KU LEUVEN

PARENTING AND SPECIAL EDUCATION RESEARCH UNIT

The Interplay of Genes, Parenting, and Personality Characteristics in the Development of Externalizing Problem Behavior in Adolescence

Martijn Van Heel

Doctoral thesis offered to obtain the degree of
Doctor of Psychology (PhD)

Supervisor: Prof. dr Karla Van Leeuwen

Co-Supervisor: Prof. dr Patricia Bijttebier

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The present dissertation examines the interplay of dopaminergic genes, parenting, and personality characteristics in the development of externalizing problem behavior in adolescence. We adopted the 'Developmental Systems Theory' as a theoretical framework to investigate this complex interplay (e.g., Bronfenbrenner, 2005; Lerner, Rothbaum, Boulos, & Castellino, 2002). Specifically, we focused on the microsystem that is the interaction between the adolescent and his/her parent(s).

The STRATEGIES project (i.e., Studying Transactions in Adolescence: Testing Genes in Interaction With Environments) provided data for the four studies that are part of this dissertation. At Wave 1, the sample consisted of 1116 Flemish adolescents from Grades 7 to 9, 747 mothers, and 645 fathers. During six years, these informants annually reported on parenting practices, adolescent temperament/personality, and externalizing problem behavior. The fourth study additionally included data from the GEM project (i.e., Genes, Environment, and Mood), which consisted of 665 American children from Grade 3, 6, or 9 and one of their parents. The GEM data used in the present dissertation was collected across three waves with a 18-month interval.

The first study examined whether parenting practices could be measured in mothers, fathers and adolescents across adolescence using the same questionnaires. Confirmatory factor analyses established (partial) scalar measurement invariance of a five-factor parenting model (i.e., support, proactive control, punitive, non-physical, control, harsh punitive, physical control, and psychological control) by Janssens et al. (2015) across informants (i.e., mothers, fathers, and adolescents) and across developmental periods (i.e., early, middle, and late adolescence). In other words, our findings indicated that this five-factor parenting model can be validly used to represent the perspectives on parenting of mothers, fathers, and adolescents across adolescence.

The second study used a person-centered approach to investigate heterogeneity in the five parenting dimensions for mothers and fathers separately. Specifically, longitudinal class growth analyses showed distinguishable longitudinal trajectory classes for each parenting dimension except harsh punitive control. Furthermore, we found these classes to differ regarding externalizing problem behavior (i.e., rule-breaking and aggressive behavior) at age 12.

The third study used random intercept cross-lagged panel models to investigate transactional associations between parental control, adolescent personality, and externalizing problem behavior. We found that adolescent personality predicted problem behavior and vice versa. Furthermore, we observed that adolescent personality also predicted parental control and vice versa across early and middle adolescence.

The fourth study used two independent samples to examine whether the association between parenting and externalizing problem behavior was mediated by adolescent effortful control, and whether this mediation was moderated by activity of the dopaminergic pathway, represented by a polygenic index score (i.e., DRD2, DRD4, DAT1, and COMT). There was no consistent support for a mediation by adolescent effortful control, but we did observe some evidence of moderation of this mediation model by dopaminergic activity.

To conclude, the four studies included in the present dissertation highlight the need of a differentiated approach in the investigation of the development of externalizing problem behavior in adolescence. Such an approach should comprise individual differences, such as personality, temperament, or genetic characteristics, as well as environmental factors, such as parenting practices. The present dissertation provided innovative insights that can aid in the development of theoretical perspectives as well as in the optimization of parenting programs and hopefully inspires future research.

Martijn Van Heel, De Wisselwerking Tussen Genen, Opvoeding, en Persoonlijkheidskenmerken in de Ontwikkeling van Externaliserend Probleemgedrag in de Adolescentie

Supervisor: Prof. Dr. Karla Van Leeuwen
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In dit proefschrift wordt de wisselwerking tussen dopaminerge genen, opvoeding, en persoonlijkheidskenmerken in de ontwikkeling van externaliserend probleemgedrag in de adolescentie onderzocht. De 'Developmental Systems Theory' diende als theoretisch kader (e.g., Bronfenbrenner, 2005; Lerner, Rothbaum, Boulos, & Castellino, 2002). Concreet focusten we op een microsysteem, met name de interactie tussen de adolescent en zijn/haar ouder(s).

Het STRATEGIES project (i.e., Studying Transactions in Adolescence: Testing Genes in Interaction With Environments) verstrekte data voor de vier studies die deel uitmaken van deze dissertatie. Op meetmoment 1 bestond de steekproef uit 1116 Vlaamse adolescenten uit het 1ste, 2de of 3^e jaar secundair onderwijs, 747 moeders en 645 vaders. Gedurende zes jaar rapporteerden de informanten jaarlijks over opvoedingsgedrag, temperament/persoonlijkheid van de adolescent en externaliserend probleemgedrag van de adolescent. De vierde studie maakte daarnaast ook gebruik van data van het GEM project (i.e., Genes, Environment and, Mood). Deelnemers waren 665 Amerikaanse kinderen uit het 4e leerjaar van het lager onderwijs, en 1ste jaar of 4e jaar van het secundair onderwijs en één van hun ouders. Ze werden bevraagd op drie meetmomenten met een tijdsinterval van 18 maanden.

De eerste studie onderzocht of opvoedingsgedragingen van ouders op een zelfde manier bij moeders, vaders en adolescenten gemeten kunnen worden doorheen de adolescentie via een vragenlijst. Confirmatorische factoranalyse vond (gedeeltelijke) scalaire meetinvariantie van een opvoedingsmodel met vijf factoren (i.e., ouderlijke steun, proactieve controle, niet-fysiek straffen, fysiek straffen en psychologische controle) over informanten (i.e., moeders, vaders en adolescenten) en ontwikkelingsperiode (i.e., vroege, midden en late adolescentie). Deze bevinding geeft aan dat dit opvoedingsmodel op een valide wijze kan gebruikt worden om de perspectieven op opvoeding van moeder, vader en adolescent weer te geven doorheen de adolescentie.

De tweede studie gebruikte een persoonsgerichte benadering om heterogeniteit in de perspectieven van moeders en vaders op de vijf voornoemde opvoedingsdimensies te onderzoeken. Via een longitudinale groei klasse analyse werden longitudinale subgroepen voor elk van de opvoedingsdimensies onderscheiden, met uitzondering van fysiek straffen. Verder vonden we dat deze subgroepen ook verschillen met betrekking tot externaliserend probleemgedrag (i.e., regel-overtredend en agressief gedrag) op 12-jarige leeftijd.

De derde studie onderzocht de transactionele associaties tussen ouderlijke controle, persoonlijkheid van de adolescent en externaliserend probleemgedrag van de adolescent. Een random intercept cross-lagged panel analyse vond dat persoonlijkheid van de adolescent probleemgedrag voorspelde en vice versa. Verder vonden we dat persoonlijkheid van de adolescent ook ouderlijke controle voorspelde en vice versa doorheen vroege en midden adolescentie.

De vierde studie gebruikte twee onafhankelijke steekproeven om te onderzoeken of de link tussen opvoeding en externaliserend probleemgedrag wordt gemedieerd door zelfregulatie van de adolescent, en of deze mediatie wordt gemodereerd door activiteit van het dopaminerg systeem, gerepresenteerd door een polygene index score (i.e., gebaseerd op DRD2, DRD4, DAT1, en COMT). Er was geen consistente steun voor de mediatie door zelfregulatie van adolescenten, maar wel moderatie door dopamine activiteit.

Concluderend kan gesteld worden dat de vier studies de nood van een gedifferentieerde aanpak in het onderzoek naar de ontwikkeling van externaliserend probleemgedrag onderstrepen. Zo een aanpak zou zowel individuele verschillen, zoals persoonlijkheid, temperament of genetica, als omgevingsfactoren, zoals opvoeding, in rekening moeten nemen. Deze dissertatie verstrekt interessante inzichten die kunnen helpen bij theorievorming en optimalisatie van opvoedingsprogramma's en die toekomstig onderzoek kunnen inspireren.

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Chapter 1
General Introduction

Abstract

An African proverb states that *"It takes a village to raise a child"*, meaning that a number of different people (e.g., parents, teachers, peers) and the interaction between them shape the context in which a child develops, and as such, the child's development itself. Although this statement is sometimes considered a platitude, it basically is an idea that is also reflected in developmental systems theories (e.g., Bronfenbrenner, 2005; Lerner, Rothbaum, Boulos, & Castellino, 2002). These models conceptualize the development of a child in terms of a reciprocal influence between individual bio-psychological characteristics and his/her environment described in multiple systems. According to Bronfenbrenner (2005) these systems concern the proximal environment of the individual, such as teachers and family (i.e., microsystems) and how these interact in for example parent-teacher meetings (i.e., mesosystems), but also the more distal environment, such as the social situation (e.g., social economic status) of an individual (i.e., exosystem) or culture in which he/she lives (i.e., macrosystem). Furthermore, a child growing up in the 2010's faces very different challenges than a child growing up in the 1950's, thus, the child's development is also influenced by the time period he/she lives in (i.e., chronosystem). The present dissertation will focus on one microsystem that is the the interaction between the child (adolescent) and his/her parents.

1. Introduction

Developmental systems theories, such as the developmental contextual model by Lerner et al. (2002; See Figure 1) or the bio-ecological model by Bronfenbrenner (2005; See Figure 2), form an ideal framework to study child behavior as the outcome of the interaction between the child with all his/her characteristics (e.g., temperament, personality, genetic make-up) and his/her environment (e.g., parents). Despite the fact that positive child behavior should not be ignored, problem behavior is and has been a major concern in Western societies. Externalizing problem behavior during adolescence is an important predictor of emotional and behavioral problems in adulthood (Reef, Diamantopoulou, van Meurs, Verhulst, & van der Ende, 2010). Especially, externalizing problem behavior in adolescence is an important predictor for problem behavior in adulthood (Narusyte, Ropponen, Alexanderson, & Svedberg, 2017).Therefore, this dissertation examines the role of individual characteristics (i.e., personality, temperament, genetics) and parenting practices in the development of externalizing problem behavior.
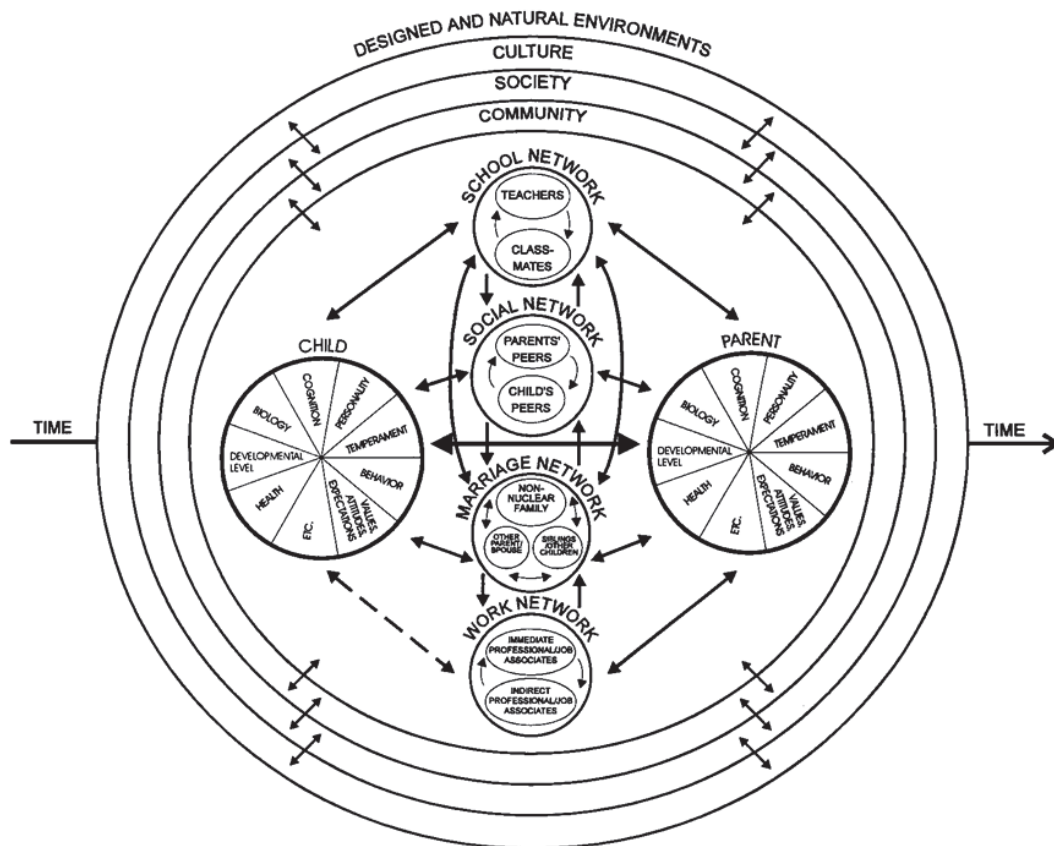
Figure 1. Representation of the developmental contextual model of human development. Reprinted from "Developmental Systems Perspective on Parenting". In M. H. Bornstein (Ed.), *Handbook of parenting: Vol. 2, Biology and ecology of parenting 2 ed.,* (p. 319), by R. M. Lerner et al., 2002, Mahwah, NJ: Lawrence Erlbaum Associates.
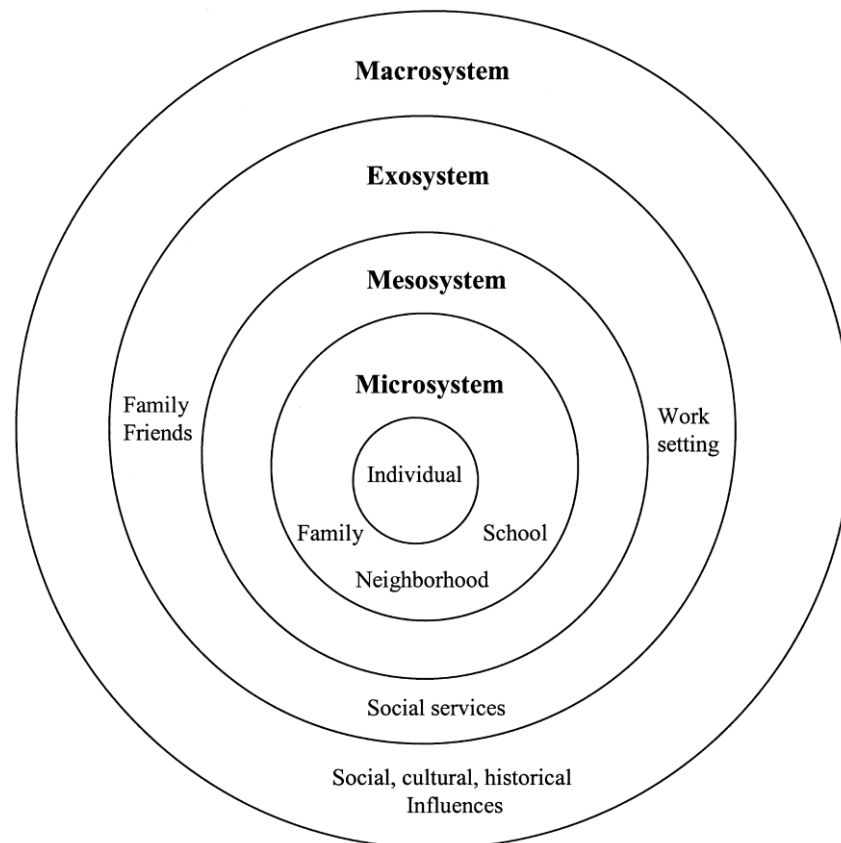
Figure 2. Representation of the bio-ecological model by Bronfenbrenner (2005). (Reprinted from "Psychosocial Development in Racially and Ethnically Diverse Youth: Conceptual and Methodological Challenges in the 21st Century" by D. P. Swanson et al., 2003, *Development and Psychopathology, 15,* p. 751.)

