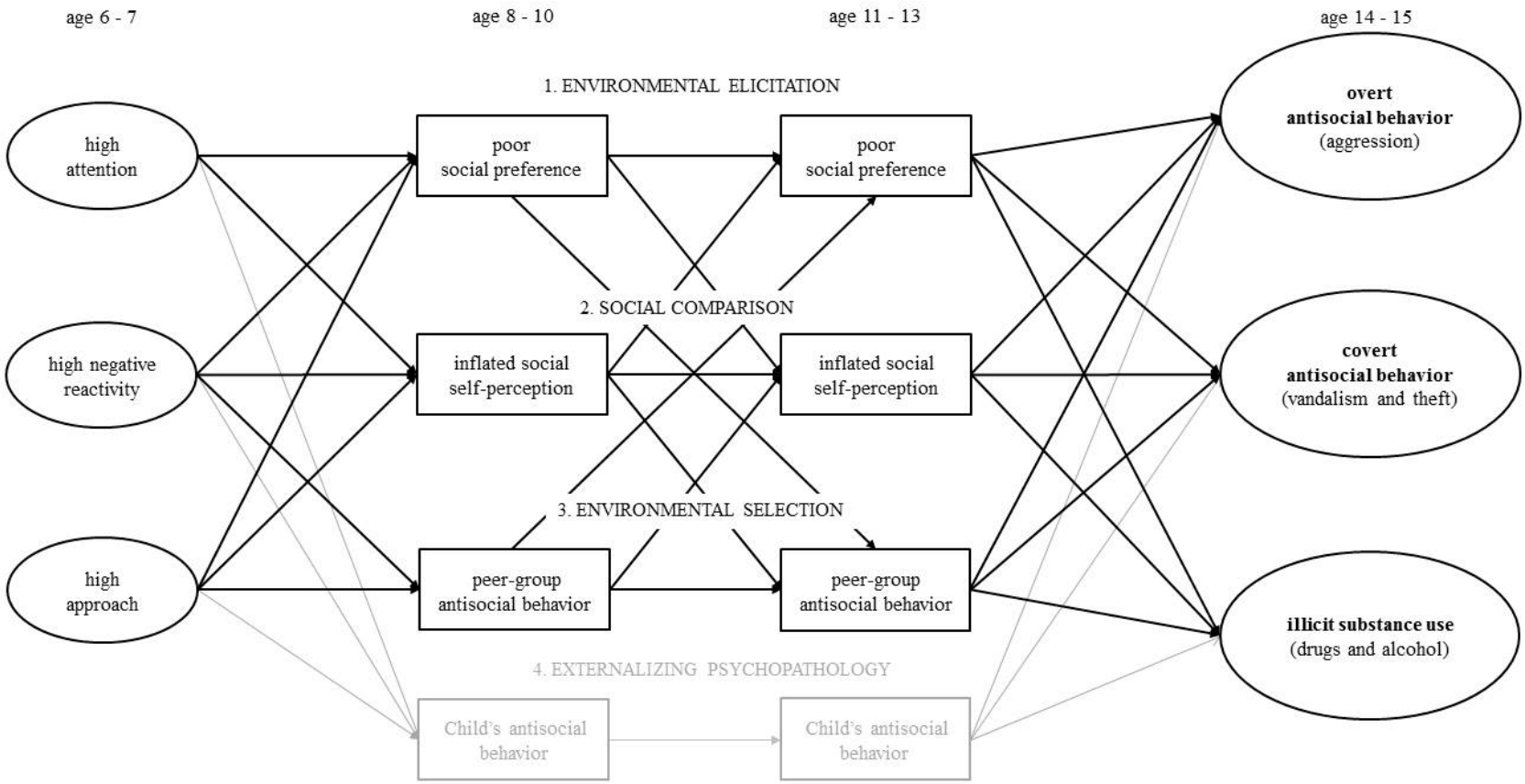

Figure 2.1. Cross-lagged model illustrating possible links between children's temperament at ages 6 and 7 years, poor social preference, inflated social self-perception, antisocial behavior of peer-group affiliates at ages 8 to 13 years and antisocial behavior and substance use at ages 14 and 15 years. Grey lines represent the 'externalizing psychopathology pathway', which links temperamental traits to the outcomes via children's own emerging and ongoing antisocial behavior. Note that paths between children's own antisocial behavior and the peer-processes were also estimated in the model, but are not depicted for reasons of clarity. Furthermore, residual error correlations between constructs were estimated in the model, but are not depicted for reasons of clarity.

Results

Descriptive Statistics

Table 2.1 gives the means and standard deviations for poor social preference, inflated social self-perception and affiliation with an antisocial peer-group, for boys and girls. Furthermore, Table 2.1 presents the results of analyses of variance (ANOVAs) comparing mean differences between boys and girls. ANOVAs indicated that boys' peer-groups had higher mean levels of antisocial behavior compared to girls' peer-groups throughout ages 8 to 10 years as well as throughout ages 11 to 13 years. In addition, throughout ages 11 to 13 years boys had poorer social preference scores than girls. None of the other variables differed significantly between boys and girls.

Table 2.1

Means and Standard Deviations for Intermediate Social Processes for Boys and Girls

	Boys		Girls		Test	
	M	*SD*	*M*	*SD*	*F*	η^2
Ages 8 to 10 years						
Poor social preference	-0.05	0.81	-0.17	0.74	2.40	.01
Inflated social self-perception	0.40	0.50	0.31	0.45	3.77	.01
Peer-group ASB	1.47	0.73	1.16	0.57	18.84^{***}	.05
Ages 11 to 13 years						
Poor social preference	0.06	0.89	-0.13	0.73	5.52^{*}	.01
Inflated social self-perception	0.39	0.49	0.30	0.41	3.66	.01
Peer-group ASB	1.77	0.90	1.49	0.59	9.00^{**}	.03

Note. ASB = antisocial behavior. Test statistic from ANOVA. η^2 = eta squared. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Analyses of structural invariance (see supplementary material chapter 2, Table 2.1S and Table 2.2S) of the latent temperament and problem behavior constructs indicated that boys and girls had similar latent means and variances for the childhood temperamental traits. Furthermore, there were no sex differences in latent variances of the three types of behavioral problems under scrutiny. However, compared to girls, boys had higher latent means of overt antisocial behavior (0.85 standard deviations higher than girls) and covert antisocial behavior (0.29 standard deviations higher than girls).

Correlations between study variables in Table 2.2 indicate within- and cross-time correlations of temperament, intermediate processes and outcomes. All significant correlations were in the expected directions, except for the negative correlations between poor social preference and level of antisocial behavior of peer-group affiliates. These negative correlations likely resulted from the fact that some of the children with low social preference scores were not part of a clique (i.e., were isolates). We performed analyses of variance (ANOVAs) to test this possibility. Table 2.3 presents the differences in poor social preference scores between clique-members and isolates. Results indicate that throughout the study period, isolates had indeed significantly lower social preference scores compared to children who were part of a clique. That is, whereas clique-members on average received more like-most nominations relative to like-least nominations, the opposite was true for isolates.

Table 2.2

Correlations for Temperamental Traits, Intermediate Social Peer Processes, Antisocial Behavior and Substance Use

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Temperament																		
1	Attention age 6	-																
2	Neg. reactivity age 6	**-.21**	-															
3	Approach age 6	-.05	.03	-														
4	Attention age 7	**.65**	**-.22**	-.05	-													
5	Neg. reactivity age 7	**-.19**	**.59**	.03	**-.30**	-												
6	Approach age 7	-.02	.09	**.49**	.00	.09	-											
Intermediate social processes 8 to 10 years																		
7	Poor social preference	**-.18**	**.26**	.02	**-.28**	**.26**	.11	-										
8	Self-perception	.07	.02	-.06	.04	-.06	.00	.04	-									
9	Peer-group ASB	.01	-.05	-.04	-.01	-.10	-.05	**-.36**	.04	-								
Intermediate social processes 11 to 13 years																		
10	Poor social preference	-.10	**.24**	.09	**-.18**	**.24**	-.01	**.57**	.02	**.12**	-							
11	Self-perception	.06	-.03	-.01	-.03	.02	.00	-.03	**.40**	-.03	.05	-						
12	Peer-group ASB	-.02	-.14	.08	.05	-.03	.09	**-.23**	-.05	**.25**	**-.32**	.02	-					
Externalizing behavior																		

13	Overt ASB age 14	.04	.02	.03	-.10	-.08	.01	.03	-.03	.06	**.13**	-.03	.12	-				
14	Covert ASB age 14	.12	.00	-.01	.07	-.03	.07	-.04	-.07	.02	-.04	-.04	.12	**.30**	-			
15	Substance use age 14	.11	.11	-.04	.09	-.03	.02	.00	-.01	-.06	**-.12**	-.01	.04	**.19**	**.39**	-		
16	Overt ASB age 15	-.05	.07	**.17**	-.04	-.01	.07	**.22**	.06	.02	**.15**	.04	.14	**.46**	**.16**	.12	-	
17	Covert ASB age 15	.02	.06	.02	.02	.02	.01	.11	-.04	-.02	.01	-.01	.09	**.22**	**.60**	**.30**	**.35**	-
18	Substance use age 15	.05	.11	.03	.04	.06	.02	.03	.08	-.10	**-.14**	.09	.13	.11	**39**	**.73**	**.22**	**.41**

Note. Estimates in bold are $p < .05$. Neg. reactivity = negative reactivity; Self-perception = inflated social self-perception; ASB = antisocial behavior.

Table 2.3

Differences for Poor Social Preference Scores between Clique-members and Isolates

	Clique members		Isolates		Test	
	M	*SD*	*M*	*SD*	*F*	η^2
Age 9	-0.34	0.82	0.44	0.90	58.27*	0.17
Age 10	-0.27	0.92	0.35	0.89	33.35*	0.09
Age 11	-0.20	0.90	0.45	1.00	25.99*	0.08
Age 12	-0.16	0.94	0.29	1.01	14.67*	0.05

Note. Negative poor social preference values indicate that children were on average more liked than disliked. Positive poor social preference values indicate that children were on average more disliked than liked. Data on clique-membership was not available for ages 8 and 13 years. *$p < .001$.

Childhood Temperament and Pathways to Antisocial Behaviors and Substance Use

Model building. To test our three hypotheses about indirect pathways linking temperament to antisocial behavior and substance use, via poor social preference, inflated social self-perception and affiliation with peers who engage in antisocial behavior, we fitted a cross-lagged model grouped into four age periods (see Figure 2.1). This model fitted the data adequately, χ^2 (1412) = 1605.60, $p < .001$, CFI = .95, RMSEA = .02. To improve model parsimony and interpretation we tested a simpler model in which all the paths that were not significant at two-sided $p < .10$ were removed. This trimmed model also fitted the data adequately, χ^2 (1461) = 1620.77, $p < .01$, CFI = .96, RMSEA = .02 (in fact, according to the fit indices the model fit became better). Results of indirect pathways for the total sample are presented in Table 2.4 and estimates for individual paths for the sample in total and sex differences in these paths are illustrated in Figure 2.2. These results are described below.

Hypothesis 1: Linking temperament to antisocial behavior and substance use via poor social preference (i.e., *environmental elicitation process*), inflated social self-perception (i.e., *social comparison process*) and antisocial behavior of peer-group affiliates (i.e., *environmental selection process*). To investigate our first hypothesis, we examined the significance of indirect pathways linking temperamental traits to later antisocial behavior and substance use via poor social preference, inflated social self-perception and antisocial behavior of peer-group affiliates. These three pathways were estimated above and beyond a developmental pathway that reflected children's personal antisocial characteristics (i.e., the externalizing psychopathology pathway).

As can be seen in Table 2.4, we found evidence for the environmental elicitation process. That is, we found an indirect pathway linking negative reactivity to overt antisocial behavior via poor social preference. Negative reactivity was also linked to substance use via poor social preference. Specifically, higher levels of negative reactivity at ages 6 and 7, were associated with lower social preference scores throughout ages 8 to 13, which in turn were associated with higher levels of overt antisocial behavior and lower levels of illicit substance use when children were 14 and 15 years old.

Negative reactivity was also related to all three types of problem behavior via the externalizing psychopathology pathway. Specifically, higher levels of negative reactivity at ages 6 and 7 were associated with higher levels of antisocial behavior throughout ages 8 to 13, which in turn were associated with higher levels of overt antisocial behavior, covert antisocial behavior and illicit substance use at ages 14 and 15 years. Furthermore, negative reactivity was linked to overt antisocial behavior via a sequential indirect pathway which is described in the results section of our second hypothesis.

We found no indirect pathways linking the temperamental traits attention and approach to the outcomes via the intermediate processes. Specifically, approach was not related to any

of the three intermediate processes, nor to children's own antisocial behavior. Regarding attention, higher levels of attention were prospectively associated with better social preference among peers, but indirect links involving these constructs did not reach statistical significance. Given that we found no indirect links that ran via inflated social self-perception or antisocial behavior of peer-group affiliates, no evidence for the processes of social comparison or environmental selection was found.

To sum up, our results showed that higher levels of negative reactivity in childhood were indirectly related to higher levels of overt antisocial behavior and to lower levels of substance use in adolescence, via the negative influence that negative reactivity has on children's standing among peers. This result is indicative of an environmental elicitation pathway. Furthermore, negative reactivity was also related to antisocial behavior (both overt and covert) and substance use via children's personal antisocial profile, which is indicative of an externalizing psychopathology pathway. In the present study, we found no evidence that social comparison or environmental selection processes explained the link between childhood temperament and adolescent problem behaviors.

Hypothesis 2: Parallel, sequential and transactional links between poor social preference, inflated social self-perception and level of antisocial behavior of peer-group affiliates. Given that we only found evidence for the environmental elicitation process, our findings do not support the hypothesis that the other peer-processes (i.e., social comparison and environmental selection) could explain the prospective association between temperament and the outcomes under scrutiny in parallel to the environmental elicitation process. In addition, we found no evidence that temperament is linked to overt antisocial behavior, covert antisocial behavior or substance use via sequential or transactional associations between the intermediate peer-processes. However and as shown in Table 2.4, we found that negative reactivity was associated with overt antisocial behavior in adolescence, via children's own antisocial behavior

at ages 8 to 10 years first and poor social preference at ages 11 to 13 years next. Specifically, higher levels of negative reactivity at ages 6 and 7 years were associated with higher levels of antisocial behavior at ages 8 to 10 years, which in turn predicted lower social preference scores at ages 11 to 13 years. Poor social preference was subsequently associated with more engagement in overt antisocial behavior. This indicates that negative reactivity at ages 6 to 7 years is not only directly related to poor preference at ages 8 to 10 years, but also to poor preference at ages 11 to 13 years via the child's own antisocial profile at ages 8 to 10 years.

Furthermore, and as can be seen in Figure 2.2, higher levels of boys' own antisocial behavior predicted an increase in their inflated social self-perception. That is, boys who showed more antisocial behavior themselves at ages 8 to 10 years showed more inflated social self-perception at ages 11 to 13 years, relative to their self-perception levels at ages 8 to 10 years. However, the indirect path linking negative reactivity to covert antisocial behavior via the boys' own antisocial behavior first and inflated social self-perception next, did not reach statistical significance.

Thus, given that we only found evidence for the environmental elicitation pathway, our hypothesis that the three intermediate peer-processes may operate in parallel, sequential or transactional ways, was not supported by our data. However, we did find evidence for a sequential pathway that involved children's own antisocial behavior. That is, higher levels of negative reactivity in earlier childhood predicted antisocial behavior in later childhood. Higher levels of antisocial behavior in later childhood, in turn, predicted poor social preference in early adolescence. Next, poor preference in early adolescence predicted higher levels of overt antisocial behavior in later adolescence. Hence, the environmental elicitation pathway and the externalizing psychopathology pathway operated not only in parallel, but the latter also influenced the former, hence representing another sequence of personal and environmental influences on the development of overt antisocial behavior.

Hypothesis 3: Differential links for overt antisocial behavior, covert antisocial behavior and substance use. As Table 2.4 shows, we found initial evidence for our third hypothesis on differential indirect effects. Specifically, poor social preference was related to both illicit substance use and overt antisocial behavior. However, whereas lower levels of social preference were positively associated with subsequent overt antisocial behavior, these were negatively associated with subsequent substance use.

We performed a follow-up analysis to test whether the indirect paths linking social preference to overt antisocial behavior and substance use, respectively, were statistically different from each other. To this end, we tested the (in)equality of the total indirect effect between negative reactivity, poor social preference and substance use and between negative reactivity, poor social preference and overt antisocial behavior. The Wald chi-square test of parameter constraints was significant ($\Delta\chi^2$ (1) = 4.11, $p < .05$). This indicates that the developmental pathway from negative reactivity to poor social preference to overt antisocial behavior is different from the developmental pathway from negative reactivity to poor social preference to substance use.

In short, we found differential developmental pathways that linked negative reactivity to overt antisocial behavior and substance use, via its negative influence on social preference. Specifically, poor preference among peers predicted higher levels of antisocial behavior in adolescence, while it at the same time predicted lower levels of substance use.

Sex differences. Constraining the estimates in our developmental model to be equal for boys and girls resulted in a significant drop in fit when this model was compared to a freely estimated model, $\Delta\chi^2$ (39) = 95.38, $p < .001$. Follow-up analyses indicated various sex differences in residual error correlations, in various links between the covariate household SES and the constructs under scrutiny and in five path estimates. Differences for the five path estimates are illustrated in Figure 2.2. These indicate that the association between affiliation

with antisocial peers and subsequent covert antisocial behavior was significant and positive for both boys and girls, but somewhat stronger for girls compared to boys. In addition, affiliation with antisocial peers was positively associated with subsequent engagement in illicit substance use for girls, but not significant for boys. Furthermore, the association between inflated social self-perception and subsequent covert antisocial behavior was significant and negative for boys, but not significant for girls. Moreover, children's own antisocial development at ages 8 to 10 years was positively associated with inflated social self-perception at ages 11 to 13 years for boys, but not significant for girls. Lastly, children's own antisocial behavior at ages 11 to 13 years was positive associated with subsequent illicit substance use and this association was stronger for boys than for girls. When the coefficients for the five individual paths (as well as significantly different residual error correlations and links between household SES and constructs) were allowed to vary between boys and girls (i.e., when these coefficients were freely estimated), this no longer resulted in a significant drop in fit compared to the totally unconstrained model $\Delta\chi^2$ (22) = 30.53, p = .11. Despite the sex-differences that were found in individual path-estimates, testing for sex differences in the indirect pathways showed that these indirect paths did not differ between boys and girls (all ps $\geq$ .08).

In sum, indirect paths that linked temperament to later antisocial behavior and substance use did not differ in magnitude between boys and girls. However, compared to boys, girls showed stronger associations between affiliation with antisocial peers and subsequent covert antisocial behavior and illicit substance use. In contrast, boys showed stronger associations between inflated social self-perception and covert antisocial behavior and between their own antisocial characteristics and subsequent illicit substance use than girls. Lastly, boys showed stronger associations between their own antisocial behavior and subsequent over-estimated self-perception than girls.

Table 2.4

Significant Indirect Effects Linking Childhood Temperament with Antisocial Behavior and Substance Use in Adolescence

											95% CI	
Ages 6 - 7		Ages 8 - 10		Ages 11 - 13		Ages 14 - 15		β	B	LL	UL
Indirect links predicting overt antisocial behavior											
neg. reactivity →	+	poor social preference →	+	poor social preference →	+	overt ASB		0.04	0.15	.008	.495
neg. reactivity →	+	own antisocial behavior →	+	poor social preference →	+	overt ASB		0.01	0.04	.001	.170
neg. reactivity →	+	own antisocial behavior →	+	own antisocial behavior →	+	overt ASB		0.05	0.17	.015	.450
Indirect links predicting covert antisocial behavior											
neg. reactivity →	+	own antisocial behavior →	+	own antisocial behavior →	+	covert ASB		0.05	0.19	.044	.490
Indirect links predicting substance use											
neg. reactivity →	+	poor social preference →	+	poor social preference →	-	substance use		-0.02	-0.05	-.150	-.001
neg. reactivity →	+	own antisocial behavior →	+	own antisocial behavior →	+	substance use		0.05	0.11	.019	.262

Note. [+] = positive association; [-] = negative association; neg. reactivity = negative reactivity; ASB = antisocial behavior; CI = confidence interval; LL = lower limit;

UL = upper limit.

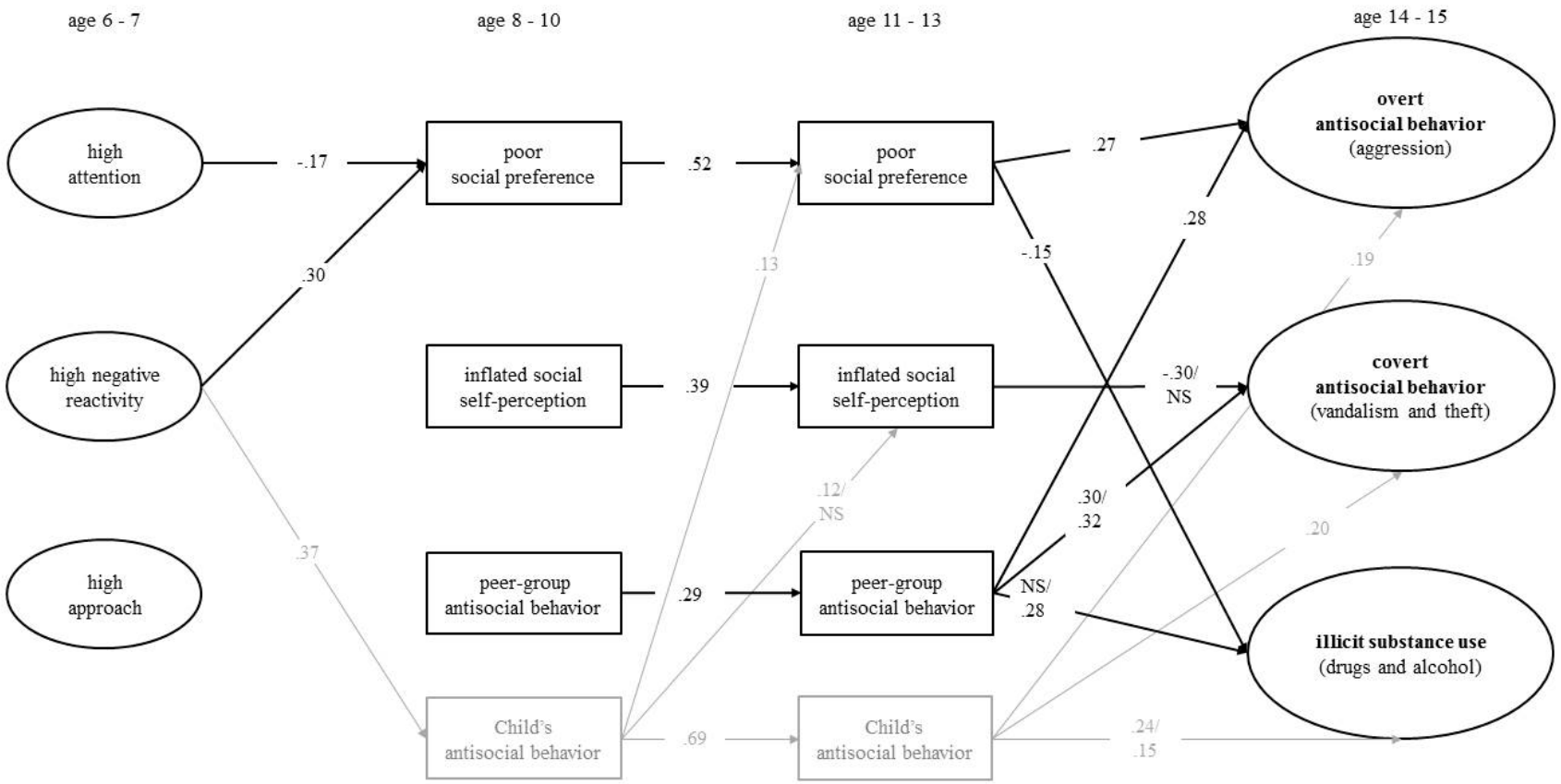

Figure 2.2. Results for the restriced model (standardized estimates). When two coefficients are presented, the upper coeffictient represents estimates for boys and the lower coefficient represents estimates for girls. Grey lines represent the 'externalizing psychopathology pathway', which links temperamental traits to the outcomes via children's own emerging and ongoing antisocial behavior. Note that residual error correlations between constructs were estimated in the model, but are not depicted for reasons of clarity. All reported coefficients were significant at $p < .05$. NS = not significant.

Discussion

Developmental Pathways Linking Temperament with Overt Antisocial Behavior, Covert Antisocial Behavior and Substance Use

The purpose of the current study was to investigate why childhood temperament may be linked with antisocial behaviors and substance use in adolescence. Three developmental pathways involving peer-related experiences were tested: a) an environmental elicitation pathway, which indicates that certain temperamental traits may elicit negative evaluations from peers, in our study indexed by poor social preference, b) a social comparison pathway, indicating that certain temperamental traits may influence how children compare themselves with others, in our study indexed by an inflated social self-perception, and c) an environmental selection pathway, which indicates that certain temperamental traits may influence with which peer-environment children choose to surround themselves, in our study indexed by affiliation with a peer-group that engages in antisocial behavior. We expected that these processes, in turn, may influence the development of antisocial behavior and substance use, above and beyond a more direct pathway that involves the child's own antisocial characteristics (i.e., the externalizing psychopathology pathway) and above and beyond socioeconomic factors (X. Chen & Schmidt, 2015; Nigg, 2006; Shiner & Caspi, 2003).

We found evidence for the hypothesized environmental elicitation pathway. That is, we found that children (boys as well as girls) who had lower thresholds for reacting in a negative way to sensory stimuli and who reacted more intensely, which represents one of the (multiple) lower-order traits related to the higher-order trait 'negative emotionality', evoked more poor social preference among peers than children who had lower levels of negative reactivity. This finding is in line with previous cross-sectional studies (De Bolle & Tackett, 2013; Jensen-Campbell & Malcolm, 2007) as well as with a longitudinal study focused on children aged 10 to 13 years (Bollmer, Harris, & Milich, 2006). The latter study indicated that high neuroticism

(a higher-order personality construct that overlaps with negative emotionality; Rothbart et al., 2000) was related to a variety of social difficulties, including low peer acceptance and being a victim of bullying (Bollmer et al., 2006). In our study, poor social preference was, in turn, positively associated with subsequent overt antisocial behavior but negatively with illicit substance use. Previous studies have indicated that poor social preference may set into motion a cascade of social difficulties, such as difficulties with forming friendships and becoming a victim of bullying (Van Lier & Koot, 2010). This indicates that several peer-processes could account for the mediating role of poor social preference. In addition to the influence of peers, negative reactivity as well as other temperamental traits may be linked to later antisocial behavior and substance use via (environmental elicitation) processes beyond peer-experiences. For example, some studies have found that certain temperamental characteristics of children, such as negative reactivity, may influence their parents' behaviors and parent-child interactions in a negative way, which then may influence the development of problematic behaviors in these children (Bates & Pettit, 2015).

Furthermore, we found evidence for the externalizing psychopathology pathway. Specifically, negative reactivity in childhood was associated with overt antisocial behavior, covert antisocial behavior as well as substance use in later adolescence, via the child's engagement in antisocial behavior in middle childhood and early adolescence. Specifically, children who scored higher on negative reactivity in earlier childhood also scored higher on subsequent antisocial behavior in later childhood and early adolescence, which in turn was associated with engagement in all three types of behavioral outcomes that were investigated in the present study. This may indicate that higher levels of negative reactivity may – to some extent – be an early manifestation of a broad spectrum of behavioral problems and that an underlying common shared etiological factor of externalizing psychopathology may explain the link between negative reactivity and antisocial behavior and substance use (see, e.g.,

Krueger et al., 2007; Nigg, 2006). For example, one such underlying etiological factor may be experiencing difficulties in emotion- and behavior-related self-regulation. That is children with high levels of negative reactivity as well as children with high levels of externalizing behaviors tend to respond to distressing or difficult situations with emotional and behavioral dysregulation (Eisenberg, Spinrad, & Eggum, 2010; Kim & Cicchetti, 2010; Veilleux, Skinner, Reese, & Shaver, 2014). Hence, our results support both the 'vulnerability' and the 'spectrum' theory of the trait-psychopathology link, indicating that these two theories –both of which aim to explain the developmental association between temperament and later psychopathology - are not mutually exclusive. This possibility warrants further research attention.

Above and beyond the environmental elicitation pathway and the externalizing psychopathology pathway, we found no evidence for the hypothesized social comparison and environmental selection pathways. That is, in the present study, we found no evidence for developmental paths linking temperament to later antisocial behavior or substance use via inflated social self-perception or via affiliation with an antisocial peer-group, when these pathways were studied together developmental paths in addition to the environmental elicitation and the externalizing psychopathology pathway. These findings contradict theoretical considerations as well as cross-sectional empirical findings that are suggestive of such developmental links (e.g., Shiner & Caspi, 2003; Steca et al., 2007; Wu, Bischof, Anderson, Jakobsen, & Kingstone, 2014). Results from the present study may suggest that such associations may vanish when studied in a longitudinal, well-controlled design. This finding is in line with a previous study that reached a similar conclusion (White & Kistner, 2011). However, it is important to recognize that all three peer-processes investigated in the current study were associated with later antisocial behavior or substance use. Thus, although inflated social self-perception and antisocial behavior of peer-group affiliates did not explain the developmental link between the childhood temperamental traits included in the present study

and engagement in problematic behaviors in adolescence, these peer processes should not be disregarded when studying the development of antisocial behavior and substance use. In addition, it is also important to note that inflated social self-perception and antisocial behavior of peer-group affiliates may be important processes linking other temperament traits beyond those investigated in the current study with antisocial behavior and substance use. For example, traits related high sensation seeking or narcissism may be linked with antisocial behavior or substance use through these processes (John & Robins, 1994; Yanovitzky, 2005).

Furthermore, in alignment with other studies and our own hypothesis, we found that lower levels of attention predicted poor social preference among peers (Coplan & Bullock, 2012), although the pathway connecting this temperamental trait to any of the outcomes under scrutiny did not reach statistical significance. Moreover, we did not find that lower levels of attention or approach predicted subsequent affiliation with antisocial peer-groups or inflated social self-perception, as was hypothesized by us and as others have found (Kendler et al., 2015; Li et al., 2016; Scholtens et al., 2012). Nor did we find that lower levels of approach were affiliated with lower levels of social preference among peers (Ilmarinen et al., 2015). The fact that, with the exception of Scholtens and colleagues (2012), none of the studies cited above controlled for children's antisocial behavior when examining developmental paths between temperament and peer-factors, may be a plausible explanation for our findings. Our study indicates that controlling for children's personal antisocial profile is of importance, because we found strong evidence for a developmental pathway linking temperament to antisocial outcomes via these antisocial characteristics (i.e., the externalizing psychopathology pathway). Hence, this may suggest that certain peer factors may no longer predict the indirect link of attention and approach with later behavioral outcomes, when emerging, concurrent and ongoing antisocial behaviors are taken into account. Furthermore, studies that found links of temperamental dimensions involving the lower-order traits approach and attention with peer-

factors, often included a more complete representation of the higher-order dimensions of temperament (e.g., 'extraversion', see Illmarinen et al., 2015; or 'effortfull control', see Ilmarinen et al., 2015; Li et al., 2016), than was utilized in the present study. This potentially indicates that our temperamental measures may be too narrowly defined to capture links between these temperamental traits and peer-factors. Moreover, Scholtens and colleagues (2012) found that inattention was related to parent-reported levels of social acceptance, but not to child-reported levels of social acceptance, indicating that the use of different informants result may in different findings. These possibilities warrant further research attention.

In sum, in the current study we found evidence for the environmental elicitation pathway and the externalizing psychopathology pathway. That is, negative reactivity was linked to higher levels of overt antisocial behavior and less use of illicit substances, via its negative effect on social preference. In addition, negative reactivity was also linked to all three outcomes via the children's personal antisocial characteristics. We found no evidence for the social comparison or the environmental selection pathway in the present study.

No Evidence for Sequential Developmental Paths Involving Peer-Processes

Second, we explored whether the intermediate peer-processes influenced each other over time, resulting in sequential or transactional indirect links that predict the association between temperament and the outcomes under scrutiny. In contrast to others who have found that poorly preferred children affiliated with peers who engage in antisocial behavior (for an overview, see D. Chen et al., 2015), we found no evidence for such a sequential link. This finding may be explained by the fact that studies that found such a developmental link used a different design and different constructs than was utilized in the present study. For example, Vitaro and colleagues (2007) found that peer rejection predicted affiliation with antisocial peers, although a more recent study failed to replicate this finding (Ettekal & Ladd, 2015). Peer rejection and poor social preference are distinct constructs, albeit related (Bukowski, Sippola,

Hoza, & Newcomb, 2000; Coie et al., 1982). That is, poor social preference refers to the extent to which children are disliked by their peers, relative to being liked. It includes both an advantageous (i.e., being liked among many and disliked by few) and a disadvantageous (i.e., being disliked by many and liked by few) end of children's social standing among peers. Peer rejection, in contrast, reflects only the negative end of the social preference spectrum. In this regard it is of interest to note that a previous study found that both higher poor social preference scores ('high rejection') as well as lower positive preference scores ('low acceptance') were associated with behavioral problems that included overt antisocial behavior, covert antisocial behavior and substance use (Buil, Koot, Olthof, Nelson, & van Lier, 2015). This indicates that the total spectrum of social preference influences the development of these behavioral problems, rather than only the negative part of the spectrum. In this light, it is also noteworthy that a previous study using similar constructs as were used in the present study, that is, poor social preference and antisocial behavior of clique-affiliates, also found no evidence for a link between these constructs over time (Bagwell, Coie, Terry, & Lochman, 2000). In addition, children who showed more antisocial behavior at ages 8 to 10 years showed lower social preference scores when they were 11 to 13 years old and boys who showed more antisocial behavior at ages 8 to 10 years tended to show more inflated social self-perception. However, none of these sequential paths could explain the link between temperament and antisocial behavior or substance use.

Despite that the intermediate peer-processes did not influence each other, we found that negative reactivity predicted later engagement in overt antisocial behavior, via children's own antisocial behavior first, and poor social preference next. This finding complements the debate on the vulnerability-trait model and the spectrum model of the temperament-psychopathology link, by showing that both models may explain the developmental link from temperament to

later psychopathology not only in parallel, but also via complex, interactive ways. This too warrants further research attention.

The Importance of Distinguishing Between Overt Antisocial Behavior, Covert Antisocial Behavior and Substance Use

Third, we hypothesized that the developmental links between temperament, the intermediate peer-processes and the outcomes, would vary depending upon the specific outcome under scrutiny. Results from the present study support this hypothesis. That is, in line with findings from others (e.g. Dodge et al., 2003; Ladd, 2006; Miller-Johnson, Coie, Maumary-Gremaud, & Bierman, 2002; Sturaro et al., 2011), our results suggest that low social preference among peers puts children at risk for engagement in overt antisocial behavior. This link may be explained through the possibility that children who are not highly preferred by peers may lack opportunities or lack sufficient motivation to learn social norms for adaptive behavior. Furthermore, overt antisocial behavior may also be a result of negative social encounters with peers such as acts of retribution resulting from low preference (Rubin et al., 2006). In addition, our results suggest that low social preference at the same time may protect children against engaging in illicit substance use, as has been found in previous studies investigating related constructs (e.g., Allen et al., 2005; Tucker et al., 2011; Van Ryzin et al., 2016). Our results indicate that children who are relatively more disliked than liked by their peers have a higher chance of being isolated from peer-groups than children who are relatively more liked. Given that youngster tend to use substances in a social manner, that is, when with peers, being isolated from peer-groups may hamper children's access to substances and may render them less influenced by peer-group norms encouraging substance use (Osgood et al., 2013; Verkooijen, de Vries, & Nielsen, 2007).

In sum, we found evidence for differential developmental pathways dependent upon which outcome was investigated. That is, negative reactivity predicted, over time, more

engagement in overt antisocial behavior and less engagement in illicit substance use and this differential effect was due to the difference in influence that poor social preference has on these two different types of behavioral problems. This finding emphasizes the importance of differentiating between several subtypes of behavioral problems within the externalizing spectrum, rather than investigating a broad spectrum of externalizing behavior as one construct.

No Evidence for Sex-Differences in the Developmental Pathways

Lastly, no evidence was found for the suggestion that developmental paths between temperament and antisocial behavior or substance use may be different for boys and girls as some other studies have found (Moffitt et al., 2001; Van Lier et al., 2005). However, some differences in individual paths between two constructs were found. For example, and in line with Laird and colleagues (1999), we found that antisocial peer affiliation was related to covert antisocial behavior for both boys and girls, but more strongly for girls. Second, antisocial peer-group affiliation was related to the use of illicit substances for girls, but not for boys. This may be explained by the finding that compared to boys, girls may anticipate more negative consequences for their friendships and expect more peer disapproval when they refuse to participate in deviant behaviors (Pearl, Bryan, & Herzog, 1990). Furthermore, girls seem to care more about close friendships than boys and may be more afraid of negative peer evaluations than boys (see overview by Rose & Rudolph, 2006), which may make them more vulnerable to negative peer-influences. Third, overestimation of one's social standing among peers was related to less engagement in covert antisocial behavior for boys, but was not related to covert antisocial behavior for girls; boys' antisocial characteristics were more strongly related to illicit substance use than girls' antisocial tendencies; and boys' antisocial characteristics were more strongly related to subsequent overestimation of their social standing among peers. This might indicate that girls are more influenced by interpersonal, peer-

relationship factors, particularly affiliation with antisocial peers, while boys may be more influenced by intrapersonal characteristics (i.e., their own antisocial behavior).

Limitations and Future Directions

There are limitations that need to be considered when interpreting the present findings. First, we used the original version of the behavioral-based questionnaire the DOTS (Lerner et al., 1982) to investigate temperamental traits. A substantive strength of this instrument is that it does not include items that overlap with the items used to measure antisocial behavior and substance use, thus avoiding spurious relationships between temperament and the outcomes (De Pauw & Mervielde, 2010; Shiner & Caspi, 2003). However, the DOTS questionnaire also has considerable weaknesses. A substantive limitation of the DOTS is that its constructs do not entirely map onto the lower-order temperament traits as they are currently conceived. In addition, the DOTS does not measure higher-order traits, nor the full range of temperamental traits that are incorporated in the most recent taxonomies of temperament. For example, the DOTS does not measure lower-order traits like deriving pleasure from low- or high intense activities, inhibitory control, sociability, or the full range of negative emotions (e.g. sensitivity to sensory stimuli is measured, but the tendency to experience anxiety or frustration is not measured). It also needs to be noted that previous studies found that convergent and discriminant validity of the DOTS scales with other measures of temperament was only moderate (Goldsmith et al., 1991; Hubert et al., 1982). Lastly, while not a limitation per se, it needs to be kept in mind that our results may not extent to other indicators of temperament, like psychobiological indicators (Rothbart, 2007). Thus, although our study provides substantive insight in how temperamental traits, via the peer-environment and via children's own antisocial characteristics, may or may not influence future engagement in antisocial behavior and substance use, studies aiming to extent our findings to a broader range of

temperamental traits as how they are currently conceived are warranted before any firm conclusions can be made.

Second, influences of peers as assessed in this study were limited to peers within the classroom. However, peers outside the classroom may also affect children's behavior. Although others have shown that influences of peers outside of the school-context are limited for elementary school children (Kupersmidt, Burchinal, & Patterson, 1995), we cannot be certain that peers outside the classroom have not influenced our results.

Third, because we used aggregated data over four age periods. Because classroom composition in Canada changes from one year to the next, we were not able to control for nesting of children within schools and classrooms.

Fourth, we studied a sample of elementary school children who were representative of the Canadian population. However, because of our general population sample, no generalization to clinical and high-risk samples is possible. Future studies may want to investigate whether similar developmental processes are indicative of substance use disorders or clinical diagnoses of antisocial behavior such as conduct disorder and antisocial personality disorder.

Fifth, we did not examine interactions between temperamental characteristics. For example, high levels of positive emotionality/surgency may not be related to environmental elicitation, social comparison, or environmental selection processes when studied in isolation. However, when high levels of positive emotionality are accompanied with high negative reactivity levels, such a relationship may in fact appear (X. Chen & Schmidt, 2015; Eisenberg, Fabes, Guthrie, & Reiser, 2000). Therefore, future studies should also consider temperament profiles, not just individual temperamental traits.

Sixth, we were able to investigate only some of the suggested pathways linking temperament with antisocial behavior and substance use. Other pathways, such as learning

processes, have been suggested (Nigg, 2006; Shiner & Caspi, 2003) and should be investigated in future studies. In relation to this latter point, future studies should investigate not only other explanatory environmental factors, but also should also investigate indicators of common, shared etiological factors, such as genetic factors (Clark, 2005). In addition, future studies may want to investigate developmental pathways that focus on environmental factors outside the peer-context such as factors within the home-context.

Seventh, only the environmental elicitation process was supported by the data in the present study. As outlined earlier, this is not to say, that the processes of social comparison and environmental selection play no part in explaining the link between temperament and later problem behaviors. Other temperamental traits not included in the present study may be related to antisocial peer-group affiliation and the development of an inflated social self-perception (John & Robins, 1994; Yanovitzky, 2005). Therefore, it should be kept in mind that the current results only extend to the measured temperamental traits in the present study and that other studies investigating other temperamental traits may reach different results and conclusions.

Conclusions and Implications

To further our understanding of the link between temperament and the development of antisocial behavior and substance use, we need to recognize the role of peer environmental factors. That is, temperamental traits, particularly negative reactivity, may influence whether or not a child establishes a positive position within the peer-group. The difficulties that children may have with mastering this important developmental task may contribute to youths' engagement in overt antisocial behavior while it may decrease risk for illicit substance use. This being said, it is also important to acknowledge the importance of a child-personal developmental pathway of antisocial behavior that is independent of peer experiences and is predicted by high negative reactivity.

Our results have implications for research and practice. First, the impact of troublesome social experiences with peers, especially poor social preference at the peer-group level, should be taken into account in order to understand developmental links between temperament and the emergence of antisocial behavior and substance use. Second, it needs to be recognized that links between temperament and these problem behaviors may differ for the behavioral outcome under scrutiny. Thus, future developmental models that aim to explain the link between temperament and behavioral problems within the externalizing spectrum should include social-environmental factors as potential explanatory factors and should investigate various forms of behavioral problems as separate, although related, outcome measures. Third, teachers and other professionals should be particularly aware of those children who show frequent and intense negative reactions to stimuli and who (subsequently) evoke poor social preference among their peers. Teachers should not ignore the significance of this poor social preference, as our findings underscore the power of poor social preference during elementary school years to explain, at least in part, how early temperamental difficulties may become manifested in later overt antisocial behavior. Related to this latter point, our results imply that improving children's poor social standing among peers might be a useful treatment target, particularly for highly reactive children.

3

Sex Differences and Parallels in the Development of Externalizing Behaviors in Childhood: Boys' and Girls' Susceptibility to Social Preference among Peers

J. Marieke Buil

Hans M. Koot

Pol A.C. van Lier

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Abstract

This study examined whether being poorly preferred by peers may partially explain why boys with oppositional behavior develop more conduct problems than girls. Children from the general Dutch population attending regular elementary schools (N = 759, 50.3% boys) were followed annually from age 7 to 10 years. Teachers-rated externalizing behavior and peer-nominated social preference was assessed across four waves. Autoregressive cross-lagged models indicated that oppositionality predicted increases in conduct problems. Above and beyond this direct link, oppositionality predicted low social preference in subsequent years, which in turn predicted an increase in conduct problems. In this latter pathway, sex difference were found. That is, oppositional boys were as likely as oppositional girls to show an increase in low social preference one year later. However, boys who had low social preference scores showed stronger increases in conduct problems one year later, compared to girls who had low social preference scores. Hence, developmental models of externalizing behavior should consider the possible sex-differential impact of troublesome peer-relationships to understand the development of milder to more severe externalizing behaviors.

Children who engage in externalizing behavior are at risk for various adverse developmental outcomes, such as criminality, psychopathology and substance dependence (Colman et al., 2009; Fergusson et al., 2009). This risk is particularly apparent for children whose behavior escalates from initial rather mild externalizing problems, such as oppositional behavior, to more severe conduct problems that inflict harm on others. Studies focused on the developmental unfolding of externalizing behavior suggest a developmental pathway in which oppositional behavior predicts subsequent conduct problems (Drabick, Bubier, Chen, Price, & Lanza, 2011; Rowe, Costello, Angold, Copeland, & Maughan, 2010). Furthermore, boys generally show higher levels of conduct problems compared to girls. However, sex differences in ratios of oppositionality are far less pronounced (Achenbach & Rescorla, 2001; Lahey et al., 2000; Van Lier, Van der Ende, et al., 2007). This may suggest that some underlying factors that explain the developmental association between oppositional behavior and conduct problems influence boys more than girls. Being poorly liked by peers (i.e., low social preference) may be one such factor (Van Lier & Koot, 2010). In the present study, using a general population sample of 759 Dutch elementary school children who were followed annually from 7 to 10 years of age, we investigated whether sex differences in the susceptibility to experiencing low social preference among peers could be one potential pathway by which oppositional boys may develop more conduct problems than oppositional girls.

Oppositional behavior in childhood can (among other negative outcomes) be an early marker for the development of conduct problems (Drabick et al., 2011; Rowe et al., 2010). However, there are marked differences in the boy-girl ratio of oppositional behavior compared to that of conduct problems. Specifically, studies have reported that sex differences in levels of conduct problems, with boys having substantially more problems than girls, are more outstanding than those in oppositional behavior in large community samples in the USA (Achenbach & Rescorla, 2001; Lahey et al., 2000) as well as in Europe (Van Lier, Van der

Ende, et al., 2007). Given that oppositionality predicts conduct problem development and given that boys have higher levels of conduct problems than girls while levels of oppositionality are fairly similar, this may indicate that certain underlying factors that explain the developmental association between oppositionality and conduct problems may influence boys more than girls.

One factor that may, at least in part, explain why oppositional boys may develop more conduct problems than oppositional girls, may be a potential sex-difference in their susceptibility to low social preference. Children who are poorly preferred among peers are typically defined in terms of sociometric ratings as children who receive few 'liked most' nominations and many 'liked least' nominations from their peers (Coie et al., 1982). Exposure to social evaluations by peers increases when children enter formal schooling and have to function in the presence of age-matched peers for a large proportion of the day. Research has shown that oppositional behavior may evoke poor social preference and being disliked by peers (Burke, Waldman, & Lahey, 2010; Carlson, Tamm, & Gaub, 1997; Vitaro et al., 2007). The early elementary school period is also the period of time in which the first conduct problems typically arise (Loeber, Green, Lahey, Christ, & Frick, 1992). Exposure to low social preference has been found to add to the prediction of early-onset conduct problems (Miller-Johnson et al., 2002). Together, these findings indicate that low social preference may act as a connecting factor explaining, at least in part, the progression from oppositional behavior to conduct problems.

Not only may low social preference be one of the potential factors that may underlie the development of oppositionality to conduct problems, it may also explain, in part, why boys show higher levels of conduct problems than girls. For example, boys are more status-oriented than girls amongst peers (Rose & Rudolph, 2006). Therefore, boys may be more focused on obtaining dominance and control in their relationships with peers than girls (Rose & Rudolph, 2006), and may more often use aggression (which is part of the umbrella term 'conduct

problems') to defend their group status (Geary, Byrd-Craven, Hoard, Vigil, & Numtee, 2003). In addition, boys may cope differently with negative peer experiences than girls (Rose & Rudolph, 2006). Disliked children have been found to be more biased in their attribution of hostile intent to peers when compared to children who are liked by their peers (Lansford, Malone, Dodge, Pettit, & Bates, 2010). Such attribution biases have been found to predict conduct problems in boys that are not highly preffered among their peers, but less so in poorly preffered girls (Schultz, Izard, & Ackerman, 2000). Finally, forceful responses to being disliked, like coercive exchanges with peers, are more often seen in boys than in girls (Snyder et al., 2008). Overall, these sex differences in the meaning of poor peer-group status and in coping style as a response to such experiences suggest that boys may be more susceptible to the effects of low social preference and may be more likely to respond with conduct problems to it than girls. In line with this, studies have shown that negative peer experiences affect boys' externalizing behavior development more than girls' externalizing behavior development (Moffitt et al., 2001; Van Lier & Koot, 2010). Thus, although boys and girls may both experience low social preference when they show oppositional behavior and although boys and girls may both respond to negative peer experiences with increases in conduct problems, the magnitude of the predictive link from social preference to conduct problems may be stronger for boys.

Despite the plausibility that susceptibility to low social preference could be one potential pathway by which oppositional boys may develop higher levels of conduct problems compared to girls, to our knowledge no prior study explored this possibility longitudinally. Therefore, this study addressed two research questions and four hypotheses. First, we investigated whether the progression of oppositional behavior to conduct problems in children that attend general elementary schools runs, in part, via experiences of low social preference. We hypothesized that over the first four years of elementary school, oppositional behavior will

add to the prediction of conduct problems, above and beyond existing conduct problems (hypothesis 1). We also hypothesized that above and beyond this direct link, oppositional behavior will predict subsequent increases in experiences of low social preference, which in turn will predict increases in levels of conduct problems (hypothesis 2). Second, we examined whether this indirect developmental pathway from oppositionality to conduct problems via low social preference varies by sex. We hypothesized that boys and girls with oppositional behavior will be equally likely to experience low social preference (hypothesis 3), and that boys in particular will increase in their engagement in conduct problems as a reaction to a poor social standing in the peer group (hypothesis 4).

In the early summer of 2004, 825 kindergarten children from 30 elementary schools located in two urban areas and one rural area in the Netherlands were targeted for inclusion in the present study. The study was approved by the ethic review boards of the Erasmus University Rotterdam and the Vrije Universiteit Amsterdam. Children were eligible for inclusion if they moved on from kindergarten to first grade (n = 750) or if they entered a participating classroom (n = 111; total N = 861) in 2005. Signed parental informed consent for participation in the study was obtained for 88% of the children, resulting in a total sample 759 children (50.3% boys, mean age 7.03 years (SD = 0.47)) in first grade. Fifty-eight percent of the children were from a Dutch/Caucasian background, 11% were Moroccan, 10% were Turkish, 7% were Surinamese, 5% were from the Netherlands Antilles, and 9% were from other ethnical backgrounds. Furthermore, 30% of the children came from low socioeconomic status (SES) families, which is largely comparable to the general Dutch population (32% low SES; (Statistics Netherlands, 2013).

Oppositional behavior, conduct problems and low social preference were assessed annually from first to fourth grade of elementary school. During the follow-up period, assessments of some children were incomplete due to retention, moving to another school, or

absence during the measurement. Data of 91.3% of the children was complete for at least two measurement moments, 77.2% had at least three complete assessments. Children with missing data did not differ from children with complete data with respect to sex distribution. However, children with missing values had higher mean levels of oppositional behavior ($F(1, 757) = 16.93$, $p < .001$, $\eta^2 = .02$) and conduct problems ($F(1, 757) = 32.31$, $p < .001$, $\eta^2 = .04$) and lower social preference scores ($F(1,755) = 33.27$, $p < .001$, $\eta^2 = .04$), compared to children with complete data. Approximately two-thirds of the children had received a preventive intervention targeting problem behavior (Good Behavior Game; Barrish, Saunders, & Wolf, 1969), which was implemented in grades 1 and 2. Given that testing for intervention effects was not an objective of this study, all estimates were controlled for intervention effects.

Measures

Teacher ratings of oppositional behavior and conduct problems. Externalizing behavior was assessed with the Problem Behavior at School Interview (PBSI; Erasmus M. C., 2000). The PBSI is a 42-item face-to-face interview, in which teachers rated pupils' behavior on a five-point Likert-scale ranging from 0 (never applicable) to 4 (often applicable). Trained research-assistants interviewed teachers face-to-face. Oppositional behaviors were assessed by 7 items (range α over the assessments = .89 - .91; e.g., 'disobeys teacher's instructions', 'is stubborn', 'argues'). Conduct problems were assessed by 12 items (range α over the assessments = .90 - .93; e.g., 'attacks other children', steals', 'destroys others' property'). Item scores per scale were averaged, resulting in scales ranging from 0 to 4 for both oppositional behavior and conduct problems.

Low social preference. Social preference scores were obtained through peer-nominations. Peer-nominations were administered at the participants' school by trained research-assistants. The protocol was partially based on the procedure described by Coie, Dodge and Copotelli (1982). Children were asked to nominate an unlimited number of

classmates whom they liked most and whom they liked least. The 'liked most' scores of each child were subtracted from his or her 'liked least' scores to obtain a score in which the high end reflects low social preference. This score was divided by the total number of children in the classroom minus one (children could not nominate themselves). Scores ranged from –1 (highest social preference) to 1 (lowest social preference).

Child's sex. Children's sex was dummy coded as 0 = male, 1 = female.

Household socioeconomic status (SES). SES was measured through the target child's parental occupation in first grade and was dummy coded as 0 = medium to high SES, 1 = low SES.

Statistical Approach

Autoregressive cross-lagged models were used to test our hypotheses (Jöreskog, 1970). Models were fitted in Mplus 7.31, Los Angeles, California (L. K. Muthén & Muthén, 1998-2015). Autoregressive paths for oppositional behavior, conduct problems and low social preference from grades 1 to 4 model the stability within constructs. Cross-lagged, cross-time paths test for developmental links between the constructs. Maximum likelihood estimation with robust standard errors (MLR-estimator) was used to account for the non-normal distribution of the data. We accounted for clustering of data within schools by using a sandwich estimator (Williams, 2000b). Missing data were handled using Full Information Maximum Likelihood (FIML) estimations. The Satorra-Bentler chi-square difference test was used to compare nested models (Satorra, 2000). Model fit was determined via the Comparative Fit Index (CFI; with values $\geq$ .95 indicating good fit and values $\geq$ .90 indicating acceptable fit), the Root Mean Squared Error of Approximation (RMSEA; with values $\leq$ .06 being acceptable) and the Standardized Root Mean Squared Residual (SRMR; with values $\leq$ .08 being acceptable; (Hu & Bentler, 1998).

We first tested the developmental links between oppositionality, low social preference and conduct problems. To this end, we departed from a baseline model in which all possible autoregressive and cross-lagged paths, in addition to cross-sectional correlations, between our constructs of interest were estimated. For reasons of parsimony, we then tested whether we could constrain recurring paths to be equal over time and whether non-significant paths could be trimmed. We used our most parsimonious model to investigate whether oppositional behavior predicted increases in conduct problems in the following school-year (hypothesis 1), and whether the development from oppositionality to conduct problem ran via low social preference (hypothesis 2). The significance of the indirect pathway from oppositional behavior to conduct problems via low social preference was estimated using the 95% confidence interval (95% CI) bootstrap resampling method (n = 10.000) for complex (i.e., clustered) data (Asparouhov & Muthén, 2010a).

We then investigated our second research question, i.e. whether the developmental links between oppositionality and social preference were similar for boys and girls (hypothesis 3), and whether the prospective association between social preference and conduct problems was more pronounced in boys (hypothesis 4). To this end, a series of multiple-group models (boys versus girls) were fitted, in which the paths from oppositional behavior to conduct problems via low social preference were compared between boys and girls. The difference between the indirect pathways from oppositional behavior to conduct problems via exposure to low social preference for boys and girls was estimated using the Wald chi-square test of parameter equalities. In all models, all parameter estimates were controlled for intervention status and low SES.

Furthermore, an alternative pathway predicting sex-differences in conduct problems might be a development pathway running from low social preference, to oppositional behavior

first, and to conduct problems next. Therefore this alternate pathway was explored and potential sex-differences in this alternative developmental pathway were tested.

Results

Descriptive Statistics

Table 3.1 shows that boys scored higher on levels of oppositional behavior and conduct problems and had lower social preference scores than girls at all time-points. Effect sizes suggest that sex differences in oppositional problems (η^2 = .06) were smaller than sex differences in conduct problems (η^2 = .11).

Table 3.2 shows the correlations between the study variables. Concurrent as well as longitudinal correlations between oppositional behaviors, social preference and conduct problems were significant for boys and girls.

Developmental Pathways from Oppositionality to Conduct Problems, via Low Social Preference

To test whether low social preference could explain the development from oppositional behavior to conduct problems, a series of nested models was fitted. Results for model fitting for the group in total are in the upper part of Table 3.3. Note that constraining recurring autoregressive and lagged paths to be equal over time and trimming non-significant paths did not worsen model fit. Therefore, the latter model formed the basis for our interpretation and additional analyses.

Results in Figure 3.1 indicate that in accordance with our hypotheses, oppositional behavior predicted increases in conduct problems the next school year for the group in total (hypothesis 1). Above and beyond this direct link, oppositional behavior predicted low social preference in the next school year, which in turn predicted increases in conduct problems one school-year later (hypothesis 2). The indirect pathways from oppositional behavior to conduct

problems via low social preference were significant (B = .03, SE = .01, 95% CI of B = .016 - .040, β = .04).

Table 3.1

Means and Standard Deviations of Oppositional Behavior, Conduct Problems and Low social preference for Boys and Girls

	Boys		Girls		Test	
	M	*SD*	*M*	*SD*	*F*	η^2
			Oppositional Behavior			
Grade 1	1.09	0.89	0.73	0.69		
Grade 2	1.01	0.85	0.77	0.77		
					31.55**	.06
Grade 3	1.02	0.85	0.70	0.69		
Grade 4	1.25	0.97	0.77	0.75		
			Conduct Problems			
Grade 1	0.74	0.64	0.44	0.47		
Grade 2	0.63	0.62	0.38	0.50		
					59.08**	.11
Grade 3	0.68	0.64	0.38	0.48		
Grade 4	0.76	0.73	0.32	0.42		
			Low social preference			
Grade 1	-0.01	0.26	-0.13	0.23		
Grade 2	-0.05	0.31	-0.22	0.25		
					30.87**	.06
Grade 3	-0.09	0.30	-0.19	0.28		
Grade 4	-0.11	0.32	-0.20	0.29		

Note. Test statistic from repeated measures ANOVA. η^2 = eta squared. ** $p < .001$

Table 3.2

Correlations Between Study Variables for Boys (below diagonal) and Girls (above diagonal)

	1	2	3	4	5	6	7	8	9	10	11	12
1. Oppositional gr. 1	-	.50	.48	.27	.80	.43	.46	.22	.39	.41	.32	.34
2. Oppositional gr. 2	.50	-	.59	.46	.48	.83	.53	.34	.32	.37	.41	.30
3. Oppositional gr. 3	.51	.55	-	.47	.52	.53	.79	.34	.30	.31	.40	.29
4. Oppositional gr. 4	.44	.59	.56	-	.31	.41	.39	.75	.25	.27	.28	.31
5. Conduct gr.1	.83	.49	.45	.38	-	.50	.59	.33	.38	.41	.33	.27
6. Conduct gr. 2	.48	.84	.48	.49	.55	-	.58	.38	.32	.38	.40	.30
7. Conduct gr. 3	.45	.47	.83	.56	.50	.48	-	.35	.30	.39	.39	.20
8. Conduct gr. 4	.39	.52	.53	.86	.42	.52	.61	-	.29	.33	.25	.29
9. LSP gr. 1	.47	.40	.30	.41	.49	.37	.35	.41	-	.59	.47	.49
10. LSP gr. 2	.44	.41	.37	.46	.45	.43	.42	.50	.62	-	.60	.54
11. LSP gr. 3	.37	.37	.35	.44	.38	.37	.43	.54	.57	.62	-	.69
12. LSP gr. 4	.29	.31	.30	.44	.26	.28	.40	.49	.55	.57	.68	-

Note. Oppositional = oppositional behavior. Conduct = conduct problems. LSP = low social preference. Gr. = grade. All correlation coefficients are significant at $p < .05$.

Table 3.3

Fit Statistics and Model Comparisons for Nested Models

	Fit					Difference Tests			
Model	χ^2	*df*	CFI	SRMR	RMSEA	Comparison	$\Delta\chi^2$	Δdf	*p*
1. Developmental Links between Oppositional Behavior, Low Social Preference and Conduct Problems									
1a. Base Model	148.05	28	.95	.06	.08				
1b. Time-constraints + trimmed model	160.51	47	.95	.07	.06	1a vs. 1b	21.04	19	33
2. Test for Sex Differences									
2a. Boys versus girls	256.06	94	.95	.07	.07				
2b. Boys = girls for non-hypothesized paths	260.55	100	.95	.08	.07	2a vs. 2b	4.62	6	.59
2c. Boys = girls for oppositionality to lsp	259.73	101	.95	.08	.06	2b vs. 2c	0.51	1	.47
2d. Boys = girls for lsp to conduct problems	264.87	102	.95	.08	.07	2c vs. 2d	4.67	1	.03

Note. lsp = low social preference

Sex Differences in Developmental Pathways

To test our hypotheses on sex-differences, multiple-group models (boys versus girls) were fitted (see Table 3, lower part). We started by investigating whether developmental pathways that were not part of our hypotheses were sex-invariant (i.e., all autoregressive and lagged pathways with the exception of the pathway from oppositionality to low social preference to conduct problems). Compared to a model in which all coefficients were estimated freely for boys and girls, restraining the paths that were not part of our hypotheses to be equal between boys and girls did not worsen model fit.

Next, we investigated our hypothesis that boys and girls with oppositional behavior would be equally likely to experience low social preference (hypothesis 3) and our hypothesis that the association between low social preference and conduct problems would be stronger boys compared to girls (hypothesis 4). Results in the lower part of Table 3 show that the paths from oppositionality to low social preference in subsequent grades were sex-invariant. However, the significant decrease in model fit when the paths from low social preference to conduct problems were constrained to be sex-invariant, indicates that they are not similar for boys and girls (hypothesis 4). Comparisons of the magnitude of the complete indirect pathways from oppositionality to conduct problems via low social preference revealed that these indirect pathways were different for boys and girls ($\chi^2(1) = 5.19$, $p < .05$) and were somewhat stronger for boys (*B* = .03, *SE* = .01, 95% CI of *B* = .015 - .041, β = .04) compared to girls (*B* = .02, *SE* = .01, 95% CI of *B* = .009 - .028, β = .03). Standardized estimates for the final model are in Figure 1. The results show that the standardized regression coefficients of low social preference predicting subsequent conduct problems were stronger in magnitude for boys compared to girls. Note that, given that we found no sex differences in developmental pathways other than the path from social preference to conduct problems, the developmental pathway from low social preference to oppositional behavior first and conduct problems next, was sex-invariant.

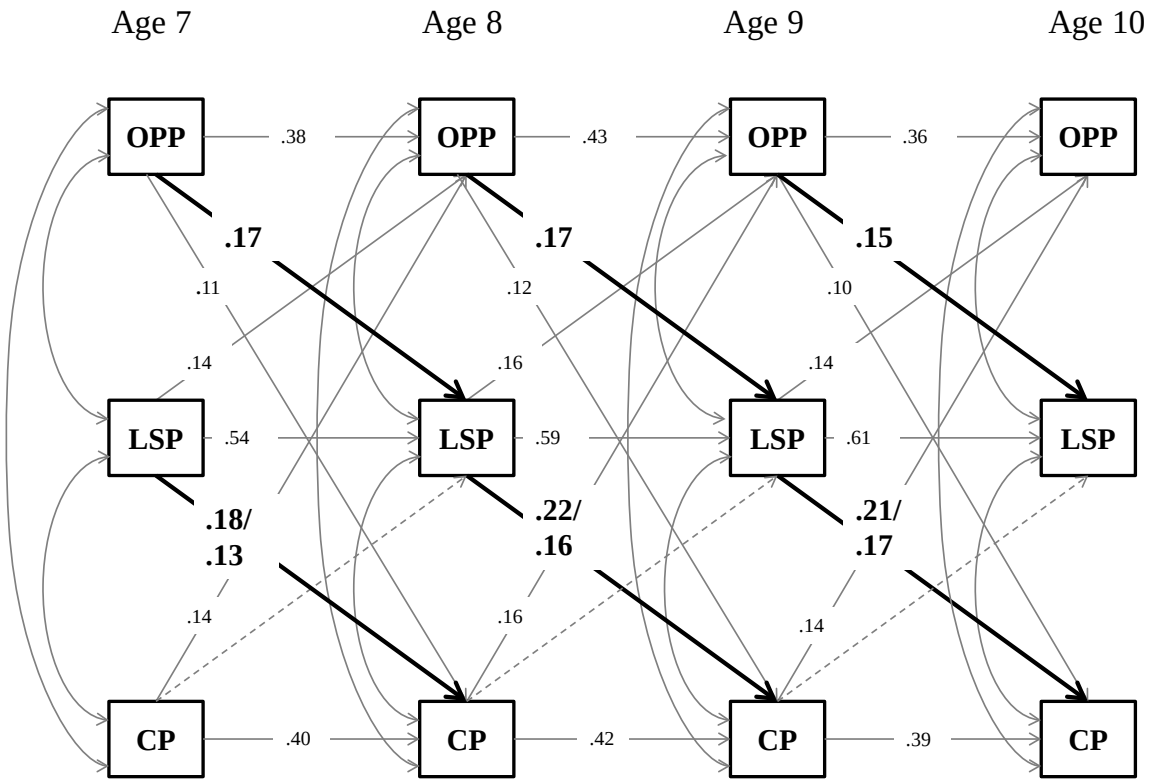

Figure 3.1. The development of oppositional problems to conduct problems via low social preference. Single entries reflex sex-invariant standardized regression coefficients. Double entries reflect regression coefficients for boys (top) and girls (bottom). OPP = oppositional behavior. CP = conduct problems. LSP = low social preference. All paths were significant at $p < .05$. Double arrowed lines are cross-sectional correlations. Grey lines reflect control paths above and beyond which the paths from oppositional behavior to low social preference to conduct problems are found. Dashed lines reflect non-significant paths.

Discussion

The development from oppositional behavior to more severe conduct problems that pose a threat to others signals a serious aggravation of troublesome behavioral tendencies of a child. The results of this study suggest that negative peer-experiences, such as being poorly preferred by peers, can to some extent explain this progression in behavioral problems during the elementary school-years, particularly for boys. Specifically, this study found that oppositional behavior predicted a subsequent poor appraisal by peers and that this poor social preference, in turn, predicted the development of conduct problems. The latter link, from social preference to subsequent conduct problem development, was stronger for boys than for girls. Thus, while both boys and girls may evoke poor preference among peers when exhibiting oppositional behavior, and while both boys and girls may respond to this negative peer-experience with conduct problems, boys were more likely than girls to engage in such responses. This sex-differential developmental pathway was found above and beyond an alternative pathway predicting conduct problem development (i.e., the development from low social preference to oppositional behavior first, and conduct problems next), that was sex-invariant and therefore held for the group in total.

Our results support previous research that has demonstrated predictive links from oppositional behavior to conduct problem development (Rowe et al., 2010). We extended these findings by using a conservative design in which all constructs were assessed in parallel over several years, which allowed us to effectively study developmental change in a general population sample. More importantly, our study showed that in order to understand the development from oppositionality to increases in conduct problems, experiences of low social preference should be considered as one of the explanatory factors. However, it also needs to be acknowledged that the magnitude of our predictive links and of the sex difference that we found were small. This suggests that, in addition to poor social preference, many other (personal and

social-relational) factors that were not investigated in the present study likely account for the escalation of behavioral problems in elementary school children, and that many other factors may explain why particularly boys with oppositional behavior may be prone to develop more severe conduct problems compared to girls.

The onset of the development of conduct problems is expected to occur during the early elementary school period (Loeber et al., 1992), which is also the period in which children are challenged to build satisfying relations with peers (Vitaro et al., 2001). Our results suggest that it is the failure to build such satisfying relationships with peers that may – at least to some extent - explain why children with oppositional behavior develop increasingly more conduct problems. Specifically, we found that across middle childhood (ages 7 to 10 years) poor preference among peers is evoked by the oppositionality of the child, not by existing conduct problems. This may imply that in the early elementary school-period, conduct problems might be a response to being poorly liked among peers rather than a precursor of low social preference. Note that we found that oppositionality was both a precursor and a consequence of poor preference among peers. In fact, we found that poor social preference predicted an increase in oppositional behavior in the next year, which in turn predicted an increase in conduct problems one school-year later. Together, these findings paint a picture of a downward spiral in which a child's negativistic behavior decreases its appraisal among peers, which subsequently increases its negativistic behavior, which, in turn, both add to the development of conduct problems. One a more positive note, this also indicates that by interrupting this downward spiral through intervening in a situation where a child becomes (increasingly more) less liked relative to liked, this might decrease the development of both oppositional behavior as well as conduct problems.

Our study moves beyond previous research on the developmental links between children's social standing among peers and externalizing behavior in school-children by

investigating two different, albeit related, types of externalizing problems (Ladd, 2006; Vitaro et al., 2007). Our results suggest a differential relation between low social preference and externalizing behavior as a function of the behavioral difficulties exhibited by the child. Oppositional, negativistic and deviant behavior at school likely results in poor relations with peers, while both oppositional behavior and conduct problems may increase as a consequence of negative peer-relations in the early years of elementary school.

In addition, our results suggest that it is the higher susceptibility to poor social preference among boys, compared to girls, that - at least to some extent - explains why boys develop higher levels of conduct problems than girls. Our findings are in line with previous research that demonstrated that poor preference tends to influence the lives of boys in particular (Moffitt, Caspi, Rutter, & Silva, 2001), and underline that potential sex differences in the response to or meaning of low social preference need to be considered to understand the aggravation of externalizing behavior in childhood. However, our findings by no means imply that low social preference is the only connecting factor between oppositional behavior and subsequent conduct problems. Low social preference only explained part of the developmental pathway from oppositionality to subsequent conduct problems two school-years later. Many other factors, such as harsh parenting or inconsistent disciplining can potentially explain the aggravation from milder to more severe externalizing problems (Burke, Pardini, & Loeber, 2008; Moffitt, Caspi, Rutter, & Silva, 2001). That is, in addition to low social preference, oppositional children may evoke harsh parenting and inconsistent disciplining, which subsequently may predict conduct problem development. In addition to low social preference, inconsistent disciplining may also explain why boys develop more conduct problems than girls, because it has been found that particularly boys may be susceptible to inconsistent disciplining in that their behavioral problems increase (Moffitt, Caspi, Rutter, & Silva, 2001). These, and other possibilities, should be investigated in future studies.

In addition, rather than being developmentally related, it is possible that a confounding fourth variable may have connected our constructs of interest. For example, it has been found that the same genetic factors or the same temperamental traits may underlie the development of oppositional behavior, low social preference as well as conduct problems (Brendgen et al., 2011; Frick & Morris, 2004). However, note that the fact that we took within-time correlations of our three constructs into account and that developmental paths were found above and beyond these within-time correlations, partially resolves this issue. That is, although we did not specifically test for potential confounding by, for example, temperament or genetic influences, the covariance between oppositionality, low social preference and conduct problems (which might be explained by underlying genetic effects or temperamental traits) within a school-years is controlled for in our model. Like others have recognized (Loeber, Green, Keenan, & Lahey, 1995), knowledge about factors that enhance the development from oppositional behavior to conduct problems and to whom they apply most, could significantly improve (preventive) interventions aimed at preventing and decreasing the development of conduct problems. Our results suggest that low social preference may be one of the key factors for intervention programs aimed at preventing or decreasing the development of conduct problems as well as classroom oppositional behavior.

The significance of low social preference in impacting particularly boys, as found in this study, coincides with results from other studies focused on low social preference. For example, interventions focused on prosocial strategies in order to gain social dominance, a goal that is highly valued by boys in particular, may prevent coercive exchanges between peers and may help boys that use misconduct to obtain a higher group-status with using positive alternative behavioral strategies (Dishion & Tipsord, 2011; Geary et al., 2003). Our findings thus underscore the importance of preventing conduct problem development by intervening in

situations in which children start to reject and dislike classmates and suggest that boys may benefit most from such preventive programs with regard to conduct problem development.