2. Externalizing Problem Behavior in Adolescence

Externalizing problem behavior refers to behavior that negatively affects people in one's close environment (e.g., parents, peers) or the society as a whole (e.g., violation of societal norms, destruction of property) (Jenson, Harward, & Bowen, 2011). Research suggests a number of constructs that can be categorized as externalizing problem behavior, such as aggressive behavior and rule breaking behavior (Frick et al., 1993; Gardner et al., 2015). We focus on behavioral problems rather than behavioral disorders and therefore we used a dimensional approach on externalizing problem behavior (cfr., Achenbach, 1991a, 1991b) instead of a categorical approach (cfr., DSM-V, American Psychiatric Association, 2013).

Externalizing problem behavior during adolescence has inspired a large body of research (Galambos, Barker & Almeida, 2003; Janssens et al., 2015; Luyckx et al., 2011). Adolescence, which is the developmental stage that ranges from approximately 12 to 22 years

of age, is characterized by major physical, psychological, and social changes. These changes are associated with an increased risk for problem behavior. Reitz, Deković and Meijer (2005) showed that 60% of the adolescents display some kind of problem behavior during the adolescence. The behavior of only a small portion of the adolescents will escalate to more serious psychopathology (e.g., conduct disorder) or criminal behavior (e.g., violence or delinquency) (Loeber, 1991; Moffitt, 1993). Research is needed to identify the adolescents that are at risk and possible predictors of externalizing behavior. This dissertation focuses on parenting practices and adolescent characteristics as potential predictors of externalizing problem behavior.

3. Parenting in Adolescence

Concerning parenting practices, a three-factor model, consisting of parental support, behavioral control and psychological control is mostly used in the parenting literature (Barber, Maughan, & Olsen, 2005). Parental support refers to the warm and loving relationship between the child and the parent. In this affectionate relationship, a parent shows acceptance, responsivity and involvement. By doing this the parent assists the adaptive functioning of the child (e.g., autonomy and social skills; Bronstein, Fox, Kamon, & Knolls, 2007; Pettit, Bates, & Dodge, 1997). Psychological control, refers to manipulating thoughts and emotions of the child by the parent (Barber, 1996) to obtain compliance. Psychological control predicts both internalizing (e.g., depression, anxiety, low self-esteem) and externalizing problems (e.g., aggression, delinquency) (Barber, Olsen, & Shagle, 1994; Pettit, Laird, Dodge, Bates, & Criss, 2001; Rogers, Buchanan, & Winchell, 2003). Behavioral control refers to parenting practices that regulate the child's behavior, and includes, for example, supervision, rule setting, and punishment. The literature shows inconsistent findings on the associations between behavioral control and child functioning, which may indicate a need to further differentiate this concept (Grolnick & Pomerantz, 2009). Behavioral control with a focus on preventive practices (e.g., setting rules, supervision) is associated with positive outcomes, such as more prosocial behavior, empathy, academic competence, and positive peer relationships (Gray & Steinberg, 1999; Krevans & Gibbs, 1996; Pettit et al., 1997; Wang et al., 2007), and also lower levels of antisocial behavior and externalizing problems (Galambos, Barker, & Almeida, 2003; Gray & Steinberg, 1999; Pettit et al., 2001). In contrast, other, more reactive forms of behavioral control following unwanted behavior of a child, such as physical and non-physical punishment, are associated with aggression, inadequate emotion regulation, depression, and, in case of severe

negative behavioral control, even suicide attempts (e.g., Bender et al., 2007; Chang, Schwartz, Dodge, & McBride-Chang, 2003; Gershoff, 2002; Lansford et al., 2011).

Janssens et al. (2015) have found a five-factor parenting model that (partly) resolves the conceptual confusion of the behavioral control concept by splitting it into three subdimensions, namely proactive control, punitive (non-physical) control, and harsh punitive (physical) control. Proactive control refers to a preventive manner of parenting, whereas punitive and harsh punitive refers to reactive parenting. This five-factor parenting model (i.e., parental support, proactive control, punitive (non-physical) control, harsh punitive (physical) control, and psychological control) was based on a factor analysis on a selection of parenting measures, This dissertation builds on the five-factor model by Janssens et al. (2015) and will examine the associations of these parenting dimensions with externalizing problem behavior.

The association between parenting practices and externalizing problem behavior is empirically supported (Hoeve et al., 2009) and research has moved on from the assumption that parenting predicts the behavior of the adolescent unidirectionally, toward the focus on bidirectional relations with the adolescent as an active agent in his/her socialization. Apart from parent- and child-directed effects, reciprocal associations between parents and adolescent behavior have been studied in longitudinal studies (De Haan et al., 2012; Huh et al., 2006; Reitz, Deković, & Meijer, 2006). Consistent with the developmental systems theory by Lerner et al. (2002), the interrelatedness of the individual and its context necessitates to study transactional associations in order to get a more detailed and accurate view on adolescent development, and in this case, adolescent externalizing problem behavior. This also means that both the environment of the adolescent (i.e., parenting) and the characteristics of the adolescent (i.e., personality, temperament) should be taken into account.

4. The Role of Adolescent Characteristics

Individuals differ from each other in their sensitivity to environmental factors, such as parenting. In this context a number of theoretical frameworks were suggested, namely diathesis-stress, differential susceptibility, and vantage sensitivity. All three theoretical models are represented in Figure 3. The *diathesis-stress model* states that certain characteristics of individuals (e.g., vulnerability genes or personality characteristics) are more likely to be adversely affected by negative environmental influences in comparison to individuals who do not have that characteristic, which is associated with negative developmental outcomes, such as problem behavior. When negative environmental influences are absent, vulnerable and

resilient individuals are not expected to differ from each other (Pluess & Belsky, 2013). In contrast to the diathesis-stress model, which suggests a heightened sensitivity to negative environmental influences, the *differential susceptibility model* suggests a heightened sensitivity to both negative and positive environmental influences (Bakermans-Kranenburg & van IJzendoorn, 2011; Belsky, 2005). Susceptible individuals both have '*heightened susceptibility to the negative effects of risky environments and to the beneficial effects of supportive environments*' (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007, p. 300). The most recent model suggested by Pluess and Belsky (2013), that is the *vantage sensitivity model*, states that - in some cases - the heightened sensitivity mainly applies to positive environmental influences. In other words, having a certain characteristic makes one more susceptible to positive environmental influences which associated with positive developmental outcomes. In this dissertation we focus on two types of individual differences, namely, personality traits and temperamental traits, (i.e., phenotypes) as well as genetic makeup (i.e., genotype). These factors can interact with each other as well as with environmental factors.
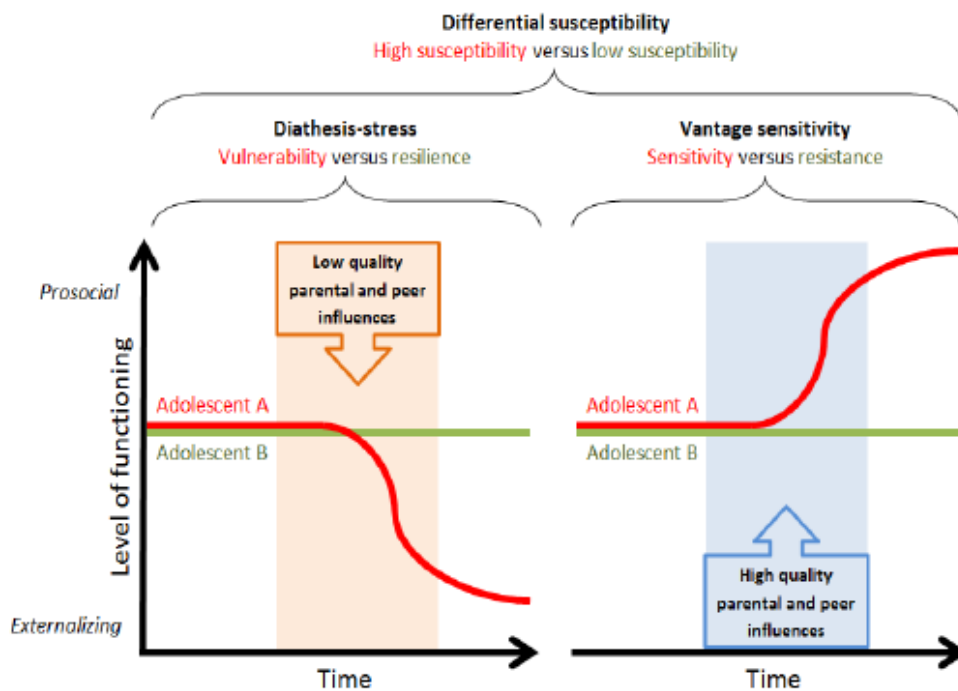
Figure 3. Representation of the theoretical models on individual differences (reprinted from "Parenting Effects in the Context of Child Genetic Differences" by M. Pluess and J. Belsky, 2012, *International Society for the Study of Behavioral Development Bulletin*, 2, p. 3.)

4.1 Phenotypes

Temperament and personality traits are closely related and both describe individual differences. However, temperament is more rooted in biological systems (including motivation-emotional and attentional tendencies). Furthermore, personality goes beyond temperament in that it also includes cognitions, beliefs, and values (Evans & Rothbart, 2007). Despite the fact that temperament is considered a subdomain of personality (Tackett, 2006), it is worthwhile to examine both in an attempt to disentangle their unique and related effects.

4.1.1 Personality

Personality refers to a characteristic pattern of thinking, feeling, and behaving. The personality concept is often represented by the five-factor model of personality (McCrae & Costa, 1987), which consists of Extraversion, Agreeableness, Conscientiousness, Emotional Stability/Neuroticism, and Intellect/Openness. Previous research suggested an association between externalizing behavior and the personality traits Agreeableness and Conscientiousness (Mervielde, De Clercq, De Fruyt, & Van Leeuwen, 2005; Prinzie et al., 2010; Tackett, 2006; Van Leeuwen et al., 2004, 2007). A number of hypotheses have been proposed to explain associations between personality and problem behavior. The *predisposition/vulnerability hypothesis* assumes that certain personality characteristics enhance the probability of problem behavior, whereas the *pathoplasty/exacerbation hypothesis* suggests that personality characteristics may alter the manifestation of problem behavior. A third hypothesis, that is the *complication/scar hypothesis* suggests a different temporal order and contends that problem behavior may predict changes in personality traits. A fourth hypothesis, the *continuity hypothesis*, stresses the simultaneousness and refers to covariation between personality and problem behavior within and across time, without implying causality, thus showing dynamic patterns of change over time between personality and externalizing problem behavior (De Bolle et al., 2012). A fifth and final hypothesis, the *spectrum hypothesis,* suggests that personality and problem behavior are situated on the same continuum, with problem behavior as a more extreme expression of a certain personality trait. This implies that some etiological factors (e.g., genetic background) are associated with both personality and problem behavior (Tackett, 2006). The numerous hypotheses concerning the link between personality and psychopathology are a clear illustration of the interest that is aroused by this topic and show the different perspectives on this association. Since explicitly testing these models would require multiple types of data (i.e., behavioral and genetic) from the complete lifespan of the individual, we will rather use these hypotheses to frame the findings in the present dissertation.

4.1.2 Temperament

The temperament model of Capaldi and Rothbart (1992) is a useful approach to represent constitutionally based individual differences in reactivity and self-regulation in adolescence. Key concepts in the temperament model of Capaldi and Rothbart (1992) are Affiliation, Affectivity, Effortful Control, and Extraversion/Surgency. Temperament is rooted in biological systems and some temperament characteristics may as such be considered as a predisposition to problem behavior. According to Nigg (2006), two temperament profiles predict externalizing problems. First, unsocialized aggressive conduct problems are associated with a temperament characterized by extremely low negative affectivity as well as low affiliation. Due to their very weak physiological arousability, these individuals develop deficits in guilt, conscience, concern about punishment, and socialization in general. Their low standing on affiliation and the emanating deficits in empathy development further amplify this pathway, which may result in the development of interpersonal callousness. Second, impulsive conduct problems are associated with a temperament characterized by extremely high surgency, in some cases combined with high levels of negative affectivity. Nigg (2006) suggested low effortful control to predispose individuals to exhibit externalizing problem behavior, which is consistent with the line of research by Eisenberg who established the importance of this trait in the development of externalizing problem behavior (Eisenberg, Fabes, Guthrie, & Reiser, 2000; Eisenberg et al., 2001; 2009). Effortful control can be defined as the ability to inhibit a dominant response in favor of a non-dominant response (Eisenberg, 2005) and is not only thought to be directly associated with externalizing problem behavior (independent or main effect), but there is evidence that it plays a moderating (de Haan, Prinzie, & Deković, 2010; Pitzer, Jennen-Steinmetz, Esser, Schmidt, & Laucht, 2011) or mediating role (Belsky, Fearon, & Bell, 2007; Eisenberg et al., 2005) in the association between parenting and externalizing problem behavior. The studies by de Haan, Prinzie, and Deković (2010) and by Pitzer et al. (2011) suggested that children with lower effortful control were more susceptible to socialization influences, such as parenting, in association with externalizing problem behavior, whereas the studies by Belsky, Fearon, and Bell (2007) and by Eisenberg et al. (2005) suggested that effortful control partly explained the association between supportive parenting and externalizing problem behavior. The aforementioned studies legitimize the inclusion of both parenting and effortful control simultaneously in research on externalizing problem behavior.