Several limitations need to be considered, when interpreting our findings. First, we used a general population sample, but schools were not randomly drawn. Although the percentage of children from low SES families was in accordance with the general Dutch population, we cannot be certain that the results generalize to the entire Dutch population. Second, we used teacher-reports on children's oppositionality and conduct problems. Teachers may not be aware these behaviors outside the school context. However, previous studies have indicated that teachers are valid informants on externalizing behavior (Hart, Lahey, Loeber, & Hanson, 1994). Moreover, longitudinal studies have found that teacher-reported conduct problems are related to multiple social and health impairments in adult life (Colman et al., 2009; Fergusson et al., 2009), indicating that teachers are significant informants for these types of behavioral problems. However, as teacher-reported conduct problems are often specific to the school situation (Fergusson et al., 2009), our results may not generalize to other contexts such as children's homes. In addition, teachers may be unaware of the full range of children's externalizing behaviors (particularly conduct problems), because children likely aim hide these type of behaviors from the teacher. Furthermore, influences of peers as assessed in this study were limited to peers within the classrooms, while poor relations with age-mates outside the classroom may also affect children's behavior. Third, we focused on externalizing behavior and social preference till fourth grade, when children were on average 10 years of age. Our results thus hold for children in middle childhood and may not extent to other developmental periods (e.g. adolescence). Fourth, children with missing values had higher levels of externalizing behavior and lower social preference scores than children with complete data. Therefore, we cannot exclude the possibility of confounds due to possible effects of differential attrition. Finally, it is important to note that our findings only scratch the surface of the role of

negative peer experiences and children's sex in externalizing behavior development. Important biologically, culturally and developmentally based sex differences in (the meaning of) both externalizing behavior and peer relations may underlie our findings (Moffitt et al., 2001; Rose & Rudolph, 2006).

Despite these and possible other limitations, our study suggests that research on externalizing behavior should consider the potential differential impact of troublesome peer-experiences on boys versus girls, in order to understand its developmental unfolding and aggravation in severity. Furthermore, our results have important implications for the identification of children who may benefit from intervention and indicate multiple pathways for preventing or interrupting the chain of negative behaviors. First, oppositional behavior should be addressed as early as possible, preferably directly after the transition to formal schooling, as this is the period when children have to function in the formal setting of a classroom and start evaluating whether they like or dislike each other. As this study showed, oppositional behavior is a strong predictor of poor appraisal by peers in this period. Second, teachers and other professionals should be particularly aware of those children with oppositional behavior who become (increasingly) disliked by peers. Teachers should not discard the significance of children being relatively less liked and more disliked by their peers in the earliest elementary school-years, as this poor appraisal by peers likely becomes stable throughout the school-years and predicts an aggravation of externalizing behavior. Third, interventions should focus on teaching children to cope with negative peer-experiences other than with aggression and other conduct problems, for example by teaching children prosocial strategies in order to gain social preference from peers. Such interventions may particularly address boys' externalizing behaviors and associated peer relationship problems and may therefore be the preferred action to prevent them from entering a pathway towards developing increasingly more severe externalizing behaviors.

4

Early Onset of Cannabis Use: Does Personality Modify the Relation with Changes in Perceived Parental Involvement?

Hanneke E. Creemers

J. Marieke Buil

Pol A.C. van Lier

Loes Keijsers

Wim Meeus

Hans M. Koot

Anja C. Huizink

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Abstract

The present study examined (1) the association between changes in perceived parental control and support from age 13 to 15 and early onset of cannabis use (before age 16), and (2) whether personality modifies the association between a decline in perceived parental control and support and early onset of cannabis use. Objectives were studied using data (three waves covering two years) from 444 Dutch adolescents participating in the Research on Adolescents' Development and Relationships (RADAR) study. Adolescents had a mean age of 13 years at baseline, and reported at each wave about perceived parental control and support. Big Five personality traits and past year cannabis use were also measured by self-report. Joint latent growth curve – discrete-time survival analyses were used to answer the research questions. Early onset of cannabis use was reported by 19.4% of the sample. Overall, a decline in perceived parental control or support from age 13 to age 15 was unrelated to the risk of early onset of cannabis use. In adolescents with low levels of emotional stability and extraversion, a stronger decline in perceived parental control was associated with an increased risk of early cannabis use. Experiencing a decline in parental control from age 13 to 15 is associated with early onset of cannabis use in adolescents characterized by low emotional stability and low extraversion.

Experimentation with cannabis is most likely to begin in adolescence and, according to European estimates, about a third of adolescents have tried cannabis by the age of 16 (Andersson et al., 2007). Among adolescent cannabis users, initiation seems to peak at age 15 (Monshouwer, Smit, De Graaf, Van Os, & Vollebergh, 2005). At the same time, cannabis involvement has been related to several adverse outcomes, including other illicit drug use, poor school performance and early dropout, crime and mental health problems including depression, psychosis and substance use disorders, that seem most pronounced in adolescents who start using cannabis before age 16 (Fergusson, Horwood, & Swain-Campbell, 2002; Lynskey & Hall, 2000; Rey, Martin, & Krabman, 2004). Research on initiation of cannabis use before age 16 can improve our understanding of a developmental pathway that may end with such serious adverse outcomes.

In search for identifying the factors that may underlie an early onset of cannabis use, researchers have focused on parenting, particularly parental control and parental warmth (Baumrind, 1989). Parental control refers to the extent to which parents require their child to obtain permission and insist on being informed about their children's whereabouts, activities, and associates. Unlike parental knowledge that may be gained primarily by spontaneous adolescent disclosure, parental control refers to active parental efforts to set limits on the child's behavior (Stattin & Kerr, 2000). Although linkages between parental control and adolescent problem behaviors are not consistently found (Racz & McMahon, 2011), previous cross-sectional and longitudinal studies have indicated that adolescent substance use (Stice & Barrera, 1995; Van der Vorst, Engels, Meeus, & Deković, 2006) and general problem behavior including substance use (Stattin & Kerr, 2000; Willoughby & Hamza, 2011); Willoughby & Hamza, 2011) are somewhat more likely among adolescents who perceive low parental control. Similarly, low levels of parental warmth or support, referring to the extent to which adolescents perceive their parents to be loving, affectionately demonstrative, supportive, and involved,

have been found to be cross-sectionally as well as prospectively related to general substance use, and specifically cannabis use, in mid-adolescence (Creemers et al., 2011; Stice & Barrera, 1995).

Despite the importance of these previous studies, the knowledge they have provided regarding the association between perceived parenting behavior and adolescent substance use is incomplete in at least two ways. First, most available studies on parenting in relation to substance use utilize variation in levels of parenting behavior at a given time point to predict variation in substance use in time. However, the adolescent years are marked by changes in the parent-child relationship in which teenagers become more autonomous and independent from their parents (Grotevant & Cooper, 1986), as well as by changes in associated parenting behavior. For instance, it has been demonstrated that, over the course of adolescence, children experience a decline in parental control and perceive their parents as becoming less emotionally supportive (Hale, Raaijmakers, van Hoof, & Meeus, 2011; Loeber, Drinkwater, et al., 2000). Experiencing more pronounced changes in parenting behavior has been linked with psychopathology development among adolescents of (Hale, Raaijmakers, van Hoof, & Meeus, 2011). However, it is unknown whether the magnitude of the change in perceived parenting behavior during the early adolescent years is associated with early onset of cannabis use.

A second gap in available research on the association between perceived parenting and adolescent cannabis use regards the lack of consideration of moderation by child factors. More specifically, the association between a decrease in perceived parental control or support and cannabis use may be most pronounced in specific subgroups of adolescents. For instance, (Engels, Vermulst, Dubas, Bot, & Gerris, 2005; Hale et al., 2011) demonstrated in a longitudinal study that the impact of low family functioning (at a given time point) on the development of problem drinking was most pronounced among individuals characterized by childhood aggression, which is by itself a risk factor for problem drinking. Following this line

of reasoning, the link between a decline in perceived parental control and support and onset of cannabis use might be most pronounced in adolescents characterized by traits associated with adverse patterns of cannabis use. In terms of the Five Factor Model of personality, (low) agreeableness, (low) conscientiousness and (high) openness have been linked with cannabis use, while such associations have not been found with emotional stability and extraversion (Fridberg et al., 2011; Terracciano, Löckenhoff, Crum, Bienvenu, & Costa, 2008). Whether the association between changes in perceived parenting behavior during adolescence and early onset of cannabis use depends upon these personality traits of the adolescent is unknown.

Using data from a longitudinal population sample of Dutch adolescents, the aims of the current study were to examine (1) the association between changes in perceived parental control and support from age 13 to 15 and early onset of cannabis use (before age 16; note that this study does not focus on early versus later onset of cannabis use but on early versus no onset of cannabis use), and (2) whether the association between changes in perceived parental control and support and early onset of cannabis use is moderated by adolescent personality characteristics.

Method

Sample and Participants

The current study presents data from a population-based prospective cohort study in the Netherlands, entitled Research on Adolescents' Development and Relationships (RADAR). Because this study, in which adolescents are followed from age 12 to 18 years, has a specific focus on delinquency development, the objective of the RADAR sampling was to oversample adolescents at risk of developing such behavior (200 at risk adolescents, 300 normal risk adolescents). To obtain this sample, a random selection of 429 elementary schools in the province of Utrecht, and the cities of Amsterdam, Rotterdam, The Hague, and Almere was invited to participate with all grade 6 classes. Of these schools, 296 were willing to participate,

and for logistic reasons, data were collected at 230. In these schools, children were screened for the presence of externalizing problems using the Teacher's Report Form, yielding information for 5150 children. Because of the intensive data collection that requires a firm grasp of the Dutch language, only children of Dutch origin were eligible for participation (N = 3,237 children). To obtain the target number of 500 families, a random selection was made consisting of 1,544 children, oversampling children with externalizing scores at or above the borderline clinical range (referred to as 'at-risk adolescents'). More specifically, 87% (N = 457) of the at-risk adolescents was selected to proceed versus 40% (N = 1,087) of the children with externalizing scores below the borderline clinical range (referred to as 'control adolescents'). Parents were approached by telephone to inform them about the project and to ask whether they were interested in participating in the RADAR study. Because phone records were missing or incorrect (N = 99), because the pre-requirements of the full family approach (both parents present, and presence of a sibling ≥ 10 years of age) were not met (N = 364), or because parents refused further participation (N = 470), 611 of the 1,544 families (40%) were included in the sample. Of these predominantly intact two-parent families, 114 did not provide written informed consent for all participating family members. Of the remaining 497 cases, 291 were control adolescents and 206 were at-risk adolescents. Non-participation in the RADAR study was not related to the target adolescent's sex (χ^2 (1, N = 1544) = 2.75, p =.10). Mean externalizing behavior scores for nonparticipating families were similar to participating families, both for control adolescents (F (1, 1085) = 0.024, p =.88) as for at-risk adolescents (F (1, 455) = 2.02, p =.16). RADAR was approved by the medical ethical committee of Utrecht University.

For the present study, data from the first (T1), second (T2), and third (T3) assessment waves of the RADAR study were used. At T1, adolescents were in the first grade of junior high (corresponding to eighth grade in US) and were 13 years old on average (SD = 0.50). At T2

and T3 adolescents were, respectively, 14 and 15 years old (*SD*s = 0.50). Attrition in the RADAR study was low, with 466 of the remaining 497 families participating at T2 (6.2% attrition) and 474 of the 497 families participating at T3 (4.6% attrition; Keijsers et al., 2012). Participants with missing information on cannabis use (*N* = 53) were excluded. The final 444 included participants (57% male) did not differ from the excluded participants in terms of perceived parental control or support, or any of the personality dimensions (all *p*'s >.05).

Measures

Cannabis use. Cannabis use was assessed at each wave using self-report questionnaires, querying the frequency of past year cannabis use (response options ranging from 0 = never to 13 = 40 times or more). Confidentiality of the study was emphasized so that adolescents were reassured that their parents would not have access to the information they provided. *Early onset of cannabis use* was defined as cannabis use at T1 (13 years), T2 (14 years) or T3 (15 years).

Perceived low parental control. Perceived low parental control was assessed at each wave using the self-report version of a questionnaire developed by Stattin and Kerr (2000). The subscale Parental Control measures the child's perception of parental rules and restrictions on their behavior, thereby limiting the amount of freedom children have to do things without telling their parents. Subjects were asked to rate items (e.g., 'Does your father/mother always require that you tell them where you are at night, who you are with, and what you do?') on a 5-point scale ("never" to "always") for their father and mother separately. From T1 to T3 (13-15 years), Cronbach's alphas for the 6-item scale parental control ranged from .84 - .88 (mother) and from .83 - .85 (father). The scale has adequate factor validity in a Dutch sample (Hawk, Hale, Raaijmakers, & Meeus, 2008). In order to obtain a measure comparable to lack of parental support, we calculated low parental control by reverse-coding the scores and by

averaging the mean-item scores (average of 6 items) for fathers and mothers (correlations ranged from .64 - .67).

Perceived lack of parental support. Perceived lack of parental support was assessed at each wave using the self-report version of the Level of Expressed Emotion Scale (Cole & Kazarian, 1988). For the subscale Lack of Emotional Support, subjects were asked to rate 19 items (e.g., 'My parents do not support me when I am upset') on a 4-point scale ("not agree at all" to "totally agree"). Mean item scores (average of 19 items) were calculated. From T1 to T3, Cronbach's alphas for this subscale ranged from .81-.92. The Level of Expressed Emotion Scale has an acceptable factor validity amongst Dutch youths (Hale et al., 2011).

Personality. Personality was assessed at each wave by the short self-report version of the Big Five personality questionnaire (Gerris et al., 1998; Goldberg, 1992). This questionnaire includes 30 general traits, six for each of the five factors. Participants were asked to indicate to what extent these traits applied to them on a 7-point scale, ranging from absolutely disagree to absolutely agree. The dimension agreeableness was measured with items such as kind and helpful (Cronbach's alphas .78 - .87). Conscientiousness was measured with items such as organized and efficient (Cronbach's alphas .52 - .90). The dimension emotional stability was assessed with reverse-codes of items such as nervous and sensitive (Cronbach's alphas .80 - .85). The dimension extraversion was assessed with reverse-codes of items such as quiet and shy (Cronbach's alphas .60 - .88). Finally, the dimension openness to experience was measured with items such as creative and having wide interests (Cronbach's alphas .71 - .84). For each of the personality dimensions, T1, T2 and T3 scores were averaged.

Covariates. Several covariates were taken into account. *Parental cannabis use* (no/yes) was defined as any past year cannabis use at T1, T2 or T3 by father or mother, measured by parent-reports. *Early alcohol use* and *early tobacco use* (no/yes) were defined as any use at T1, assessed with the items 'Have you ever tried alcohol?' and 'Have you ever tried

tobacco smoking?'. *Past year presence of any disruptive disorder* (no/yes), including DSM-IV attention deficit and/or hyperactivity disorder, oppositional defiant disorder and conduct disorder, was assessed at T1 using the parent version of the Diagnostic Interview Schedule for Children (DISC; Ferdinand & van der Ende, 2002).

Statistical Approach

For descriptive purposes, means of variables and correlations between them were calculated. To investigate our research aims, joint latent growth curve – discrete-time survival analyses (LGM-DTSA) were fitted in Mplus 6.11 (L. K. Muthén & Muthén, 1998-2015). Maximum likelihood estimation with robust standard errors using a numerical integration algorithm, was used to account for the non-normal distributions of study variables. Models were fitted separately for parental control and support and were controlled for male sex, parental cannabis use, early tobacco use, early alcohol use, and presence of any disruptive disorder. Personality scores were standardized to a mean of 0 and a standard deviation of 1.

Because we were particularly interested in the development of parenting from age 13 to 15, we first determined the development of parental control and support using latent growth modeling (LGM). In LGM, random effects are used to capture individual differences in development. The random effects are conceptualized as continuous latent factors; the growth factors. The growth curves were determined by two latent growth factors: intercepts, which represent the initial status of the growth curve; and linear slopes, which represent the linear developmental change. Model fit of LGMs was determined using the comparative fit index (CFI, critical value ≥ 0.95) and the root mean square error of approximation (RMSEA, critical value ≤ 0.08) (Bentler, 1990; Browne & Cudeck, 1993).

We then investigated the association between changes in the two parenting measures with risk for early onset of cannabis use, using LGM-DTSA (see Figure 1; B. Muthén & Masyn, 2005). Discrete-time survival analysis (DTSA) enables to study the probability, or hazard, of

experiencing a non-repeatable event, such as onset of cannabis use. This type of analysis considers the timing as well as the occurrence of the first time an adolescent uses cannabis, and thus allows for examining the longitudinal progression of the likelihood that cannabis initiation occurs within a one-year interval. DTSA models right-censored data and properly accounts for the fact that many adolescents will not initiate use during the observation period. Furthermore, DTSA can be combined with latent growth curve models to investigate whether changes in the latent growth factors are associated with probability of an event occurring.

An illustration of our LGM-DTSA model is presented in Figure 4.1. In this figure, the factor 'risk' specifies a proportional odds assumption for the hazard of cannabis initiation. By regressing the latent 'risk' factor on the LGM intercepts and slopes of perceived parenting, the joint development of probability of onset of cannabis use as a function of change in perceived parenting was tested. We ran these models (a) without accounting for time-invariant covariates (Model 1), and (b) accounting for sex, parental cannabis use, early tobacco use, early alcohol use, and presence of any disruptive disorder (Model 2). To achieve the most parsimonious models, non-significant covariates were excluded from the models.

To test if associations between changes in parenting and early cannabis use were moderated by personality, we performed separate LGM-DTSAs for parental control and support in combination with each of the personality dimensions. We tested main effects in step 1, including the significant covariates. Interactions between parenting and personality were added in step 2. Sex differences were explored.[1]

[1] We explored sex differences in cannabis initiation and levels of cannabis use, parental control and support, and personality, as well as sex differences in the associations between parenting measures, personality and cannabis initiation (three-way interaction). Note that these analyses are not reported in the published manuscript.

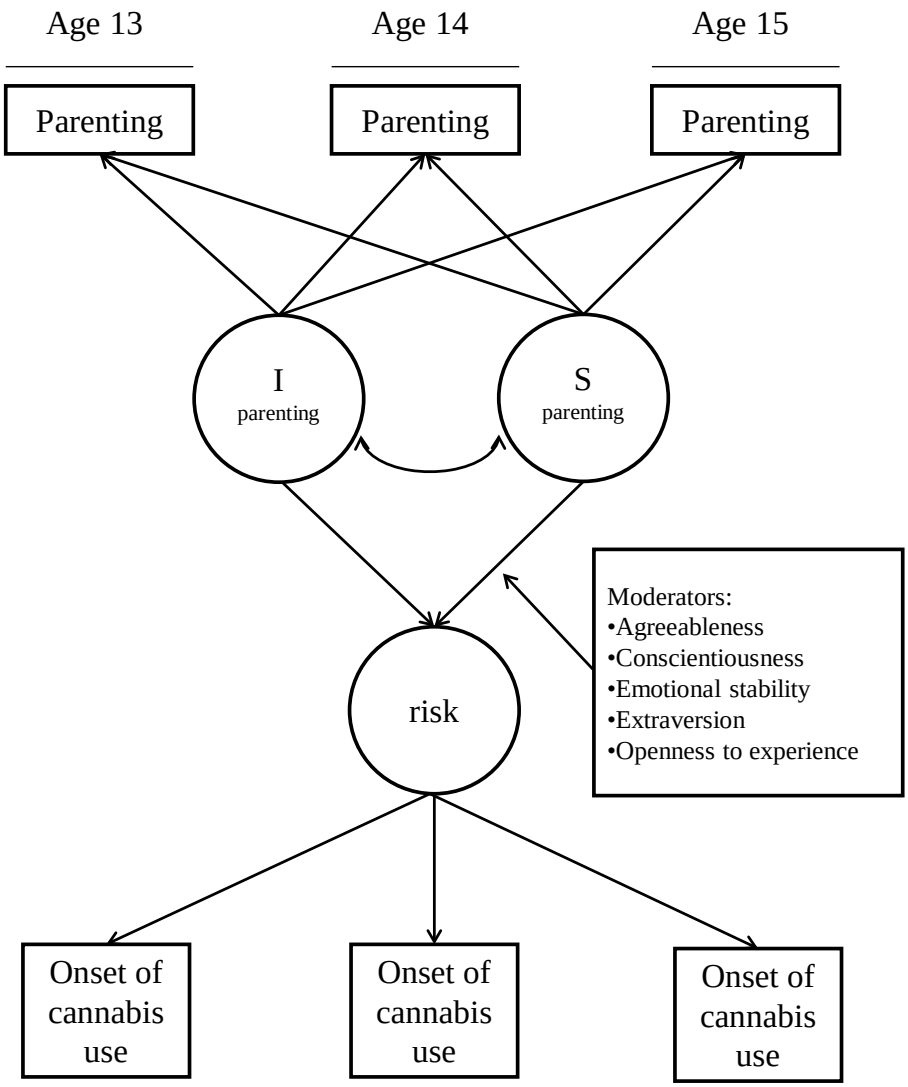

Figure 4.1. Hypothesized model. I = latent intercept, S = latent linear slope

Results

Descriptive Information

Early onset of cannabis use was reported by 19.4% (*N* = 86; 22.9% for boys; 15.9% for girls) of the adolescents. Means of parenting and personality measures from T1 to T3 for the group in total are represented in Table 4.1. Repeated measures ANOVA indicated that boys and girls had equal levels of cannabis use in the past 12 months (i.e., a continuous measure of how many times cannabis was used in the past 12 months) and boy-girl ratios for cannabis initiation at T1, T2 and T3, respectively, were also equal for boys and girls. Furthermore,

repeated measures ANOVAs indicated that throughout T1 – T3 boys and girls had equal levels of perceived parental control and support. Lastly, average levels (averaged over T1 – T3) of conscientiousness and extraversion also were equal for boys and girls. However, compared to girls, boys on average had lower levels of agreeableness ($F(1,442 = 10.67, p < .01, \eta^2 = .02$), higher levels of emotional stability ($F(1,442) = 28.94, p < .001, \eta^2 = .06$) and lower levels of openness to experience ($F(1,442) = 6.08, p < .05, \eta^2 = .01$), throughout T1 – T3. Correlations between the variables are shown in Table 4.2.

Table 4.1

Means of Parenting and Personality Measures at T1, T2 and T3

	T1	T2	T3	T1-T3
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Low parental control	1.45 (0.92)	1.60 (0.95)	1.77 (0.95)	
Lack of parental support	0.60 (0.39)	0.60 (0.44)	0.64 (0.49)	
Agreeableness	4.48 (0.76)	4.43 (0.76)	4.48 (0.70)	4.46 (0.61)
Conscientiousness	2.99 (1.11)	3.04 (1.15)	2.94 (1.15)	2.98 (1.00)
Emotional stability	3.39 (1.12)	3.51 (1.21)	3.51 (1.23)	3.47 (1.01)
Extraversion	4.09 (1.05)	4.12 (1.09)	4.08 (1.08)	4.10 (0.91)
Openness to experience	3.90 (0.95)	3.91 (0.97)	3.91 (0.95)	3.90 (0.82)

Note. T1 = first assessment wave (mean age 13 years old), T2 = second assessment wave (mean age = 14 years old), T3 = third assessment wave (mean age = 15 years old).

Table 4.2

Correlations Between Early Onset of Cannabis Use, Low Parental Control at T1 to T3, Lack of Parental Support at T1 to T3, Personality and all Covariates.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Early onset of cannabis use T1-T3																
2	Low parental control T1	-.03															
3	Low parental control T2	.04	**.47**														
4	Low parental control T3	.06	**.36**	**.57**													
5	Lack of parental support T1	**.14**	**.16**	**.15**	**.11**												
6	Lack of parental support T2	**.14**	.12	**.13**	.06	**.66**											
7	Lack of parental support T3	**.16**	.12	.09	.04	**.50**	**.67**										
8	Agreeableness	-.04	-.12	**-.14**	**-.19**	**-.39**	**-.38**	**-.39**									
9	Conscientiousness	**-.13**	.05	**-.14**	**-.14**	**-.10**	**-.17**	**-.14**	**.32**								
10	Emotional stability	-.01	-.04	.04	.06	**-.10**	**-.12**	**-.13**	**-.09**	**-.13**							
11	Extraversion	**.15**	-.04	-.01	.07	**-.19**	**-.24**	**-.18**	**.20**	**-.16**	**.46**						
12	Openness to experience	.02	.03	-.09	**-.12**	**-.10**	**-.16**	**-.14**	**.56**	**.26**	**-.21**	.06					
13	Sex	-.08	.07	**-.10**	-.09	-.01	-.05	-.02	**.16**	.06	**-.23**	.01	**.12**				
14	Disruptive behavior disorder	.08	-.09	-.01	.01	**.12**	**.15**	.08	-.04	**-.12**	-.09	-.04	.02	-.04			
15	Parental cannabis use	**.23**	.08	.07	**.12**	.01	.03	.04	-.02	-.06	.03	.09	.01	-.01	.05		
16	Early tobacco use	**.33**	.07	**.11**	.07	**.20**	**.20**	**.14**	**-.10**	**-.18**	-.01	.07	-.02	-.06	**.14**	**.11**	
17	Early alcohol use	**.22**	.08	.05	.06	.09	**.11**	**.17**	**-.11**	**-.14**	.08	.05	.01	**-.18**	-.01	.06	**.34**

Note. We used point-biserial correlations for associations between a continuous and a dichotomous variable. Estimates in bold are $p < .05$.

Table 4.3 presents the estimated developmental changes in perceived parental control and support from age 13 to age 15. Fit indices indicated that models fitted the data adequately (CFI = 1.00; RMSEA = 0.00 for parental control and CFI = 0.99; RMSEA = 0.08 for parental support). Slope factors of low parental control were significant, indicating that adolescents perceived a linear decrease in parental control over time (mean slope = .15; *SE* = .03, $p < .001$; note that the value of the mean slope indicates an increase in low parental control). No significant changes over time were found for lack of parental support (mean slope = .02; *SE* = .01, $p = .15$). However, the significant variance around the slope factor of perceived parental support indicated that there was significant variation amongst individuals in the rate of change of perceived parental support (variance =. 03; *SE* = .01, $p < .001$).

Early Onset of Cannabis Use as a Function of Parenting Behavior

The unconditional DTSAs to estimate the probability of early onset of cannabis use resulted in observed hazards (i.e., the probability of cannabis use in a specific time interval on condition that it has not occurred previously), of .023, .049 and .133, at age 13, 14 and 15, respectively. Nested model comparisons were used to investigate the proportionality assumption (Satorra, 2000). Results showed that all covariates had similar effects across all ages, except for early tobacco use. Because early tobacco use was positively related to cannabis use at age 15, but not related to cannabis use at age 13 and 14, it was retained in the models only for age 15. Results of the LGM-DTSA are in Table 4.4. Irrespective of the inclusion of the significant covariates in the model, neither initial levels nor changes in perceived parental control were associated with early onset of cannabis use. Changes in perceived parental support were also not associated with early cannabis initiation. However, higher initial levels of perceived lack of parental support were significantly associated with a higher likelihood of early cannabis initiation.

Table 4.3

Estimated Levels and Rates of Development in Low Parental Control and Lack in Parental Support using Latent Growth Modeling

	Intercept		Slope		Model fit			
	Mean (SE)	Variance (SE)	Mean (SE)	Variance (SE)	χ^2	df	CFI	RMSEA
Low parental control	1.47 (0.05)***	0.51 (0.10)***	0.15 (0.03)***	0.15 (0.04)**	0.76	1	1.00	0.00
Lack of parental support	0.60 (0.02)***	0.13 (0.02)***	0.02 (0.01)	0.03 (0.01)***	3.80	1	0.99	0.08

Note. Coefficients are unstandardized estimates. $^{**}p < .01$, $^{***}p < .001$

Table 4.4

The Association between Changes in Parenting Behavior and Early Onset of Cannabis Use

	Low parental control				Lack of parental support			
	Model 1		Model 2		Model 1		Model 2	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Slope parenting	2.20	0.86 – 5.61	2.00	0.76– 5.06	3.28	0.62– 17.44	3.17	0.57 – 17.65
Intercept parenting	1.06	0.69 – 1.62	0.90	0.56 – 1.43	3.96**	1.81 – 8.66	4.16**	1.86 – 9.30
Parental cannabis use			3.90***	2.05 – 7.37			4.35***	2.30 – 8.26
Early alcohol use			3.59***	1.92 – 6.11			3.28***	1.81 – 5.97

Note. $^{**}p < .01$, $^{***}p < .001$. After including parenting behavior, early tobacco use and presence of any disruptive disorder were no longer significantly related to early onset of cannabis use and were therefore removed from the model.

Moderation by Personality

Testing for main effects in step 1 (not presented in a table) yielded one main effect of personality. Specifically, higher levels of extraversion were positively associated with early cannabis use (OR = 1.37, 95% CI= 1.09 - 1.73, $p < .01$ in the model for parental control and OR = 1.67, 95% CI = 1.29 - 2.17, $p < .01$ in model for parental support). Results of step 2, in which moderation by personality was tested, are in Table 4.5. For parental control, findings of the parenting by personality interactions indicated that the levels of emotional stability and extraversion moderated the association of change in perceived parental control with cannabis use. To decompose the direction of effect of these moderations, the significant two-way interaction terms were probed by estimating the effects of change in perceived parental control on cannabis use, with levels of emotional stability or extraversion being high (*M* + 1 *SD*) or low (*M* - 1 *SD*; Holmbeck, 2002). As illustrated in Figure 4.2a, results indicated that a stronger decline in perceived parental control was associated with a higher likelihood of cannabis use in adolescents with low levels of emotional stability (OR = 5.18, 95% CI = 3.07 - 8.71, $p <.001$), but not in adolescents with high levels of emotional stability (OR = 0.65, 95% CI = 0.26 – 1.67, $p = .38$). Furthermore, and illustrated in Figure 4.2b, a stronger decline in parental control was associated with a higher likelihood of cannabis use in adolescents with low levels of extraversion (OR = 5.01, 95% CI = 1.67 - 14.98, $p < .01$), but not in adolescents with high levels of extraversion (OR = 0.91, 95% CI = 0.36 – 2.32, $p = .85$). For parental support, no moderation by personality was found.

Sex Differences. Sex differences in the moderation models were tested by investigating the significance of three-way interactions (sex x parenting x personality) for each model separately. Results indicated that all effects were similar for boys and girls (all *p*s $\geq .26$).

Table 4.5

Early Initiation of Cannabis Use as a Function of Development in Lack of Parental Control and Support over time, Personality, and Parenting by Personality Interactions

	Low parental control		Lack of parental support	
	OR	95% CI	OR	95% CI
Agreeableness				
Slope	1.76	0.76 – 4.10	3.39	0.61 – 18.73
Agreeableness	0.73	0.49 – 1.10	1.12	0.83 – 1.50
Agreeableness X slope	2.23	0.58 – 8.55	0.64	0.02 – 18.23
Conscientiousness				
Slope	1.64	0.73 – 3.71	2.50	0.40 – 15.56
Conscientiousness	0.79	0.54 – 1.17	0.80	0.61 - 1.06
Conscientiousness X slope	0.91	0.31 – 2.64	0.78	0.07 – 9.13
Emotional stability				
Slope	1.79	0.90 – 3.59	3.46	0.60 – 20.07
Emotional stability	1.17	0.89 – 1.54	0.98	0.77 – 1.23
Emotional stability X slope	0.36**	0.20 – 0.65	1.95	0.45 – 8.56
Extraversion				
Slope	2.18	0.94 – 5.04	4.31	0.74 – 25.13
Extraversion	1.66**	1.25 – 2.21	1.68***	1.30 – 2.17
Extraversion X slope	0.40**	0.18 – 0.88	0.95	0.28 – 3.17
Openness to experience				
Slope	1.98	0.88 – 4.45	3.36	0.59 – 19.18
Openness to experience	0.99	0.66 – 1.42	1.17	0.89 – 1.55
Openness X slope	1.37	0.49 – 3.83	0.31	0.06 – 1.61

Note. Corrected for the intercept of parental control/support and for parental cannabis use and early alcohol use; *p <. 05, **p < .01.

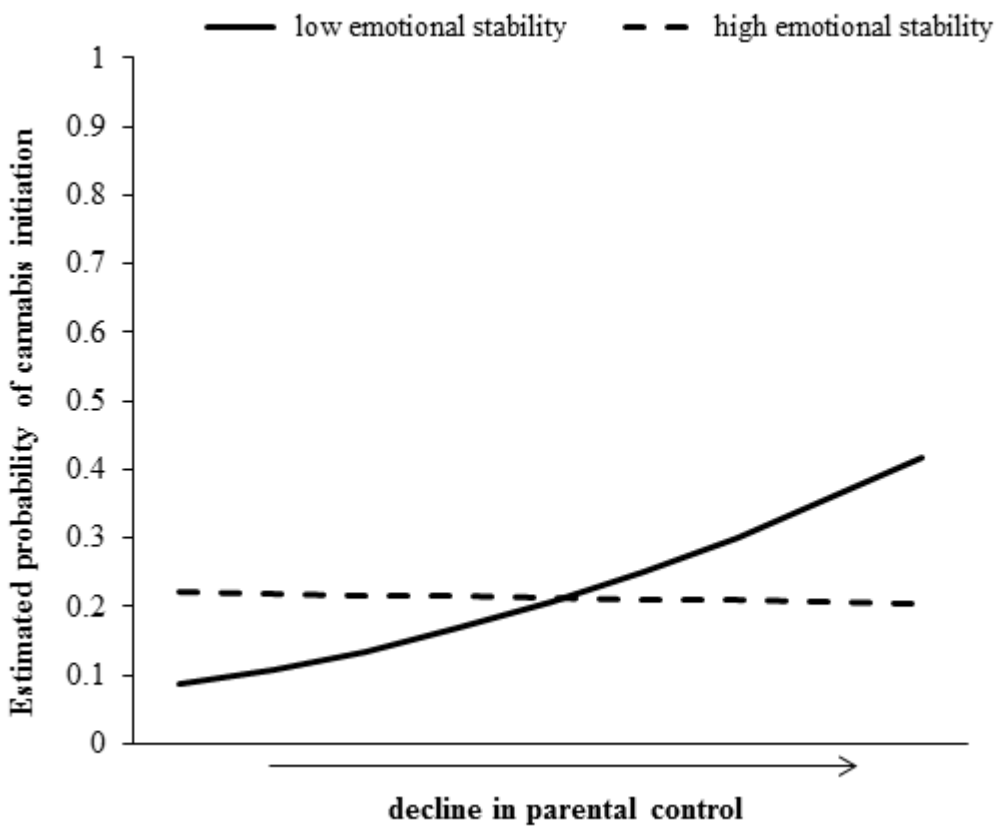

Figure 4.2a. Graphical presentation of the emotional stability by parental control interaction in relation to early onset of cannabis use

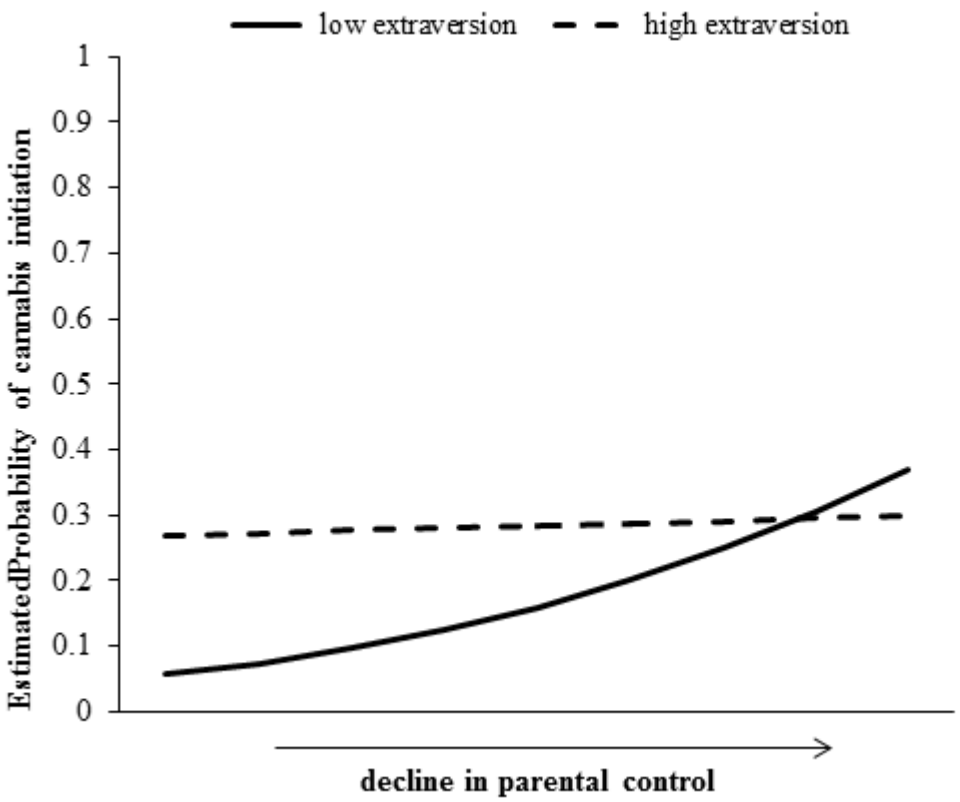

Figure 4.2b. Graphical presentation of the extraversion by parental control interaction in relation to early onset of cannabis use.