4.2 Genotype: Dopaminergic Pathway

Genetics and environment have inspired a large body of research in the context of externalizing problem behavior, both directly and in interaction with each other (GxE) (Schmidt, Fox, & Hamer, 2007; Seo, Patrick, & Kennealy, 2008; Weeland et al., 2015). Results of behavioral genetic studies, but recently also molecular genetic studies, have shown evidence of an association between genetic disposition and problem behavior (Moffitt, Caspi, & Rutter, 2006). The genetic pathway that has been widely investigated in the context of externalizing problem behavior, is the dopaminergic pathway (Matthys, Vanderschuren, & Schutter, 2012). The dopaminergic pathway is thought to be associated with externalizing problem behavior through its involvement in reward-based learning and motivation in the human brain. A recent systematic review of Weeland et al. (2015) stressed the opportunities that lie in GxE research. However, this review also shows that GxE findings in studies with single candidate genes are often inconsistent. Despite the possibility that a single genetic marker explains a small, but significant portion of phenotypic variation (e.g., personality, behavior), it will not always attain significance in a large-scale association study. Rather than focusing on single gene effects, an interesting alternative is to consider genetic pathways (e.g., dopamine pathway) of which the dynamic process is intertwined with environmental associations. This approach is partly prompted by the difficulty in identifying specific genes responsible for complex psychiatric outcomes (Dick, 2011) and can also aid in improving the interpretability of GxE findings. One can create polygenic risk scores of biological pathways, which already showed an association with certain phenotypes. For example, a study by Smith et al. (2013) showed an association between the dopaminergic pathway and the temperamental trait effortful control. This indicates that it is legitimate to investigate the polygenic risk of the dopaminergic pathway in the context of externalizing problem behavior.

Finally, GxE research can also take into account temperament/personality characteristics, as proposed in the Biosocial Developmental Model by Beauchaine and McNulty (2013), by assuming that adolescent temperament characteristics, such as activity level, negative affectivity, and inhibitory control, share genetic foundations. Therefore these temperament characteristics may predict externalizing behavior, especially in high-risk parenting environments (characterized by physical punishment or low levels of support). This rationale of common etiological factors (i.c., genetic foundation) is also found in the spectrum hypothesis (Tackett, 2006). There is evidence for the genetic basis for temperament such as genes that influence dopamine levels (e.g. DRD4, DRD2, DAT1, and COMT) that seems to be

related to self-regulation or effortful control (Posner & Rothbart, 2009).

Although the last decades much progress is made in research on the etiology of externalizing behaviors, there is still need for research to identify factors that may differentiate between variants of externalizing behavior based on prospective assessment. Plausible candidate factors may include adolescent characteristics, such as genotypic biomarkers, temperament, or personality traits, and environmental factors, such as parenting.

5. Research Aims

The purpose of this dissertation is to examine the parent-child dyad in the development of externalizing problem behavior. Since there are numerous variables, both personal and environmental, to take into account, the research aims will progressively include more variables. A first aim is to make sure that the proposed five-factor parenting model by Janssens et al. (2015) is valid across developmental periods (i.e., early, middle, and late adolescence) and informants (i.e., mothers, fathers, and adolescents) (See Chapter 2). This parenting model will be used throughout the present dissertation. A second research aim concerns the association between parenting and externalizing problem behavior across adolescence and is twofold (See Chapter 3). We will assess whether we can distinguish different trajectories in five parenting dimensions on the one hand, and how these trajectories are related to the development of externalizing problem behavior on the other hand. The third research aim is to investigate the interplay between parental control, adolescent personality and externalizing problem behavior in early and middle adolescence (See Chapter 4). Finally, the fourth research aim is to examine whether the association between parenting and externalizing problem behavior is mediated by adolescent temperament (i.e., effortful control), and whether this mediation model is moderated by adolescent genetic characteristics (i.e., dopaminergic pathway) (See Chapter 5). The four research aims are discussed in detail below.

5.1 Research Aim 1: Assessing Measurement Invariance of Parenting Across Adolescence and Across Informants

An empirical study by Janssens et al. (2015) used confirmatory factor analyses on several parenting measures and suggested that a model with five broad-band parenting dimensions showed the best fit. This model consisted of parental support, proactive control, punitive (non-physical) control, harsh punitive (physical) control and psychological control. In the context of this dissertation, the first research aim is to assess whether this five-factor

parenting model is valid for the perspective of the parents, both mothers and fathers, as well as for the perspective of the adolescent. Furthermore, since adolescence is a period with numerous major changes in the parent-child relation, we will also assess whether the five-factor parenting model is valid throughout the adolescence (i.e., from 12 to 18 years of age). In other words, the first research aim concerns assessing whether the parenting model coined by Janssens et al. (2015) can be validly used across informants and developmental period, which is novel in the literature concerning parenting. Therefore, this first research aim will provide the groundwork for the following research aims included in this dissertation.

5.2 Research Aim 2: Parenting and Externalizing Problem Behavior in Adolescence: Combining the Strengths of Variable-Centered and Person-Centered Approaches

The association between parenting across adolescence and externalizing problem behavior has been extensively investigated (Manrique Millones et al., 2011; Soenens, Vansteenkiste, Luyckx, & Goossens, 2006), but most of these studies assume that the population is homogeneous concerning these parenting dimensions. However, it is likely that for different parenting dimensions a number of subpopulations can be distinguished showing different trajectories in parenting over time. The number and the course of these trajectories may also differ for parenting of mothers and fathers. Furthermore, these subpopulations in maternal and paternal parenting practices can show differences regarding externalizing problem behavior. Specifically, the second research aim in the present dissertation is innovative in that we not only investigate whether subclasses of maternal or paternal parenting exist, but also, assess whether these subclasses differ concerning development of two variants of externalizing problem behavior, namely rule-breaking behavior and aggressive behavior.

5.3 Research Aim 3: Assessing the Longitudinal Interplay Between Parental Control, Adolescent Personality, and Externalizing Problem Behavior

The third research aim concerns the investigation of the interplay of adolescent personality, parental control, and externalizing problem behavior in early and middle adolescence. Despite the fact that theoretical frameworks, such as the developmental systems theory (Bronfenbrenner, 2005; Lerner et al., 2002), assume that transactional associations partly explain adolescent development, the aforementioned interplay has not been thoroughly investigated. Given this extended time span (i.e., early and middle adolescence), it is important to acknowledge two levels of analysis in this interplay in order to draw clear conclusions. Specifically, the trait-like (i.e., long term) component of the aforementioned variables needs to

be distinguished from the more state-like (i.e., short term) component of the variables. Given the heterogeneity of the parental control concept, three variants were included, namely, proactive control, punitive control, and psychological control. Concerning adolescent personality, previous studies suggested the concepts of conscientiousness and agreeableness to be important in the context of externalizing problem behavior (Prinzie et al., 2010; Tackett, 2006; Van Leeuwen et al., 2004, 2007; Mervielde et al., 2005). Using the state-of-the-art statistical technique of random intercept cross-lagged panel models, this research aim will provide a detailed picture of the direct and indirect associations among adolescent personality, parental control, and externalizing problem behavior as well as their timing in adolescence.

5.4 Research Aim 4: Assessing the Role of the Dopaminergic Pathway in the Association Between Parenting and Externalizing Problem Behavior, Mediated by Effortful Control

The literature has suggested that parenting and the temperament trait effortful control are associated with externalizing problem behavior (i.e., rule-breaking behavior and aggressive behavior). More recently, GxE studies showed that the association between environment and externalizing problem behavior is moderated by dopaminergic genes. The fourth research aim of this dissertation builds on this finding by including the role of dopaminergic genes, in addition to parenting and effortful control. Specifically, we examined associations between parenting, effortful control, and externalizing problem behavior, and whether these associations change depending on a polygenic score based on dopaminergic genes. Concerning the dopaminergic genes, we will go beyond the candidate gene approach, which is mostly used in previous studies (Beauchaine, 2009, 2010, Davies, Cicchetti, & Hentges, 2015, Weeland et al., 2015), by using a polygenic index score including four genes (i.e., DRD4, DRD2, DAT1, and COMT). This fourth research goal is innovative in that it includes parenting, temperament, and genetic characteristics and we aim to provide support for theoretical frameworks that stress the importance of including multiple levels of analysis, such as environment (i.e., parenting), temperament (i.e., effortful control), and genetics (i.e., dopaminergic system) in the investigation of problem behavior.

6. Methodology

6.1 Participants and Procedures

6.1.1 Sample 1 (STRATEGIES)

Sample 1 (See Chapters 2, 3, 4, and 5) was collected within the STRATEGIES project (i.e., Studying Transactions in Adolescence: Testing Genes in Interaction With Environments). This longitudinal study was conducted from 2012 to 2017 and annually question adolescents and their parents in Flanders, the Dutch-speaking part of Belgium. They were selected through a randomized multistage sampling approach. In a first stage, Flemish secondary schools were invited to take part in the study. Stratification was used to include students from general, technical and vocational tracks. In the second stage, nine schools participated in the study, from which 121 classes in the seventh, eighth and ninth grade were selected. Within these classes, 2,254 students and their parents were invited to participate. The final sample at Wave 1 consisted out of 1,116 adolescents (50% response rate), $M_{age} = 13.79$, $SD_{age} = 0.93$, 51% boys), 747 mothers ($M_{age} = 43.59$, $SD_{age} = 4.45$) and 645 fathers ($M_{age} = 45.32$, $SD_{age} = 4.69$). Compared to Wave 1, the retention rate in Wave 2 was 89% for adolescents, 75% for mothers, and 72% for fathers. In Wave 3 the retention rate decreased to 79% for adolescents, 66% for mothers and 63% for fathers. In Wave 4, the retention rates were respectively 45%, 38%, and 40%. Finally, in Wave 5, the retention rates were respectively 34%, 30%, and 33% (N adolescents = 381, N mothers = 223, N fathers = 210).

Family characteristics were representative for the general population $\chi^2(2) = 2.78$, $p = .25$, with 82% two-parent families, 7% single-parent families, and 11% blended families (Janssens et al., 2017; King Baudouin Foundation, 2008). The educational level (EDU) and employment activity level (ACT) of parents differed for both mothers (EMP: $\chi^2(3) = 30.34$, $p < .01$; ACT: $\chi^2(1) = 15.87$, $p < .01$) and fathers (EMP: $\chi^2(3) = 34.19$, $p < .01$; ACT: $\chi^2(1) = 15.13$, $p < .01$) with bachelor degrees and active employees being slightly overrepresented (Janssens et al., 2017; Research Department of the Flemish Government, 2010, 2011). Despite this small deviation, it can be concluded that participants represent all categories for socioeconomic status.

The STRATEGIES project used an accelerated longitudinal design. This enables research across a larger age span. Across the six annual waves, the ages range from 12 to 20 years old. At each wave the same sample was invited to participate in the study. The present dissertation uses data from the first five Waves of the STRATEGIES project.

Researchers visited participating schools and presented the adolescents with the questionnaire. At Wave 1 they also collected a saliva sample. In concert with the school, adolescents were provided two hours to finish the questionnaire. In case they did not finish the questionnaire within the provided time, they were allowed to finish the questionnaire at home and hand it in later using specially designated boxes. From Wave 4 onward, adolescents who left school or graduated were contacted through e-mail and received an online version of the questionnaire. At Wave 1, parents could either fill out their questionnaires online or on paper. The latter was provided through the adolescents and could also be handed in using the designated boxes. From Wave 2 onward, parents filled out the online version of the questionnaire. Active informed consent forms were signed by parents and adolescents. Approval for the study was obtained from the Institutional Review Board of the Faculty of Medicine at the University of Leuven (ML7972).

6.1.2 Sample 2 (GEM)

Sample 2 (See Chapter 5) was collected within the GEM project (i.e., Genes, Environment Mood). Participants were recruited at two sites, namely the University of Denver and Rutgers University. Families with a child in 3rd, 6th, or 9th grades in the broader Denver and central New Jersey areas were sent a letter to inform and invite them to the study. Of these families, 1108 parents called the laboratory to ask for additional information. It was established that both the parent and the child were fluent in English. Furthermore, it was established that the child did not have an autism spectrum disorder, psychotic disorder, or intellectual disability. Of these 1108 families, 665 (60%) qualified as study participants. The remaining 498 (40%) were not retained for the study for the following reasons: 4 (1%) were excluded because the parents reported that their child had an autism spectrum disorder or low IQ; 13 (3%) were non-English speaking families; 330 (71%) declined after learning about the study's requirements; 113 (25%) did get an appointment but did not show up for assessment. Data was collected over a period of three years with an 18-month interval.

6.2 Instruments

6.2.1 Adolescent Externalizing Problem Behavior

Adolescents' externalizing behavior was assessed using 31 items of the Youth Self Report (YSR; Achenbach, 1991a) on rule breaking and aggressive behavior (e.g., "I break rules at home, school, or elsewhere"). All items were answered on a 3-point scale from (0) 'not true',

(1) 'somewhat or sometimes true', to (2) 'very true or often true'. Higher scores indicate more externalizing problem behaviors.

6.2.2 Parenting Practices

In the STRATEGIES data set (i.e., Sample 1), parenting was rated by mothers, fathers, and adolescents using a total of 64 items from a selection nine subscales from multiple questionnaires. These questionnaires and respective subscales were selected based on their availability in Dutch (i.e., participants' native language), theoretical relevance, adequate psychometric properties, and use in previous parenting research (Janssens et al., 2015). A confirmatory factor analysis (CFA) on these questionnaires resulted in the five parenting dimensions mentioned earlier (Janssens et al., 2015).

The dimension *Parental Support* comprised three parenting measures: (a) the Positive Parenting subscale (8 items; e.g., "If I want to tell something, my parents take their time for listening to me") from the Parental Behavior Scale- Short Form (PBS-S; Van Leeuwen et al., 2013), (b) the Responsivity subscale (7 items; e.g., "My parents can make me feel better when I am feeling upset") from the Louvain Adolescent Perceived Parenting Scale (LAPPS; Delhaye, Beyers, Klimstra, Linkowski, & Goossens, 2012), which is an adaptation of a subscale of the Child Report of Parental Behavior Inventory (CRPBI; Schludermann & Schludermann, 1988), and (c) the Autonomy Support scale (8 items; e.g., "My parents take into account my opinion on affairs that concern me"), based on the Perceptions of Parents Scale (POPS; Grolnick, Ryan, & Deci, 1991) and the Research Assessment Package for Schools (RAPS; Institute for Research and Reform in Education, 1998).

The dimension *Proactive Control* consisted of two measures, that is, the subscale Setting Parental Expectations for Behavior (6 items; e.g., "My parents expect me to behave in a certain manner") and Parental Monitoring of Behavior (6 items; e.g., "My parents remind me of the rules they made"). They were selected from the Parental Regulation Scale (PRS-YSR; Barber, 2002), which was translated in Dutch by Soenens, Vansteenkiste, Luyckx, and Goossens (2006).

The dimension *Punitive control* consisted of the punishment subscale (4 items; e.g. "If I do something I was not supposed to, my parent punish me") from the Parental Behavior Scale – Short Form (PBS-S; Van Leeuwen et al., 2013).

The dimension *Harsh Punitive Control* was measured through the subscale Harsh Punishment (5 items; e.g., "My parents hit me in the face when I misbehave myself") from the Parental Behavior Scale – Short Form (PBS-S; Van Leeuwen et al., 2013).

The dimension *Psychological Control* consisted of two subscales. The subscale Psychological Control (8 items; e.g., "My parents do not talk to me when I disappointed them until I please them again") was taken from the translated version of Barber's Psychological Control Scale (Barber, 1996; Soenens et al., 2006). One additional item for this subscale was based on a study by Soenens, Sierens, Vansteenkiste, Dochy, and Goossens (2012). The subscale Hostility (6 items; e.g., "My parents yell at me when I misbehave") was based on the Verbal Hostility Scale (Nelson & Crick, 2002), which was developed to assess intrusive parenting alongside corporal punishment.

All items were rated by mothers, fathers, and adolescents on a 5-point scale ranging from 1 = *(almost) never* to 5 = *(almost) always*. The parent version of the questionnaires was adapted to reflect their perspective (e.g., "My parents" was replaced with "I"). Mothers and fathers reported on their own respective parenting behavior, whereas the adolescent reported on parenting in general, with no differentiation made between maternal and paternal parenting. This decision was made to limit the number of questions - on the already extensive questionnaires - for the adolescent and is justified by previous research suggesting that children's ratings of mother's and father's Positive Parenting ($r = .74$) and Negative Control ($r = .70$) are highly correlated (Janssens et al., 2015; Van Leeuwen, Mervielde, Braet, & Bosmans, 2004).

In the GEM data set (i.e., Sample 2), parental support and criticism were observed during the parent-child interaction task at Wave 1. Global codes for each aforementioned parenting construct were assigned on a scale of 1 to 5 (1 = "*not at all characteristic of the parenting behavior during the interaction*" and 5 = "*highly characteristic of the parenting behavior during the interaction*"). These codes were based on validated parent-child coding systems and reflect theoretically grounded parenting dimensions (Melnick & Hinshaw, 2000; NICHD Early Child Care Research Network, 1999). Codes are consistent with prior work assessing positive and negative parenting (Chi & Hinshaw, 2002; Corona et al., 2005; Davidov & Grusec, 2006). About 20% of observations were videotaped and double coded.

6.2.3 Adolescent Personality

General personality characteristics are measured at Wave 1 to 6 (mother, father, and adolescent reports) with the Quick Big Five (QBF; Vermulst & Gerris, 2005). The Big Five personality dimensions are *Openness* (6 items; e.g., "artistic"), *Conscientiousness* (6 items; e.g., "organized"), *Extraversion* (6 items; e.g., "withdrawn"), *Agreeableness* (6 items; e.g., "friendly") , and *Neuroticism* (6 items; e.g., "anxious"). Participants indicate to which extent

the characteristic adequately describes themselves on a Likert scale ranging from 1 *(totally incorrect)* to 7 *(totally correct).*

6.2.4 Adolescent Temperament

A short form of the Adult Temperament Questionnaire (ATQ; Evans & Rothbart, 2007), measuring Negative affect (26 items; e.g., "I find loud music unpleasant"), Extraversion/Surgency (17 items; e.g., "In general, I like to talk a lot"), Effortful control (19 items; e.g., "I am capable of persisting on a task, even I do not want to do it."), and Orienting sensitivity (15 items; e.g., "I appear to comprehend things intuitively"), is completed by the adolescents in Wave 4 to 6. All items were rated by adolescents on a 7-point scale ranging from 1= *(almost) never* to 7= *(almost) always*.

6.2.5 Genetic markers

To obtain genetic information, adolescents donated a saliva sample using Oragene DNA collection kits (DNA Genotek; Ontario, Canada) at Wave 1. DNA is available for 97% of the sample. For genotyping Illumina technology was used. Previous studies used a candidate gene approach (Schmidt, Fox, & Hamer, 2007; Seo, Patrick, & Kennealy, 2008), which means that they investigated the association between a Single Nucleotide Polymorphisms (SNP) in a single gene and an outcome. A SNP is a variation in a single base pair in the human genome. For example, the replacement of a C for a G in the following nucleotide sequence AACGAT results in AACCAT. As mentioned before, a polygenic approach proves to be an interesting alternative for the single gene approach. In Chapter 5, a Biologically Informed Multilocus Profile Score (BIMPS) by Nikolova et al. (2011) is used. Using this approach, a BIMPS score was computed for each adolescent including four dopaminergic polymorphisms. Two variable number tandem repeats (VNTRs), the 40-bp VNTR in the DAT1 gene and the 48-bpVNTR in the DRD4 gene as well as two single nucleotide polymorphisms (SNPs), the DRD2 Taq1A polymorphism (rs1800497) and the COMT Val/Met polymorphism (rs4680). Nikolova et al. (2011) also used a fifth polymorphism, the DRD2-141C Ins/Del polymorphism (rs1799732), but this was not available in the present dataset. In the method of Nikolova et al. (2011) genotypes associated with relatively high striatal dopamine signaling and/or reward-related ventral striatum reactivity received a score of 1, intermediate genotypes a score of 0.5, and low genotypes a score of 0. The BIMPS was computed by summing all the scores, which resulted in a continuous variable.

7. Overview of the Chapters

The following four chapters of this dissertation will address in detail the research aims mentioned in Chapter 1. *Chapter 2* investigates measurement invariance of the five-factor parenting model by Janssens et al. (2015) across informants (i.e., mothers, fathers, and adolescents) and across developmental periods (i.e., early, middle, and late adolescence) and provides a description of the developmental trajectories of these five parenting dimension across adolescence. *Chapter 3* presents a study investigating heterogeneity in parenting practices. Specifically, this chapter assesses whether there are distinguishable longitudinal subgroups per parenting dimension and whether these subgroups differ regarding the development of externalizing problem behavior across adolescence. *Chapter 4* examines the interplay between parental control, adolescent personality, and externalizing problem behavior in early and middle adolescence. *Chapter 5* presents a study that uses two independent samples to investigate whether the longitudinal association between parenting and externalizing problem behavior is mediated by adolescent effortful control, and whether this mediation is moderated by activity of the dopaminergic pathway. We used a polygenic index score (i.e., DRD2, DRD4, DAT1, and COMT) to represent dopamine activity. Finally, *chapter 6* provides a general discussion of findings in the present dissertation. Besides indicating the scientific contribution of the studies, we discuss future research directions as well as practical implications of this dissertation.

Chapter 2
Measuring Parenting Throughout Adolescence: Measurement Invariance Across Informants, Mean Level, and Differential Continuity

Abstract

First, we examined whether an established five-dimension parenting model including support, proactive control, punitive control, harsh punitive control, and psychological control, showed longitudinal invariance across time (i.e., early, middle, and late adolescence) and measurement invariance across informants (i.e., mothers, fathers, and adolescents). Second, patterns of continuity and discontinuity in these dimensions were examined from the perspective of the different informants. In a four-wave accelerated longitudinal study with 1,111 adolescents and their parents, a multigroup structural equation modelling showed partial scalar invariance across adolescence and across informants. Subsequent growth modelling indicated that parenting was relatively stable over time and that similar patterns were present for mother, father, and adolescent ratings of parenting. Future research on associations between parenting and adolescent development can build on the findings of this study, given that comparing perspectives on parenting by different informants and over time seems to be valid.

1. Introduction

Parenting is considered a crucial factor in the development of adaptive and maladaptive functioning in adolescents (Lerner, Rothbaum, Boulos, & Castellino, 2002). For example, studies have shown that a lack of behavioral control, which refers to parenting practices attempting to influence and control children's behavior (Barber, Olsen, & Shagle, 1994), is associated more strongly with the development of externalizing problem behavior (Janssens et al., 2015). Psychological control, that is, the act of manipulating children's thoughts, feelings, and emotions to restrict their emotional and psychological development (Barber, 1996), is linked more strongly to internalizing problem behavior (Galambos, Barker, & Almeida, 2003; Soenens, Vansteenkiste, Luyckx, & Goossens, 2006). Concerning adaptive functioning, parenting is linked to the child's emotional regulation and overall psychosocial adjustment (Otterpohl & Wild, 2013). According to Darling and Steinberg (1993), parenting practices are specific goal-directed attempts by the parent to socialize the adolescent in a particular fashion, for instance, laying down homecoming rules to prevent rule-breaking behavior, or giving a compliment to stimulate academic achievement. Despite the acknowledgment of parenting as an environmental factor influencing adolescent development, its conceptualization and operationalization are still unclear. In empirical studies, various dimensions have been hypothesized to constitute parenting (Brown, Mounts, Lamborn, & Steinberg, 1993; Lamborn, Mounts, Steinberg, & Dornbusch, 1991; Sessa, Avenevoli, Steinberg, & Morris, 2001). However, these dimensions are operationalized in different ways and sometimes parallel concepts are labeled differently. For example, the labels nurturance and affection seem to cover more or less the same content.

In studying associations between parenting practices and adolescent outcomes, a first crucial question is whether adolescents and their parents conceive parenting dimensions in a similar way. Adolescents and parents can have different perspectives on parenting practices. For example, adolescents may think that parental supervision is too strict, whereas parents deem it only normal. Studies have not only confirmed these discrepancies between informants but also found evidence for associations between perceived parenting differences, on the one hand, and adolescent problem behavior and the efficacy of prevention programs, on the other (Achenbach, McConaughy, & Howell, 1987; De Los Reyes et al., 2012; De Los Reyes & Kazdin, 2005; Laird & De Los Reyes, 2013). To arrive at valid conclusions about parenting when using different informants, it is important to check first of all whether these informants rate parenting in a similar way, that is, to test measurement invariance across informants.

A second question pertains to the development of parenting throughout adolescence. Because of the physical, cognitive, and intraindividual changes in adolescents, combined with developmental transformations in their parents who are entering midlife, parent–child interactions may change (Steinberg & Silk, 2002). For example, parents could increase supervision of their adolescent's behavior, because they want to monitor the social relationships of their son or daughter or prevent rule-breaking behavior, or they could be more autonomy supporting. However, because parenting is thought of as providing a stable context in which a child develops (Darling & Steinberg, 1993), it is also possible that it is rather stable over time. A perusal of the literature revealed that surprisingly few studies have examined parenting development throughout adolescence (De Goede, Branje, & Meeus, 2009; Giles-Sims, Straus, & Sugarman, 1995). Therefore, it is difficult to arrive at conclusive statements on this matter. A preliminary requirement when examining this topic is to establish measurement invariance of the questionnaires assessing parenting across time. The current study examines whether there is a single factor structure that fits the parenting concept and its underlying dimensions across early, middle, and late adolescence, and across ratings by fathers, mothers, and adolescents.

1.1 Previous Research on Parenting as a Multidimensional Concept

In his seminal work on parenting, later supported by Baumrind's (1991) theory of parenting styles, Schaefer (1965) has provided the theoretical basis for further research with his three-dimensional framework. He referred to these dimensions as acceptance/rejection, psychological control/psychological autonomy, and firm control/lax control. In line with previous studies (Barber, Maughan, & Olsen, 2005), and for the sake of clarity and consistency, the labels parental support, behavioral control, and psychological control will be used in the present study. Empirical studies have moved beyond Schaefer's theoretical perspective and have shown that more than three dimensions are needed to grasp the complexity of the parenting concept. For example, Janssens et al. (2015) conducted confirmatory factor analyses (CFAs) on several parenting measures in a sample of 12- to 14-year-old adolescents and found that five broadband dimensions showed the best fit with the concept of parenting. These dimensions were parental support, proactive control, punitive (nonphysical) control, harsh punitive (physical) control, and psychological control. Configural and metric invariance was established across mothers, fathers, and adolescents. Another study (Spithoven, Bijttebier, Van Leeuwen, & Goossens, 2016) replicated this structure in a sample of early adolescents and found evidence for four of these parenting dimensions, that is, parental support, psychological control, reactive

control, and proactive control. The fifth dimension, that is, harsh punitive control, was not replicated due to a lack of variance for this construct.

In this section, we discuss previous research on each of these five dimensions with a focus on early, middle, and late adolescence (i.e., ages 12-14, 15-16, and 17-18 years, respectively). *Parental support* refers to involvement, acceptance, emotional availability, and responsivity, which will assist a child in developing a sense of individuality and the capacity to self-regulate (Janssens et al., 2015). Although parental support remains important throughout adolescence, mean levels do not always seem stable. A study by De Goede et al. (2009) showed that over a 4-year period, adolescents perceived a decline in parental support from early to middle adolescence. The same study suggested a gender difference in the transition from middle to late adolescence, with girls reporting an increase in support, and boys perceiving support as stable (De Goede et al., 2009). The extent to which adolescents feel supported by their parents predicts a broad array of developmental outcomes (Bronstein, Fox, Kamon, & Knolls, 2007; Tang & Davis-Kean, 2015). For example, studies have found that parental support at age 11 positively predicts the sense of morality in late adolescence (Bronstein et al., 2007), and a warm and supportive home environment is related to better academic performance (Tang & Davis-Kean, 2015). A lack of parental warmth, by contrast, has been shown to predict depressive symptoms, test anxiety, and diminished self-confidence (Ringeisen & Raufelder, 2015; Wang, Chan, Lin, & Li, 2015).

Proactive control is a preventive technique to anticipate undesirable child behavior by providing a structured environment through rule setting and monitoring (Janssens et al., 2015). This technique predicts more favorable developmental outcomes than reactive forms of behavioral control (e.g., time-out from an enjoyable activity or slapping; Bender et al., 2007; L. Chang, Schwartz, Dodge, & McBride-Chang, 2003; Galambos et al., 2003; Gray & Steinberg, 1999; Grolnick & Pomerantz, 2009). More proactive control is associated with less externalizing problem behavior in early adolescence (Barber et al., 1994; Galambos et al., 2003; Mason, Cauce, Gonzales, & Hiraga, 1996). Furthermore, proactive control is also associated with positive development in the domains of academic performance in early adolescence and peer relations in middle to late adolescence (Gray & Steinberg, 1999; Krevans & Gibbs, 1996). Punitive (nonphysical) control is a type of controlling behavior characterized by using nonphysical punishments, such as a time-out, lecturing, or grounding. It is a reactive form of parenting following unwanted child behavior, and can be distinguished from another reactive form, that is, harsh physical punitive control. The latter form of control includes a crucial physical aspect (Janssens et al., 2015). Effects of nonphysical punishments in adolescence have

received rather limited research attention. One study (Tang & Davis-Kean, 2015) indicated that nonphysical punitive strategies in middle adolescence were associated with a diminished academic performance 5 years later.

Harsh (physical) punitive control denotes physical punishment (e.g., spanking), following unwanted behavior. Physical punishment declines in early adolescence (Giles-Sims et al., 1995). Studies have shown that early and middle adolescents who have experienced physical punishment reported higher levels of externalizing problem behavior and depression (Bender et al., 2007; Lansford et al., 2011). A recent meta-analysis (Gershoff & Grogan-Kaylor, 2016) on the effects of parental spanking to correct misbehavior supported these findings, because it showed associations between this punishment technique and detrimental child and adolescent outcomes, such as externalizing and internalizing problems, and lower moral internalization and self-esteem, with no moderating effect of age group. More spanking was also related to a larger risk of physical abuse by parents, and spanking and physical abuse seemed to have similar associations with child outcomes (Gershoff & Grogan-Kaylor, 2016). Externalizing problems and physical punishment may trigger each other alternately, and this vicious cycle can have detrimental effects in the long term (Wang & Kenny, 2014). The mechanism may be comparable to Patterson's coercion theory (1982), which states that caregiver's inadequate responses (e.g., giving in, hostile, and harsh reactions) to difficult child behaviors (e.g., resistance to a request) result through a process of mutual reinforcement in escalating child aversive and aggressive behaviors. However, various additional factors should be considered concerning the effects of childhood physical punishment on developmental outcomes, such as the perceived intentions of the punishment and genetic vulnerabilities (Boutwell, Franklin, Barnes, & Beaver, 2011; MacKinnon-Lewis, Lindsey, Frabutt, & Chambers, 2014).