Discussion

The aims of the present study were to examine the association between changes in parental control and support from age 13 to 15 and early onset of cannabis use, and to determine whether this association was moderated by adolescent personality characteristics. In line with findings from previous research, adolescents experienced their parents as becoming less controlling from age 13 to 15 (Keijsers & Poulin, 2013), suggesting that adolescents became more autonomous and independent during this period. Adolescents did not perceive their parents as becoming less supportive. This inconsistency with findings from previous research (Hale et al., 2011; Loeber, Drinkwater, et al., 2000) might be due to the fact that the focus of our study was on mid-adolescence, while others observed a growing lack of perceived support from mid to late adolescence. Possibly, the experience of a decline in parental support is more clearly manifested at later stages of adolescence.

Our results indicated that, overall, perceiving lower levels of parental control or support over time was not associated with early onset of cannabis use. However, specific personality traits appeared to moderate the relation between changing levels of perceived parental control, though not support, and cannabis use. For adolescents with lower levels of emotional stability and extraversion, there was a positive association between a stronger decline in perceived parental control and early onset of cannabis use. Because emotional stability was not correlated with early cannabis use in this study and has not been generally associated with cannabis use (Fridberg et al., 2011; Terracciano et al., 2008), our finding pertaining to emotional stability is not in line with the thought that a decline in perceived parental control might be more detrimental for adolescents who are more likely to use cannabis based upon their personality. Possibly, adolescents with lower levels of emotional stability, who are emotionally reactive and vulnerable to stress, may experience a decline in perceived parental control as frightening, further increasing their vulnerability. Extraversion, however,

was positively related to cannabis use in this study. Yet, since lower levels of extraversion seem to protect adolescents against early cannabis use, our finding contrasts the thought that particularly adolescents who are more likely to use cannabis are affected by a decline in perceived parenting behavior. We speculate that peer influences may explain our contrasting finding. Adolescents who experience decreasing levels of control may find more opportunities to spend an unsupervised leisure time with peers. This may heighten their risk of negative behavior, including early experimentation with cannabis use. For adolescents with lower levels of extraversion this may reduce the protective effect of their personality on the risk of early cannabis use. An alternative explanation for the positive association between a decline in parenting and early onset of cannabis use in adolescents with lower levels of emotional stability and extraversion is that parents may lower their control when adolescents are engaged in problem behaviors, such as substance use (Stice & Barrera, 1995; Willoughby & Hamza, 2011). However, it remains unclear why this would only occur in adolescents with lower levels of emotional stability and extraversion. Future prospective research in early adolescent samples is needed to understand the direction of the association between changes in parental control and support and early onset of cannabis use, as well as differential sensitivity based on adolescent personality characteristics.

The present study is not without limitations. First, population samples are characterized by low levels of cannabis use, especially when young age groups are studied. For this reason, we did not have sufficient information to also study frequency of cannabis use. Second, the sampling procedure and composition of the sample might have had an influence on the main variables in this study other than cannabis use. Despite the oversampling of children with risk of developing delinquency in our sample, the prevalence rate of lifetime cannabis use in this study is comparable to national estimates of lifetime cannabis use among 15-year olds (van Dorsselaer et al., 2010). However, the fact that predominantly intact two-

parent families were recruited for this study (86%), and that families with low socio-economic status were underrepresented in the sample, might limit the generalizability of our findings to broken families and to families from low socio-economic backgrounds. Third, although confidentiality of the study had been emphasized, self-reports of substance use may be subject to over- or underreporting of cannabis use (D. M. Murray & Perry, 1987), which may have influenced the results. Fourth, the longitudinal design we employed aimed at testing linkages between changes in parenting and the risk of early cannabis use, and moderation by personality, and did not test the temporal sequence of changes in parenting and risk of early cannabis use. As a result, we cannot draw any conclusions about the direction of the associations. In addition, although the big five personality dimensions have been found to be relatively stable in most adolescents (Pullmann, Raudsepp, & Allik, 2006), individual differences in developmental changes in some personality traits (i.e. behavioral control) have been linked to the risk of substance use (Wong et al., 2006). Such mechanisms should be further examined in future research.

Another suggestion for future research is to measure parenting from childhood to late adolescence, to test if the timing of changes in parental control and support is related to age at onset of cannabis use. Possibly, a decline in parental control or support is perceived earlier (in late childhood/early-adolescence) by adolescents who start using cannabis at a (very) early age than by adolescents who start using cannabis at a later age or who do not initiate cannabis use. Although not the focus of this study, it would also be interesting to study the relative influence of sibling cannabis use, which has been related to cannabis initiation in previous research (Ellickson, Tucker, Klein, & Saner, 2004).

In conclusion, this study demonstrated that experiencing a decline in parental control and support from age 13 to 15 is not generally associated with early onset of cannabis use. However, for parental control this does not apply to all individuals, as a decline in parental

control and early onset of cannabis use are positively related in adolescents characterized by low emotional stability and low extraversion. Our findings suggest that stimulating parents to maintain developmentally appropriate levels of control in combination with supporting behavior across the first years of adolescence may contribute to the prevention of early cannabis use in at least a subgroup of adolescents. In addition, our results indicating that early substance use and parental cannabis use are associated with an increased risk of early cannabis use emphasize that prevention work should also focus on these risk factors.

5

DRD4 Genotype and the Developmental Link of Peer Social Preference with Conduct Problems and Prosocial Behavior across Ages 9 to 12 Years

J. Marieke Buil

Hans M. Koot

Tjeert Olthof

Kelly A. Nelson

Pol. A.C. van Lier

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Abstract

The peer environment is among the most important factors for children's behavioral development. However, not all children are equally influenced by their peers, which is potentially due to their genetic make-up. The dopamine receptor D4 gene (DRD4) is a potential candidate gene that may influence children's susceptibility to the peer environment. In the present study, we explored whether variations in the DRD4 gene moderated the association between children's social standing in the peer group (i.e., social preference among classmates) with subsequent conduct problems and prosocial behavior among 405 (51% females) elementary school children followed annually throughout early adolescence (ages 9 to 12 years). The behavioral development of children with and without the DRD4 7-repeat allele was compared. The results indicated that children who had higher positive social preference scores (i.e., who were more liked relative to disliked by their peers) showed less conduct problem development in subsequent years relative to children who had lower positive social preference scores. In contrast, children who had more negative preference scores (i.e., who were more disliked relative to liked among peers) showed more conduct problem development in subsequent years, relative to children who had less negative preference scores. However, these effects only occurred when children had a 7-repeat allele. For children who did not have a 7-repeat allele, the level of social preference was not associated with subsequent conduct problems. No evidence for gene-environment interaction effects for prosocial behavior was found. The implications for our understanding of conduct problem development and its prevention are discussed.

In school, children have to function in a classroom for a significant amount of time every day, across the better part of their childhood and later adolescent years. As in every social setting, children evaluate classmates and form opinion on who they do and do not like. As a consequence of this evaluation, some children will become highly preferred and liked among many of their peers. These highly preferred children have been found to develop high-quality friendships (Parker & Asher, 1993), have positive relationships with teachers (J. N. Hughes, Zhang, & Hill, 2006), and generally show favorable developmental outcomes such as prosocial behavior (Bierman & Erath, 2006). However, the dark side of the peer evaluation process is that some children become disliked and poorly preferred by their classmates, which is a robust predictor of maladjustment. For instance, these children are at risk of peer victimization and friendlessness (Van Lier & Koot, 2010) and poor support or rejection by teachers (Leflot, van Lier, Verschueren, Onghena, & Colpin, 2011). As such, it may come as no surprise that children who are poorly preferred by their peers are at risk of developing behavioral problems (Ladd, 2006; Van Lier & Koot, 2010).

Thus, there is a vast body of research linking children's social standing among peers, also known as "peer social preference" (Coie et al., 1982), to childhood adjustment and maladjustment. However, individual differences in the predictive links are striking. Recent findings have suggested that the genetic make-up of children may be of relevance in understanding why children are more or less affected by their social environment (for a meta-analysis, see Bakermans-Kranenburg & van IJzendoorn, 2011). That is, several studies have indicated that the dopamine receptor D4 gene (DRD4) may render children susceptible to environmental influences "for better and for worse" (Bakermans-Kranenburg & van IJzendoorn, 2011, p. 39). According to this viewpoint, carriers of the 7-repeat allele (DRD4-7r) may be disproportionally susceptible for developing negative behavioral outcomes in an adverse environment, but are also more likely to respond with positive behavioral outcomes

when in a favorable environment (Belsky & Hartman, 2014). In the present study, we aimed to investigate the possible moderating role of DRD4 in the prospective association between low and high levels of peer social preference and the development of conduct problems and prosocial behavior, among children attending elementary school who were followed annually from age 9 to 12 years.

DRD4 7-repeat Allele and Environmental Influences

According to the differential susceptibility hypothesis (Belsky, 1997; Belsky & Hartman, 2014), some genetic variants may render individuals more malleable to negative as well as positive environments with respect to subsequent development, while other individuals - depending on their genetic make-up - are altogether less influenced by their environment. In a nutshell, this viewpoint proposes that in order to increase reproductive fitness it makes evolutionary sense that some children are more susceptible to their environment than others (Belsky, 1997; Belsky & Hartman, 2014). That is, parents may (subconsciously or consciously) aim to modify children's behavior so that it matches the environmental requirements. If the future environment is predicted correctly, a beneficial behavior-environment match occurs that may support the offspring's health and reproductive fitness. However, given that future environmental circumstances are uncertain, for some children a mismatch occurs, potentially resulting in adverse outcomes. Thus, if within a family some children are born with a genetic disposition that renders them highly susceptible to their environment and others have a genetic disposition that renders them less susceptible, the probability that for all offspring such a detrimental mismatch takes place decreases (example adapted from Belsky, 1997).

A potential candidate gene that may further our understanding of individual differences in sensitivity to the environment is the dopamine receptor D4 gene, DRD4 (Bakermans-Kranenburg & van IJzendoorn, 2011; Belsky & Hartman, 2014). DRD4 regulates dopamine receptor activity in the brain, particularly in brain regions of the mesocorticolimbic dopamine

pathway (Oak, Oldenhof, & Van Tol, 2000). The neurotransmitter dopamine plays a major role in reward, punishment, attention and motivation mechanisms related to social interaction and learning. Furthermore, dopamine may signal the salience of social events and is a key factor in the imprinting of motivational importance to environmental factors (Trainor, 2011).

The coding DNA sequence of DRD4 is highly polymorphic, resulting in receptor variants that may be functionally different. In this regard, the 48-bp tandem repeat (48-bp VNTR) in the third exon, consisting of 2 to 11 repeats, has received much research attention in behavior genetics. It has been shown that DRD4 has higher potency for dopamine-mediated coupling to adenylyl cyclase in the presence of the short 2-repeat and 4-repeat alleles, than when receptors are encoded by the 7-repeat allele, known as DRD4-7r (Oak et al., 2000; Schoots & Van Tol, 2003). Decreased postsynaptic inhibition due to the 7-repeat allele results in lower dopaminergic tone and a suboptimal response to dopamine. This is associated with heightened reward-related reactivity in the ventral striatum and reward-related behaviors like impulsivity (Forbes et al., 2009). In addition, the mesocorticolimbic dopamine pathway is associated with the functioning of the anterior cingulate cortex, which is related to processing punishment and reward stimuli. Changes in dopamine levels due to the DRD4 polymorphism could thus enhance social-environmental signals related to reward and punishment (Posner & Rothbart, 2009). Indeed, subjects with the 7-repeat allele show increased reactivity to social-environmental stimuli compared to subjects without this allele, as evidenced by findings from brain imaging, observational and experimental studies in humans and animals (Grady et al., 2013; Sheese, Voelker, Rothbart, & Posner, 2007). When confronted with emotional stimuli, carriers of the DRD4-7r allele were found to show more brain activity than non-carriers in brain regions associated with attention to and appraisal of negative emotional stimuli, as well as in brain regions involved in preparation for action (Gehricke et al., 2015). To the best of our knowledge, as of yet no studies have used functional brain imaging to investigate whether brain

regions that are involved in reactivity and attention with regard to negative stimuli also apply to positive stimuli. However, observational research has indicated that individuals with the 7-repeat allele show heightened sensitivity to positive parenting environments when compared to individuals without this allele (Bakermans-Kranenburg & van IJzendoorn, 2011). Together, these findings may suggest that individuals with a 7-repeat allele of the DRD4 gene are more susceptible to their environment than individuals without this allele, irrespective of whether this environment is positive or negative. Furthermore, some authors suggested that the dopaminergic system is key to the development of social behavior (Insel, 2003). This statement is supported by the fact that on a behavioral level DRD4-7r has been related to aggression in children (Schmidt, Fox, Rubin, Hu, & Hamer, 2002), to conduct problems and oppositional behavior in individuals with Attention Deficit Hyperactivity Disorder (ADHD; J. Holmes et al., 2002; Kirley et al., 2004), and to diminished levels of prosocial behavior (Anacker, Enge, Reif, Lesch, & Strobel, 2013; DiLalla, Elam, & Smolen, 2009; Jiang, Chew, & Ebstein, 2013).

A recent meta-analysis showed that children with less efficiently functioning dopamine-related genetic variants (of which DRD4 was the most studied gene) do worse in negative parental rearing environments than children without such alleles (Bakermans-Kranenburg & van IJzendoorn, 2011). At the same time, the authors concluded that children with susceptibility alleles are also likely to profit most from positive rearing environments (Bakermans-Kranenburg & van IJzendoorn, 2011). Despite that the results presented in that meta-analysis generally supported the differential susceptibility hypothesis, the study of differential susceptibility of DRD4 to the social environment is far from complete.

First, although gene-environment interaction (G*E) studies of DRD4 in the parenting context are fairly common, only a few studies focused on the peer environment (i.e., DiLalla et al., 2009; Kretschmer, Dijkstra, Ormel, Verhulst, & Veenstra, 2013). As said, children in elementary school function in the presence of their peers for a large proportion of their day.

Consequently, the peer environment becomes increasingly important for the development of school-aged children (Sroufe et al., 2009). None of the studies that investigated the peer environment* DRD4 interaction effects focused on the elementary school period. DiLalla and colleagues (2009) found that preschoolers carrying the DRD4-7r allele showed more aggression during peer-play in an environment where there was little peer aggression, while in a highly aggressive environment all children showed aggressive behavior regardless of genotype. No evidence of G*E was found for the association between peers' prosocial behavior and children's own prosocial behavior in that study. Kretschmer and colleagues (2013) focused on victimization and social well-being during adolescence as predictors of delinquency. These authors found that, in contrast to previous findings and their own hypotheses, the adolescents who did *not* have the DRD4-7r allele, as opposed to those who did have this allele, were more susceptible to the effects of victimization and social well-being. Thus, information on the elementary school peer environment is lacking and the scarce studies with regard to moderation by DRD4 genotype in the relation between peer experiences and maladjustment have produced inconclusive findings.

Second, many previous studies have studied environmental variables that not all children will be exposed to on a daily basis and for the better part of the week, such as bully-victimization, intrusive parenting, or peer aggression (e.g., DiLalla et al., 2009; Kretschmer et al., 2013; Propper, Willoughby, Halpern, Carbone, & Cox, 2007). It is currently not known whether moderating effects of DRD4 also extend to peer experiences that children will encounter on each typical school day. In the present study we therefore focused on children's social preference among peers as the environmental factor of interest. Peer social preference in the classroom refers to the extent to which children are liked relative to disliked by their classmates. It is the result of a natural evaluation process that occurs in every social setting, for every individual within that setting (Coie et al., 1982; Rubin et al., 2006). Establishing a

positive social standing in the larger peer-group is a key developmental task for children in elementary school, which facilitates a healthy behavioral development (Sroufe et al., 2009). Indeed, the impact of low social preference within the peer group on behavioral misconduct in children has been well documented (for overviews, see Parker, Rubin, Erath, Wojslawowicz, & Buskirk, 2006; Rubin et al., 2006). However, and in accordance with the "for better and for worse" hypothesis, the influence of peer relations is multidirectional: being mostly disliked among peers may elevate the risk for the development of conduct problems and may hinder prosocial development; in contrast, being mostly liked may protect against the development of conduct problems and may promote prosocial behavioral development (Ladd, 2006; Twenge, Baumeister, DeWall, Ciarocco, & Bartels, 2007; Wentzel, 2014; Wentzel & McNamara, 1999; Witvliet, Van Lier, Cuijpers, & Koot, 2009). Therefore, by focusing on social preference as the environmental peer-factor of interest we aim to expand previous results found in the field of gene*peer environment interactions.

Third, and related to the previous argument, none of the previous studies focused on both negative and positive environments with regard to both negative and positive outcomes. The study by Kretschmer and colleagues (2013) focused on negative and positive peer environmental factors with respect to predicting negative behavioral outcomes. The study by DiLalla and colleagues (2009) focused on a positive peer environment with respect to predicting positive behavioral outcomes and a negative environment with respect to predicting negative behavioral outcomes. Other studies also focused on either the positive environment or the negative environment and/or either positive outcomes or negative outcomes (e.g., see examples in the overview of Bakermans-Kranenburg & van IJzendoorn, 2011). However, less negative behavioral outcomes or even the absence of negative behavioral outcomes does not necessarily mean that behavioral outcomes are positive. This also applies vice versa: less positive behavioral outcomes or the absence of positive outcomes does not necessarily mean

that behavioral outcomes are negative. The same holds for the environment: the absence of a negative environment or a less negative environment does not necessarily mean that the environment is positive, and vice versa. Ideally, the study of differential susceptibility includes both negative and positive environments as well as both negative and positive behavioral outcomes to test for all possibilities: a) a negative environment predicting more positive behavioral outcomes and less negative behavioral outcomes and b) a positive environment predicting less positive behavioral outcomes and more negative behavioral outcomes. To this end, we focused on peer social preference as our environmental factor of interest and conduct problems and prosocial behavior as our behavioral outcomes of interest. Peer social preference encompasses both a risk (i.e., negative social preference scores: children who are more disliked relative to liked) and a protective end (i.e., positive social preference scores: children who are more liked relative to disliked). Thus, this allows for a comprehensive test of the differential susceptibility hypothesis. That is, moderation by DRD4 genotype in both the "for better" and the "for worse" direction can be tested by including both positive and negative peer environmental factors with respect to predicting both positive and negative outcomes.

Lastly, many previous studies suffered from design limitations because most were cross-sectional or longitudinal prediction studies that were built upon the assumption that children's environment predicts subsequent behavior and not vice versa. However, previous studies have shown that associations between social preference and behavior may be bidirectional: children's social standing among peers may influence their behavior and their behavior may influence their social preference among peers (e.g., Van Lier & Koot, 2010). Thus, when developmental models do not account for the possibility of these bidirectional effects, the direction of influence between environmental and behavioral factors may be obscured. Furthermore, by using the participants as their own controls, our longitudinal study in which the behavioral and environmental factors are assessed in parallel over four years

enables investigating whether behavior has changed from a prior baseline level after experiencing low or high social preference.

Present Study and Hypotheses

Using a sample of mainstream elementary school children (N = 405) in which social preference, prosocial behavior and conduct problems were assessed in parallel, annually across ages 9 to 12 years (four waves), we aimed to extend previous research on the moderating role of DRD4 in four ways. First, we focused on the peer environment in elementary school children, thereby extending studies on parental environmental factors as well as studies focused on the peer environment in kindergarten and adolescence. Second, we focused on a peer environmental factor that all children experience on a daily basis for the better part of the week, namely peer social preference. We thereby expand previous research that used peer factors that likely not all children are exposed to. Third, by focusing on both negative and positive peer environmental factors in predicting both negative and positive behavioral outcomes, we tested the differential susceptibility hypothesis in a comprehensive manner. Lastly, we investigated potential G*E effects in a longitudinal design where children were followed over four years, which enabled us to investigate the direction of influence between the behavioral and environmental constructs.

We started by investigating whether positive social preference scores and negative social preference scores would be prospectively associated with conduct problems and prosocial behavioral development, above and beyond possible direct effects of DRD4 on the environmental and behavioral variables, as well as above and beyond potential opposite effects (i.e., behavior affecting social preference). We hypothesized that children who had higher positive preference scores would have lower levels of conduct problems and higher levels of prosocial behavior in subsequent years, relative to children with lower levels of positive preference scores. Furthermore, we expected these effects to be mirrored for children who had

negative social preference scores. That is, we hypothesized that children who had more negative preference scores would have higher levels of conduct problems and lower levels of prosocial behavior in subsequent years, relative to children with less negative preference scores (hypothesis 1). Within these models, direct associations between DRD4 and social preference scores as well as between DRD4 and behavioral outcomes were explored.

Next we examined our main hypothesis, namely whether the prospective association between peer social preference and behavioral development varied as a function of DRD4 polymorphisms. In line with the differential susceptibility hypothesis, we tested whether the potential moderation by DRD4 occurred "for better and for worse" (hypothesis 2). Specifically, we hypothesized that children who had higher positive preference scores would have lower levels of conduct problems and higher levels of prosocial behavior in subsequent years, but in both cases particularly when they had a DRD4-7r allele (i.e., G*E "for better"). In addition, we expected that particularly for children with a DRD4-7r allele more negative preference scores would be related to subsequent higher levels of conduct problems and lower levels of prosocial behavior (i.e., G*E "for worse").

Method

Participants

Participants were children attending 48 different mainstream elementary schools and were part of two longitudinal research projects on children's social, emotional and behavioral development in the Netherlands. These research projects were conducted by the department of Developmental Psychology, VU University Amsterdam. Parental consent for participation was obtained for a total of 1,091 children. In the first project, schools were recruited from two urban areas in the western part of the Netherlands and one rural area in the eastern part of the Netherlands. A convenience sample was utilized in which the first 30 schools that accepted our invitation to participate in the project were included. In the other project, eighteen schools from

the northern and the eastern part of the Netherlands were recruited via municipal health services. In both projects, all children were followed annually across elementary school. Additional information on the participants, design, and procedures is provided elsewhere (Gooren, van Lier, Stegge, Terwogt, & Koot, 2011; Menting et al., 2011). The ethic review boards of the Erasmus University Rotterdam and the VU University Amsterdam approved the projects. In first and second grade, a preventive intervention targeting problem behavior (either the Good Behavior Game; Barrish, Saunders & Wolf, 1969; or PATHS curriculum; Kusché & Greenberg, 1994) was implemented in which approximately 60% of the children participated, with the remaining 40% serving as controls. To prevent confounding by intervention effects, data covering ages 9 to 12 years (grades 3 to 6, four waves) were used in the present study. Moreover, all estimates were controlled for potential long-term intervention effects and three-way interactions including condition (intervention or control; G*E*condition) were tested. More detailed information about both interventions can be found in the section 'supplementary material chapter 5'.

At age 13, children were asked to provide DNA through a saliva sample. Children and parents who granted permission were eligible for inclusion in the present study (N = 406; 51% girls). DRD4 genotyping was successful for 405 out of the 406 subjects. Of these, 143 (35%) subjects carried one or two 7-repeat alleles (referred to as DRD4-7r) and 262 (65%) subjects carried no 7-repeat alleles (referred to as DRD4-no7). Of the DRD4-no7 group, all but 2 children carried either a 2-repeat allele or a 4-repeat allele. More details on the distribution of the DRD4 polymorphisms and the assignment to groups is provided in supplementary material (Table 5.2S)

Eighteen percent of the children came from low socioeconomic status (SES) families. Furthermore, 87% of the present sample had a Dutch/Caucasian background, 3.8% were Moroccan, 3.8% were Surinamese, 2% were from the Netherlands Antilles, and 3.4% of the

children came from other ethnical backgrounds (i.e., Turkey, Somalia, Pakistan, Iraq, Congo-Kinshasa or Sri Lanka). Given that the DRD4-environment interaction may be dependent on race (e.g., Propper et al., 2007), we examined whether results changed when only native Dutch (i.e., Caucasian) children remained in the sample. In addition, because the developmental relation between peer experiences and subsequent behavioral development may differ for boys and girls (Moffitt et al., 2001; Van Lier & Koot, 2010; Witvliet et al., 2009) and that moderating effects of DRD4 may be influenced by the child's sex (Froehlich et al., 2007), we investigated potential sex differences in the moderation by DRD4 (i.e., G*E*sex).

Participants who declined participation in DNA collection did not differ from those who conceded with participation on average levels of conduct problems, ($F(1, 973) = 2.49$, $p = .12$) or negative social preference scores ($F(1, 1{,}089) = 1.48$, $p = .22$) over ages 9 to 12 years. However, children who declined participation compared to children who participated had slightly lower average levels of prosocial behavior ($F(1, 972) = 11.44$, $p < .01$, $\eta^2 = .01$; $M = 2.87$, $SD = 0.57$ for children who participated, $M = 2.74$, $SD = 0.62$ for children who declined participation), as well as slightly lower levels of positive social preference scores ($F(1, 1{,}010) = 6.27$, $p < .05$, $\eta^2 < .01$; $M = 0.23$, $SD = 0.16$ for children who participated, $M = 0.20$, $SD = 0.17$ for children who declined participation) over ages 9 to 12 years. During the follow-up period used in the present study, data of 91% of the children were complete for at least two measurement moments. Missing data was due to retention, moving to another school, or because of absence during the measurements. Children with missing data did not differ from children with complete data on any of the study variables in third grade, indicating that there was no evidence for selective attrition during the period investigated in the present study.

Measures

Teacher ratings of conduct problems. Teacher ratings of conduct problems were assessed annually with the conduct problems scale from the Problem Behavior at School

Interview (PBSI; Erasmus M. C., 2000). The PBSI is a face-to-face interview in which teachers rated pupils' behavior on a five-point Likert-scale ranging from 0 (never applicable) to 4 (often applicable). Conduct problems were assessed by 12 items (range α over the assessments = .90 - .92). Sample items include: "attacks other children physically", "bullies", "steals", "destroys property belonging to other children", "is absent from school without permission", "curses or swears". Item scores were averaged, resulting in a scale ranging from 0 to 4.

Teacher ratings of prosocial behavior. Teacher ratings of prosocial behavior were assessed annually with the prosocial behavior scale from the Social Experiences Questionnaire (SEQ-T; Crick & Grotpeter, 1996). During a face-to-face interview teachers rated pupils' behavior on a 5-point Likert scale ranging from 0 (never applicable) to 4 (often applicable). Prosocial behavior was assessed by 4 items (range α over the assessments = .75 - .83). Sample items include: "Comforts a child who is sad" and "Is nice to other children". Item scores were averaged, resulting in a scale ranging from 0 to 4.

Peer nominations on social preference. Peer nominations on social preference were obtained by asking children to nominate an unlimited number of children in their classroom whom they liked most and whom they liked least. The "liked least" scores of each child were subtracted from his or her "liked most" scores to obtain a social preference score. This score was divided by the total number of children in the classroom, minus one (it was not allowed to nominate oneself), resulting in a score ranging from -1 (disliked by all classmates and liked by none) to +1 (liked by all classmates and disliked by none). This procedure was adapted from the protocol described by Coie, Dodge and Copotelli (1982). Social preference is generally regarded as a reliable and valid measure of sociometric status (Rubin et al., 2006). We then differentiated between children with *positive social preference scores*, that is children who were more liked relative to disliked and children with *negative social preference scores*, that is children who were more disliked relative to liked. Negative social preference scores were

then multiplied by minus 1 such that higher scores reflected a more negative social preference score. Children who were equally liked as disliked or who were not nominated at all (between 3.3% and 6.5% of all children throughout ages 9 to 12 years) received a score of zero.

Covariates

Children's sex. Children's sex was dummy coded as 0 = female, 1 = male. ***Household socioeconomic status (SES).*** SES was measured through parental occupation in third grade. Father's and mother's occupations were classified into one of five levels (0 = unemployed, 1 = elementary level, 2 = lower level, 3 = medium level, 4 = higher level). Levels of occupation were assigned according to the Dutch Working Population Classifications of Occupations Scheme (Statistics Netherlands, 2001), which is based upon the International Standard Classification of Occupations (ISCO; International Labour Organization, 1987a; 1987b). The highest occupation level (from father or mother) was considered to reflect household SES. Household SES was then dummy coded as 0 = medium to higher level SES, 1 = unemployed to lower level SES. ***Intervention status.*** Intervention status was dummy coded as 0 = no intervention, 1 = intervention.

Genotyping of VNTR in exon 3 of DRD4. DNA was extracted from saliva using the Oragene™ DNA Self-collection Kit according to the manufacturer's instructions (DNAGenotek, Ottawa, Ontario, CAN). The 48 base pair VNTR in exon 3 of DRD4 (2-11 repeats) was genotyped using PCR and fragment analysis on a 3130 Genetic Analyzer (Life Technologies, Carlsbad, CA). The PCR assay was a modification of the method by Boór and colleagues (Boór et al., 2002). In accordance with previous studies (e.g., Kretschmer et al., 2013), children were coded as DRD4-7r (at least one allele had 7-repeats) or DRD4-no7 (no 7-repeat alleles).

Statistical Approach

Autoregressive cross-lagged models (Jöreskog, 1970) were used to test our two hypotheses. Models were fitted in Mplus 6.11, Los Angeles, California (L. K. Muthén & Muthén, 1998-2015). We aimed to test links between social preference scores, conduct problems and prosocial behavior in two separate models. That is, we specified one model for links between positive social preference scores and behavioral development and another model for links between negative social preference scores and behavioral development. Within each model, autoregressive paths from ages 9 to 12 years tested for stability within the environmental and behavioral constructs, while cross-lagged paths assessed the developmental links between these constructs (see Figure 5.1 for an illustration). All estimates were controlled for potential long-term intervention effects, SES status and sex.

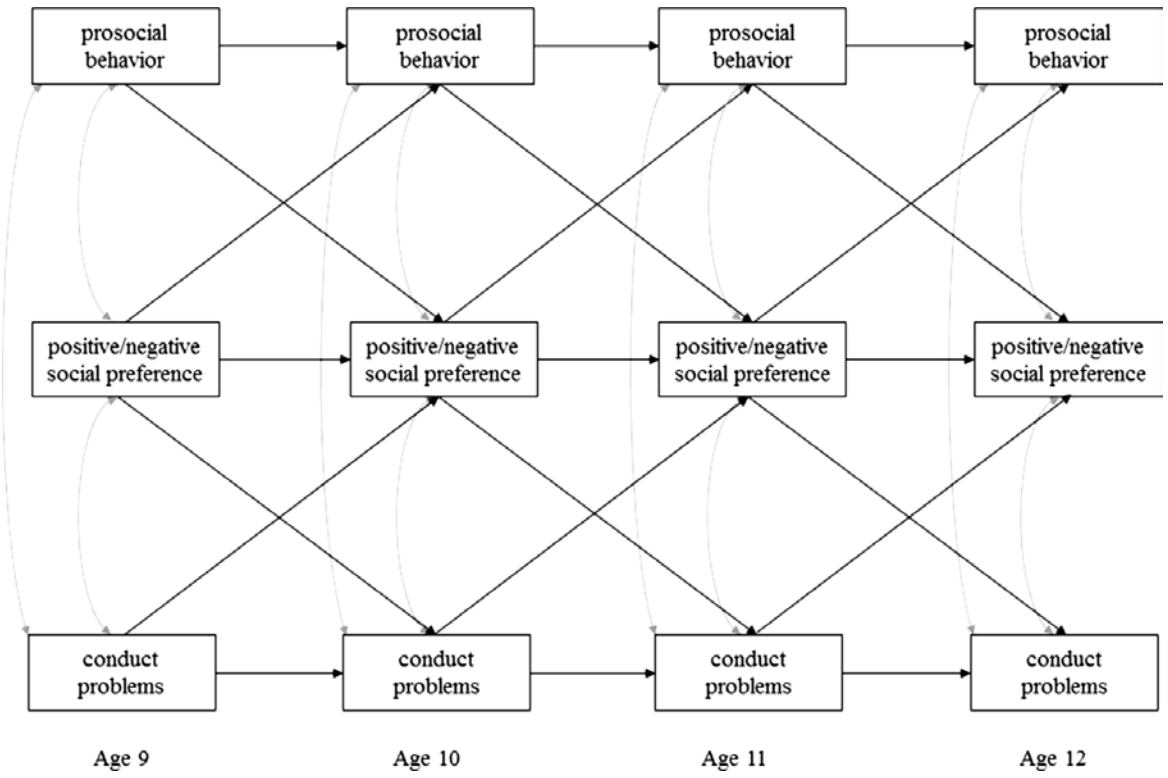

Figure 5.1. Illustration of the model used for hypotheses testing. This model was tested for positive social preference and negative social preference separately.

Power analysis. Given that statistical power is a major concern in modern behavioral genetics(L. E. Duncan & Keller, 2011), we conducted an a priori Monte Carlo simulation study to ensure that power was sufficient given our models and sample size before starting with testing our hypotheses. Statistical power is the probability of detecting a significant result given that the alternative hypothesis (in our study: that particularly children with a 7-repeat allele are susceptible to the peer environment "for better and for worse") is true. Low statistical power is problematic, because it implies that true findings are likely to be missed (type II error) and because low power increases the proportion of significant results that are published, but that are actually false (type I error).

***Monte Carlo simulation*.** In an a priori Monte Carlo analysis, data are generated from a population with hypothesized parameter values. Then, a large number of samples are drawn and a model is estimated for each sample. Parameter values and standard errors are averaged over the samples (L. K. Muthén & Muthén, 2002). We expected effects for negative social preference and positive social preference to be similar, thus we only investigated power for the model including positive social preference. We used 10,000 replications to ensure that stability would be reached. Data for a multiple-group model were generated using the following population values (see also supplementary material chapter 5, Table 5.1S). For the DRD4-7r group as well as for the DRD4-no7 group, means and variances of variables were standardized to 0 and 1 respectively; the standardized regression coefficients for autoregressive paths of social preference, conduct problems and prosocial behavior were all 0.60; standardized regression coefficients of lagged paths from behavioral outcomes to social preference were 0.05 and -0.05 for prosocial behavior and conduct problems respectively; and standardized residual correlations were 0.10 between social preference and prosocial behavior and -0.10 for social preference and conduct problems and for conduct problems and prosocial behavior. For the DRD4-no7 group the standardized regression coefficients of the lagged paths from social

preference to prosocial behavior as well as to conduct problems were 0. These values were chosen based upon Keith and colleagues' consideration that within the social sciences estimates (i.e., standardized regression coefficients) < 0.05 are too small to interpret, estimates ≥ 0.05 are small but meaningful, estimates ≥ 0.10 are moderate, and estimates ≥ 0.25 are large (Keith, 2006; Keith & Cool, 1992).

The focus of the power investigation in the multiple-group autoregressive cross-lagged model was the standardized regression coefficient of the lagged paths from social preference to prosocial behavior and to conduct problems for the DRD4-7r group. Different standardized regression coefficients were estimated, starting from 0.05 (which is a small, but meaningful effect; Keith, 2006) until a power of 0.80 by $p < .05$ was reached. Results are in supplementary material in Table 5.1S. These indicated that a power of 0.80 ($p <. 05$) would be reached when the standardized regression coefficients would be 0.12 for the link between positive social preference and subsequent prosocial behavior and -0.12 for the link between positive social preference and subsequent conduct problems. A beta of 0.12 indicates a moderate effect in the social sciences (Keith, 2006), which we deemed both reasonable and relevant. Under the condition of no effect (i.e., $\beta = 0$) for the DRD4-no7 group, this results in a significant difference in slopes at $p < .001$ when standard errors are 0.01 for the DRD4-7r group and.0.03 for the DRD4-no7 group (i.e., when both groups have a SD of .06), respectively. Furthermore, coverage for the parameters of interest was 0.94, which indicates that the 95% confidence intervals of 94% of the 10,000 replications included the simulated population value of 0.12 (prosocial behavior) and -0.12 (conduct problems; see supplementary material chapter 5, Table 5.1S). Hence, we assumed power to be sufficient to test our hypothesis on G*E effects.