Psychological control includes intentional, strategic parental behavior that manipulates or dominates the child, for example, by invalidating expressed feelings, constraining verbal expression, or using love withdrawal and guilt induction (Barber, 1996; Barber, Xia, Olsen, McNeely, & Bose, 2012). Given the intrusive nature of this parenting practice, it is negatively associated with adequate adolescent development. In most studies, adolescent-reported measures of psychological control are used. In early to middle adolescence, this parenting practice predicts internalizing and, to a lesser extent, externalizing problems (Barber et al., 1994; Pettit, Laird, Dodge, Bates, & Criss, 2001). The negative effects of this parenting technique are also noticeable in lower satisfaction with peer relationships (Tuggle, Kerpelman,

& Pittman, 2014), and in some studies even hampered overall emotional functioning (Wang, Pomerantz, & Chen, 2007).

A detailed picture of multiple parenting dimensions as they unfold over time, from the perspective of both parents and adolescents, is not available today. However, if we want to investigate internalizing problems, we first need to know whether the structure of parenting is invariant across and covary with developmental outcomes. For example, a fluctuating course of a parenting dimension may show a stronger association with an outcome variable than a stable course.

1.2 The Present Study

The present study had three objectives. First, we investigate the validity of a five-factor model of parenting that was suggested earlier by Janssens et al. (2015) for the age range 12 to 14 years. The current study uses data from the same longitudinal project that Janssens et al. (2015) relied on, but expands on the findings of that study by investigating measurement invariance and stability of parenting across the entire range of adolescence (i.e., from 12 to 18 years) in a longitudinal design and across mothers, fathers, and adolescents as informants. Measurement invariance is a basic condition for all further analyses. Second, if such invariance is established, the developmental course for all of the dimensions identified will be systematically described through analyses of mean-level continuity. Third, analyses on differential continuity will provide information on the stability of interindividual differences between successive ages. This type of stability entails that an individual who scores high at one point in time, also scores high at the next time point. Such associations can be expressed through autoregressions. All analyses will be conducted on data from four annual waves of parenting questionnaires that were completed by adolescents, fathers, and mothers separately.

Concerning the developmental course of the parenting dimensions throughout adolescence, some hypotheses can be formulated. We expect that, on average, parental support will decrease from early to middle adolescence, with a stable course from middle to late adolescence based on results by De Goede et al. (2009). The course of the behavioral control dimensions (i.e., proactive control, punitive, and harsh punitive control) is hypothesized to decline from early over middle to late adolescence. This course was already established for harsh punitive control in previous research (Giles-Sims et al., 1995). In line with our hypotheses for behavioral control, we expect psychological control to decrease throughout adolescence. In general, both behavioral and psychological control are expected to decrease, because the adolescent is gaining more autonomy with advancing age. Concerning possible gender

differences, that is, whether parenting takes on a different form for boys and girls over the course of adolescence, we expected that adolescent gender is not significantly associated with differences in the trajectories of the parenting dimensions. This hypothesis is based on previous research that there are some gender differences in parenting (e.g., slightly more controlling parenting for boys), but that their effect size is negligible (Endendijk, Groeneveld, Bakermans-Kranenburg, & Mesman, 2016). Furthermore, earlier work did not find a gender effect concerning autonomy-supportive parenting (Endendijk et al., 2016). Concerning interindividual stability, we expect high stability over time, given that Loeber et al. (2000) found high relative stability of family interactions from middle childhood through late adolescence.

2. Method

2.1 Participants and Procedure

Data were collected within the STRATEGIES project (i.e., Studying Transactions in Adolescence: Testing Genes in Interaction With Environments), a longitudinal study with annual measurements and conducted in Flanders, the Dutch-speaking part of Belgium. A randomized multistage sampling approach was used. First, Flemish secondary schools were invited to take part in the research project. To include students from the general, technical, and vocational tracks, the schools were stratified by educational track. Second, from the nine schools that participated in the study, 121 classes in the seventh, eighth, and ninth grade were selected. Within these classes, all students and their mothers and fathers were invited to participate and to provide active consent. Adolescents filled out the questionnaires at school under supervision of a researcher and when extra time was needed, they finished it at home within 2 weeks. Parents completed questionnaires at home, either online using a personal link through e-mail, or using a paper-and-pencil version which they returned in a closed envelope via regular mail.

This approach resulted in a sample at Wave 1 of 1,116 adolescents (M_{age} = 13.79, SD = 0.93, 51% boys), 747 mothers (M_{age} = 43.59, SD = 4.45), and 645 fathers (M_{age} = 45.32, SD = 4.69). The retention rate was 89% for adolescents, 75% for mothers, and 72% for fathers in the second wave. In the third wave, the retention rate for adolescents fell to 79%, with a retention rate of 66% for mothers and 63% for fathers. In the fourth wave, the retention rates were 45%, 38%, and 40%, respectively (N adolescent = 498, N mother = 322, N father = 288). Family characteristics of the sample were representative for the general population, but bachelor

degrees and active employees were slightly overrepresented regarding socioeconomic status (Janssens et al., 2015).

The STRATEGIES project used an accelerated longitudinal design. The main benefit of this design is its ability to span a wider age range than would be possible with a regular longitudinal design. The underlying concept is that in every wave a particular age range is covered, which will overlap with the age range of the next wave. This way, the total age range will expand faster than a regular longitudinal design. This allows us to study an age range of 6 years, that is, from age 12 to 18 years, using data from four waves. In Wave 1, Grades 7, 8, and 9 were included. In Wave 2, Grades 8, 9, and 10 were included. Wave 3 used a sample that comprised Grades 9, 10, and 11, whereas Wave 4 included Grades 10, 11, and 12. The study design is represented in Table 1.

Table 1

Schematic Representation of an Accelerated Longitudinal Design of Four Waves, Resulting in Six Time Points

	T1	T2	T3	T4	T5	T6	
Wave 1	7	8	9				
Wave 2		8	9	10			grade
Wave 3			9	10	11		
Wave 4				10	11	12	

2.2 Measures

2.2.1 Parenting behavior

Parenting was rated by mothers, fathers, and adolescents using a total of 64 items from 10 subscales from multiple questionnaires. These questionnaires and respective subscales were selected based on their availability in Dutch (i.e., participants' native language), theoretical relevance, adequate psychometric properties, and use in previous parenting research (e.g., Manrique Millones, Ghesquière, & Van Leeuwen, 2014). A CFA on these questionnaires resulted in the five parenting dimensions mentioned earlier (Janssens et al., 2015). Cronbach's alphas of the subscales in the current study are presented below.

The dimension Parental Support comprised three parenting measures: (a) the Positive Parenting subscale (eight items, Cronbach's α from .85 to .88; e.g., "If I want to tell something, my parents take their time for listening to me") from the Parental Behavior Scale–Short Form

(PBS-S; Van Leeuwen et al., 2013), (b) the Responsivity subscale (seven items, α from .83 to .89; e.g., "My parents can make me feel better when I am feeling upset") from the Louvain Adolescent Perceived Parenting Scale (Delhaye, Beyers, Klimstra, Linkowski, & Goossens, 2012), which is an adaptation of a subscale of the Child Report of Parental Behavior Inventory (Schludermann & Schludermann, 1988), and (c) the Autonomy Support scale (eight items, α from .81 to .84; e.g., "My parents take into account my opinion on affairs that concern me"), based on the Perceptions of Parents Scale (Grolnick, Ryan, & Deci, 1991) and the Research Assessment Package for Schools (Institute for Research and Reform in Education, 1998).

The dimension Proactive Control consisted of two measures, that is, the subscale Setting Parental Expectations for Behavior (six items, α from .78 to .82; e.g., "My parents expect me to behave in a certain manner") and Parental Monitoring of Behavior (six items, α from .66 to .72; e.g., "My parents remind me of the rules they made"). They were selected from the Parental Regulation Scale (Barber, 2002), which was translated in Dutch by Soenens et al. (2006). The dimension Punitive Control consisted of the punishment subscale (four items, α from .86 to .88; e.g., "If I do something I was not supposed to, my parents punish me") from the PBS-S (Van Leeuwen et al., 2013).

The dimension Harsh Punitive Control was measured through the subscale Harsh Punishment (five items, α from .78 to .88, e.g., "My parents hit me in the face when I misbehave myself") from the PBS-S (Van Leeuwen et al., 2013).

The dimension *Psychological Control* consisted of two subscales. The subscale Psychological Control (8 items, α from .73 to .79; e.g., "My parents do not talk to me when I disappointed them until I please them again") was taken from the translated version of Barber's Psychological Control Scale (Barber, 1996; Soenens et al., 2006). One additional item for this subscale was based on a study by Soenens, Sierens, Vansteenkiste, Dochy, and Goossens (2012). The subscale Hostility (6 items, α from .77 to .85; e.g., "My parents yell at me when I misbehave") was based on the Verbal Hostility Scale (Nelson & Crick, 2002), which was developed to assess intrusive parenting alongside corporal punishment.

All items were rated by mothers, fathers, and adolescents on a 5-point scale ranging from 1 = *(almost) never* to 5 = *(almost) always*. The adolescent version of the questionnaires was adapted to reflect their perspective (e.g., "I" was replaced with "My parents"). Mothers and fathers reported on their own respective parenting behavior, whereas the adolescent reported on parenting in general, with no differentiation made between maternal and paternal parenting. This decision was made to limit the number of questions – on the already extensive questionnaires – for the adolescent and is justified by previous research suggesting that

children's ratings of mother's and father's Positive Parenting ($r = .74$) and Negative Control ($r = .70$) are highly correlated (Van Leeuwen, Mervielde, Braet, & Bosmans, 2004).

2.3 Analysis Strategy

All analyses were carried out in MPlus Version 7 (Muthén & Muthén, 2012). Due to dropout throughout this longitudinal study, sample size varied across time points. This dropout was recorded as missing values and was handled in MPlus through Full Information Maximum Likelihood (FIML).

2.3.1 Measurement Invariance (MI) Analysis

Measurement invariance analysis was used to examine whether the same factor structure fitted the parenting concept across informants and time. More specifically, the subscales described above were included in the analyses to investigate invariance of the respective parenting dimensions. This approach consisted of stepwise multigroup CFAs which tested three nested models from which an increasing number of parameters were constrained gradually (Meredith, 1993). These three nested models reflected three levels of measurement invariance, that is, configural, metric, and scalar invariance. First, configural invariance is the most lenient form of invariance (Meredith, 1993). At this level, one tests whether the same number and pattern of latent factors (i.e., parenting dimensions) underlie a given concept across informants and time. This is accomplished by fitting a model with the same factors for each informant or for each time moment, but factor loadings may depend on the informant or time point. A good model fit indicates that parenting is conceptualized in the same manner across informants or across time. Second, metric invariance implies that factor loadings are held equal across informants or across time, whereas the item intercepts are allowed to differ (Meredith, 1993). If the model fit does not significantly worsen compared with the previous model that was used to assess the configural level, metric invariance is established. This means that the latent dimensions are measured in the same way across informants or across time and that score differences reflect actual differences in responses which cannot be attributed to measurement error. Third, scalar invariance represents the highest level of measurement invariance (Meredith, 1993). To test for this type of invariance, both the item factor loadings and intercepts are held equal across informants or across time. If the model fit again does not significantly worsen compared with the fit of the previous model, it is meaningful to compare the scores, or means, across informants or across time. Being able to compare across contexts provides the broadest amount of information and assists in mapping out the concept of parenting. However, full scalar invariance represents a very stringent demand and is far from self-evident. When this

demand is not met, it is possible to test for partial scalar invariance, which also allows researchers to compare parenting scores across informants or across time points (Byrne, Shavelson, & Muthén, 1989). In the case of partial invariance, at least two indicators per factor need to be invariant (Steenkamp & Baumgartner, 1998). Our model has a limited number of indicators per construct, and, as such, the possibilities to relax constrained parameters are limited. Nevertheless, partial scalar invariance will be tested if full scalar invariance is unattainable.

Across informants analyses. Measurement invariance was tested across informants for each time point separately. The data were analyzed for the three groups of informants simultaneously (i.e., three-group measurement invariance), as well as for the respective dyads, that is, mother–father, mother–adolescent, and father–adolescent at each of the six time points. The analyses concerning the dyads were conducted to provide a more detailed overview of the situation across informants. Also, in the case of noninvariance, these analyses can provide more information on where the invariance or lack thereof is situated. This approach led to a total of 4 x 6 or 24 measurement invariance analyses. Dependency within families was accounted for by clustering the data of parents and adolescents from the same family.

Across age analyses. The same type of analysis was carried out to assess whether the parenting measures employed were invariant across age for each informant separately. Six time points per informant were included and that covered early, middle, and late adolescence. One analysis for the whole time span per informant was conducted to assess invariance across time, which resulted in three MI analyses.

Multiple criteria were used to assess model fit for the simple reason that every criterion captures different aspects of the model specification. Using a larger number of criteria provides more information and leads to a well-advised decision concerning model acceptance or rejection (Vandenberg & Lance, 2000). Chen et al. (2007) suggested three widely used model fit criteria, that is, the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean squared residual error (SRMR). Concerning the CFI, a value above .95 is deemed a good fit. The cut-off value for the RMSEA is .08, but below .05 is preferred. Finally, the value of the SRMR should not exceed .08 (Browne & Cudeck, 1992; Hu & Bentler, 1999). When testing for metric invariance, model fit should not be significantly worse compared to the configural level. Specific cut-off values are used to assess these differences in fit criteria between successive levels of measurement invariance. Such differences should not exceed .010 for the CFI (ΔCFI < .010), .015 for the RMSEA (ΔRMSEA< .015), and .030 for the SRMR (ΔSRMR< .030) (Chen, 2007). For the fit differences between

the metric and scalar level, these values are .010, .015 and .010 respectively (i.e., ΔCFI < .010, ΔRMSEA < .015, and ΔSRMR < .010) (Chen, 2007). In case of inconsistency across the three fit indexes, we based our decision on the two criteria that pointed in the same direction.

2.3.2 Mean-Level Continuity

To examine the continuity of the five dimensions that underlie parenting, growth curve modelling was used. These growth curves were also plotted to visually inspect the stability of the means of each parenting dimension per informant. Gender was taken into account as a covariate to assess its effect on the growth parameters (i.e., intercept and slope of the growth curve). This allowed us to explore whether parenting differs for boys and girls over the course of adolescence. These analyses were carried out for each of the dimensions per informant separately (i.e., 5 dimensions x 3 informants)

2.3.3 Differential Continuity

A third and last type of analysis was meant to provide information about the continuity or lack thereof between two successive time points, that is, differential continuity. Whether and how Time point k is linked with Time point $k + 1$ was assessed per dimension and per informant between successive time points by autoregressing Time point $k + 1$ on Time point k.

3. Results

3.1 Measurement Invariance Analyses

The mean scores and standard deviations of the parenting dimensions per informant and per time point are presented in Table 2. To assess whether comparisons between informants are allowed, measurement invariance analyses were conducted, for each time point, across the three groups of informants simultaneously and between dyads. Results are shown in Table 3 Panels A and B. Across the three informants, full scalar invariance held at T5 and T6, whereas partial scalar invariance was established at T1 and T4. Metric invariance was found at T2 and T3. Concerning the Mother–Father dyad, full scalar invariance was found at T5, whereas partial scalar invariance was established at T1, T2, T3, and T4. A remarkable observation was that at T6, none of the forms of invariance held, including the simplest form, configural invariance. Concerning the Mother–Adolescent dyad, we concluded that full scalar invariance held at T5 and T6, whereas partial scalar invariance held at T1, T3, and T4. Metric invariance was found at T2. Concerning the Father–Adolescent dyad, full scalar invariance held at T5, and T6, whereas partial scalar invariance was established at T1, T3, and T4. Metric invariance held at

T1 and T2. There was no distinct pattern in the results of measurement invariance analyses across informants. The dyads showed at least partial scalar invariance at the majority of the time points, which allows researchers to compare these dyads at these time points.

Table 2

Means (Standard Deviation) of Five Parenting Dimensions per Informant at Each Time Point

	Mean (SD)				
	Support	Proactive control	Punitive control	Harsh punitive control	Psychological control
Mother					
T1	4.29 (0.40)	4.23 (0.53)	3.02 (0.97)	1.11 (0.26)	1.87 (0.51)
T2	4.28 (0.41)	4.17 (0.51)	2.93 (0.89)	1.06 (0.21)	1.82 (0.49)
T3	4.25 (0.42)	4.14 (0.50)	2.84 (0.88)	1.07 (0.24)	1.84 (0.52)
T4	4.23 (0.42)	4.09 (0.51)	2.74 (0.93)	1.05 (0.18)	1.81 (0.50)
T5	4.24 (0.43)	4.05 (0.54)	2.48 (0.91)	1.03 (0.13)	1.76 (0.49)
T6	4.20 (0.43)	3.81 (0.56)	2.14 (0.83)	1.02 (0.08)	1.58 (0.42)
Father					
T1	4.00 (0.54)	4.05 (0.62)	2.96 (0.90)	1.12 (0.30	1.96 (0.52)
T2	3.97 (0.50)	4.00 (0.51)	2.83 (0.87)	1.09 (0.28)	1.91 (0.51)
T3	4.06 (0.52)	4.05 (0.54)	2.79 (0.88)	1.08 (0.30)	1.84 (0.49)
T4	4.11 (0.50)	4.04 (0.52)	2.73 (0.90)	1.05 (0.16)	1.81 (0.49)
T5	4.14 (0.46)	4.00 (0.56)	2.44 (0.89)	1.04 (0.15)	1.77 (0.50)
T6	3.91 (0.63)	3.84 (0.59)	2.25 (0.89)	1.01 (0.06)	1.75 (0.60)
Adolescent					
T1	3.99 (0.64)	3.72 (0.67)	2.80 (1.05)	1.33 (0.64)	1.87 (0.66)
T2	3.90 (0.65)	3.74 (0.64)	2.69 (1.00)	1.23 (0.54)	1.87 (0.64)
T3	3.82 (0.66)	3.79 (0.60)	2.64 (1.00)	1.19 (0.45)	1.95 (0.65)
T4	3.85 (0.63)	3.83 (0.58)	2.53 (1.01)	1.16 (0.43)	1.94 (0.66)
T5	3.89 (0.59)	3.89 (0.59)	2.41 (0.99)	1.09 (0.29)	1.89 (0.59)
T6	3.98 (0.56)	3.92 (0.58)	2.29 (0.94)	1.09 (0.28)	1.92 (0.61)

Table 3a

Measurement Invariance Analyses at Each Time Point

		Three-Group Comparisons						Mother-Father Comparisons					
	Type	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR	ΔSRMR	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR	ΔSRMR
T1	Configural	.975		.066		.030		.985		.047		.029	
	Metric	.973	.002	.063	.003	.054	.024	.987	.002	.041	.006	.031	.002
	Scalar	.944	.029	.086	.023	.078	.024	.973	.014	.056	.015	.047	.016
	Part. scalar	.957	.016	.078	.015	.044	.010	.979	.008	.051	.010	.036	.005
T2	Configural	.977		.062		.028		.977		.057		.028	
	Metric	.977	.000	.059	.003	.044	.016	.978	.001	.053	.004	.033	.005
	Scalar	.942	.035	.087	.028	.073	.029	.961	.017	.067	.014	.052	.019
	Part. scalar	.950	.027	.083	.024	.055	.011	.965	.013	.065	.012	.042	.009
T3	Configural	.975		.064		.026		.971		.065		.028	
	Metric	.975	.000	.060	.004	.037	.011	.972	.001	.061	.004	.030	.002
	Scalar	.949	.026	.081	.021	.061	.024	.956	.016	.073	.012	.045	.015
	Part. scalar	.958	.017	.076	.016	.042	.005	.961	.011	.070	.003	.038	.008
T4	Configural	.973		.070		.029		.970		.066		.029	
	Metric	.969	.004	.071	.001	.056	.027	.970	.000	.063	.003	.039	.010
	Scalar	.947	.022	.086	.015	.075	.019	.950	.020	.078	.015	.052	.013
	Part. scalar	.954	.015	.083	.012	.064	.008	.953	.017	.077	.014	.049	.010
T5	Configural	.969		.075		.036		.962		.079		.035	
	Metric	.967	.002	.073	.002	.060	.024	.957	.005	.080	.001	.063	.028
	Scalar	.960	.007	.075	.002	.061	.001	.952	.005	.081	.001	.063	.000
T6	Configural	.956		.097		.048		.916		.137		.060	
	Metric	.968	.012	.077	.020	.060	.012						
	Scalar	.961	.007	.081	.004	.064	.004						

Note. CFI= Comparative Fit Index, RMSEA= Root Mean Square Error of Approximation, SRMR= Standardized Root Mean square Residual, Δ = Difference with the previous level.

Table 3b

Measurement Invariance Analyses at Each Time Point

	Type	*Father-Adolescent Comparisons*						*Mother-Adolescent Comparisons*					
		CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR	ΔSRMR	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR	ΔSRMR
T1	Configural	.971		.072		.031		.971		.074		.031	
	Metric	.969	.002	.071	.001	.060	.029	.970	.001	.071	.003	.052	.021
	Scalar	.936	.033	.098	.028	.088	.028	.958	.012	.081	.010	.058	.006
	Part. scalar	.950	.019	.089	.018	.049	.011	.964	.006	.077	.006	.036	.015
T2	Configural	.977		.064		.028		.978		.063		.028	
	Metric	.976	.001	.062	.002	.046	.018	.977	.001	.061	.002	.039	.011
	Scalar	.943	.033	.091	.029	.077	.031	.959	.018	.079	.018	.053	.014
	Part. scalar	.952	.024	.085	.023	.056	.01	.961	.016	.078	.017	.054	.015
T3	Configural	.978		.060		.025		.975		.066		.025	
	Metric	.978	.000	.058	.002	.037	.012	.975	.000	.063	.003	.034	.009
	Scalar	.954	.024	.079	.021	.062	.025	.961	.014	.075	.012	.046	.012
	Part. scalar	.963	.015	.073	.015	.039	.002	.963	.012	.074	.011	.041	.007
T4	Configural	.974		.069		.029		.973		.074		.029	
	Metric	.972	.002	.068	.001	.051	.022	.969	.004	.076	.002	.055	.026
	Scalar	.954	.018	.083	.015	.067	.016	.959	.010	.083	.007	.067	.012
	Part. scalar	.959	.013	.080	.012	.052	.001	.963	.006	.081	.005	.065	.002
T5	Configural	.973		.069		.036		.969		.078		.037	
	Metric	.968	.005	.072	.003	.061	.025	.971	.002	.072	.006	.045	.008
	Scalar	.0965	.003	.072	.000	.063	.002	.966	.005	.076	.004	.045	.000
T6	Configural	.960		.090		.043		.975		.074		.044	
	Metric	.970	.01	.074	.016	.051	.008	.978	.003	.066	.008	.057	.013
	Scalar	.960	.01	.081	.007	.050	.001	.975	.000	.068	.002	.064	.007

Note. CFI= Comparative Fit Index, RMSEA= Root Mean Square Error of Approximation, SRMR= Standardized Root Mean square Residual, Δ = Difference with the previous level.

The longitudinal invariance of the five-dimension model was tested per informant across six time points. Results are summarized in Table 4. Using the criteria discussed in the Method section, we concluded that full scalar measurement invariance was established for mothers, fathers, and adolescents, respectively, across the six time points. This means that meaningful comparisons can be made for each informant across adolescence.

Table 4

Measurement Invariance Analysis of the Five Factor Parenting Model Across Six Time Points (Adolescent Grade 7 to 12)

	Type	CFI	ΔCFI	RMSEA	ΔRMSEA	SRMR	ΔSRMR
Mother	Configural	.972		.063		.030	
	Metric	.975	.003	.054	.011	.046	.016
	Scalar	.969	.006	.057	.003	.052	.006
Father	Configural	.970		.071		.031	
	Metric	.973	.003	.063	.008	.045	.014
	Scalar	.969	.004	.062	.001	.048	.003
Adolescent	Configural	.976		.070		.029	
	Metric	.976	.000	.064	.006	.037	.008
	Scalar	.971	.005	.066	.002	.039	.002

Note. CFI = Comparative Fit Index, RMSEA = Root Mean Square Error of Approximation, SRMR = Standardized Root Mean square Residual, Δ = Difference of the index with the previous level.

3.2 Mean-Level Continuity

The trajectories of the five parenting dimensions as reported by mothers, fathers, and adolescents are visualized in Figure 4. The general course of the dimensions appeared to be similar across informants. The support and the proactive control dimensions showed the highest mean scores and seemed to show a similar course. Both trajectories were relatively flat across the 6 years, with a small decline in proactive control at T6. Punitive control showed a declining trend from Time point 1 to Time point 6 in all three informants. Psychological control and harsh punitive control showed a stable course throughout adolescence with consistently low scores (harsh punitive control: scores ranging from 1 to 1.5 on a 5-point scale; psychological control: scores ranging from 1.5 to 2.5 on a 5-point scale) for both dimensions.
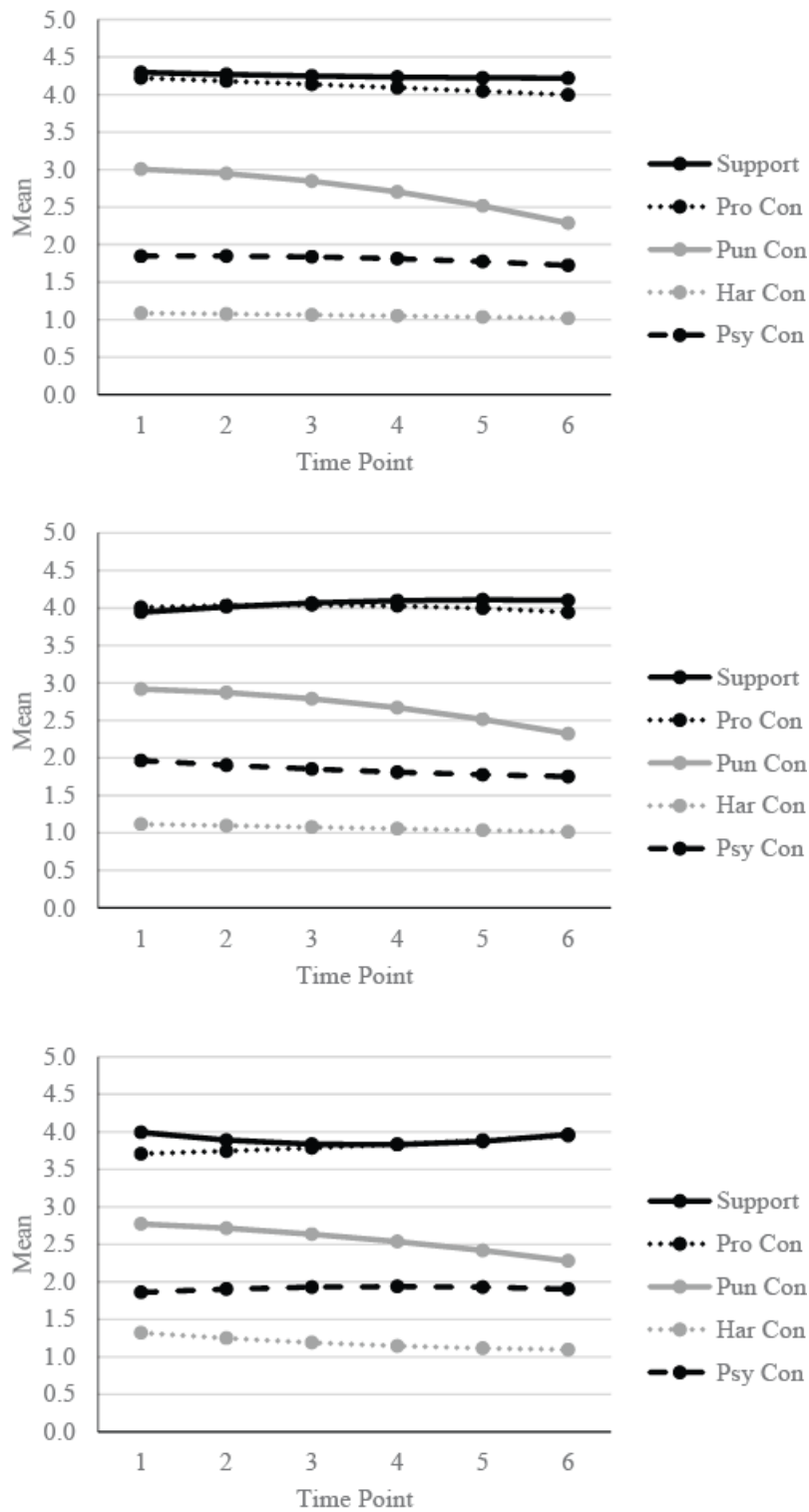
Figure 4. Development of (a) mother-reported parenting dimensions, (b) father-reported parenting dimensions, and (c) adolescent-reported parenting dimensions.

Note. Support = parental support; Pro Con = proactive control; Pun Con = punitive control; Har Con = harsh punitive control; Psy Con = psychological control.