Hypotheses testing. After sufficient power was assured, we tested our two hypotheses. We started by testing the prospective influence of social preference on subsequent behavioral development. To this end, we started with a model that included autoregressive paths and cross-

lagged paths as well as cross-sectional correlations between social preference and the behavioral phenotypes (models 1; see example in Figure 5.1). We also included direct effects of genotype on the environmental and behavioral variables. This model allowed us to test bidirectional effects (i.e., whether positive/ negative social preference scores added to behavioral development above and beyond possible prospective associations between behavioral development and subsequent environmental changes), cross-sectional correlations and direct effects of DRD4 (hypothesis 1). We tested these models separately for positive social preference scores and negative social preference scores, but the development of prosocial behavior and conduct problems was estimated simultaneously. We then continued by testing whether recurring autoregressive and cross-lagged paths could be constrained to be equal over time in order to create parsimonious models (models 2).

Next, we tested our second and main hypothesis, namely whether DRD4 moderated the prospective link between social preference and behavioral development. The following hierarchy of nested model comparisons was applied to test for potential differences between DRD4-7r and the DRD4-no7 groups. Multiple-group models were used in which children with the DRD4-7r allele were compared to children with DRD4-no7 alleles. First, all parameters were freely estimated between the groups (models 3); next, we tested whether pathways that were not part of our hypotheses (i.e., autoregressive paths and paths from the behavioral constructs to the environment) were equal between groups (models 4); and lastly, we investigated our hypothesized G*E effects by testing whether paths between social preference and prosocial behavior (models 5) and between social preference and conduct problems (models 6) were equal between groups. As said, two models were tested: one for positive social preference scores and one for negative social preference scores. In order to support our second hypothesis, constraining autoregressive paths and paths from the behavioral constructs to social preference to be equal between DRD4-7r carriers and DRD4-no7 carriers (models 4) should

not significantly decrease model fit, while constraining the pathways between social preference and behavioral phenotypes to be equal for DRD4-7r carriers and DRD4-no7 carriers (models 5 and 6) should result in a significant drop in fit. In each model testing step, constraints that did not result in a significant drop in model fit were remained in subsequent models.

Full Information Maximum likelihood estimation with robust standard errors (FIML, MLR-estimator) was used to account for missing data. We accounted for clustering of data within schools by using a sandwich estimator (Williams, 2000a). The Satorra-Bentler chi-square difference test was used to compare nested models (Satorra, 2000). Model fit was determined via the Comparative Fit Index (CFI; with values ≥ .95 indicating acceptable fit), and the Standardized Root Mean Squared Residual (SRMR; with values ≤ .08 being acceptable) (Hu & Bentler, 1998; Marsh, Hau, & Wen, 2004). We tested for potential sex-differences and differences due to intervention status in the moderation by DRD4 using three-way interactions (G*E*sex and G*E*condition, respectively). Furthermore, using the equation provided by Duncan and Keller (2011) we calculated the False Discovery Rate (FDR) from Monte Carlo power analyses. The FDR indicates the proportion of false discoveries (i.e., the proportion of false support for our hypotheses when this support actually represents type I errors).

Results

Descriptive Statistics

Distribution of the DRD4 polymorphisms was comparable to reported global repeat frequencies (see supplementary material; Chang, Kidd, Livak, Pakstis, & Kidd, 1996). Allele frequencies of DRD4 polymorphisms were analyzed from Hardy-Weinberg equilibrium (HWE) using χ^2 tests. No deviations from HWE were detected, χ^2 (2) = 0.20, p = .90.

Table 5.1 gives the means and *SDs* for study variables for boys and girls, as well as correlations between study variables. Analyses of variance (ANOVAs) indicated that from ages

9 to 12 years, boys had on average higher levels of conduct problems ($F(1, 394) = 57.83$, $p < .001$, $\eta^2 = .13$) and lower levels of prosocial behavior ($F(1, 395) = 80.50$, $p < .001$, $\eta^2 = .17$), than girls. In addition, boys had slightly lower levels of positive social preference scores ($F(1, 362) = 15.30$, $p < .001$, $\eta^2 = .04$), and slightly higher levels of negative social preference scores ($F(1, 363) = 10.69$, $p < .01$, $\eta^2 = .03$), than girls. Correlations indicated significant cross-time correlations of conduct problems, prosocial behavior, positive and negative social preference in the expected directions. Furthermore, ANOVAs indicated that DRD4-7r and DRD4-no7 carriers did not differ in their average levels of conduct problems, prosocial behavior or social preference throughout ages 9 to 12 years.

Hypothesis 1: Social Preference and Behavioral Development

We started by investigating the prospective associations between peer social preference and behavioral outcomes over time. No moderation by DRD4 genotype was tested at this stage. Links between positive social preference scores, conduct problems and prosocial behavior and negative social preference scores, conduct problems and prosocial behavior were tested in two separate models (see Figure 5.1). We fitted bivariate cross-lagged autoregressive models with stability paths and directional paths from social preference to behavior and vice versa, in addition to cross-sectional correlations. Direct effects between DRD4 and social preferences and between DRD4 and behavioral outcomes were also included in the models.

Results of model fitting are presented in Table 5.2. The two models fitted the data adequately according to fit indices (models 1; CFIs $\geq .95$, SRMRs $\leq .06$). Constraining recurring autoregressive and lagged paths to be equal over time (model 2) did not result in worsened model fit for any of the two models (see Table 5.2). Therefore, these time-constraints were retained in the models. Estimates for models 2 are displayed in Table 5.3. For conduct problem development, neither positive social preference scores nor negative social preference scores were related to subsequent conduct problem development, although trends were

observed (i.e., $p \leq .08$). Furthermore, the paths from conduct problems to subsequent positive social preference as well as negative social preference were non-significant, although in the latter link again a trend was observed (i.e., $p \leq .07$.).

For prosocial behavioral development, higher positive social preference scores were related to higher subsequent prosocial behavior and more negative social preference scores were related to lower levels of subsequent prosocial behavior. Furthermore, higher levels of prosocial behavior were related to higher levels of subsequent positive social preference, while the paths between prosocial behavior and negative social preference scores were non-significant. These effects were found above and beyond stability paths and cross-sectional correlations, and all estimates were controlled for sex, SES and intervention status. Furthermore, neither the direct effects of DRD4 on social preference, nor the direct relationships between DRD4 and behavioral outcomes were significant (see Table 5.3).

Table 5.1

Correlations, Means and Standard Deviations for Peer Social Preference and Behavioral Phenotypes

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Positive social preference																	
1	Age 9	-															
2	Age 10	.70**	-														
3	Age 11	.49**	.65**	-													
4	Age 12	.35**	.48**	.63**	-												
Negative social preference																	
5	Age 9	-.45**	-.34**	-.27**	-.29**	-											
6	Age 10	-.30**	-.43**	-.32**	-.30**	.53**	-										
7	Age 11	-.26**	-.35**	-.45**	-.41**	.53**	.59**	-									
8	Age 12	-.18**	-.24**	-.35**	-.47**	.49**	.47**	.69**	-								
Conduct problems																	
9	Age 9	-.40**	-.37**	-.30**	-.25**	.48**	.43**	.29**	.34**	-							
10	Age 10	-.28**	-.37**	-.34**	-.26**	.43**	.45**	.37**	.36**	.66**	-						
11	Age 11	-.23**	-.24**	-.23**	-.10	.31**	.22**	.28**	.25**	.55**	.58**	-					
12	Age 12	-.18**	-.23**	-.28**	-.24**	.34**	.32**	.28**	.36**	.57**	.55**	.65**	-				
Prosocial behavior																	

13	Age 9	.37**	.34**	.34**	.31**	-.33**	-.17*	-.19**	-.24**	-.53**	-.32**	-.35**	-.37**	-		
14	Age 10	.25*	.29**	.34**	.25*	-.38**	-.35**	-.25**	-.08	-.34	-.65**	-.32**	-.38**	.39**	-	
15	Age 11	.17**	.29**	.34**	.24**	-.17**	-.20**	-.23**	-.24**	-.29**	-.35**	-.44**	-.30**	.37**	.60**	-
16	Age 12	.29**	.39**	.32**	.30**	-.26**	-.29**	-.24**	-.30**	-.29**	-.33**	-.29**	-.43**	.40**	.46**	.48**
Mean boys		0.20	0.19	0.20	0.28	0.07	0.08	0.07	0.06	0.69	0.71	0.57	0.58	2.63	2.73	2.61	2.66
SD boys		0.19	0.19	0.20	0.22	0.13	0.16	0.15	0.14	0.62	0.69	0.58	0.60	0.66	0.69	0.71	0.73
Mean girls		0.27	0.26	0.28	0.34	0.03	0.03	0.03	0.03	0.36	0.30	0.24	0.25	3.00	3.09	3.16	3.15
SD girls		0.24	0.23	0.21	0.24	0.10	0.11	0.10	0.09	0.50	0.38	0.35	0.37	0.69	0.53	0.60	0.61

Note. * Significant at $p < .05$, ** significant at $p < .01$, *** significant at $p < .001$

Table 5.2

Gene-environment Interactions between DRD4 and Positive as well as Negative Peer Social Preference in Predicting Conduct Problems and Prosocial Behavior: Fit Statistics and Nested Model Comparisons

Model	χ^2	df	CFI	SRMR	Comp.	$\Delta\chi^2$	Δdf	*p*
positive social preference								
Total sample								
1. Base model	91.14	33	.95	.05				
2. Time constraints	111.67	47	.94	.05	1 versus 2	20.37	14	0.119
DRD4-7r versus DRD4-no7								
3 No constraints	172.69	94	.94	.07				
4. Non-hypothesized paths equal	183.71	103	.94	.08	3 versus 4	9.87	9	0.361
5. GxE: positive social preference → prosocial behavior equal	183.31	104	.94	.08	4 versus 5	0.06	1	0.805
6. GxE: positive social preference → conduct problems equal	186.87	105	.94	.08	5 versus 6	5.70	1	0.017
negative social preference								
Total sample								
1. Base model	84.66	33	.95	.06				
2. Time constraints	96.27	47	.95	.05	1 versus 2	14.84	14	0.389
DRD4-7r versus DRD4-no7								
3 No constraints	184.49	94	.93	.07				

4.	Non-hypothesized paths equal	194.34	103	.93	.07	3 versus 4	9.27	9	0.413
5.	GxE: negative social preference → prosocial behavior equal	196.67	104	.92	.07	4 versus 5	2.85	1	0.091
6.	GxE: negative social preference → conduct problems equal	204.01	105	.92	.07	5 versus 6	9.81	1	0.002

Note. $\Delta\chi 2$ statistics are based on the Satorra-Bentler chi-square difference test.

Table 5. 3

Coefficients for Paths between Positive Social Preference, Negative Social Preference and Behavioral Phenotypes

Pathways	Estimates			
Positive social preference	*B*	*SE*	*β*	*p*
Positive social preference predicting prosocial behavior	.47	.12	.14	.000
Prosocial behavior predicting positive social preference	.03	.01	.11	.006
Positive social preference predicting conduct problems	-.17	.10	-.07	.075
Conduct problems predicting positive social preference	.01	.01	.03	.453
Negative social preference				
Negative social preference predicting prosocial behavior	-.58	.17	-.10	.001
Prosocial behavior predicting negative social preference	-.01	.01	-.03	.423
Negative social preference predicting conduct problems	.34	.18	.07	.061
Conduct problems predicting negative social preference	.02	.01	.09	.061

Note. As recurring paths were constrained to be similar over time, these results apply to all recurring paths in the model.

Hypothesis 2: Differential Susceptibility of DRD4 to the Environment "For Better and for Worse"

We then tested whether the magnitude of the prospective links between positive and negative social preference scores, prosocial behavior and conduct problems (see Figure 5.1 for an illustration), were different for DRD4-7r and DRD4-no7 children (hypothesis 2). Multiple group models were used (DRD4-no7 versus DRD4-7r). Table 5.2 shows fit indices for models in which all paths were estimated freely between DRD4 groups (models 3), models in which the paths that were not part of our hypothesis were constrained to be equal between the DRD4 groups (models 4), and models in which developmental pathways from social preference to the behavioral outcomes were constrained to be equal between DRD4 groups (models 5 and 6).

Comparisons of fit indices showed evidence for moderation by DRD4 in the link between social preference and subsequent conduct problems only. As can be seen in Table 5.2, multiple group models in which paths between social preference and subsequent conduct problems were estimated freely between the DRD4-7r and DRD4-no7 groups (models 5), are the best fitting models for children with positive as well as for children with negative social preference scores. Results from analyses for prosocial behavior indicate that neither positive nor negative social preference scores had a differential effect on prosocial behavior as a function of DRD4 (see Table 5.2).

Estimates of gene-environment interaction effects for conduct problem development are in Figure 5.2. Figure 5.2 shows that positive social preferences scores were prospectively associated with lower levels of conduct problems, but only among DRD4-7r carriers. These effects were mirrored for children with negative social preference scores. That is, being more disliked than liked among peers was associated with more conduct problems, but again only among DRD4-7r carriers. No relation was found between the positive or negative social preference scores and conduct problems for DRD4-no7 children. Note that no G*E interaction effect was found for prosocial behavior. Hence, estimates for associations between social preference and prosocial behavior were similar for the DRD4-7r and DRD4-no7 groups (i.e., similar to findings of the total sample) and can be found in Table 5.3.

We ran a number of additional tests to test the robustness of our findings. First, potential effects of ethnicity were tested. Specifically, we investigated whether results were similar when only native Dutch children remained in the sample (N = 342; n = 127 for DRD4-7r, n = 215 for DRD4-no7). Results of these tests indicated that removing non-Dutch children from the sample did not influence the results for nested model comparisons. Second, we tested whether the moderating role of DRD4 in the prediction of conduct problems from social preference scores were influenced by the children's sex. To this end, we investigated the effects of three-

way interactions (G*E*sex) on conduct problem and prosocial behavior development, which were all non-significant. Thus the moderation of DRD4 in the association between social preference (positive or negative), prosocial behavior and conduct problems did not differ between boys and girls. Third, we tested whether the moderating role of DRD4 in the prediction of prosocial behavior and conduct problems from social preference scores was influenced by whether or not children had participated in an intervention. To this end, we investigated the effects of three-way interactions (G*E*intervention status) on conduct problem and prosocial behavior development, which were all non-significant. Thus the moderation of DRD4 in the association between social preference (positive or negative), prosocial behavior, and conduct problems was not dependent upon intervention status. Lastly, we performed post Monte Carlo power analyses (10,000 repetitions) using our sample estimates to calculate the False Discovery Rate (FDR) in our study. Power for our parameters of interest was .0.95 and 1.00 for predicting conduct problem development from positive and negative social preference respectively, which equaled a FDR of 0.05 and 0.01 for positive and negative social preference respectively. This indicates that 5% of evidence for our hypotheses for positive social preference and 1% of evidence for our hypotheses for negative social preference with regard to conduct problem development, may actually be type 1 errors.

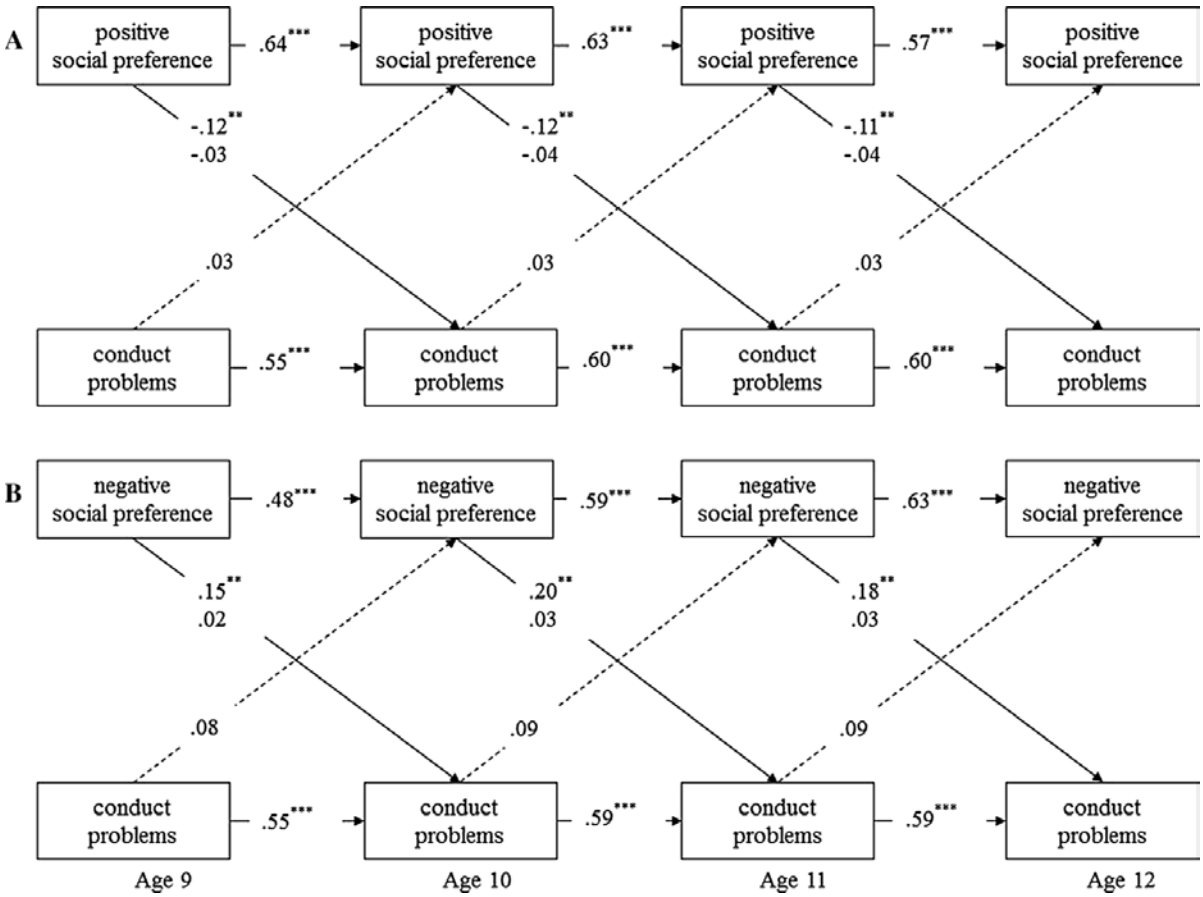

Figure 5.2. Multiple-group (DRD4-7r versus DRD4-no7) model of positive social preference (A) and negative social preference (B) predicting conduct problems Results are a graphical presentation of models 5. Entries reflect standardized regression coefficients. Paths that were different for the DRD4-7r and DRD4-no7 children have two coefficients: upper entries are estimates for DRD4-7r, lower entries are estimates for DRD4-no7. All entries are controlled for sex, SES and intervention status. Dashed lines represent non-significant pathways. * Significant at $p < .05$, ** significant at $p < .01$, *** significant at $p < .001$.

Discussion

The main aim of the current study was to investigate whether the dopamine receptor D4 gene (DRD4) moderated the association of positive social preference (i.e., children that were more liked than disliked among classmates) and negative social preference (i.e., children that were more disliked than liked among classmates) among peers with subsequent positive and negative behavioral development. This study was one of the first to investigate differential susceptibility of DRD4 to a common peer environmental experience that covers positive as

well as negative aspects of the peer environment. Our first hypothesis that social preference would be related to behavioral development in subsequent years for the group in total was only partially supported. That is, throughout ages 9 to 12 years children with higher positive social preference scores showed a larger increase in prosocial behavior in subsequent years than children with lower positive social preference scores. This effect was mirrored for negative social preference scores: children with more negative social preference scores showed a larger decrease in prosocial behavior in subsequent years compared to children with less negative social preference scores. Contrary to our expectations, we did not find strong evidence for developmental links between social preference (either positive or negative) and conduct problems in subsequent years for the group in total, although a trend was observed for these developmental links. Our second hypothesis that developmental links between social preference and behavioral outcomes would be moderated by DRD4 "for better and for worse" was also partially supported. As we hypothesized, we found that throughout ages 9 to 12 years children with higher positive social preference scores showed a larger decrease in subsequent conduct problem development relative to children with lower positive preference scores and that children with more negative social preference scores showed an larger increase in subsequent conduct problem development relative to children with less negative social preference scores, but in both cases only when they carried a DRD4-7r allele. When children did not have this allele, their conduct problem development was not influenced by their social preference among peers. In contrast and contrary to our expectations, prosocial behavioral development was influenced by negative as well as positive social preference among peers regardless of the genetic make-up of the children. Taken together, these findings provide evidence in support of the differential susceptibility hypothesis of DRD4 for conduct problem development, but not for the development of prosocial behavior.

Our findings add to existing knowledge on individual differences in the impact of peer environmental aspects, dependent upon children's genetic make-up. It concurs with previous studies on bully-victimization (Kretschmer et al., 2013) and peer aggression (DiLalla et al., 2009), in that dopamine-related genes are of importance in understanding the impact of peer environmental factors on behavioral development. Specifically, the results we found in children followed from age 9 to 12 years are in line with DiLalla and colleagues (2009) who focused on gene-environment interplay in kindergarten and found that children with the DRD-7 repeat allele were particularly susceptible to their peer environment. Interestingly, Kretschmer and colleagues (2013) found an opposite effect for adolescents aged 13 to 18 years of age. That is, their results suggested that it are the DRD4-no7 repeat carriers and not the 7-repeat carriers who are particularly susceptible to the negative as well as the positive environment. A possible explanation for these differential effects for younger versus older children may be that adolescence is a developmental period in which major neurological and biological changes occur, which may influence the effect of DRD4 polymorphisms on behavior/outcomes (Kretschmer et al., 2013). Our findings extend these previous studies by showing that the DRD4-7r allele may not only affect how children respond to these rather extreme peer experiences, but also influences how children respond to common peer evaluations that all children encounter on a daily basis over the elementary school years. In addition, together with the studies of DiLalla and colleagues (2009) and Kretschmer and colleagues (2013), the present results warrant attention to the specific developmental period that is under investigation as results from gene-environment interactions may change throughout development.

It is important to note that our findings on gene-environment interplay only held for conduct problems and not for prosocial behavior. In line with differential susceptibility theorizing that DRD4 moderation of environmental effects would be "for better and for worse", we expected this moderation to be domain general in that both the development of conduct

problems and the development of prosocial behavior would be affected. However, our results suggest that this moderation is domain specific. Specifically, our results suggest that DRD4 effects likely depend on the specific environment-behavioral phenotype relation that is investigated. In line with this suggestion, DiLalla and colleagues (2009) found DRD4 to only moderate the effect of peer aggression on children's aggressive behavior, but DRD4 did not moderate the effect of peer prosocial behavior on children's prosocial behavior. As such, the present findings and those of DiLalla and colleagues (2009) both contribute to a rapidly accumulating body of knowledge that will eventually inform us about the extent to which differential susceptibility effects are domain general or domain specific.

The present findings suggest that Belsky's (1997) differential susceptibility theory may not only apply to rearing practices, but also to the peer environment. When susceptible children's position within the peer group is threatened by peer rejection or low preference, one way to strengthen their position is through the use of dominance-oriented social strategies, including aggression (Reijntjes et al., 2013). This is likely to increase individuals' social dominance position which improves their chances for obtaining attractive resources and (in the future) makes them attractive for mating (Pellegrini & Long, 2003), thus improving their chances for reproduction. For susceptible children who are socially preferred by their peers, behaving aggressively to strengthen their dominance position in the peer group is not necessary and given dangerous side-effects (like becoming injured from fighting) may even be undesirable, thus explaining the decrease in subsequent conduct problem development for socially-preferred susceptible children.

Children who were less susceptible (i.e., DRD4-no7 carriers) seemed to be unaffected by their peer environment in that their conduct problem development was not influenced by their social standing among peers. Perhaps children with dopamine-related alleles that are not related to decreased postsynaptic inhibition (e.g., children with DRD4-no7 alleles) have better

self-regulatory skills. There is indeed some evidence pointing in this direction (Fan, Fossella, Sommer, Wu, & Posner, 2003; Fossella et al., 2002; Posner & Rothbart, 2009). Better self-regulatory skills may facilitate effective socialization and may enable children to inhibit inappropriate responses like conduct disordered behavior and to behave in accordance with social demands from parents, teachers, and peers. In line with Belsky's (1997) reasoning regarding differential susceptibility to parenting, it makes evolutionary sense that some children are particularly vulnerable to their peer environment and adapt their behavior accordingly, while others are not influenced by their peers. Future research may elaborate on this suggestion by investigating differential susceptibility of children with DRD4-7r alleles to the peer environment in relation to other behavioral strategies that may strengthen their position in the peer group, such as the combined use of both aggressive and cooperative strategies (Hawley, 1999) and behaving as a bully (Olthof, Goossens, Vermande, Aleva, & van der Meulen, 2011).

This study is not without limitations. First of all, although we used a normative sample, the selection of schools was not at random. Children included in our study came from families with higher SES status than is generally reported for the Dutch population (Statistics Netherlands, 2012). Furthermore, children whose parents did not consent to having their child's DNA collected had slightly lower positive social preference scores was well as slightly lower levels of prosocial behavior than children that did participate in the DNA collection. Although the reported differences were small, we cannot be certain that the results generalize to the broader Dutch population. Second, we used teacher reports on children's prosocial behavior and conduct problems. Teachers may not be aware of these behaviors outside the school context and children may hide certain conduct problems, such as stealing, from their teacher. Although previous studies have indicated that teachers are valid informants of children's conduct problems and prosocial behavior (Becker, Woerner, Hasselhorn, Banaschewski, &

Rothenberger, 2004; Hart et al., 1994), our results should only be interpreted within the school context. Third, influences of peers as assessed in this study were limited to peers within the classroom. However, poor relations with peers outside the classroom may also affect children's behavior. Although others have shown that influences of peers outside of the school context are limited for elementary school children (Kupersmidt et al., 1995), we cannot be certain that peers outside the classroom have not influenced our results. Fourth, by investigating the influence of social preference on subsequent behavioral phenotypes while taking into account the stability of these constructs as well as concurrent links between environment and behavior, we were able to identify the actual change in behavioral phenotypes that can be ascribed to peer environment, genetic effects, and their interplay. However, we want to stress that no causality can be inferred from this design. Fifth, although we took both the for better and the for worse side of the differential susceptibility hypothesis into account, we could not directly examine whether the same children who do worse than comparisons in adverse peer environments, also do better when they experience supportive peer environments. Future studies may want to include designs that allow studying the same children in various environmental conditions, such as an experimental study in which the same children encounter peer exclusion as well as inclusion situations (Rutter, Pickles, Murray, & Eaves, 2001). In addition, from our study it cannot be inferred which brain processes and neurocognitive functions that are associated with the DRD4 gene account for our differential susceptibility findings. This is of particular importance given the different results that have been found for kindergarten and elementary school children versus older adolescents. Future studies may want to investigate these brain processes and neurocognitive functioning that are associated with differential susceptibility (Ellis & Boyce, 2011), ideally within a developmental framework in which potential differences in brain processes and functioning throughout development can be studied. As a last and perhaps most important limitation we want to note that we were not able

to directly replicate our results in an independent sample using the same measures. Therefore, our results should be interpreted with caution until replicated.

The DRD4 7-repeat allele may render children and young adolescents susceptible to their everyday peer environment for better and for worse with regard to subsequent conduct problem development. We found that, throughout ages 9 to 12 years, children who experienced a more positive peer environment at a given age showed less conduct problem development one year later when compared to children who experienced a less positive environment; vice versa, children who experienced a more negative peer environment showed more conduct problem development in subsequent years relative to children who experienced a less negative environment. However, in both situations these effects only held when children had a DRD4-7 repeat allele. Integral strengths of this study were the use of a peer environmental factor that included both a protective and a risk end to assess how a positive and negative daily peer environment may influence the development of conduct problems and prosocial behavior and whether allelic variations within the DRD4 gene may moderate these developmental relations. Other strengths include the use of multiple informants and our longitudinal design. Our findings enhance further understanding of the developmental relationship between youths' social standing among peers and subsequent behavioral development and advance current knowledge on why some, but not all, children and adolescents are influenced by peer experiences. We suggest that part of the individual differences in responding to the peer environment may be explained by differences in the genetic make-up of these individuals.

Furthermore, our findings have implications for preventive interventions for those children at risk for conduct problem development. The peer environment, regardless whether this environment is positive or negative, affects conduct problem development for those children who are susceptible to it. Preventive interventions that succeed in prohibiting the development of poor peer preference or that improve disliked children's appraisal among peers

to a more neutral level, may decrease the development of conduct problems in susceptible children. Although research on endophenotypes related to susceptibility is still in its infancy, future discoveries of endophenotypes associated with susceptibility may advance the early screening of at-risk children that likely will profit from improvements in peer appraisal. At the same time, as others have suggested (Bakermans-Kranenburg & van IJzendoorn, 2011), early detection of those children who likely will not benefit from preventions targeting the peer environment may ideally lead to more individual-based interventions and thus more effective strategies of targeting conduct problem development.

6

Familial Influences on the Effectiveness of a Universal Classroom-Based Preventive Intervention on Peer Acceptance and Conduct Problem Development

J. Marieke Buil

Amber de Wilde

Hans M. Koot

Pol A. C. van Lier

Abstract

A positive classroom climate stimulates a healthy behavioral development in elementary school children. Children who grow up in a disadvantageous home environment may benefit exceptionally from such a safe classroom environment. In the present study, we used a longitudinal randomized controlled design to test to what extent a classroom-based universal intervention aimed at stimulating early elementary school children to take the joint responsibility for creating a positive classroom environment (i.e., the Good Behavior Game; GBG) decreased the development of conduct problems in participating children, through the program's positive effect of children's acceptance among classmates. Furthermore, we tested whether children who were exposed to family risk factors (i.e., maternal depression, maternal delinquency, parenting stress and abusive disciplining), benefitted exceptionally from the GBG intervention and improved acceptance among peers. To this end, we followed 554 children annually from kindergarten to second grade of elementary school (three waves). Conduct problems and peer acceptance were assessed via teacher-ratings and peer-nominations, respectively. Children's mothers reported on their own levels of depressed mood, delinquent behavior, abusive disciplining and parenting stress. Results showed that the GBG was effective in reducing conduct problems for all children. However, the process explaining its effectiveness (i.e., via improved peer acceptance) existed only for children of mothers with high levels of delinquency and for children of mothers who used abusive disciplining tactics. Our findings imply that for these children's behavioral development, the positive classroom climate that was created through the GBG intervention may make up to what their home environment fails to provide.

Conduct problems, such as aggressive behavior, lying and bullying, pose a significant threat to children's psychosocial development. For example, children who show conduct problems in elementary school are at risk of later psychopathology, delinquency and societal

dropout (Fergusson et al., 2009; Moffitt et al., 2002). Multiple classroom-based interventions aimed at improving children's behavior have been developed. An example of such an intervention for elementary school children is the Good Behavior Game (GBG; Barrish et al., 1969). The GBG is an evidence-based preventive intervention aimed at providing a positive and safe classroom environment through facilitating prosocial classroom interactions. Several studies have found that the GBG is effective in reducing the development of various types of behavioral problems at school - including conduct problems - through the impact of the program on improvements in children's peer relationships (Leflot, van Lier, Onghena, & Colpin, 2013; Menting et al., 2014). However, the beneficial effects of the GBG do not affect all children equally. Previous studies have found that children who were at risk for an adverse psychosocial development due to personal risk factors, benefitted exceptionally from the GBG intervention (Leflot et al., 2013; Menting et al., 2014). Children who grow up in a disadvantageous or unsafe home environment are also at risk for poor behavioral adjustment (M. R. Holmes, Yoon, & Berg, 2017). Therefore, such children may also benefit exceptionally from the impact of a classroom-based program aimed at providing a safe school environment, such as the GBG intervention.

The present study used a longitudinal randomized controlled design to test whether children who had high levels of exposure to various risk factors within their home environment (i.e., maternal depressed mood, maternal delinquency, abusive disciplining and parenting stress) benefitted more of the GBG intervention with respect to their conduct problem development than children who were less exposed to these risk factors. A second goal was to test whether improvements in peer acceptance, as achieved through the GBG intervention, explained this potential differential effect between children with higher risk versus lower risk home environments. That is, whether improved peer acceptance could explain why particularly

children from an at-risk home context showed reductions in the development of conduct problems.

Peer Acceptance and the Development of Conduct Problems

After the transition to elementary school, children need to function among and cooperate with age-matched peers for a significant time during the week days. Acceptance among classmates has been identified as a fundamental need for elementary school children (Sroufe et al., 2009). Importantly, poor acceptance among peers has been described as a key explanatory factor within the peer environment that predicts the development of conduct problems (Rubin et al., 2006). Indeed, numerous studies illustrated that difficulties with establishing a positive position in the larger peer-group is related to the development and escalation of behavioral problems (Ladd, 2006; Sturaro et al., 2011) and adds to the prediction of early-onset conduct problems (Miller-Johnson et al., 2002).

Many explanations have been proposed for the link between being poorly accepted among classmates and developing conduct problems. For example, poorly accepted children are less likely to be involved in positive social interactions with mainstream peers and thus may receive relatively few social corrections and guidelines for their behavior (Rubin et al., 2006). Furthermore, children who are poorly accepted by their peers may develop feelings of hostility towards their peers (Dodge et al., 2003), potentially inflicting acts of aggression and other forms of retaliation against their peers. In addition, poor acceptance may set into motion a cascade of peer-relationship difficulties such as bullying-victimization, friendlessness and affiliation with deviant friends (Van Lier & Koot, 2010; Vitaro et al., 2007). In turn, these processes may facilitate, maintain or exacerbate the development of conduct problems (for an overview, see Rubin et al., 2006).

The Good Behavior Game

Given the many adjustment problems that may follow poor peer acceptance at school as well as the detrimental developmental outcomes that have been found for children who show early conduct problems, multiple (preventive) interventions have been developed to impede these social and (consequently) behavioral problems. Among these, the Good Behavior Game (GBG; Barrish et al., 1969) is amongst the most successful evidence-based classroom interventions (Hahn et al., 2007; Wilson & Lipsey, 2007). The GBG is a classroom-based preventive intervention which assists teachers and children in creating a safe and positive classroom environment, thereby improving children's relationships with classmates and reducing behavior problems. One of the key components of the GBG is that it facilitates positive peer-interactions. For instance, during the GBG children work together in groups and group members are encouraged to support each other in behaving in a prosocial manner. Thus, the GBG does not target individual children. In contrast, the team as a whole is responsible for securing that all team members show prosocial and appropriate classroom behavior. Furthermore, the GBG helps teachers to create a clear and predictable classroom structure, thereby further supporting a safe and predictable classroom environment. Various studies have found that the GBG leads to a decrease of conduct problems at school (for overviews, see Embry, 2002; Nolan, Houlihan, Wanzek, & Jenson, 2014; Tingstrom, Sterling-Turner, & Wilczynski, 2006). In line with the alleged role of peer-relationship difficulties in conduct problem development, several previous studies indicated that reductions in conduct problems found among children who participated in the GBG intervention, were explained by improvements in peer relationships (Leflot et al., 2013; Menting et al., 2014).

However, not all children benefit equally from the GBG intervention. Studies focused at moderating factors of GBG impact found that improved peer acceptance due to the GBG was particularly effective in reducing conduct problems for children who were at risk for an

adverse psychosocial development at baseline (Embry 2002; Leflot et al., 2013; Menting et al., 2014). For example, Leflot and colleagues (2013) found that the GBG was only effective in reducing conduct problems for children who had difficulties with showing on-task behavior. That is, particularly for children with low on-task behavior, the impact of the GBG on conduct problems was explained by improvements in peer relations. Similarly, Menting and colleagues (2014) found that improved peer acceptance among children who participated in the GBG intervention predicted a decrease in behavioral problems, but only for children with lower vocabulary skills. Thus, these studies showed that individual differences in children's cognitive skills modified the association between improved peer relationships and conduct problem development. That is, particularly children with (disadvantageous) cognitive skills benefited from the GBG induced improved relationships with classmates.