Results of the analyses with adolescent gender as a covariate are shown in Table 5. Gender appeared to only significantly interact with the intercept of the trajectories, which meant that boys and girls had different values at T1, but that linear development of the dimensions (i.e., slope) was similar. For mother reports, there was a significant gender effect on the intercept, indicating that on average, mothers reported less proactive control (β = -0.093; p = .026), less punitive control (β = -0.315; p < .001) and, at a trend level, less harsh punitive control (β = -0.028; p = .086) for girls than for boys at T1. For father reports, a significant gender effect was found for the intercept of punitive control (β = -0.199; p = .010) and, at a trend level, less psychological control (β = -0.068; p = .069). Adolescents reported more support (β = 0.134; p = .001), less punitive control (β = -0.224; p = .001), less harsh punitive control (β = -0.085; p = .010), and, at a trend level, less psychological control (β = -0.084; p = .053) for girls than boys at T1.

3.3 Differential Continuity

Autoregressive coefficients (see Table 6) between parenting dimensions at two time points with a one-year interval were calculated to assess differential continuity. For mother reports, autoregressive coefficients for support, proactive, punitive and psychological control were all significant (p < .001) and standardized coefficients ranged from 0.132 to 0.947. For harsh punitive control, all autoregressions were significant at the .001 level, except for the autoregression of T6 at T5, which was still significant, but only at the .05 level. It should be noted that the autoregressive coefficient for the latter analysis was remarkable smaller (0.057), compared to the aforementioned range. For father reports, autoregressions for support, proactive and psychological control were significant at the .001 level and standardized coefficients ranged from 0.747 to 0.918. Autoregressions of punitive and harsh punitive control were significant at the .001 level, except for punitive control T2 at T1 (significant at .05 level) and harsh punitive control T6 at T5 (not significant). Together with the similar finding for the mother reports, this seems to indicate that individual differences in harsh punitive control reported by parents are relatively stable, but this stability diminishes over time. For adolescent reports, autoregressive coefficients were all significant at the .001 level and standardized coefficients ranged from 0.235 (Harsh punitive control T6 on T5) to 0.977 (Harsh punitive control T5 on T4). These findings indicated that the individual differences in perspectives on parenting practices as reported by adolescents seem stable throughout adolescence.

Table 5

Gender Effects on the Growth Parameters of Parenting Dimensions

Gender effect on	Parameter	β	SE	*p*
Mother				
Support	Intercept	0.035	1.070	.284
	Slope	0.017	1.058	.290
Proactive control	Intercept	-0.093	0.042	.026
	Slope	0.014	0.020	.487
Punitive control	Intercept	-0.315	0.073	.000
	Slope	0.056	0.035	.109
Harsh punitive control	Intercept	-0.028	0.016	.086
	Slope	0.004	0.005	.406
Psychological control	Intercept	-0.042	0.040	.302
	Slope	-0.004	0.019	.847
Father				
Support	Intercept	0.013	0.045	.781
	Slope	0.009	0.020	.654
Proactive control	Intercept	-0.035	0.049	.475
	Slope	-0.008	0.021	.703
Punitive control	Intercept	-0.199	0.077	.010
	Slope	0.021	0.035	.550
Harsh punitive control	Intercept	-0.016	0.021	.449
	Slope	-0.002	0.006	.797
Psychological control	Intercept	-0.068	0.037	.069
	Slope	0.000	0.003	.981
Adolescent				
Support	Intercept	0.134	0.042	.001
	Slope	0.007	0.019	.737
Proactive control	Intercept	0.000	0.43	.991
	Slope	0.023	0.019	.225
Punitive control	Intercept	-0.224	0.068	.001
	Slope	0.032	0.032	.317
Harsh punitive control	Intercept	-0.085	0.033	.010
	Slope	0.003	0.012	.803
Psychological control	Intercept	-0.084	0.043	.053
	Slope	0.009	0.020	.651

Table 6

Autoregressive Analyses (Standardized β) Assessing Differential Continuity Between Successive Time Points for Three Informants

	Time points	Support	Proactive control	Punitive control	Harsh punitive control	Psychological control
Mother						
	T2 on T1	0.901***	0.813***	0.907***	0.868***	0.132***
	T3 on T2	0.877***	0.813***	0.935***	0.955***	0.905***
	T4 on T3	0.912***	0.738***	0.924***	0.983***	0.947***
	T5 on T4	0.897***	0.881***	0.836***	0.892***	0.882***
	T6 on T5	0.985***	0.661***	0.563***	0.057**	0.218***
Father						
	T2 on T1	0.870***	0.918***	0.593**	0.413***	0.818***
	T3 on T2	0.907***	0.800***	0.920***	0.041**	0.771***
	T4 on T3	0.851***	0.747***	0.839***	0.955***	0.821***
	T5 on T4	0.823***	0.824***	0.602***	0.978***	0.792***
	T6 on T5	0.878***	0.893***	0.379***	0.007	0.850***
Adolescent						
	T2 on T1	0.853***	0.800***	0.811***	0.899***	0.879***
	T3 on T2	0.812***	0.741***	0.899***	0.846***	0.813***
	T4 on T3	0.805***	0.786***	0.906***	0.851***	0.827***
	T5 on T4	0.898***	0.849***	0.890***	0.977***	0.838***
	T6 on T5	0.852***	0.863***	0.604***	0.235***	0.881***

Note. *** < .001, ** < .01, * < .05

4. Discussion

For 4 years, a large sample of adolescents from seventh to ninth grade and their parents were invited annually to fill out questionnaires on parenting. This study (a) assessed whether latent parenting constructs were valid across informants and across adolescence (Grades 7-12), (b) determined the average course of these dimensions per informant, (c) and checked whether individual differences remained stable throughout adolescence.

4.1 Measurement Invariance

To our knowledge, the invariance of parenting dimensions across adolescence and informants was never reported on before, although this is a necessary condition to arrive at valid conclusions regarding the role of parenting in adolescent development. If measurement

invariance was not established, this would indicate that the parenting concept is variable across informants and across age, which would greatly complicate this line of research. A number of factors has been suggested due to which concepts can show lack of invariance. One of these is that the concept is more differentiated in one group than the other (Chen, 2008). Our approach seems stringent, and the analyses conservative, but our results allow us to argue that, in future research on the multidimensional concept of parenting, both comparisons across informants and over time seem to be justifiable. For mothers, fathers, and adolescents full scalar invariance of a multidimensional model of parenting was found over time. In 75% of the analyses across informants at least partial scalar invariance was established, which suggests that the general concept and underlying dimensions—along with the respective associations among them—are invariant. Furthermore, the differences in scores are assumed to reflect differences in the latent factor, which makes meaningful comparisons between time scores per informant and between informants possible. Our findings may also indicate retrospectively that results of previous studies that conducted longitudinal analyses and comparisons across informants without prior checking for invariance of parenting constructs can be trusted (e.g., Barber et al., 1994; Bender et al., 2007; De Goede et al., 2009; Tang & Davis-Kean, 2015).

4.2 Mean-Level Continuity

Despite the longstanding interest in the effects of parenting on a wide variety of outcomes, little is known about parenting continuity in adolescence. The mean levels of the dimensions across adolescence as reported by mothers, fathers, and adolescents show the same and stable pattern. According to previous studies, this pattern reflects a certain degree of "adequate" parenting. Support and proactive control have the highest mean scores. These are parenting practices that are related to favorable developmental outcomes (Bender et al., 2007; Bronstein et al., 2007; Chang, Shaw, Dishion, Gardner, & Wilson, 2015; Tang & Davis-Kean, 2015). Adolescent reports on parental support suggests a very stable course throughout adolescence. This finding is in contrast to previous research in which Dutch adolescents reported a decline in support from early to middle adolescence (De Goede et al., 2009). Longitudinal trends in psychological control and harsh punitive control have been reported less frequently in the literature. They are associated more negatively with developmental and academic outcomes (Barber et al., 1994; Bender et al., 2007; Chang et al., 2003; Pettit et al., 2001). It can be concluded that almost no harsh punitive control was reported overall, with a decrease in variance in late adolescence. These results support the findings of a previous study in an American sample (Giles-Sims et al., 1995). Punitive control seems to diminish over time

with a decline between Grades 11 and 12. This could be explained by the fact that during the course of adolescence, adolescents gain more responsibility and autonomy and are less subjected to the authority of their parents. The additional information on temporal characteristics of parenting dimensions, including their overall course, can benefit future studies in that these additional aspects can provide a more detailed picture of associations between parenting dimensions and developmental outcomes. Furthermore, in contrast to the study of Endendijk et al. (2016), the findings of the current study do suggest a difference in parenting for boys and girls.

4.3 Differential Continuity

Differential continuity was assessed to examine whether individual differences on the parenting dimensions are consistent throughout adolescence. For example, high continuity implies that an individual who scores higher than another individual on support at a given moment in time still scores higher at a next occasion. The results seem to indicate differential continuity for parenting as reported by mothers, fathers, and adolescents. However, there may be an indication of declining stability in harsh punitive control as reported by mothers and fathers as the adolescents get older. Future research could explore possible reasons for this pattern of differential continuity. The fact that the decline in stability is not observed for all three informants raises the question whether it reflects a real decline in adolescence or whether it results from a biased view of the parents. Future research could investigate differences in adolescent and parent perspectives because such differences may influence adolescent development and outcomes (Guion, Mrug, & Windle, 2009; Laird & De Los Reyes, 2013). It is also possible that the smaller sample size at Grades 11 and 12 has led to less reliable results.

4.4 Limitations

Despite the strengths, a number of limitations should be noted concerning this study. First, mothers and fathers reported on their own respective parenting behavior, whereas the adolescents reported on parenting in general, across mother and father. This lack of differentiation leads to the inability to investigate the perception of the adolescent on both parents separately. Generally speaking, high correlations have been observed between adolescents' reports for mothers and fathers in earlier work (Van Leeuwen et al., 2004). Still, it is possible that an adolescent has a better relationship with one of the two parents, a fact that we could not detect in the present study. This may be especially relevant when parents have separated or when parenting practices differ strongly between mothers and fathers. Future

research may benefit from including separate adolescent reports regarding mothers' and fathers' parenting.

Second, in a longitudinal study, the number of participants often decreases over time, as is the case in this study. This was partly due to the fact that data were collected through schools and because some students who changed school in the course of the study were no longer traceable. However, given the large sample we started out with, there was still a large number of participants in Wave 4 (N adolescents = 498, N mothers = 322, N fathers = 288).

Third, the data on parenting behavior were obtained through questionnaires, which allowed researchers to examine a wide array of parenting practices. These reports have not been validated by observational data. Also, the sample in this study was recruited in Flanders, the Dutch-speaking part of Belgium. However, some studies have compared the psychometric properties of our parenting measures (i.e., the Louvain Adolescent Perceived Parenting Scale and the PBS) in Dutch and French-speaking samples from Belgium. Delhaye et al. (2012) showed that the internal consistency, factor structure, and average scores on the instrument were highly similar. Meunier and Roskam (2007) replicated the factor structure of the PBS in a sample of children, adolescents, and parents and found evidence for acceptable internal consistency, interrater reliability between children and their parents, and test–retest reliability. No significant association emerged with a measure of social desirability.

Finally, our sample was limited to predominantly Caucasian, European families. Because parenting may vary across cultures (e.g., Dwairy, 2010), we cannot generalize our results to all other cultures. Also, replication of the five-factor model of parenting across informants and time in other samples and contexts is needed in future studies.

5. Conclusion

This study aimed to provide a foundation for further research on parenting and a systematic description of a five-dimension parenting model throughout adolescence. The findings indicate that valid conclusions can be drawn from research across adolescence and across informants because measurement invariance holds. This invariance is an essential step in shedding light on the parenting concept in all its complexity. A second important finding is that the parenting dimensions are relatively stable over time and that their developmental course is comparable between mothers, fathers, and adolescents.

Chapter 3
Parenting and Externalizing Problem Behavior in Adolescence: Combining the Strengths of Variable-Centered and Person-Centered Approaches

Abstract

Previous studies often assumed that parenting practices are similar across families. This assumption is difficult to hold, especially throughout adolescence, a period of major change for both adolescents and their parents. By combining a person-centered and a variable-centered approach, the present study adds to the literature by identifying trajectory classes in parenting behaviors and assessing their associations with externalizing problem behavior. The study aimed (a) to examine the existence of subgroups with different trajectories for five parenting dimensions (i.e., Support, Proactive Control, Punitive Control, Harsh Punitive Control, Psychological Control) in mothers and fathers separately, and (b) to assess whether membership of a subgroup is associated with the development of rule-breaking and aggressive behavior, respectively. The current study used four waves of data, with adolescents' age ranging from 12 to 18 years. Mothers ($N= 747$) and fathers ($N = 645$) reported on their own parenting behavior, whereas adolescent ($N= 1,116$) reported on externalizing problem behavior. Latent Class Growth Analyses per parenting dimension showed that trajectory classes could be distinguished for support, proactive, punitive, and psychological control, but not harsh punitive control, and this for both mother and father. Conditional growth models per parenting dimension and per parent did not show different trajectories for aggressive and rule-breaking behavior across adolescence for the distinct parenting trajectories. However, analyses indicated that depending on the parenting trajectory, there was a difference in initial (age 12) levels of problem behavior. Suggestions for additional research on longitudinal heterogeneity of parenting among mothers and fathers of adolescents are outlined.

1. Introduction

Parenting is a complex concept that can be framed from various theoretical perspectives (Baumrind, 1971; Darling & Steinberg, 1993). There is, however, consensus on the main purpose of parenting, namely to socialize the child/adolescent, that is, to help children and adolescents to develop social, emotional, and cognitive skills needed to function in a social environment (Grusec & Davidov, 2010). Inadequate parenting can lead to child and adolescent maladaptive functioning such as exhibiting externalizing problem behavior (Eichelsheim et al., 2010; Galambos, Barker, & Almeida, 2003; Hanisch, Hautmann, Plück, Eichelberger, & Döpfner, 2014). Externalizing problem behavior refers to behavior that is directed outwards and victimizes others (e.g., aggression and delinquency) (Achenbach, 1991a, 1991b) and can be split up into two subtypes: aggressive behavior (e.g., hitting someone) and rule-breaking behavior (e.g., breaking the evening curfew) (Achenbach, 1991a, 1991b). A study by Reitz et al. (2005) showed that approximately 60% of the adolescents exhibit some kind of problem behavior during adolescence. Furthermore, boys appear to exhibit higher levels externalizing problem behavior and their increase in such problem behavior is larger across adolescence (Hicks et al., 2007 Given the detrimental effects of these problem behaviors for the environment and adolescent psychosocial functioning, it is worthwhile to study this life stage to be able formulate suggestions for prevention and intervention.

The associations between problem behavior and parenting are well established in adolescence (De Haan et al., 2012) as well as the association between problem behavior in adolescence and problem behavior in adulthood (Reef, Diamantopoulou, van Meurs, Verhulst, & van der Ende, 2010). Several parenting dimensions are associated with externalizing problem behavior in adolescence. Some have been linked to higher levels of problem behavior, such as negative parenting (i.e., lax and overreactive discipline and hostile parenting practices; Hanisch et al., 2014) and psychological control (Pettit, Bates, & Dodge, 1997), whereas other dimensions are linked to less problem behavior, such as parental monitoring (Denham et al., 2000) or parental support (Tuggle, Kerpelman, & Pittman, 2014). Previous studies in adolescence have established that different aspects of parenting each have unique relationships with externalizing problem behavior (e.g. Hanisch et al., 2014; Lansford et al., 2011; Mabbe, Soenens, Vansteenkiste, & Van Leeuwen, 2016; Pettit, Bates, & Dodge, 1997; Stormshak, Bierman, McMahon, & Lengua, 2000). Furthermore, it is important to assess both maternal and paternal parenting since previous studies have indicated that both uniquely contribute to the

adolescent's development (Hoeve Dubas, Gerris, van der Laan, & Smeenk, 2011; Jeynes, 2016).