Risk Factors within the Family Context as Moderators of GBG Impact

Risk factors within the family context, such as maternal depressed mood, maternal delinquent behavior, abusive disciplining and parenting stress, may also increase children's vulnerability for developing behavioral problems (for an overview, see Parritz & Troy, 2014). For example, children may transfer (negative) relationship and behavioral patterns that they have learned within their family context to other domains, including the school environment (Ladd & Pettit, 2002; Rubin & Burgess, 2002). Also, studies have shown that children whose mother's experience depression or high levels of parenting stress are at risk for the development of conduct problems (Parritz & Troy, 2014). However, is has been suggested that other environments that children are exposed to may make up to what the family environment might fail to provide (Ladd & Pettit, 2002). Because the GBG intervention has been found to improve children's relationships with classmates (Leflot et al., 2013; Menting et al., 2014), the GBG may be particularly effective for children who are exposed to risk factors within the home-context. That is, by creating a safe alternative context for children who are exposed to an unsafe

home context, the GBG might reduce the development of conduct problems for such at-risk children.

Present Study

The aim of the present study was to investigate if risk factors within the family environment (i.e., maternal depressed mood, delinquent behavior, abusive disciplining and parenting stress) influenced the impact of the classroom-based GBG intervention on the development of children's conduct problems at school, and whether improvements in children's acceptance among classmates accounted for this potential differential impact. To this end, we followed 554 Dutch mainstream elementary school children from kindergarten through second grade (age 6 to 8 years) who attended classrooms that were randomly assigned to the GBG or a 'care as usual' control condition.

Our research question was investigated in two steps. We first investigated whether maternal depressed mood, delinquent behavior, abusive disciplining and parenting stress moderated the association between the GBG and conduct problem development. Based on previous findings (Leflot et al., 2013), we hypothesized that children who were exposed to a disadvantageous home context would benefit exceptionally from the GBG, compared to children who were not subjected to family risk factors. Thus, we expected that the GBG would reduce the development of conduct problems particularly for these at-risk children. Second, we tested whether the association between the GBG and conduct problem development was mediated by improved peer acceptance (due to the GBG), and whether this mediating pathway held in particular for at-risk children. We hypothesized that for at-risk children in particular (compared to children not exposed to a disadvantageous home context), improved peer acceptance would be related to a decrease in conduct problems. Thus, we expected that acceptance among classmates increased for children in the GBG condition compared to

children in the control condition. Moreover, we expected that children who were subjected to an unsafe home environment benefitted exceptionally from improved acceptance among peers.

Method

Participants

In the early summer of 2004, 825 kindergarten children from 47 classes in 30 regular elementary schools were targeted for inclusion in a longitudinal study on children's social, behavioral and emotional development. The participating schools were located in two urban areas and one rural area in the Netherlands. Children were eligible for inclusion if they transitioned from kindergarten to first grade (n = 750) or if they entered a participating classroom (n = 111; total N = 861) in first grade. Signed parental informed consent for participation in the study was obtained for 88% of these children, resulting in a total sample of 759 participants.

In the present study, only children who had data for two or more assessments (i.e., at least two out of three out assessment waves) were included in the present sample (N = 554, 73% of the total sample; 51% boys, mean age 6.0 years (SD = 0.42) in kindergarten). The sample was ethnically diverse: 64% of the children were from a Dutch/Caucasian background, 11% were Moroccan, 9% were Turkish, 4% were Surinamese, 4% were from the Netherlands Antilles and 8% were from other non-western ethnical backgrounds. Twenty-nine percent of the children came from low socioeconomic status (SES) households, which is largely comparable to the general Dutch population (32% low SES; Statistics Netherlands, 2013). Inclusion in the present study was not related to intervention condition, sex or levels of family risk factors. However, included children had somewhat lower levels of conduct problems (F(1, 647) = 15.41, p < .001, η^2 = .02) and somewhat higher levels of peer acceptance (F(1, 754) = 6.41 p < .05, η^2 = .01) at baseline when compared to excluded children. Noe that effects sizes for these differences were very small.

Design

The study protocol was approved by the Medical Ethical Committee of the Erasmus University Medical Center (protocol number MEC 199.979/2001/53). Before implementing the GBG program, the study-coordinator randomly assigned participating schools to one of two conditions: (a) the Good Behavior Game, Dutch: Taakspel (GBG; 65% of the present study; Dolan, Jaylan, Werthamer, & Kellam, 1989; Van der Sar & Goudswaard, 2001) or (b) a control condition in which teachers continued their typical teaching curriculum. Teachers rated conduct problems annually at three measurement moments: 0) spring of kindergarten, 1) spring of first grade, and 2), spring of second grade. Peer acceptance was assessed through peer-nominations in the spring of first and second grade. Data on family risk factors and household SES were collected when children were approximately 7 years old (i.e., in first grade of elementary school). It is important to note that the study period for GBG-effectiveness lasted two years (first and second grade). After the second grade of elementary school, all participating schools were allowed to implement the GBG and this was no longer monitored by our research team.

Good Behavior Game (GBG)

The GBG is a classroom-based preventive intervention aimed at creating a safe and predictable classroom environment by promoting adaptive, prosocial classroom behavior. Positively formulated classroom rules are chosen together by the teacher and the students. To facilitate positive peer interactions, teachers assign children to small teams, equally composed of children who find it difficult to follow classroom rules and children who experience no such difficulties. In order to create these teams, teachers assessed children's behavioral problems through classroom observations. Observation forms are part of the GBG implementation protocol. Team members are encouraged to work together and behave according to classroom rules. All teams receive a set of cards at the beginning of the game-period during which children

attend to regular school tasks (e.g., during instruction). Each time a member violates a rule, the teacher takes a card away from that team, thus providing a consistent, non-emotional response or cue to 'bad' behavior. Teams as a whole are rewarded (e.g., by extra leisure time) when at least one card remains at the end of the game-period. Game-periods lasted between 10 and 60 minutes, building up from shorter to longer game-periods once the children got to know the game better. During and after the game, compliments are given to the students and teams when children behave appropriate.

The GBG was implemented in three phases, according to the manual's instructions: 1) introduction phase, in which the GBG was played three times per week for 10 minutes to become familiar with the game; (2) expansion phase, in which duration of playing, settings and targeted behaviors were expanded, and rewards were postponed; (3) generalization phase, where the teacher explained that GBG rules apply outside the GBG. In the generalization phase prosocial behavior was promoted also at times when the GBG was not played, rewards became more often intangible and were given after a longer game period, and the game was not specifically announced beforehand. In the expansion and generalization phase the GBG was played during different activities, and GBG classroom rules were adjusted to the particular activity when needed. All three phases were implemented in both intervention years. In the second intervention year, teachers moved more swiftly to the expansion and generalization phase, as the class was already familiar with the game.

Teachers received three afternoons of training each year, and licensed GBG supervisors visited the classrooms ten times for in-class supervision. The supervisors observed the teachers in their use of the elements of the GBG, such as having the positively formulated class-rules visible before starting the game, announcing the beginning and ending of the game and giving compliments during and after the game. The supervisors provided teachers with feedback and when needed they motivated teachers in moving on with the implementation of the program.

Measures

School assessments

Conduct problems were assessed annually from kindergarten to second grade with the Problem Behavior at School Interview (PBSI; Erasmus M. C., 2000). The PBSI is a 39-item face-to-face interview, in which teachers rated pupils' behavior on a 5-point Likert-scale ranging from 0 (never applicable) to 4 (often applicable). Trained research-assistants interviewed teachers face-to-face. Conduct problems were assessed by 12 items (range α over the assessments = .88 - .92; e.g., "starts fights", "destroys other's belongings, "curses/swears"). Item scores per scale were averaged, resulting in a scale score ranging from 0 to 4.

Peer acceptance scores were obtained in first and second grade through peer-nominations, administered one-on-one at the participants' schools by trained research-assistants. The nomination protocol was partially based on the procedure described by Coie, Dodge and Copotelli (1982). Children were asked to nominate an unlimited number of classmates whom they liked most, divided by the total number of children in the classroom minus one (children could not nominate themselves). Scores ranged from minimum 0 to maximum 1 (0 = not nominated as "liked most" by any of the classmates, 1 = nominated as "liked most" by all classmates).

Home assessments

Maternal depressed mood was assessed with the subscale "Depressed Mood" of the K10 scale, which is a short screening device designed to monitor population prevalence of psychological distress (Kessler et al., 2002). The questionnaire included 3 items (e.g., "How often do you feel depressed?"; α = .84), rated on a 5- point Likert-scale (0 = never; 4 = always). Items were averaged to create a total scale ranging from 0 to 4. The psychometric properties of the K10 have previously been evaluated as "good" (Kessler et al., 2002).

Maternal delinquency was assessed using five questions on delinquent behavior (i.e., in the past two years have you: "threatened someone?", "received something that you knew to be stolen?", "made false statements to the tax authority?", "made false statements to a social security/benefits agency?", and "have you ever been arrested by the police?"). The questionnaire was adapted from self-report measures of delinquency from previous studies (D. S. Elliott & Ageton, 1980; Zwirs et al., 2012). The first four items were rated on a 5-point Likert-scale (0 = never, 4 = six or more times); the last item was dummy coded as 1 = yes and 0 = no. Items were standardized and averaged to calculate a total scale. Internal consistency of the total scale was $\alpha = .67$.

Parenting stress was assessed using the "Parent Domain" of the Nijmegen Parenting Stress Index (PSI; De Brock, Vermulst, Gerris, & Abidin, 1992). Mothers rated 11 items (e.g., "Being a parent to this child is more difficult than I thought"; $\alpha = .75$) on a 6-point Likert scale ranging from 0 (completely disagree) to 5 (completely agree). Items were averaged to create a total scale ranging from 0 to 5. The psychometric properties of the Dutch version of the PSI have previously been evaluated as "acceptable to good" (De Brock et al., 1992).

Abusive disciplining was assessed with 1 item (i.e., "how often do you hit your child with a belt, switch or other object when he/she has done something wrong?") from the subscale "corporal punishment" of the Alabama Parenting Questionnaire (APQ; Shelton, Frick, & Wootton, 1996). Note that the other items of this scale assess corporal punishment strategies that are generally not considered to be abusive (e.g., spanking), and were therefore not included in the abusive disciplining measure. The item was rated on a 5-point Likert scale (0 = never, 4 = always). The psychometric properties of the APQ have previously been evaluated as "good" (Dadds, Maujean, & Fraser, 2003; Shelton et al., 1996).

Intervention status was dummy coded as 0 = control group; 1 = intervention group.

Children's sex was dummy coded as 0 = female, 1 = male.

Household socioeconomic status (SES) was measured through the target child's parental occupation in first grade. Father's and mother's occupations were then classified into one of five levels (0 = unemployed, 1 = elementary, 2 = lower, 3 = medium, 4 = higher). Levels of occupation was assigned according to the Dutch Working Population Classifications of Occupations Scheme (Statistics Netherlands, 2001), which is based upon the International Standard Classification of Occupations (ISCO; International Labour Organization, 1987a; 1987b). The highest household occupation level (from father or mother) counted as "household socioeconomic status". Household SES was then dummy coded as 0 = medium to higher SES, 1 = unemployed to lower SES.

Statistical Approach

To test our first hypothesis on possible moderation of the overall GBG effect by risk factors within the home environment, a three-level growth model with variation across time (level 1), variation across individuals (level 2) and variation across classrooms (level 3), was fitted. After testing for main effects of the GBG, we tested whether individual variation in levels of home environment risk moderated the effect of the GBG on the development of conduct problems. To this end, a random slope parameter was specified, in which the individual slope parameter was regressed on family risk level (each moderator separately). The random slope parameter was regressed on intervention status (classroom-level variable), to reflect a cross-level (classroom-to-individual level) interaction variable. A significant effect of intervention status on this random slope parameter indicates that GBG impact on the growth parameters of conduct problems depends on exposure to risk factors within the home environment.

To test our second hypothesis on possible moderation of GBG impact on the development of conduct problems via improvements in peer acceptance, a mediation model was fitted. Because our aim was to test whether individual level differences of GBG impact on

peer acceptance within classrooms mediated conduct problem development, we used a two-level latent growth model (1 = time, 2 = individual level). Second-grade peer acceptance was regressed on intervention status and on first-grade peer acceptance to test for improvements in peer acceptance associated with GBG participation. The slope parameter of conduct problems was regressed on second grade peer acceptance (see Figure 6.1).

To test for moderation of the indirect effect via peer acceptance we added three two-way interactions, being: GBG x moderators (see Figure 6.1, paths 1 and 2) and peer acceptance x moderators (see Figure 6.1, path 3; Preacher, Rucker, & Hayes, 2007). Moderation of the mediation pathway implies that the mediation pathway is stronger for one group (e.g., at-risk children) than for the other group (e.g., children not at risk). That is, at least one of the paths that form the total mediation pathway (e.g., GBG to peer acceptance and/or peer acceptance to the slope of conduct problems), should be moderated by risk status. Note that in this situation it is likely (but not necessary) that the direct effect of GBG on the slope of conduct problems (Figure 1, path 1) is also stronger for one group compared to the other group and hence is moderated too. Variables that were used to calculate interaction terms were z-standardized. Standard errors were adjusted for the nesting of conditions within classrooms by using a sandwich estimator (Williams, 2000a). We controlled for potential level differences in conduct problems at baseline due to differences in home environment risk, by regressing the intercept of conduct problems on the moderators.

In all models, path estimates were controlled for children's sex and household SES. Models were tested for each moderator separately. Models were fitted in Mplus 7.31 (L. K. Muthén & Muthén, 1998-2015). Missing data was handled using Full Information Maximum Likelihood estimation (FIML). Model fit was based on the Comparative Fit Index (CFI), with values $< .90$ indicating poor fit and values $\geq .95$ indicating adequate fit (Bentler, 1990; Hu & Bentler, 1999), and the Root Mean Square Error of Approximation (RMSEA), with values $\leq$

.08 indicating acceptable fit (Marsh et al., 2004). The significance of the indirect pathways from intervention status to conduct problem development via peer acceptance was estimated using the 95% confidence interval (95% CI) bootstrap resampling method (n = 10.000) for complex (i.e., clustered) data (Asparouhov & Muthén, 2010b).

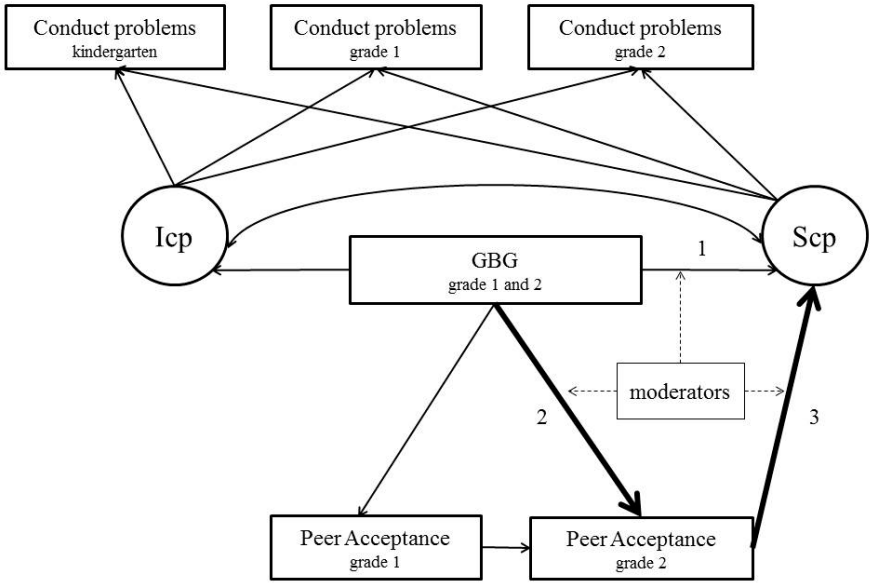

Figure 6.1. Graphical model representation. Mediation paths are shown in bold lines. Moderation is indicated by dashed arrows. Path 1 represents the direct effect of the GBG. Paths 2 and 3 together form the mediation pathway in which path 2 represents the first part of the mediation pathway and path 3 represents the second part of the mediation pathway. Paths 1, 2, and 3 together represent the total GBG effect (i.e., mediation plus direct effect).

Results

Descriptive Analyses

Table 6.1 shows means, standard deviations and results of mean difference testing for GBG) and control group children. There were no differences between these two groups in mean levels of conduct problems in kindergarten and first grade or in peer acceptance in first grade. However, in second grade, children in the GBG group had lower levels of conduct problems and higher levels of peer acceptance than control children. No differences between GBG and control group children were found in levels of maternal delinquency, abusive disciplining and

parenting stress. However, mothers of intervention children reported somewhat lower levels of depressed mood than mothers of control children.

Table 6.1

Means, SDs and Difference Tests of Study Variables in the Intervention versus Control Group

	GBG		Control		Test	
	M	*SD*	*M*	*SD*	*F*	η^2
Conduct problems kindergarten	0.56	0.56	0.49	0.55	2.13	.00
Conduct problems grade 1	0.51	0.51	0.60	0.59	3.29	.01
Conduct problems grade 2	0.42	0.53	0.63	0.63	16.38***	.03
Peer acceptance grade 1	0.25	0.16	0.24	0.15	1.45	.00
Peer acceptance grade 2	0.35	0.18	0.28	0.17	17.35***	.03
Maternal delinquency	-0.03	0.54	0.09	0.96	1.91	.01
Maternal depressed mood	0.33	0.54	0.57	0.73	9.71**	.03
Abusive disciplining	0.08	0.31	0.07	0.31	0.16	.00
Parenting stress	0.84	0.69	0.96	0.74	2.51	.01

Note. ** p <.01, *** p <.001.

Correlations between study variables are in Table 6.2. Throughout the study period, peer acceptance correlated significantly and negatively with conduct problems. Furthermore, in general the home environment risk factors were, in general, positively associated with conduct problems and negatively with peer acceptance. However, these correlations were always small in magnitude and not always significant (see Table 6.2).

Table 6.2

Correlations between Study Variables

	Variable	1	2	3	4	5	6	7	8
1	Conduct problems kindergarten	-							
2	Conduct problems grade 1	.49**	-						
3	Conduct problems grade 2	.44**	.58**	-					
4	Peer acceptance grade 1	-.25**	-.24**	-.21**	-				
5	Peer acceptance grade 2	-.30**	-.37**	-.29**	.55**	-			
6	Maternal delinquency	-.09	-.04	.01	.06	.02	-		
7	Maternal depressed mood	.08	.11	.21**	-.08	-.09	.18**	-	
8	Maternal abusive disciplining	.15**	.16**	.13**	-.06	-.10*	.10	.03	-
9	Maternal parenting stress	.12*	.11*	.12*	-.12*	-.18**	.18**	.28**	.22**

Note. $^{*}p < .05$, $^{**}p < .01$.

GBG Impact on Conduct Problem Development: Moderation by Family Risk Factors

A three-level LGM was fitted in which main effects of the GBG on the development of conduct problems was tested. The negative estimate of the GBG parameter on the slope of conduct problems indicates that children in the intervention group showed reduced growth in conduct problems compared to children in the control condition (see Table 6.3). In fact, as is also illustrated by the means in Table 6.1, average levels of conduct problems decreased over time for children in the GBG group (B = -.08, SE = .04, p = .05) and remained stable for children in the control condition (B = .07, SE = .05, p = .13). The magnitude of the difference in change between GBG and control group children from kindergarten to second grade change in levels of conduct problems was of moderate magnitude (Cohen's d = 0.50; Cohen, 1988).

We then investigated whether family risk factors affected the impact of the GBG on the slope parameter of conduct problems, by testing for cross-level moderation. We specified random slopes in which the within-level growth parameters of conduct problems were

regressed on the moderators (each moderator in a separate model), and subsequently regressed these random slopes on the between-level intervention status factor. None of the links between GBG and the random slopes were significant (all *p*s ≥ .16; data not presented in a table, but available from the first author). These non-significant estimates indicate that - although GBG children as a whole had reduced growth in conduct problems when compared to controls – the reductions in conduct problems among GBG children were not affected by family risks.

Table 6.3

Direct Effects of the GBG Intervention on the Development of Conduct Problems

	Intercept conduct problems		Slope conduct problems	
	B	*SE*	*B*	*SE*
Within level				
Sex	0.33**	0.04	-0.03	0.02
Low SES	0.21**	0.06	-0.05	0.03
Between level				
Factor mean	0.54**	0.04	0.01	0.04
Factor intercept	0.50**	0.05	0.09*	0.04
GBG	0.06	0.07	-0.12*	0.05

Note. $N = 554$. χ^2 (7) = 4.82, $p = .68$; CFI = 1.000; RMSEA = 0.00; $^{*}p < .05$, $^{**}p < .01$.

In order to obtain factor means for children when household SES and sex were at mean level, estimates for factor means are from a conditional model with z-standardized control variables.

Moderation of the Indirect Effect of GBG on Conduct Problems, via Peer Acceptance

Although the overall GBG effect was not moderated by family context risk, it may nonetheless be that the indirect path via peer acceptance (i.e., that part of conduct problem development that is affected by improved peer acceptance) is moderated by family context risks. This was therefore tested next.

Results for the overall group are in Figure 6.2. These show that when specifying peer acceptance as a mediator, the indirect path from GBG to the slope of conduct problems via peer acceptance was significant. This indicates that the GBG intervention reduced the development of conduct problems via improvements in peer acceptance.

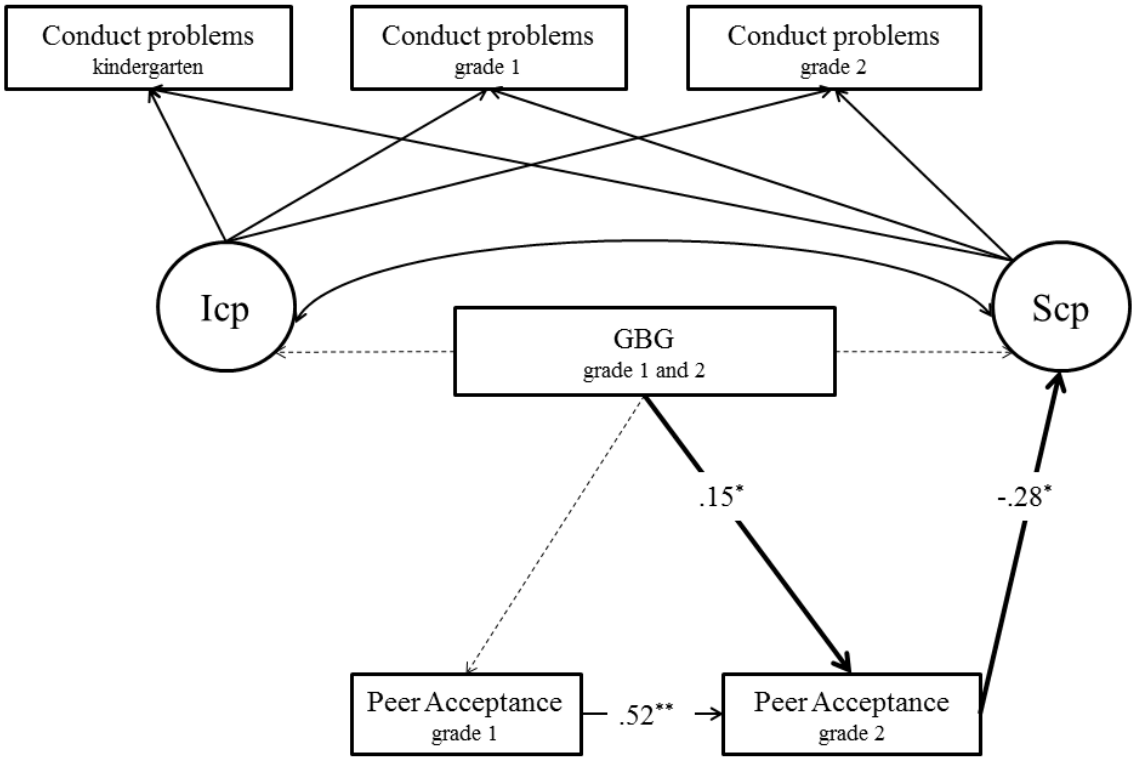

Figure 6.2. Mediation model results. Coefficients are standardized estimates. $N = 554$. χ^2 (11) = 32.39, $p < .001$; CFI = .93; RMSEA = .06. $^{*}p < .05$, $^{**}p < .01$. Indirect effect: $B = -.01$ [95% CI of $B = -.035 – -.003$], $SE = .01$, $\beta = -.04$, $p < .05$.

We then tested whether family risk factors moderated the indirect GBG effect on the development of conduct problems, via peer acceptance. We found that maternal depressed mood and parenting stress did not moderate the indirect pathway. However, significant moderation effects on the indirect pathway were found for maternal delinquency and maternal abusive disciplining.

Table 6.4

Moderating Effects of Family Risk Factors on Peer Acceptance and the Development of Conduct Problems

	Improved Peer Acceptance			Slope Conduct Problems		
	β	*B*	*SE*	β	*B*	*SE*
Maternal depressed mood						
GBG	.15	.31*	.13	-.33	-.13	.07
Peer acceptance	-	-	-	-.27	-.04**	.01
Depressed mood	-.02	-.03	.08	.09	.02	.03
GBG x depressed mood	.00	-.00	.10	.09	.01	.02
Peer acceptance x depressed mood	-	-	-	-.13	-.02	.02
Maternal delinquency						
GBG	.15	.31*	.13	-.34	-.12	.07
Peer acceptance	-	-	-	-.27	-.04**	.02
Delinquency	.02	.02	.02	.18	.03**	.01
GBG x delinquency	-.02	-.03	.08	.14	.04*	.02
Peer acceptance x delinquency	-	-	-	-.26	-.04**	.01
Maternal abusive disciplining						
GBG	.15	.32**	.12	-.35	-.12	.07
Peer acceptance	-	-	-	-.28	-.05**	.01
Abusive disciplining	-.01	-.01	.03	-.35	-.06**	.02
GBG x abusive disciplining	-.07	-.10*	.04	.25	.05*	.03
Peer acceptance x abusive disciplining	-	-	-	-.16	-.03*	.01
Maternal parenting stress						
GBG	.15	.31*	.12	-.36	-.12	.07
Peer acceptance	-	-	-	-.27	-.04**	.01
Parenting stress	-.08	-.08	.12	-.22	-.04	.02

GBG x parenting stress	-.04	-.06	.08	.16	.03	.02
Peer acceptance x parenting stress	-	-	-	.00	.00	.02

Note. Coefficients are estimates from latent growth curve analyses. Improved peer acceptance = second grade peer acceptance controlled for first grade peer acceptance. Estimates are controlled for children's sex and household SES. $^{*}p < .05$, $^{**}p < .01$.

Results in Table 6.4 indicate that maternal delinquency moderated the association between peer acceptance and the slope of conduct problems (second part of the mediation path) and between the intervention status and the slope of conduct problems (direct path, i.e., that part of the GBG effect that is not explained by improved peer acceptance). These significant interactions were probed by estimating effects of intervention status on second grade peer acceptance and of peer acceptance on the slope of conduct problems with maternal delinquency being high (M + 1 SD) and maternal delinquency being low (M – 1 SD; Holmbeck, 2002).

Findings showed that for children whose mothers reported high levels of delinquency, peer acceptance mediated the link between intervention status and conduct problem development (B = -.02 [95% CI of B = -.046. – -.005], SE = .01, β = -.06, $p < .05$). Specifically, for these children, the GBG intervention increased their acceptance among peers in second grade relative to their first grade peer acceptance levels (B = .31, SE = .13, β = .15, $p < .05$). Furthermore, improved peer acceptance predicted a decrease in conduct problem development (B = -.07, SE = .02, β = -.40, $p < .001$), and the direct effect of the GBG on conduct problem development was no longer significant (p = .15).

In contrast, for children whose mothers reported low levels of delinquency, peer acceptance did not mediate the link between intervention status and conduct problem development (B = -.01 [95% CI of B = -.035. – .001], SE = .01, β = -.03, p = .20). Specifically, similar to children whose mothers reported high levels of delinquency, the GBG increased acceptance among peers for children of mothers who reported low levels of delinquent behavior

(*B* = .31, *SE* = .13, β = .15, *p* < .05). However, unlike for children with mothers who showed high levels of delinquency, improved peer acceptance for children with low levels of maternal delinquency was unrelated to the development of conduct problems (*p* = .10). Lastly, as was the case for children of mothers with high levels of delinquency, the direct effect between the GBG and conduct problem development was not significant for children whose mothers had low levels of delinquency (although a trend was observed, *p* = .07). See Figure 6.3 for an illustration of the interaction effect between improved peer acceptance and conduct problem development for children with mothers who had high versus low levels of delinquency.

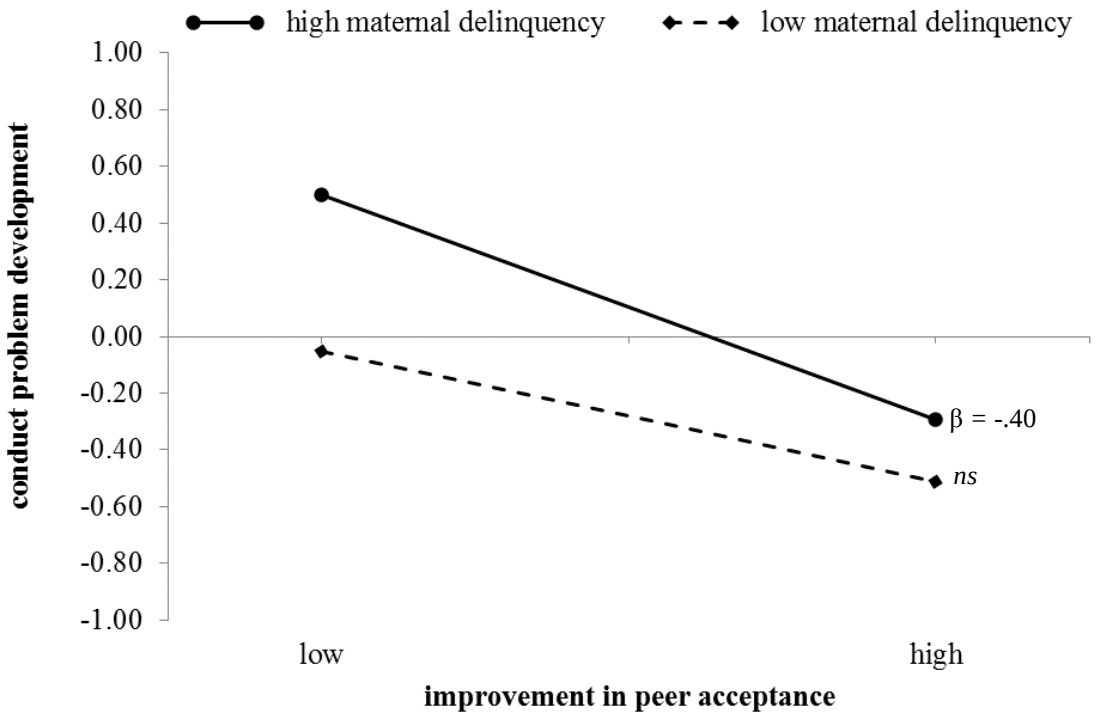

Figure 6.3. Association between improvements in peer acceptance in second grade compared to first grade levels and the slope parameter of conduct problems for children of mothers with high levels of delinquency (*M* + 1 SD) and children of mothers with low levels of delinquency (*M* – 1 SD). Slope parameter values > 0 imply an increase in conduct problems, values < 0 imply a decrease in conduct problems. Children's intervention status, sex and household SES variables were Z-standardized with *M* = 0, *SD* = 1 for this Figure to obtain estimates for children of mothers with low/high delinquency when all other variables were at mean level.

For abusive disciplining, all three two-way interactions were significant. That is, abusive disciplining moderated the association between intervention status and peer acceptance (i.e., the first part of the mediation path), the association between peer acceptance and conduct problem development (i.e., the second part of the mediation path), and the association between intervention status and conduct problem development (i.e., the 'left over' direct effect).

Probing of interaction effects indicated that peer acceptance mediated the link between intervention status and conduct problem development for children whose mothers had high levels of abusive disciplining (B = -.02 [95% CI of B = -.045 – -.005], SE = .01, β = -.06, p < .05). Specifically, for these children, the GBG increased their peer acceptance (B = .32, SE = .12, β = .15, p < .01), and this improved acceptance among peers decreased the development of conduct problems (B = -.07, SE = .01, β = -.40, p < .001). Furthermore, the direct effect between the GBG and conduct problem development was not significant for children with mothers who engaged in high levels of abusive disciplining (p = .17).

For children whose mothers showed low levels of abusive disciplining, peer acceptance did not mediate the link between intervention status and conduct problem development (B = -.01 [95% CI of B = -.038. – .002], SE = .01, β = -.04, p = .16). Specifically, for these children, intervention status was significantly associated (and slightly stronger than for children with mothers with high abusive disciplining) with improved peer acceptance (B = .41, SE = .14, β = .19, p < .01), but peer acceptance was not associated with the development of conduct problems (p = .10). In fact, intervention status was directly associated with a reduced development of conduct problems (B = -.15, SE = .07, β = -.43, p = .05). Note that this latter association is the part of the total GBG effect that is not explained by the mediator "improved peer acceptance". See Figure 6.4a for an illustration of the significant interaction effect between abusive disciplining and intervention status on peer acceptance and see Figure 6.4b for the interaction between abusive disciplining and peer acceptance on the slope of conduct problems.

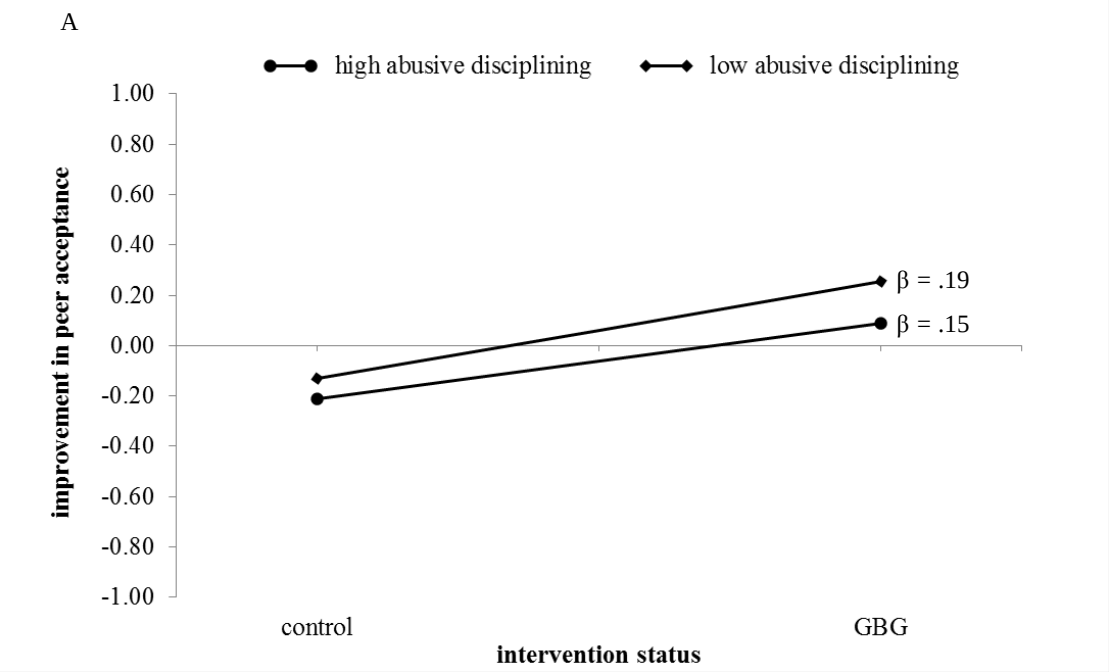

Figure 6.4a. Association between intervention status and improvement in peer acceptance in second grade compared to first grade levels for children of mothers with high levels of abusive disciplining (*M* + 1 SD) and children of mothers with low levels of abusive disciplining (*M* – 1 SD). Values > 0 imply an increase in peer acceptance, values < 0 imply a decrease in peer acceptance. Control variables were Z-standardized with *M* = 0, *SD* = 1 for this Figure, to obtain estimates for children of mothers with low/high abusive disciplining when all other variables were at mean level.

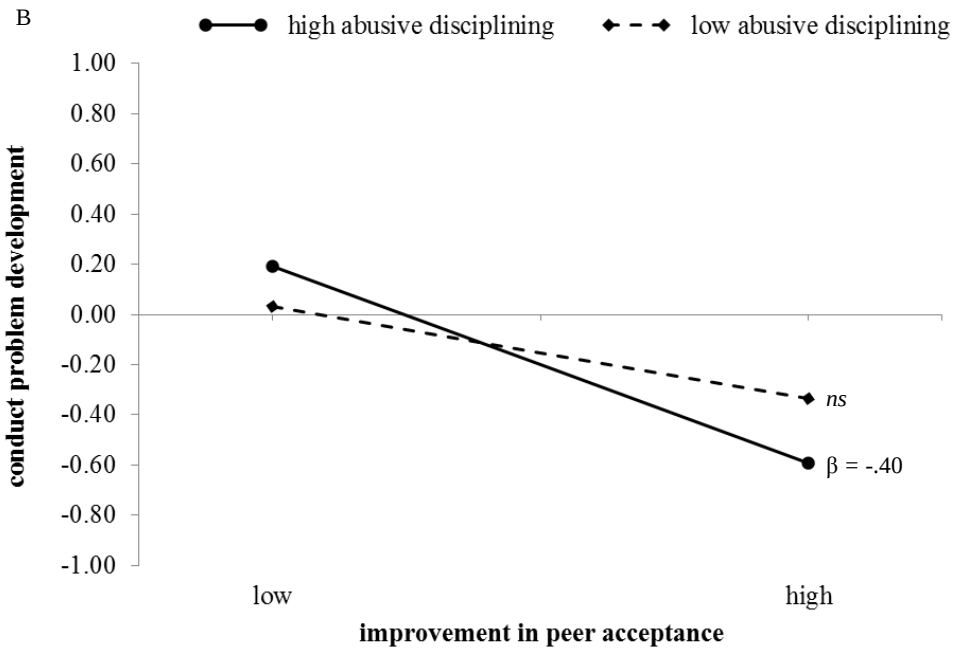

Figure 6.4b. Association between improvements in peer acceptance in second grade (compared to first grade levels) and the slope parameter of conduct problems for children of mothers with high levels of abusive disciplining (*M* + 1 SD) and children of mothers with low levels of abusive disciplining (*M* – 1 SD). Values > 0 imply an increase in conduct problems, values < 0 imply a decrease in conduct problems. Control variables were Z-standardized with *M* = 0, *SD* = 1 for this Figure, to obtain estimates for children of mothers with low/high abusive disciplining when all other variables were at mean level.

Discussion

The current study used a longitudinal randomized controlled design to test whether children at risk for conduct problem development in elementary school due to problems within their home environment, would benefit more from the GBG intervention compared to children not at risk through factors within their family context. Furthermore, we tested whether this potential differential effect of the GBG on conduct problem development for children at risk versus not at risk, would be explained by improvements of peer acceptance. We found that children who received in the Good Behavior Game (GBG) intervention showed on average a decrease in their level of conduct problems from kindergarten to second grade, while for children in the control group their levels of conduct problems remained stable. However, in

contrast to our first hypothesis, this GBG effect was not affected by mother-reported levels of their own depressed mood, delinquency, parenting stress or abusive disciplining. Nevertheless, when peer acceptance was added to the model as a potential mediating factor explaining the GBG reductions in children's conduct problem development, two maternal risk factors did indeed affect the magnitude of this indirect pathway from GBG to conduct problem development via peer acceptance. That is, we found that improved peer acceptance explained why conduct problems decreased for children whose mothers reported delinquent behaviors and for children whose mothers reported to engage in abusive disciplining. Although conduct problem development was also reduced for children in the intervention condition who were not exposed to these externalizing maternal risk factors, GBG-improved peer acceptance was not the explanatory factor for the reduced conduct problem development for these children. Mothers' internalizing problems (i.e., parenting stress and depressed mood) did not influence the association between the improved peer acceptance and decreased conduct problem development.

The findings of this study suggest that children who encounter certain risk factors within the home context are particularly susceptible to a positive peer/classmate-environment. Children with abusive or delinquent mothers are likely to experience a suboptimal, and perhaps even unsafe, home environment. Our result thus suggest that for these children, providing a safe classroom environment in which positive peer relations are facilitated, may compensate for the unsafe or problematic home situation. This may ultimately result in reductions in conduct problems in these children. Furthermore, the findings of this study suggest that this may go both ways. That is, for children from at-risk home environments who were in the control condition, their – lower levels of – peer acceptance were associated with increased levels of conduct problems when compared to their at-risk GBG counterparts. These findings

are in line with Ladd (2002) who explained that children's relations with peers may make up for what their home-context may fail to provide.

It is important to note that our evidence for the positive effect of peer acceptance on children's conduct problem development comes from a randomized controlled trial. The use of randomized controlled design is an important step forward for the uncovering of potential causal effects (Rutter, 2007). By using a randomized controlled design in which the peer-environment was manipulated, we proceed previous correlational and longitudinal observations that have supported the alleged role of peer relationships in conduct problem development (e.g., Ladd, 2006). Our results thus strengthen the role of peer acceptance in the development of conduct problems in early elementary school children. It also showed that this role of peer acceptance may be limited to children at risk. Only among those children who were at potential risk for transferring negative behavioral styles and interactions learned from their mothers at home to other social contexts such as the classroom, was improved peer acceptance linked to reduced conduct problem development. Although an important step forwards, from our findings we cannot definitely imply a causal role of peer acceptance in the development of conduct problems. Other, non-included factors that may have been affected by the GBG, such as classroom climate may have accounted for the found effects.

Children who at baseline were not at risk for psychosocial maladjustment due an at-risk home environment, also showed a reduction in conduct problem development when receiving the GBG intervention. However, providing a safe classroom-environment with positive peer relations was not the explanatory process for these children. Perhaps other key elements of the GBG could be alternative explanations of its effectiveness in reducing conduct problems for these children not at risk. For example, Embry (2002) provides an overview of elements of the GBG that were most efficacious in promoting positive classroom behavior and found that the division of classes into teams, the GBG's focus on non-emotional cueing for "bad" behavior

(i.e., removing a card from the team without giving negative attention, such as scolding the child, to negative behavior), positive consequences for a team winning the game and a low threshold for winning the GBG, were key effective components of the GBG that were linked to reductions in behavioral problems for normative elementary school children. In contrast to our expectations, our results showed no differential effects for maternal depressed mood or parenting stress. Perhaps depressive symptoms or parenting stress as measured in this study did not affect the child's perception of a safe home-climate to a similar extent as does the exposure to maternal delinquent and abusive behaviors. This possibility needs to be studied with a more in depth investigation of how the children perceived their home environment.

Lastly, contributing to previous studies (see overviews by Embry, 2002; Nolan et al., 2013; Tingstrom et al., 2006), our findings underline the effectiveness of the GBG at reducing children's conduct problem development. More importantly, our study shows that this classroom-based intervention program is effective in reducing conduct problem development for both children from low and higher risk home environments, thereby underlining its *universal* applicability. However, our study shows that one of the possible underlying processes explaining the GBG's effectiveness on reducing the development of conduct problems, that is, improvements in peer relations, only holds for children who are at risk for psychosocial maladjustment at baseline due to family risk factors. These results are in line with previous studies by Leflot and colleagues (2013) and Menting and colleagues (2014) who found that only children at risk due to child personal factors benefitted from improvements in peer acceptance. This study extends these previous studies by showing that the same may apply to children growing up in an at-risk home environment.

Limitations and Implications

The current study has potential limitations. First of all, we utilized a convenience sample of children in schools who were willing to participate in the randomized controlled

study. Therefore, results may not generalize to the broader Dutch population. A second limitation is the use of teacher-reported conduct problems, while teachers also implemented the GBG. This limitation may be mitigated as we also used peer-nominations of acceptance. Although children were aware of playing the GBG, we think it is unlikely that the nominations of peer acceptance were biased because of these 6 – 7 year old children's knowledge of their intervention status. However, the teachers' perceptions of children's conduct problems might be influenced because they were not blind to the condition. Future studies might want to investigate the alleged role of the GBG in reducing children's behavioral problems using a blind design with observers who are unaware of children's condition. Third, it is widely acknowledged that the association between peer acceptance and behavioral problems is reciprocal (e.g., see Rubin, Bukowski & Parker, 2006), with more peer acceptance predicting less behavioral problems and less behavioral problems predicting more peer acceptance. Therefore, it may as well be that the GBG improved children's acceptance among peers, because of their GBG-improved behavior. Actually, given the previously mentioned reciprocal associations between per acceptance and behavioral problems, this is very likely. However, the GBG is more focused on promoting positive peer-relations and on-task behavior, than on reducing conduct problems per se. In addition and more importantly, our main conclusion (i.e., that at-risk children benefit exceptionally from a positive classroom environment that scaffolds positive relationships with peers) remains similar, regardless whether the association between peer acceptance and conduct problems is reciprocal. Fourth, our study focused on maternal psychopathology and maternal reported parenting risk factors within the children's home-context. Future studies should also include measures of paternal psychopathology and father-child relationship problems to assess whether fathers are similarly influential as mothers.

Despite these potential limitations, our findings have implications for future researchers and practitioners. Conduct problems decreased as children's social relations improved, and

therefore it is essential that any intervention program aimed at reducing conduct problems in children incorporates a peer-relationship component. Our results also imply that low peer acceptance in combination with living in a high-risk home environment is an important early marker for later conduct problems development. Therefore, screening for children at risk for conduct problems should start early, at or even before elementary school entry and should also include an assessment of risk factors within children's home-context. Moreover, during the first years of elementary school, teachers should monitor children's acceptance among classroom peers as low acceptance is strongly linked to conduct problem development. Lastly, theoretical considerations and developmental models of conduct problem development should take into account the role of children's social relationships with peers as well as the delinquent behavior and abusive parenting style of children's mothers, as these are important explanatory factors of why and for whom conduct problems might occur.

7

General Discussion

Children and adolescents who engage in externalizing behaviors, such as oppositionality, aggression, and property violations are of great concern to their parents, teachers and the society at large. Not only may their behaviors impact others (Anderson, 2008; R. D. Duncan, 1999; Friedman, 1995; Romeo et al., 2006), engaging in externalizing behavior is also harmful for the perpetrators themselves. This because it puts them at risk for a broad spectrum of concurrent and later mental health problems, substance abuse, academic failure, criminality and societal dropout (Fergusson et al., 2009; Heron et al., 2013; Kretschmer, Hickman, et al., 2014; Maughan et al., 2014). Therefore, understanding externalizing behavior development is a matter of uttermost importance.

Previous theoretical considerations as well as empirical studies indicated that the manifestation of externalizing behavior should be understood as a developmental process in which children's (adverse) personal endowments and their (adverse) social environments become intertwined, influencing and aggravating each other over time and thereby setting the stage for the development of a broad spectrum of externalizing and related problems (Dodge & Pettit, 2003; Granic & Patterson, 2006). However, many of the previous studies aimed at investigating this interplay focused on the interplay between children's personal endowments and rather extreme and manifest experiences in the home and peer-context such as being maltreated by parents or being victim of bullying (DiLalla et al., 2015; Ouellet-Morin et al., 2016). The potential influence of subtler factors in children's social environments that may be influential has been studied less. That is, a priori less than optimal appreciation among peers or limited involvement of parents may not be considered extremely adverse, or overt risk factors for the developing child. However, these are conditions to which many more children are exposed than to the more severe conditions mentioned above, and therefore of potential importance for the mental health of many children in society. Moreover, if experienced on a daily basis and for the most part of the week, such factors may become important influences

on children's development especially in interaction with liabilities in the child's personal characteristics. Therefore, the overall aim of the present thesis was to increase the understanding of how differences in children's personal endowments (in the present thesis we focused on children's genetic make-up, temperament, personality and sex) as well as their daily home and peer environment, work together in explaining why some children (start to) engage in externalizing behaviors, while others do not. Furthermore, we aimed to understand which children in particular may be prone to developing externalizing and related problems. The studies in this thesis addressed three overarching questions:

1) First, we investigated several pathways of environmental mediation in order to understand the processes through which children develop, continue and aggravate in their externalizing behaviors. Specifically, we addressed the question to what extent children's daily experiences with peers may be relevant for understanding why children's personal vulnerabilities may become expressed in externalizing behavior via environmental mediation, environmental selection and social comparison processes. Furthermore, we tested to what extent children's daily experiences with peers may add to the continuation and aggravation of externalizing problems.
2) Second, we investigated environmental moderation in order to understand to what extent children with certain personal characteristics may be particularly prone to developing externalizing behaviors when exposed to negative daily home or classroom experiences. Specifically, we investigated to what extent children's negative daily home and peer environments may determine whether children who are potentially at risk for developing externalizing problems (e.g., due to their personal endowments), actually develop externalizing problems. And on a more positive note, to what extent children's positive daily home and peer environments may buffer against the development of externalizing behavior for children at risk.

3) Third, we investigated whether a positive peer environment may make up to what the home environment fails to provide. Specifically, we investigated to what extent the facilitation of children's acceptance among peers in the classroom through a preventive intervention program may protect them against developing externalizing behavior problems, and whether the protective effect of increased peer acceptance may differ for children who experienced a more negative daily home environment compared to children who experienced a less negative daily home environment.

HOW MAY CHILDREN'S PERSONAL VULNERABILITIES MAY BECOME EXPRESSED IN EXTERNALIZING BEHAVIORS?

The developmental association between children's personal endowments and later externalizing behavior may be explained through the influence of these personal endowments on the social environment that the children encounter (e.g., see Shiner & Caspi, 2003). In the present thesis, we referred to this general mechanism as 'environmental mediation'. Our social-environmental factor of interest was children's peer environment. We tested three potential explanatory pathways: the *environmental elicitation pathway*, the *environmental selection pathway* and the *social comparison pathway*. We hypothesized that children at risk for the development of externalizing behavior because of their personal endowments *elicit* or *select* certain (negative) peer environments. We expected that this, in turn, may then set the stage for the development, continuation and aggravation of externalizing and related problem behaviors (chapter 2 and chapter 3). Furthermore, we hypothesized that children's personal endowments may influence how they compare themselves with their peers. We expected that if this social comparison process resulted in an overestimated social self-perception, this may too set the stage for the development and escalation of externalizing behaviors (chapter 2).

Evidence for environmental mediation through environmental elicitation

Results presented in chapter 2 and chapter 3 show support for our hypothesis that the development of externalizing behaviors can be understood – in part – via the process of environmental elicitation. This indicates that children may (unintentionally) evoke certain (negative) responses from their peers because of their personal endowments (D. M. Buss, 1987), which may then result in developing increasingly more and more severe externalizing behavioral problems. Specifically, in chapter 2 we found that young children who were prone to reacting negatively to external stimuli (i.e., who had higher levels of the temperament trait 'negative emotionality') became less liked among their peers in their later childhood years. This poor social standing in the peer group was subsequently associated with more engagement in interpersonal violence, but with less engagement in illicit substance use, when they were adolescents. Hence, these children likely evoked poor appraisal from their peers (indicative of environmental elicitation), which then stimulated engagement in interpersonal violence, but protected them against using illicit substances.

Additional evidence for the environmental elicitation process is presented in chapter 3. In this chapter we did not specifically test whether children evoked negative peer appraisal based on their personal predispositions. Instead, we investigated whether children's (initially rather mild) behavioral problems evoked poor peer appraisal, which then resulted in an aggravation of this behavior towards more severe forms of externalizing behaviors. In this chapter, we found that children who scored higher on mild externalizing behaviors such as oppositional, negativistic and defiant behaviors at the start of elementary school, became relatively less liked among their peers in the following school years. This, in turn, predicted the development of more severe forms of externalizing behaviors, such as engagement in severe rule breaking behavior and aggression, one school-year later.

Oppositional behavior and the temperament trait negative reactivity are both conceptualized – in part – as problems of negative affect and negative emotionality (Burke, Hipwell, & Loeber, 2010; Shiner et al., 2012; Stringaris & Goodman, 2009). Empirical evidence supports this notion and shows that oppositional behavior and negative emotionality are closely related and likely share the same underlying genetic basis (Singh & Waldman, 2010). Furthermore, it is of importance to note that both of the environmental elicitation pathways presented in chapters 2 and 3 were found even when controlling for children's concurrent and ongoing behavioral problems. Children's social standing among peers thus added to the prediction of the development and aggravation of externalizing problems over time, above and beyond already existing problems of such nature. Results from chapters 2 and 3 combined show that not only may the elicitation of negative peer appraisal add to relative increases (i.e., in rank-order) in externalizing behavior and the continuation of such behaviors, it may also explain why externalizing behaviors may escalate from initially milder problems into more severe externalizing behaviors as children grow older.

On perhaps a more positive note it is important to mention that we did not only find risk effects of poor social preference. That is, we also found that low social preference seemed to protect children against using illicit substances. However, in light of others' notions that experimenting with illicit substances such as alcohol in the mid- to later adolescent years is rather normative and may even be a sign of healthy adolescent exploratory behavior instead of psychopathology (Rodgers et al., 2000), it remains to be debated whether this latter 'protective' effect should be regarded as a positive or a negative consequence of poor peer appraisal.

No evidence for environmental mediation through environmental selection or social comparison

In the present thesis, we found no support for our hypothesis that children's personal endowments may be linked to externalizing behavior development via environmental selection

or social comparison processes. That is, we found no evidence that certain temperamental characteristics predicted affiliation with a peer group that engaged in externalizing behaviors (i.e., environmental selection), nor did we find evidence that children's temperament traits may influence how they compare themselves with others (i.e., social comparison). In other words, peer social selection and comparison are not dependent on children's personal characteristics as measured in the present thesis. Note however that this by no means implies that environmental selection or social comparison processes play no role in explaining the development of externalizing behavior. In contrast, results from chapter 2 indicated that these two peer processes (i.e., affiliation with peers who engage in antisocial behavior as an indicator of an environmental selection process and overestimated social self-perception as an indicator of a social comparison process) were related to later externalizing behaviors, although not consistently in the expected direction. Specifically, we found that antisocial peer-group affiliation predicted engagement in aggression, vandalism and theft, as well as substance use. Overestimated social self-perceptions, however, predicted less engagement in vandalism and theft. This provides initial evidence that environmental selection and social comparison processes may indeed play an important role in explaining why children develop externalizing behaviors (or why not), but that other personal endowments of the child than were studied in the present thesis should be investigated in order to make any further and more firm conclusions about the question whether children are differentially affected by these processes. In the present thesis we were only able to investigate a very small subset (i.e., we only investigated three temperamental traits) of the many varying personal endowments that may underlie the development of externalizing behaviors through the influence that these personal characteristics may have on children's peer environment.

Overall, the results from chapter 2 and chapter 3 point towards a developmental cascade which runs from children's personal endowments to their social preference among peers, and

subsequently to engagement in externalizing behaviors. That is, dependent upon their temperamental characteristics (i.e., higher levels of negative emotionality as indicated by children's negative reactivity) and negativistic classroom behavior (i.e., oppositionality), children may evoke negative evaluations from their peers resulting in a lower ranking in the peer-group hierarchy of likeability. In other words: they become more and more disliked and less and less liked. Subsequently, the negative daily peer environment that these children encounter because of their temperamental and behavioral characteristics may fuel engagement in more and in more severe forms of externalizing behaviors, particularly interpersonal aggression and other forms of severe misconduct. Thus, elicitation of negative peer appraisal may partially explain why the initially mild or even benign risk of the child manifests itself in various forms of externalizing behavior, and results in the continuation and aggravation of these externalizing problems. At the same time, elicitation of negative peer appraisal may protect children against using illicit substances in later adolescent years, but the precise health- and adjustment outcomes and correlates of this 'protective' effect remain to be investigated.

WHICH PERSONAL VULNERABILITIES BECOME EXPRESSED IN EXTERNALIZING BEHAVIORS THROUGH THE INFLUENCE OF SOCIAL EXPERIENCES?

In addition to explaining *how* certain children may develop externalizing behavior problems, children's daily experiences in their social environment may also determine *who* may be particularly prone to developing these problems. That is, whether children's personal endowments become expressed in later externalizing behavior may be determined by the daily social environment that these children encounter (Shiner & Caspi, 2003). In this thesis, we

referred to this as 'environmental moderation'[2]. Our social-environmental factors of interest were children's family and peer environment to which children might be exposed on a daily basis.

We found support for our hypotheses on environmental moderation for children's daily home environment as well as for their daily peer environment. That is, in the study presented in chapter 4, we found that whether adolescents would be prone to initiate cannabis use at an early age (i.e., before they were 16 years old) depended on their personality traits in combination with how strongly they perceived that their parents' involvement in their daily lives declined. We found that adolescents who showed more emotional instability and who were less extravert were at risk for cannabis use at an early age, but only when they experienced a strong decline in parental involvement (specifically: in parental control). This indicates that lower levels of emotional stability and lower levels of extraversion per se may not put youth at risk for the early use of cannabis. However, when emotionally instable and less extraverted children feel that their parents become less controlling, they may indeed become at risk for using cannabis at an early age.

Further support for environmental moderation was found when we investigated the interplay between children's genetic make-up and their daily peer environment, as is presented in chapter 5. In this chapter we focused on whether or not children had a DRD4 7-repeat allele; an allele that is hypothesized to render children more susceptible to their environment. We found that this genetic variant by itself did not influence the development of externalizing behavior. However, when children's daily peer environment was taken into account as a

[2]Note that we actually tested moderation by children's genetic make-up and personality in the prospective association between their social environment and later externalizing behavior. However, moderators and predictors are statistically - and in our case also theoretically - interchangeable and hence we interpret the results of chapter 3 and chapter 4 as environmental moderation.

moderating factor, such a predictive association did in fact appear. That is, children who were more susceptible to their environment because of their genetic make-up showed an increase in externalizing behavior throughout ages 9 to 12 years, but only when they were generally disliked by their peers (i.e., experienced a negative daily peer environment). Vice versa, being more susceptible to the environment because of genetic factors was associated with a decrease in externalizing behaviors for children who were generally liked among peers (i.e., experienced a positive daily peer environment). For children who were less susceptible to environmental influences because of their genetic make-up (i.e., who did not have a DRD4 7-repeat allele), their peer environment – regardless whether this environment was negative or positive – did not influence the development of externalizing behavior.

In sum, our findings reported in chapter 4 and 5 indicate that children with certain personal endowments, specifically certain personality traits and genetic characteristics, which in itself were not risk factors for developing externalizing behavior in our studies, may become at risk for developing externalizing behavior *only* when they encounter certain social experiences. On a more positive note, we also found that a positive daily peer environment may decrease engagement in externalizing behaviors, but again only for those individuals who are susceptible to its influence. Importantly, in our studies this were social experiences that children or adolescents may experience with their peers and parents on a daily basis.

Sex differences in the development of externalizing behavior

Although not the main topic of this thesis, we also explored sex differences in the development of externalizing behavior. We found across studies that boys always had higher levels of externalizing behavior than girls. These level differences were particularly strong in the more serious externalizing behaviors, such as aggression, violence, vandalism and theft, compared to what is generally regarded less severe externalizing behavior, such as oppositionality (see chapter 2, 3 and 5). For illicit substances, levels of use were similar for

boys and girls (see chapter 2 and 4). These findings converge with those from a multitude of worldwide studies that have reached the same conclusion (Demmer, Hooley, Sheen, McGillivray, & Lum, 2016; Meier, Slutske, Heath, & Martin, 2011; Moffitt et al., 2001).

However, despite these level differences and despite clear hypotheses set by others and ourselves (see also chapter 3; Côté et al., 2002; McEachern & Snyder, 2012), overall we found limited support for sex-specific developmental pathways of externalizing behavior. Importantly, when we did find sex differences in developmental pathways of externalizing behavior, these were always small in magnitude. Furthermore, results from the different studies in this thesis are not in line with each other with respect to sex differences. For example, in chapter 3 we found that boys in particular were prone to develop more severe externalizing problems after experiencing poor appraisal by their peers, but these findings were not replicated in the study presented in chapter 2. Therefore, it seems that the personal endowments and social environments that were studied in the present thesis cannot answer the question why the very apparent sex differences in levels of externalizing problems exist.

It is important to note that sex differences in levels of problems do not necessarily say anything about sex differences in developmental pathways of these problems. It hence might be the case that the development of externalizing behavior from children's personal endowments and their social experiences indeed does not differ between boys and girls. For example, it has been suggested that sex differences in externalizing behavior are different regarding the developmental timing (i.e., boys developing externalizing behavior earlier than girls), rather than in form (Silverthorn & Frick, 1999). It also needs to be acknowledged that our research projects were not specifically designed to capture why there are sex differences in levels of externalizing behavior. For example, we did not focus on specific personal endowments that others have suggested to be important markers that explain the development of externalizing behavior and that are related to someone's sex. For example, studies have

found that boys might be particularly prone for developing externalizing behavior because of higher levels of prenatal exposure to testosterone (Martel, 2013). In addition, (culturally driven) differences in the general attitude towards displaying externalizing behavior for boys versus girls may explain why boys develop more externalizing behavior than girls. That is, people might expect boys to be more rough, tough and aggressive (e.g., masculine ideology) than girls thereby stimulating these types of behaviors via gender-specific socialization, while such behaviors generally are considered to be less appropriate for girls. Thus, it might be that compared to girls boys are more exposed to factors that underlie the development of externalizing behavior. Lastly, the complex developmental models that were tested in the present thesis likely lacked sufficient power to detect subtle sex differences in developmental pathways.

TARGETING EXTERNALIZING BEHAVIORS: CAN THE PEER ENVIRONMENT MAKE UP TO WHAT THE FAMILY CONTEXT MIGHT FAIL TO PROVIDE?

In the previous paragraphs of this general discussion we have outlined the evidence we found in our studies for environmental mediation and environmental moderation, regarding the development of externalizing behavior. With this information we added to the understanding of how and for whom externalizing behavior might develop, continue and escalate. We found that the daily social environment that children encounter plays an important role in this development and that children's social standing among peers in particular seems to be important. Given this progressive insight we wondered whether enhancing children's acceptance among peers could help reduce the development of externalizing behavior. This possibility formed the stepping stone for our final research question: to what extent can the facilitation of children's positive peer-relationships protect them against developing externalizing behavior problems and does this possible protective effect differ depending upon

risk factors within children's home environment? In the final empirical study of the present thesis (see chapter 6), we therefore investigated whether facilitation of children's acceptance among peers through a universal school-based intervention program, protected them against developing externalizing behavioral problems and - more importantly - whether this potential protective effect depended upon children's home context. We investigated the potential moderating role of children's home context in the association between acceptance among peers and externalizing behavior for rather extreme and active parent(ing) factors, such as using abusive disciplining tactics and parental engagement in criminal activities, as well as for subtler, more conventional parent(ing) characteristics, such as experiencing parenting stress and depressive symptoms.

Results in chapter 6 indicated that the Good Behavior Game (GBG) intervention effectively reduced children's externalizing behavior (in this study: conduct problems). Children in classrooms who received the GBG also scored higher on peer acceptance, compared to children whose teacher's used their normal classroom routine. The reduced development of conduct problems among GBG children when compared to control group children was partially explained by improved peer acceptance. However, the mediation pathway from GBG to improved peer acceptance to reduced conduct problem development, existed only for children of mothers with high levels of criminal behavior and children of mothers who reported using abusive disciplining tactics. These findings imply that children at risk for developing externalizing behavior due to an unsafe home environment benefitted from the GBG intervention because this intervention helps teachers to create a classroom-environment that is safe and predictive; characteristics that are lacking in the home environment. In contrast, maternal depressive symptoms and parenting stress did not moderate the association between improved peer acceptance and reduced conduct problems. These findings thus suggest that providing a safe and predictable classroom environment and thereby

facilitating positive peer relationships may be particularly beneficial for children who grow up in families where mothers themselves show signs of externalizing problems, rather than for children who grow up with mothers with internalizing problems.

To summarize, with the studies presented in this dissertation we confirmed that the development of externalizing behavior should be understood as a complex socio-behavioral process. Our results add to existing knowledge of the interplay between children's personal characteristics and their social environment in that our main focus was on relatively subtle social-environmental experiences that affected children encounter on a daily basis for the majority of the week. We showed that even when children may not be clearly at risk for developing externalizing behavior when looking at their personal endowments and even when the social environment that they encounter is not clearly negative or harsh and not predictive of externalizing behavior development when studied in isolation, the combination of subtle personal and environmental 'risks' may indeed render children prone to developing externalizing behavior.

On a more positive note, we also found that a positive daily peer environment may decrease engagement in externalizing behaviors, particularly for children who are genetically susceptible to this environment. In a randomized controlled design, we confirmed the importance of this positive peer environment for vulnerable children by showing that improving children's peer acceptance through a universal classroom-based intervention decreased the development of externalizing behavior, particularly for children who came from an unsafe family context.

Together these findings indicate that neither children's personal endowments nor their social experiences that we investigated should be labelled as 'negative' and 'a risk factor' or 'positive' and 'a protective factor' in themselves. In contrast, our findings make it more likely that it depends on the specific combination of the child's personal characteristics with its daily

social experiences at home and with peers that determines whether a certain endowment or environment may have a harmful or protective effect on the child's behavioral development.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The present thesis adds to a better understanding of the development of externalizing behaviors, with a special focus on how and for whom children's and adolescents' personal endowments and daily peer- and parent environment factors, even if not a direct 'risk' in themselves, may contribute to the development, continuation and aggravation of externalizing behavior. However, there are a number of limitations that need to be taken into account when drawing conclusions from the study results reported in this thesis.

First, in none of our studies participants were randomly chosen. That is, in the sample of the study described in chapter 2, all participants came from a small community in northwestern Quebec, Canada. The samples of the studies described in chapters 3, 5 and 6, all used a convenience sample and participants in the sample of the study described in chapter 4 were oversampled based on their level of externalizing behavior. Furthermore, the grand majority of the included children and adolescents had a western, Caucasian background. Specifically, four of our five samples included children living in the Netherlands and one sample included children living in Canada. Therefore our results may not generalize to children from non-western backgrounds.

Second, although it is a considerable strength that all of our studies used a longitudinal design, our samples suffered from selective attrition. That is, generally children with missing data had higher levels of externalizing behavior than children with complete data. Although effects sizes of differences between children with missing data and children without missing data were always small, we cannot conclude with certainty that results remain the same had our samples had no such selective attrition.

Third, with the exception of the RADAR sample (chapter 4), our samples came from the general population and hence mean levels of children engaging in externalizing problems were low, with very few children scoring in the extreme ends of our measures. This may have hampered our power to find strong associations between some of our constructs of interest. Future studies may want to oversample high-risk children (e.g., children whose siblings show externalizing problems) to investigate whether similar conclusions may be reached for these children. Furthermore, as mentioned earlier, power issues may also explain why we didn't find sex differences in developmental pathways of externalizing behavior. However, the reason that we could not find strong evidence for sex-differential developmental pathways, may also stem from the fact that our studies were not specifically designed to capture potential sex differences. Others may want to study potential differential developmental pathways for boys and girls by implementing a more in-depth investigation of possible sex differences. For example, by focusing on personal endowments or social factors that others have found may be relatively sex-specific risk factors for externalizing behavior development. These may include, among others, inherited or acquired vulnerabilities such as poor self-control, hyperactivity, emotion regulation problems, experiences of neglect and (sexual) abuse, interparental violence and conflict, and romantic relationships with antisocial partners (Bowie, 2010; Monahan, Dmitrieva, & Cauffman, 2014; Moretti, Bartolo, Craig, Slaney, & Odgers, 2014; Mrug et al., 2014).

Fourth, our investigation of the peer-context was in all studies limited to peers within children's classrooms. However, peers outside the classroom may as well have influenced children's externalizing problems, particularly when children grow older. For example, various studies have found that affiliation with older (male) friends in particular is predictive of engagement in delinquency, substance use and other types of behavioral problems (McAdams, Salekin, Marti, Lester, & Barker, 2014; Stattin, Kerr, & Skoog, 2011). Therefore, future studies

may want to investigate the influence of other peers, such as school-mates outside children's own classroom, peers within the broader family, neighborhood friends or peers met at sports clubs and other activities where youngsters meet and hang out.

Fifth and related to the previous limitation, our investigation of the family-context was in all studies limited to maternal influences. A growing body of studies indicates that fathers' influences may have unique contributions to children's (externalizing) development that differ from those of mothers (e.g., see Kochanska, Brock, Chen, Aksan, & Anderson, 2015; Kochanska, Kim, Boldt, & Yoon, 2013). However, there are also many similarities between fathers' and mothers' influences on children's externalizing behavior (DeKlyen, Speltz, & Greenberg, 1998). Future studies may want to investigate if our findings regarding the interplay between children's personal endowments and maternal parenting styles and characteristics as well as between the peer context and maternal factors also hold for fathers, or whether unique developmental pathways may be discovered when the interplay between children's personal endowments and their fathers' parenting style or characteristics are investigated.

Sixth, it needs to be kept in mind that the longitudinal associations that we found between children's personal endowments and their social environment cannot say anything about the causality of these factors for externalizing development. Our study presented in chapter 6, where a randomized controlled design was used to manipulate children's peer environment, presents the strongest but not conclusive evidence for causality of the peer environment. This study hints that peer acceptance in concert with children's family environment may indeed play a causal role in the development of externalizing behavior. However, before any firm conclusions can be made our results regarding the peer environment should be replicated and broadened towards children's home environment. Other studies may want to extent our findings by using other randomized controlled designs that include (universal) preventive interventions aimed at scaffolding and improving children's

relationships with parents and peers. Other useful research designs that may aid our knowledge on causality include using natural experiments (e.g., genetically sensitive designs intended to control for possible genetic mediation; Rutter, 2007), lab paradigms that simulate positive and negative daily social experiences (e.g., the cyber ball game to study the effects of peer exclusion and inclusion and its association with children's personal endowments) or – a relatively newly developed field – using serious video games to improve children's social relationships and behavior (Elias-Lambert, Boyas, Black, & Schoech, 2015; Santamaria et al., 2011).

Lastly, although we found that various personal endowments in concert with the peer and family environment were associated with externalizing behavior development and aggravation of externalizing behaviors, many more potential mechanisms underlying these associations need to be further investigated in order to truly understand why externalizing behaviors develop. For example, an interesting research question might be whether children's daily peer and parental experiences that they encounter because of their personal endowments, may become further embedded in their biology through the influence that these social experiences may have on children's gene-expression, endocrine functioning or brain development. For example, studies have found that experiences of parent- and peer abuse (such as being a victim of maltreatment or bullying) may result in changes in children's DNA methylation patterns (Cecil et al., 2014), stress-regulation (Ouellet-Morin et al., 2011), and brain functioning (Will, van Lier, Crone, & Güroğlu, 2016), which in turn may be related to the development and escalation of externalizing behaviors. Might it be that a similar biological embeddedness may result from the daily social experiences that were studied in the present thesis? If so, we might want to reconsider our ideas regarding the influence of seemingly mild negative social-environments such as poor likability as compared to obviously negative experiences such as being abused or neglected.

IMPLICATIONS FOR RESEARCH AND PRACTICE

In sum, the findings from the studies presented in the current thesis emphasize the relevance of children's personal endowments as well as their daily family and peer environment for understanding the development, continuation and aggravation of a broad spectrum of externalizing behaviors in childhood as well as in adolescent years. First, our findings indicate that children's personal characteristics may not put them directly at risk for developing externalizing behavioral problems, but these personal endowments may indeed become a significant risk factor when they (start to) influence children's daily relationships with others. Furthermore, we found that it depends on a specific combination of children's and adolescent's personal endowments and their daily social experiences with peers and parents, whether they may or may not be prone to developing externalizing problems. Therefore, it is important that developmental models of externalizing behavior take both aspects, that is, children's personal characteristics as well as their daily social experiences, into account. We stress that studies should not only focus on clearly negative social environments or relationships, such as maltreatment by parents or peers, but should also pay special attention to daily experiences that may seem rather subtle, such as children's acceptance among peers or the daily involvement of their parents. Developmental studies that simultaneously take both subtle as well as clearly negative peer and family environments into account, may ultimately shed a light on which factors are the driving forces underlying externalizing behavior development.

We found that (the lack of) being accepted and liked by the larger peer-group in particular was a common thread important for understanding externalizing behavior development. That is, poor peer acceptance explained why initially seemingly benign personal endowments that in itself were not necessarily directly associated with externalizing behavior development (e.g., having a temperament characterized by negative reactivity or being carrier of a specific genetic variant) eventually may indeed become manifested in later externalizing

behavior. In addition, we also found that improvements of children's acceptance among peers reduced externalizing development and particularly helped children who were at risk for externalizing development due to an unsafe home environment. Hence, our results imply that the development of a systematic standardized monitoring system on children's social standing among peers might be an important step forwards to help teachers to keep a close eye on children's social development and interpersonal relationships with their peers.

In the Netherlands, the first steps towards developing such a social monitoring program have been taken. In 2015, the Dutch Ministry of Education, Culture and Science launched a legal provision for education which obligates all Dutch schools to monitor children's welfare and safety at school and to prevent bullying (Ministerie van Onderwijs, 2015). Since then, several school-safety monitors have been developed. Examples in the Netherlands include the 'Veiligheidsmonitor' (English: 'The Safety Monitor'; Radboud Universiteit Nijmegen, 2014), and the school-safety monitor of the anti-bullying program 'KiVA' (Salmivalli, Garandeau, & Veenstra, 2012). However, these monitors measure school-safety mainly based upon children's experiences with bullying-victimization. The results of the present thesis emphasize that not only bullying, but also children's acceptance or social preference among peers should be monitored at schools. Furthermore, these monitors are based on self-report questionnaires and therefore require that children have sufficient reading skills. Consequently, most monitors are developed for older children (e.g., for children in grades 3 to 6), while the studies in this thesis emphasize the importance of screening and monitoring children directly after the entrance to formal schooling (i.e., from kindergarten onwards). In addition, self-reports may not be sufficiently reliable for early elementary school children, as these young children might not have adequate insight in their social standing among peers (Kurdek & Krile, 1982), although research in this area is scarce. Moreover, particularly children who show externalizing behaviors tend to have problems with forming a realistic social self-perception and tend to

overestimate their social standing among peers (Webster-Stratton & Lindsay, 1999). Therefore, monitors and screening devices on school safety for younger children should use – as we did in the present thesis – a peer-nomination approach rather than self-reports and should rely less on reading skills. For example, questions could be read out loud by a school-safety coordinator or by a computer program. For very young children, McCandless and Marshall's (1957) picture sociometric technique could be utilized, using photographs of peers. Lastly, to the best of our knowledge there are as of yet no standardized screening and monitoring programs of school-safety in which the social development of individual children can be compared to general norms of this development in the Netherlands (as for example is done with the Dutch 'CITO' for monitoring the academic development of children and screening children who fall behind). Consequently, the screening of at-risk children is hampered as it is hard to reliably distinguish at-risk children from children not at risk. Therefore, we prompt researchers, teachers, government officials and other professionals responsible for securing the school-safety of children to bundle their forces in order to develop a standardized, universally applicable monitoring and screening device that helps us to systematically monitor the school-safety of elementary school children from kindergarten onwards and screen children at risk in good time.

However, before such a systematic device can be developed and implemented, we need to take into account an important ethical consideration. That is: do we harm children by asking them to nominate children who they like and who they dislike? May asking such questions further stigmatize poorly accepted children by inadvertently constructing and reinforcing social difficulties? Some researchers think they do and therefore have criticized using sociometrics as a method of measuring social relationships among children in social groups, such as school classes (Child & Nind, 2013). Furthermore, although an early study found no observable negative effects on preschool children's interpersonal behavior following their involvement in sociometric nominations, the authors of this study acknowledged that sociometric ratings may

have other, less observable negative impacts on children. For example, sociometric ratings may inflict lower self-esteem among disliked children (Hayvren & Hymel, 1984). Furthermore, Iverson and Iverson (1996) investigated children's long-term reactions to participating in sociometric assessments. They found that children overall liked participating in the peer-nominations although they liked negative nominations of their peers significantly less than positive nomination techniques. Furthermore, the authors analyzed children's comments about the nomination techniques and found no evidence of harm (Iverson & Iverson, 1996). Nevertheless, these findings warrant the importance of further research into this matter and emphasize that cautious use of sociometric measures is still warranted until we have confirmed with certainty that no harm is done.

The results presented in this theses indicate that a monitoring and screening system of children's social experiences should not only focus on social experiences with peers, but should also include experiences within the home environment. To this end, the monitoring and screening system could include a parent-questionnaire in which parents report on their daily involvement with their children and their parenting preferences. Many elementary schools acknowledge the importance of parents' involvement in the school of their children for children's academic development. And many of these schools already (informally) monitor parents' involvement in the academic development of students and aim to stimulate this involvement. Furthermore, in the Netherlands the 'meldcode Huiselijk Geweld en Kindermishandeling' (English: Reporting Code Domestic Violence and Child Abuse) obliges professional, including school personnel, to report cases of (suspected) physical child abuse and neglect and other unsafe home conditions to official government authorities. This monitoring of unsafe home conditions could be standardized and broadened by including the monitoring of general involvement and parenting practices and preferences. In addition, teachers could also report on these matters. Actually, it used to be common practice for Dutch

elementary school teachers (and still is for some school) to yearly visit their students' family homes and to make note of the child's home environment. During these house-visits teachers asked the student's parents, for instance, about the child's and their own well-being and parenting preferences. Such a practice could be reintroduced as part of the monitoring and screening device, in a standardized and systematic format.

A next step in securing a healthy behavioral adjustment for children is the further development and improvement of effective and efficient intervention programs targeting externalizing behaviors. Our results on the importance of children's daily (classroom) experiences with peers in the development of externalizing behavior, suggest that such intervention programs should include components focused on improving these daily experiences with peers. For instance, interventions could focus on preventing that children become increasingly disliked among peers. However, intervening in situations where children become increasingly less liked and increasingly more disliked among peers, might proof to be a challenge for teachers. That is, in contrast to active expressions of negative social evaluations, such as bullying behaviors that can be actively prohibited by teachers and parents, it is not possible to 'force' children to stop disliking or start liking other children. Therefore, one of the challenges for preventing the development, continuation and aggravation of externalizing problems is to develop interventions that help vulnerable children to increase their likeability among peers. Given that peer acceptance is a group process, the group as a whole should be included in these types of interventions. Universal classroom-based intervention, that aim to create a positive classroom climate that stimulates positive peer relationships, such as the Good Behavior Game, might be a good start to scaffold children's peer acceptance. Furthermore, classroom-based interventions help to identify vulnerable children who do not respond to such universal programs and therefore are in need of more targeted interventions.

CONCLUSION

The studies presented in this thesis confirm that the development of externalizing behavior should be understood as a complex bio-social process. The personal endowments (the 'bio' part of the process) that we investigated were children's genotype, temperament, personality and sex. Our results showed that children might not be at risk for developing externalizing behavior solely based on these personal endowments. In addition, the social environments (the 'socio' part of the process) we investigated were children's experiences in the home and peer context. Again, our results showed that children might not be at risk for developing externalizing behavior as a consequence of these social environments only. In contrast, the results of the present thesis point out that it is a specific combination of a child's personal endowments and its social environment that can indicate whether a child has a high chance to 'make it' or a high chance 'to break it' with respect to developing externalizing problems.

English Summary

Children and adolescents who engage in externalizing behaviors, such as oppositional behavior, aggression, vandalism, and illicit drug or alchohol use, are of great concern to their parents, teachers and society at large. Not only may their behaviors impact others, engaging in externalizing behavior can also be harmful for the perpetrators themselves because it puts them at risk for a broad spectrum of concurrent and future problems. The studies presented in this thesis aimed to clarify the role of children's social environment (i.e., children's peer and home context) in explaining why children's personal endowments (i.e., children's genotype, temperament, personality and sex) are expressed in developing externalizing behaviors. To this end, the present thesis addressed the following research topics:

The first set of studies focused on environmental mediation. I aimed to study how daily experiences with peers may explain why children's early temperamental traits (chapter 2), or milder forms of behavioral difficulty (chapter 3) develop into later, more serious conduct problems. The second set of studies examined environmental moderation. I studied how the home and peer environment may aggravate, of buffer, the link between a child's personality (chapter 4) or genetic makeup (chapter 5) and their engagement in, respectively, cannabis use and conduct problems. My final aim was to investigate whether social relationships in the peer context at school could compensate for negative experiences that children may have in their home context. In chapter 6, I therefore studied to what extent the facilitation of children's positive peer experiences - through a preventive intervention program - could protect children who were exposed to an at-risk home environment against developing externalizing problems. Lastly, potential sex differences in developmental pathways were explored in all studies.

In order to answer these questions, I analyzed data from four different studies: two studies focused on Dutch elementary school children, one study focused on Dutch adolescents and one study focused on Canadian youth. All studies were characterized by multi-informant, longitudinal research designs in which children were followed annually for several years.

Together, the studies covered the developmental period from the start of formal schooling (age 6 years), throughout elementary school, into adolesence (age 15 years).

Children's personal endowments, peer relations and externalizing behaviors: Environmental mediation?

Our findings reported in chapter 2 and chapter 3 showed that children with a temperament characterized by negative emotionality (**chapter 2**) and children who showed oppositional behavior (**chapter 3**) became increasingly more disliked and increasingly less liked by their peers. Subsequently, these negative peer perceptions predicted engagement in more serious externalizing problems. Thus, elicitation of negative peer appraisal because of a child's personal endowments may partially explain why an initially mild or even benign personal risk factor may become manifested in externalizing behavior, and may result in the continuation and aggravation of this behavior.

Children's personal endowments, social experiences and externalizing behaviors: Environmental moderation?

In **chapter 4** we found that adolescents who showed more emotional instability and who were less extravert were at risk of using cannabis at an early age, but only when they experienced a strong decline in parental control. In **chapter 5**, we focused on children's genotype of the dopamine receptor D4 (*DRD4*) gene. Individual differences within this gene have been shown to affect children's susceptibility to environmental input. We found that children who had the alleged 'risk' variant of the *DRD4* gene (i.e., the 7-repeat allele) showed an increase in externalizing behavior throughout ages 9 to 12 years, but only when they were disliked by their peers. However, we also found a protective effect of this alleged risk-allele. That is, children with the 7-repeat allele of the *DRD4* gene showed less externalizing behaviors when they were liked among their peers. Thus, the results reported in chapter 4 and chapter 5

imply that whether children's personal endowments may become expressed in externalizing behavior depends upon which type of social environment these children experience.

Can the peer environment make up for what the family context might fail to provide?

In **chapter 6**, we investigated whether the effects of children's negative experiences in the home context, which may predispose them to develop externalizing problems, could be diminished by facilitating positive peer relations at school. Children were considered to be exposed to home risk when their mother engaged in abusive disciplining or criminal behavior (which may be seen as maternal externalizing problems), and when their mother experienced parenting stress or a depressed mood (which may be seen as maternal internalizing problems). The facilitation of positive classroom peer relationships was done through a universal classroom-based intervention program: the Good Behavior Game (GBG). Results showed that regardless of children's home risk, children who were in GBG classrooms showed decreasing levels of externalizing behavior compared to children who were in control classrooms. Results also showed that regardless of their home risk, children were more accepted by their peers in GBG classrooms than in control classrooms. However, it was the higher level of peer acceptance that explained why children who came from an at-risk home context characterized by maternal externalizing problems showed reductions in externalizing problems. For children whose mothers had internalizing problems, the positive effect of the GBG on the development of externalizing behavior could not be explained by increased peer acceptance. These findings thus imply that facilitating positive peer relations in school may counter the development of externalizing behavior for children whose mothers have externalizing problems themselves.

Lastly, in all studies we explored potential sex differences in the associations between personal endowments, the social environment and externalizing disorder. With the exception of substance use, we found in all studies that boys had higher levels of externalizing behavior than girls. Despite this sex difference in the level of externalizing behavior, we found limited

support for sex-specific developmental pathways of externalizing behavior in our studies. Furthermore, when we did find sex differences in developmental pathways of externalizing behavior, these were always small in magnitude.

Conclusion

The studies presented in this thesis confirm that the development of externalizing behavior should be understood as a complex bio-social process. The personal endowments (the 'bio' part of the process) that we investigated were children's genotype, temperament, personality and sex. Our results showed that children are not at risk for developing externalizing behavior solely based on these personal endowments. In addition, the social environments (the 'socio' part of the process) we investigated were children's experiences in the home and peer context. Again, our results showed that children are not at risk for developing externalizing behavior as a consequence of these social environments only. In contrast, the results of the present thesis point out that it is a specific combination of a child's personal endowments and its social environment that can indicate whether a child has a high chance to 'make it' or a high chance 'to break it' with respect to developing externalizing problems.

Nederlandse Samenvatting

Externaliserend gedrag bij kinderen en adolescenten, zoals oppositioneel gedrag, agressie, vandalisme en illegaal drugs of alcohol gebruik, is een grote reden tot zorg voor ouders, leerkrachten en de samenleving in het algemeen. Externaliserend gedrag leidt niet alleen tot ongemak en overlast voor anderen, maar brengt ook risico's met zich mee voor de jeugdigen zelf. Dit omdat deze jeugdigen een verhoogde kans lopen op een breed scala aan andere problemen, zowel direct als in hun toekomst. Dit proefschrift had als doel te onderzoeken welke rol de sociale omgeving (specifiek: de peer- en thuisomgeving) van jeugdigen speelt in het verklaren van de link tussen persoonlijke eigenschappen (specifiek: hun genotype, temperament, persoonlijkheid en sekse) en de ontwikkeling van externaliserend gedrag. Hiertoe zijn de volgende onderzoeksonderwerpen behandeld:

De eerste twee studies van dit proefschrift waren gericht op omgevingsmediatoren. Ik heb onderzocht hoe dagelijkse ervaringen met leeftijdsgenoten (*i.e.*, peers) de ontwikkeling van moeilijke temperamentstrekken (hoofdstuk 2) en milde gedragsproblemen (hoofdstuk 3) bij jonge kinderen, naar ernstig externaliserend gedrag op latere leeftijd kunnen verklaren. In de volgende twee studies heb ik mij gericht op omgevingsmoderatoren. Ik heb onderzocht welke aspecten binnen de thuis- en peeromgeving van jeugdigen de associatie van persoonlijkheidskenmerken (hoofdstuk 4) en genotype (hoofdstuk 5) met de ontwikkeling van externaliserend gedrag (respectievelijk cannabisgebruik en norm-overschrijdend gedrag) kunnen versterken of afzwakken. Mijn laatste doel was te bestuderen of een positieve peeromgeving de effecten van een ongunstige thuisomgeving kan goedmaken. Hiertoe heb ik in hoofdstuk 6 onderzocht in hoeverre het creëren van een positieve peeromgeving – door middel van een preventief interventieprogramma – kinderen die opgroeien in een ongunstige thuisomgeving kan beschermen tegen het ontwikkelen van externaliserend gedrag.

Om deze vragen te kunnen beantwoorden heb ik data van vier verschillende onderzoekspopulaties gebruikt: twee studies zijn gedaan bij Nederlandse basisschoolkinderen,

één studie is gedaan bij Nederlandse adolescenten en één studie is gedaan bij Canadese jeugdigen. Alle studies hadden een longitudinaal design waarin kinderen gedurende meerdere jaren zijn gevolgd. Er vonden jaarlijks metingen plaats en data werd verkregen via verschillende informanten. Gezamenlijk omvatten deze studies de ontwikkelingsperiode vanaf de vroege kindertijd (6 jaar) tot in de adolescentie (15 jaar).

Persoonlijke kenmerken, relaties met leeftijdsgenoten en externaliserend gedrag bij jeugdigen: Mediatie door omgevingsfactoren?

Uit de resultaten van de studies beschreven in hoofdstuk 2 en hoofdstuk 3 blijkt dat kinderen met temperament gekenmerkt door negatieve emotionaliteit **(hoofdstuk 2)** en kinderen met oppositioneel opstandig gedrag **(hoofdstuk 3)** steeds minder leuk en steeds vaker niet leuk worden gevonden door hun klasgenoten. De negatieve waardering voorspelt vervolgens of kinderen ernstiger externaliserend gedrag zullen ontwikkelen. Dus, kinderen kunnen op basis van hun persoonlijke kenmerken negatieve reacties uitlokken bij leeftijdsgenoten en dit kan vervolgens verklaren waarom een in eerste instantie milde persoonlijke kwetsbaarheid zich kan ontwikkelen tot (persistent en ernstig) externaliserend gedrag.

Persoonlijke kenmerken, relaties met leeftijdsgenoten en externaliserend gedrag bij jeugdigen: Moderatie door omgevingsfactoren?

De resultaten in **hoofdstuk 4** tonen aan dat adolescenten die een hoge mate van emotionele instabiliteit ervaren en die weinig extrovert zijn, een verhoogd risico lopen om op jonge leeftijd cannabis te gebruiken. Echter, dit verband werd enkel gevonden bij adolescenten die vonden dat hun ouders gedurende hun adolescentie steeds minder controle op hen uitoefenden. **Hoofdstuk 5** was gefocust op de rol van het dopamine receptor D4 (*DRD4*) gen in de ontwikkeling van externaliserend gedrag bij basisschoolkinderen. Eerder is gevonden dat dragers van de ‘risico’ variant van dit gen (*i.e.,* het *DRD4*-7 repeat allel) gevoeliger zijn voor

omgevingsinvloeden dan personen zonder dit allel. Onze resultaten toonden aan dat het *DRD4*-7 repeat allel enkel in het geval dat kinderen niet aardig werden gevonden door klasgenoten was geassocieerd met een toename in externaliserend gedrag. Afhankelijk van de omgeving kon het allel echter ook een beschermende functie hebben. Dat wil zeggen, kinderen met het *DRD4* 7-repeat allel die aardig werden gevonden door klasgenoten, ontwikkelden juist minder externaliserend probleemgedrag dan kinderen zonder dit allel. Dus, de bevindingen in hoofdstuk 4 en hoofdstuk 5 impliceren dat het afhankelijk is van de sociale omgeving of kinderen met persoonlijke kwetsbaarheden externaliserend gedrag zullen ontwikkelen of niet.

Kan een positieve peer omgeving de effecten van een ongunstige thuisomgeving goedmaken?

In **hoofdstuk 6** hebben we onderzocht of potentiele effecten van een ongunstige thuisomgeving op de ontwikkeling van externaliserend gedrag, afgezwakt kunnen worden door een positieve peeromgeving op school. Wij beschouwden de thuisomgeving als ongunstig indien moeders van de participanten hardhandige disciplineringstrategieën hanteerden of crimineel gedrag lieten zien (*i.e.,* moeders met externaliserende problemen) of indien moeders veel opvoedingsstress of depressieve klachten ervoeren (i.e., moeders met internaliserende problemen). Het preventieve interventieprogramma Taakspel werd ingezet om een positieve sfeer in de klas te creëren. Onze resultaten tonen aan dat kinderen in de Taakspel conditie minder externaliserend gedrag ontwikkelden, en meer werden geaccepteerd door hun klasgenoten, dan kinderen in de controle conditie. Deze effecten bestonden onafhankelijk van de thuisomgeving. Echter, het effect dat een verbeterde acceptatie onder klasgenoten had op de ontwikkeling van externaliserend gedrag werd wel beïnvloedt door de thuisomgeving. Wij vonden dat enkel de kinderen wiens moeders externaliserend gedrag lieten zien profiteerden van een positieve peeromgeving en dus zelf minder externaliserend gedrag ontwikkelden. Voor kinderen van moeders met internaliserende problematiek kon het positieve effect van Taakspel

op de ontwikkeling van externaliserend gedrag niet verklaard worden verbeterde acceptatie onder peers. Deze resultaten impliceren dat een positieve peeromgeving in sommige gevallen de effecten van een ongunstige thuisomgeving kan tegen gaan.

In alle studies van dit proefschrift zijn potentiele sekseverschillen in de links tussen persoonlijke kenmerken, de sociale omgeving, en de ontwikkeling van externaliserend gedrag onderzocht. Met uitzondering van middelengebruik, vonden wij in alle studies dat jongens meer externaliserend gedrag lieten zien dan meisjes. Ondanks dit sekseverschil in de mate van externaliserend gedrag vonden wij weinig evidentie voor het bestaan van verschillende ontwikkelpaden van externaliserend gedrag voor jongens en meisjes. In het geval er wel sekseverschillen werden gevonden in ontwikkelpaden, waren deze verschillen niet noemenswaardig.

Conclusie

De resultaten van de studies in dit proefschrift bevestigen dat de ontwikkeling van externaliserend gedrag moet worden beschouwd als een complex bio-sociaal proces. De persoonlijke kenmerken die in dit proefschrift zijn onderzocht (*i.e.,* het ‘bio’ gedeelte) zijn het genotype, temperament, persoonlijkheid en de sekse van jeugdigen. Onze bevindingen tonen aan dat het niet aannemelijk is dat jeugdigen externaliserend gedrag ontwikkelen enkel en alleen doordat zij persoonlijke kwetsbaarheden hebben. De omgevingsfactoren die in dit proefschrift zijn onderzocht zijn de thuis- en peeromgeving (*i.e.,* het ‘socio’ gedeelte). Wederom blijkt uit onze bevindingen dat kinderen waarschijnlijk niet enkel en alleen op basis van een ongunstige sociale omgeving externaliserend gedrag zullen ontwikkelen. Wat de resultaten van dit proefschrift onderstrepen is dat het juist een specifieke combinatie van kinderen hun persoonlijke kenmerken en hun sociale omgeving is, die bepaalt of zij een verhoogde kans lopen om het ‘te maken’ of ‘te kraken’ wat betreft de ontwikkeling van externaliserend gedrag.

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Supplementary Material

Supplementary Material Chapter 2

Measurement invariance requires that a score assigned to an individual on a rating scale is determined solely by the individual's actual behavior and not by an interpretation of behavior that stems from "irrelevant" characteristics such as sex (Mellenbergh, 1989; Meredith, 1993). Structural invariance indicates that latent variances and means are equal between groups. We tested for potential violations of invariance in factor structure, factor loadings, item intercepts/thresholds, residual variances, factor variances and latent means using a series of nested multiple-group CFA models. For childhood temperament, we used maximum likelihood estimation with robust standard errors (MLR-estimator) to fit the CFA models. Nested models were compared using change in CFI index (ΔCFI > -.001 is worse fit), change in RMSEA index (ΔRMSEA > +.005 is worse fit; F. F. Chen, 2007; Cheung & Rensvold, 2002), and the Satorra-Bentler scaled chi-square difference test (Satorra, 2000). Because part of our indicators in the model for antisocial behavior and substance use were binary, we used the WLSMV-estimator to fit this model. For this latter model, nested models were compared using change in CFI index (ΔCFI > -.001 is worse fit), change in RMSEA index (ΔRMSEA > +.005 is worse fit; Chen, 2007; Cheung & Rensvold, 2002) and the robust chi-square difference test (DIFFTEST) function of Mplus. When two out of three fit indices indicated significantly worse fit for the more constrained models, this was deemed as an indication for invariance.

As can be seen in Table 2.1S (temperament) and Table 2.2S (antisocial behavior and substance use), measurement invariance was fully established for both models. Structural invariance was also established for the temperament model. However, structural invariance did not hold for the model of antisocial behavior and substance use. Follow up analyses indicated that the latent means of overt antisocial behavior and covert antisocial behavior were respectively .851 and .293 standard deviations higher for boys compared to girls.

SUPPLEMENTARY MATERIAL

Table 2.1S

Cross-sex Measurement and Structural Invariance Testing of Latent Temperament Model

	Temperament (correlated 3-factor model)							
	Fit indices		Difference tests					
	CFI	RMSEA	Comparison	ΔCFI	ΔRMSEA	$\Delta\chi^2$	df	*p*
Measurement model								
1 Factor structure invariance	.88	.06						
2 Factor loadings invariance	.87	.06	1 versus 2	-.003	-.001	24.42	20	.225
3 Item intercepts invariance	.87	.06	2 versus 3	-.006	.000	28.81	18	.051
4 Residual variance invariance	.87	.06	3 versus 4	+.001	-.001	22.48	21	.372
Structural model								
5 Latent variances invariance	.87	.06	4 versus 5	+.001	-.001	1.66	3	.646
6 Latent mean invariances	.87	.06	5 versus 6	+.001	.000	1.77	3	.622

Table 2.2S

Cross-sex Measurement and Structural Invariance Testing of Latent Antisocial Behavior and Substance Use Model

	Antisocial Behavior and Substance Use (correlated 3-factor model)							
	Fit indices		Difference test					
	CFI	RMSEA	Comparison	ΔCFI	ΔRMSEA	$\Delta\chi^2$	df	*p*
Measurement model								
3 Factor structure invariance	.97	.04						
4 Factor loadings invariance	.97	.03	1 versus 2	+.007	-.005	21.89	23	.527
3 Item thresholds invariance	.96	.04	2 versus 3	-.008	+.004	106.01	23	<.001
4 Residual variance invariance	.96	.04	3 versus 4	0	0	37.70	26	.065
Structural model								
5 Latent variances invariance	.96	.04	4 versus 5	-.003	+.002	8.55	3	.036
6.1 Latent means invariance	.95	.04	5 versus 6.1	-.012	+.005	25.26	3	<.001
6.2 Partial latent means invariance	.96	.04	5 versus 6.2	-.001	0	2.45	1	.118

Note. The means of overt antisocial behavior and covert antisocial behavior were respectively .851 and .293 standard deviation lower for girls than for boys.

Supplementary Material Chapter 5

Description of Interventions

Approximately 60% of the children in the present study participated in a preventive intervention targeting problem behavior. Half of the children in the intervention group received the Good Behavior Game intervention (Barrish et al., 1969) and the other 50% of the intervention children received the PATHS curriculum intervention (Kusché & Greenberg, 1994). The interventions were implemented in first and second grade of elementary school.

Good Behavior Game (GBG). The GBG (Barrish et al., 1969) is a classroom-based preventive intervention aimed at creating a safe and predictable classroom environment, by promoting adaptive, prosocial classroom behavior. Positively formulated class rules are chosen by the teacher and the students together. To facilitate positive peer interaction, teachers assign children to teams of 4 to 5 members, equally composed of children with and without disruptive behavior. Team members are encouraged to work together and behave adaptively. All teams receive a set of cards at the beginning of the game period in which children work on regular school tasks (e.g., instruction, working alone, and reading). Each time a member violates a rule, the teacher takes a card away from that team. Teams as a whole are rewarded (e.g. by extra leisure time, stickers, compliments) for adaptive behavior when at least one card remains at the end of the game period. Game periods lasted between 10 and 60 minutes. During and after the game, compliments are given to the students and teams when deemed appropriate (Dolan, Jaylan, Werthamer, & Kellam, 1989).

PATHS curriculum. PATHS (Kusché & Greenberg, 1994) is a program that targets the development of social and emotional competence in order to decrease the risk of behavioral and social problems. Emotional, cognitive, and social skills are promoted through lessons taught by the teacher. PATHS emphasizes techniques to promote positive interaction amongst students and to reduce peer rejection. For instance, children are taught to adequately express

and understand peers' emotions by using so-called "emotion cards". Also, children learn problem-solving and anger-management techniques that are generalized throughout the classroom and the school context. Furthermore, the "child of the week" receives particular attention and is allowed to help the teacher throughout the week.

SUPPLEMENTARY MATERIAL

Table 5.1S

Model Specifications and Outcomes for A Priori Multiple-group Power Analysis Using Monte Carlo Simulations (n repetitions = 10,000)

	DRD4-7r *n* = 143			DRD4-no7 *n* = 262		
Path	Estimate	Coverage	Power	Estimate	Coverage	Power
Autoregressive paths positive social preference	0.60	0.95	1.00	0.60	0.95	1.00
Autoregressive paths prosocial behavior	0.60	0.95	1.00	0.60	0.95	1.00
Autoregressive paths conduct problems	0.60	0.94	1.00	0.60	0.94	1.00
Positive social preference predicting prosocial behavior	0.12	0.94	0.80	0.00	0.95	0.05
Positive social preference predicting conduct problems	-0.12	0.94	0.81	0.00	0.95	0.06
Prosocial behavior predicting positive social preference	0.05	0.95	0.51	0.05	0.95	0.51
Conduct problems predicting positive social preference	-0.05	0.94	0.51	-0.05	0.94	0.51
Correlations positive social preference and prosocial behavior	0.10	0.95	0.22	0.10	0.95	0.36
Correlations positive social preference and conduct problems	-0.10	0.95	0.23	-0.10	0.95	0.38
Correlations prosocial behavior and conduct problems	0.10	0.95	0.23	0.10	0.95	0.37

Note. Estimates of paths reflect standardized regression coefficients. Correlations between constructs reflect residual error correlations. Means of all constructs were estimated to be 0 and variances of all constructs were estimated to be 1. Recurring paths were constrained to be similar over time, hence estimates hold for all recurring paths. Estimates < .05 are considered too small to interpret, estimates ≥ .05 are small but meaningful, estimates ≥ .10 are moderate, estimates ≥ .25 are large (Keith, 2006).

Table 5.2S

Distribution of the DRD4 Polymorphisms and Assignment to Groups

Genotype	*n*	%
DRD4-no7 (*n* = 262)		
2/2	4	1.0%
2/3	3	0.7%
2/4	34	8.4%
2/5	1	0.2%
2/6	1	0.2%
3/4	28	6.9%
3/5	1	0.2%
4/4	173	42.7%
4/5	7	1.7%
4/6	4	1.0%
4/8	5	1.2%
5/5	1	0.2%
DRD4-7r (*n* = 143)		
2/7	9	2.2%
3/7	7	1.7%
4/7	111	27.4%
5/7	1	0.2%
7/7	14	3.5%
7/8	1	0.2%

Note. DRD4-no7 includes participants with no 7-repeat alleles. DRD4-7r includes participants with at least one 7-repeat allele. The three most common repeat frequencies in our sample were the 4-repeat (66%), the 7-repeat (19%), and the 2-repeat (7%)

Curriculum Vitae

Marieke Buil was born on July 5th, 1983, in Winterswijk, the Netherlands. In 2000, she completed secondary education at De Driemark in Winterswijk. Thereafter, she studied higher professional education at Iselinge Hogeschool in Doetinchem, where she obtained her bachelor's degree in education in 2004. During her studies at Iselinge Hogeschool she became interested in elementary school children's behavioral problems and continued her education on this topic at Leiden University, where she obtained a bachelor's degree in educational sciences in 2008. After completion of this bachelor, she started the research master in educational sciences: normal and deviant patterns of attachment and self-regulated learning, at Leiden University. For her research master's project she studied childhood cognitive and behavioral antecedents of adult psychosis in a twenty-year follow-up study of a childhood psychiatric cohort. After her graduation in 2010, she started her PhD project on the interplay between youth's personal endowments and their social environment in the development of externalizing behavior at the Vrije Universiteit, Amsterdam, under supervision of prof. dr. Pol van Lier and Prof.dr. Hans Koot. During her PhD project, Marieke visited dr. Frank Vitaro at the Université de Montréal, and dr. Mara Brengen at the Université du Québec à Montréal, Canada, to collaborate on a joint paper. In addition, she contributed as a lecturer and tutor at the Vrije Universiteit Amsterdam, King's College London, UK and the Erasmus University Rotterdam. Since September 2016, Marieke has worked as a post-doctoral researcher at the Erasmus University Rotterdam, collaborating with various national and international scholars. The focus of her current work is two folded: on a more practical level she focuses on the evaluation of a preventive anti-bullying intervention program for elementary schoolchildren and on a more fundamental level she focuses on the interplay between children's social school environment and DNA methylation in the development of psychopathology. Starting in 2018, she will continue this focus at the Vrije Universiteit Amsterdam. Marieke is the daily supervisor of two PhD students, and is a member of the editorial board of the *Journal of Youth and Adolescence.*

List of Publications

Publications Accepted

2018

Behnsen, P., **Buil, M.**, Koot, S., Huizink, A., & van Lier, P (2018). Classroom social experiences in early elementary school relate to diurnal cortisol levels. *Psychoneuroendocrinology, 87,* 1-8.

Buil, J.M., Kosters, M., & Koot, H.M. (accepted pending minor revisions). Measurement invariance of the revised child anxiety and depression scale (RCADS) across sex and ethnicity in the Netherlands. *European Journal of Developmental Psychology.*

2017

Buil, J.M., Koot, H.M., & Van Lier, P.A.C. (2017). Sex Differences and Parallels in the Development of Externalizing Behaviours in Childhood: Boys' and Girls' Susceptibility to Social Preference Among Peers. *European Journal of Developmental Psychology, 1-16.*

Buil, J.M., van Lier, P.A.C., Brendgen, M.R., Koot, H.M., & Vitaro, F. (2017). Developmental pathways linking childhood temperament with antisocial behavior and substance use in adolescence: Explanatory mechanisms in the peer environment. *Journal of Personality and Social Psychology, 112,* 948 – 966.

Buil, J. M., Koot, H. M., Olthof, T., Nelson, K. A., & Lier, P. A. (2015). DRD4 genotype and the developmental link of peer social preference with conduct problems and prosocial behavior across ages 9–12 years. *Journal of Youth and Adolescence, 44,* 1360-1378.

He, J., Koot, H. M., **Buil, J. M.**, & van Lier, P. A. C (2017). Impact of Low Social Preference on the Development of Depressive and Aggressive Symptoms: Buffering by Children's Prosocial Behavior. *Journal of Abnormal Child Psychology,* 1-11.

van der Zwan, J. E., de Vente, W., Tolvanen, M., Karlsson, H., **Buil, J. M.**, Koot, H. M., ... & Karlsson, L. (2017). Longitudinal associations between sleep and anxiety during pregnancy, and the moderating effect of resilience, using parallel process latent growth curve models. *Sleep Medicine, 40,* 63-68.

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Creemers, H.E., **Buil, J.M.,** van Lier, P.A.C., Keijsers, L., Meeus, W., Koot, H.M., & Huizink, A.C. (2015). Early onset of cannabis use: Does personality modify the relation with changes in perceived parental involvement? *Drug and Alcohol Dependence, 146,* 61-67.

Publications submitted

Asscheman, S., Koot, S., **Buil., J.M.,** Krabbendam, L., & van Lier, P.A.C. (submitted). Peer rejection and the development of elementary school children's sharing behavior with peers.

Behnsen, P., **Buil, J.M.,** Koot, S., Huizink, A.C., & van Lier, P.A.C. (submitted). Relational peer victimization related to heart rate and perceived stress.

Buil, J.M., De Wilde, A., Koot, H.M., & Van Lier, P.A.C. (submitted). Impact of maternal psychopathology and parenting behaviors on the effectiveness of an early elementary school intervention program targeting conduct problems.

Evans, B.E., **Buil, J.M.,** Burk, W.J., Cillessen, A.H.N., & van Lier, P.A.C. (revised /resubmitted). Urbanicity is associated with behavioral and emotional problems in Dutch elementary school-aged children.

He, J., **Buil, J.M.,** Koot, H.M., & van Lier, P.A.C. (submitted). Associations of Oxytocin Receptor (*OXTR)* genotype with likability, dislikability and friendships among peers in mainstream elementary schoolchildren

Tieskens, J., **Buil, M.**, Koot, S., Krabbendam, L. & van Lier, P. (submitted). Elementary school children's associations of aggressive and oppositional defiant behaviour with risk-taking across 7 to 11 Years.

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Courage is a heart word. The root of the word courage is cor - the Latin word for heart. In one of its earliest forms, the word courage meant "to speak one's mind by telling all one's heart". Over time, this definition has changed, and today we typically associate courage with heroic and brave deeds. But in my opinion, this definition fails to recognize the inner strength and level of commitment required for us to actually speak honestly and openly about who we are and about our experiences – good and bad. Speaking from our hearts is what I think of as 'ordinary courage'.

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