In the aforementioned studies, which used a variable-centered approach to study parenting, conclusions were made across families, and the authors assumed that the covariation of parenting and problem behavior is the same for all families (Mandara, 2003). However, it is unlikely that associations between parenting and child outcomes will be similar for all families in the population. A person-centered approach takes into account that there might be subgroups of individuals and that individuals within such a group or category are more alike than individuals across groups (Jung & Wickrama, 2008). Identifying subgroups of parents, showing different trajectories in their use of parenting practices, might reveal distinct relationships with child externalizing behavior. For example, it could be that adolescents with problem behavior have parents who are members of pronounced parenting trajectories (e.g. consistently low positive or extremely inadequate parenting, or unstable, turbulent parenting trajectories), whereas adolescents without problem behavior have parents who are assigned to moderate parenting trajectories. To our knowledge, only two studies (Luyckx et al., 2011, Okado & Haskett, 2015) combined a person-centered and variable-centered approach to report on the relation between parenting trajectories and externalizing problem behavior, adopting different but complementary approaches.

Okado and Haskett (2015) used observational data on parenting practices and examined two broad parenting dimensions: positive and negative parenting. The former refers to a warm and responsive relationship between parent and child, whereas the latter refers to a detached and hostile relationship. The authors performed two Latent Class Growth Analyses (LCGA) (i.e., one for positive and one for negative parenting) on a small sample of abusive parents of children ($N = 43$) and identified two subpopulations per parenting dimension that differed in developmental trajectory across (three years of) early childhood. Their results showed that the children from the "warmer" trajectory class, in which parents exhibited consistently high levels of positive parenting and low levels of negative parenting, showed better behavioral adjustment later on in childhood.

Luyckx et al. (2011) investigated a more detailed parenting model comprising positive parenting, monitoring, and inconsistent discipline using questionnaire data. The positive parenting dimension resembles positive parenting in the study by Okado and Haskett (2015). Monitoring was referred to as supervising children's behavior within reasonable boundaries by creating an organized and predictable environment, whereas inconsistent discipline referred to the act of being inconsistent with said boundaries and creating an unpredictable environment

(Luyckx et al., 2011). The latter two dimensions are a positive and a negative indicator, respectively, of behavioral regulation. The authors investigated the heterogeneity in trajectories of parenting practices throughout adolescence (ages 12-18) in a large sample of children (N = 1,049) and applied LCGA to these dimensions simultaneously. In other words, they included all the parenting dimensions in a single LCGA. The results revealed four trajectory classes for parenting in concordance with the theoretical framework of Steinberg (2001). This theory conceptualizes four parenting styles (i.e., authoritative, authoritarian, indulgent, and uninvolved parenting) on the basis of two main parenting dimensions, that is, positive parenting and behavioral regulation. Luyckx et al. (2011) showed that the "authoritative" trajectory class (i.e., consistently high parental support combined with high behavioral regulation; cfr. Baumrind, 1967) was the most beneficial for the adolescent in the long term. More specifically, membership of this trajectory class was associated with less adolescent alcohol and cigarette use, fewer internalizing problems, and fewer externalizing problems. The approaches of Okado and Haskett (2015) and of Luyckx et al. (2011) provided very useful information but also indicated a gap in the literature. No study has assessed trajectory classes within a large sample, starting from a more comprehensive parenting model and taking into account both maternal and paternal parenting.

In the current study, we addressed this gap, by examining the associations between trajectories of externalizing problem behavior across adolescence with membership to subpopulations in maternal and paternal parenting (i.e., fitting separate LCGA per parenting dimension cfr. Okado & Haskett, 2015), starting from a comprehensive five-factor parenting model (Janssens et al., 2015) consisting of parenting dimensions that were found to be related to externalizing behavior (cfr. Luyckx et al., 2011). The person-centered approach offers the added value of distinguishing groups of individuals in their use of certain parenting practices. In the current study the person-centered approach is particularly interesting since it concerns distinguishing groups across a period where parents have to adapt their parenting practices to the maturing adolescent, which goes beyond assessing static representations of parenting behavior.

1.1 A Five-Factor Model of Parenting and its Relation With Externalizing Problem Behavior

Janssens and colleagues (2015) identified a model of parenting by performing confirmatory factor analyses on questionnaire data from mothers, fathers, and adolescents. A five-factor solution emerged, including parental support, proactive control, punitive (non-

physical) control, harsh punitive (physical) control, and psychological control. In the following section, we discuss each of these five dimensions and their link with externalizing problem behavior in early (age 12-14), middle (age 15-16) and/or late adolescence (age 17-18).

Parental support is an umbrella term which comprises, among other things, parental involvement, acceptance, emotional availability, and responsivity. In general, it shows negative associations with child/adolescent externalizing problem behavior (Hanisch et al., 2014; Laible, Carlo, & Raffaelli, 2000). Results from previous studies also suggested a positive association between parental support, on the one hand, and social development (e.g., Barber, Stolz, & Olsen, 2005), academic performance (Tang & Davis-Kean, 2015) and morality (Bronstein, Fox, Kamon, & Knolls, 2007), on the other. *Proactive control* involves the use of a structured environment to anticipate and prevent possible undesirable child or adolescent behavior. Such an environment can be created through rule setting and parental monitoring (Socolar, 1997). Given the increasing number of activities and relationships outside the family context, it can be hypothesized that proactive control gains importance in adolescence. Parents will not always be present to shape the behavior of their son or daughter, and thus preventive rule setting (partially) takes over this role (Pettit et al., 1997). This parenting dimension has been found to correlate negatively with externalizing problem behavior (Galambos et al., 2003; Gray & Steinberg, 1999; Pettit et al., 1997). *Punitive (non-physical) control* is characterized by non-physical punishment (e.g., giving chores or setting an earlier curfew) and is considered to be an effective way to induce immediate compliance (Baumrind, 1996). Despite this efficacy, it is associated with more externalizing problem behaviors in the long term (Brenner & Fox, 1998; Stormshak, Bierman, McMahon, & Lengua, 2000). *Harsh (physical) punitive control* refers to the use of corporal punishment (e.g., slapping following unwanted behavior). Young people who suffered physical punishment throughout early and middle adolescence show more externalizing problem behavior (Bender et al., 2007; Lansford et al., 2011). A study by Wang and Kenny (2014) suggested a vicious cycle between physical punishment and externalizing problem behavior. Children's externalizing problem behavior triggers physical punishment from the parents, which in turn, elicits more problem behavior. This interplay can escalate with devastating effects for adolescent development. *Psychological control* includes manipulating thoughts, feelings, and emotions (Barber, 1996). This intrusive parenting practice uses children's desire not to disappoint their parents, to attain behavioral compliance (Assor, Roth, & Deci, 2004). Barber, Olsen, and Shagle (1994) found an association between psychological control and internalizing problem behavior. Later research also suggested an association with externalizing problem behavior (Ahmad, Vansteenkiste, & Soenens, 2013; Mabbe et al., 2016).

This overview of studies shows that every dimension of the five-factor parenting model is associated with externalizing problem behavior. Therefore, it is useful to assess trajectory classes in each of the five dimensions.

1.2 The Present Study

The aim of the present study was twofold. First, we examined whether subgroups with distinctive trajectories across adolescence could be identified for each of the five parenting dimensions that were established by Janssens et al. (2015). These dimensions were assessed at four time points, which leads to more dynamic measures of the parenting behaviors. More specifically, the trajectories covered adolescent age from 12 to 18 years. It is strategically important to investigate this age range, which covers early, middle, and late adolescence, because adolescents undergo great developmental changes during this period of life. Parenting trajectories were assessed for mothers and fathers separately, in order to examine whether the number and the shape of the trajectories are different for mothers and fathers. We expected to find such differences, given that the literature has revealed differences in maternal and paternal parenting practices at least in samples with younger children (Videon, 2005; Winsler, Madigan, & Aquilino, 2005).

Second, we assessed whether membership to one of the trajectory classes or adolescent gender was associated with the initial levels and changes of externalizing problem behavior. We expected that parents who are member of trajectory groups showing high levels of parental support (Stice, Barrera, & Chassin, 1993) or proactive control (Galambos, Barker, & Almeida, 2003) would have adolescents with lower levels of rule breaking and aggressive behavior, compared to parents who are members of trajectories with low levels of support or proactive control. Parents from trajectory classes showing high levels of punitive (Larzelere, Cox, & Smith, 2010), harsh punitive (Gershoff & Grogan-Kaylor, 2016), or psychological control (Pettit, Laird, Dodge, Bates, & Criss, 2001) were expected to have adolescents showing higher levels of both rule breaking and aggressive behavior, compared to parents from trajectory classes characterized by moderate or low levels of punitive, harsh punitive or psychological control. Because the literature indicates that there are differences in externalizing problem behavior between boys and girls (Bongers, Koot, van der Ende, & Verhulst, 2004), gender was included in all analyses. This study will add to the literature by providing a more dynamic and differentiated image of parenting behaviors related to subtypes of externalizing behavior, by identifying trajectories over time for both mothers and fathers, instead of the static and broad

image that is usually derived from questionnaire data at a single time point from a single informant.

2. Methods

2.1 Participants and Procedure

Data were collected within the STRATEGIES project (i.e., Studying Transactions in Adolescence: Testing Genes in Interaction With Environments). Permission for the STRATEGIES project was obtained from the institutional review board of the Faculty of Medicine at the University of Leuven (ML7972). For four years, this longitudinal study annually examined adolescents and their parents in Flanders, the Dutch-speaking part of Belgium. Adolescents and their parents were selected through a random multistage sampling approach. Twenty Flemish secondary schools were randomly selected and invited to take part in the study. Of the nine schools who indicated to be willing to participate, 121 classes in Grades 7 to 9 were randomly selected. Stratification at the class level was used to attain an adequate reflection of the population concerning the distribution of students from the general, technical, and vocational tracks. Within these classes, 2,254 students and their parents were invited to participate. From these 2.254 students, 1,116 students responded and agreed to participate in this study, whereas the remaining 1,138 did not respond to our invitation. These 1,116 students also received an informed consent to pass on to their mother and father. Adolescents were offered 5 euros (per wave) and a raffle of a larger prize, e.g. i-Pod) for their participation, whereas parents did not receive any incentive. The final sample at Wave 1 comprised 1,116 adolescents in three cohorts (grade 7, 8, and 9) (M_{age} = 13.70, SD = 0.93, 51% boys), 839 mothers (M_{age} = 43.54, SD = 4.45) and 717 fathers (M_{age} = 45.45, SD = 4.69). In Wave 1, 710 adolescents had their both parents reporting, whereas 129 (7) had only their mother (father) reporting. Compared to Wave 1, the retention rate in Wave 2 was 89% for adolescents, 75% for mothers, and 73% for fathers (both parents : 495; only mother: 135; only father: 28). In Wave 3, the retention rate remained 79% for adolescents, 66% for mothers and 63% for fathers (both parents : 427; only mother: 105; only father: 19). In Wave 4, the retention rates were 45%, 38%, and 37%, respectively (N adolescents = 499, N mothers = 318, N fathers = 268) (both parents: 255; only mother: 50; only father: 7). The drop in retention rates in Wave 4 is remarkably stronger. This may be caused by the oldest cohort graduating from high school in the transition from Wave 3 to Wave 4, which made data collection more difficult. Family characteristics were representative for the general population $\chi^2(2)$ = 2.78, p = .25, with 82% two-parent families,

7% single-parent families, and 11% percent blended families (Janssens et al., 2017; King Baudouin Foundation, 2008). The educational level (EDU) and employment activity level (EMP) of parents differed for both mothers (EDU: χ^2((3) = 30.34, p = <.001; EMP: χ^2((1) = 15.87, p = <.001) and fathers (EDU: χ^2 (3) = 34.19, p = .00; ACT: χ^2 (1) = 15.13, p = <.001) with bachelor degrees and active employees being slightly overrepresented (Janssens et al., 2017; Research Department of the Flemish Government, 2010, 2011). Despite this small deviation, it can be concluded that participants represent all categories for socioeconomic status.

Researchers visited the school and presented the questionnaire to the adolescents. In concert with the school, adolescents were provided two hours to fill out the questionnaire. In case they did not finish the questionnaire within the provided time, they were allowed to finish the questionnaire at home and hand it in later using specially designated boxes. Adolescents who left the school or graduated were contacted through e-mail and received an online version of the questionnaire. Parents could either fill out their questionnaires online or on paper. The latter was provided through the adolescents and could also be handed in using the designated boxes.

The STRATEGIES project used an accelerated longitudinal design. This design allows researchers to cover a larger age span, compared to a classical longitudinal design, during a shorter time span. In every wave, an age range is covered, which will overlap with the age range of the next wave. At each wave, the same sample was invited to participate in the study. Across the four annual waves, the ages ranged from 12 to 18 years old. Given the accelerated longitudinal design, there is dependency between the data points of one adolescent and (structurally) missing data points (e.g., a child that was first assessed in grade 9 cannot have data at age 12).

2.2 Measures

2.2.1 Parenting Behavior

Parenting was rated by mothers and fathers using a total of 64 items from 9 subscales from multiple questionnaires. These questionnaires and their respective subscales were selected based on theoretical relevance, adequate psychometric properties, and use in previous parenting research (Janssens et al., 2015). A confirmatory factor analysis (CFA) on these questionnaires resulted in the five-factor model of parenting dimensions described in the Introduction (Janssens et al., 2015). Janssens et al. (2015) showed that this five factor model was to be preferred over a three or four factor model, which provides support for the value of the different parenting dimensions. According to Cohen's criteria for effect sizes (Cohen, 1992), correlations

between parenting dimensions were small to medium. Furthermore, Van Heel et al. (2017) established at least partial scalar measurement invariance across adolescence and across informants for this five factor parenting model on the same dataset, hence, these constructs can be validly compared. This shows that the five factor model is robust across adolescence and for different informants (i.e., mothers, fathers, and adolescents).

The dimension *Parental Support* (Cronbach's α at W1 = .89, W2= .90, W3= 0.90 , W4= .91, (mother) and W1= .93, W2= .93, W3= .93, W4= .93 (father)) was measured using three parenting measures. The first one was the Positive Parenting subscale (8 items, e.g., "If my son or daughter wants to tell something, I take my time for listening to him/her") from the Parental Behavior Scale- Short Form (PBS-S; Van Leeuwen et al., 2015). The second one was the Responsivity subscale (7 items, e.g., "I can make my son or daughter feel better when he or she is feeling upset) from the Louvain Adolescent Perceived Parenting Scale (LAPPS; Delhaye et al., 2012). This instrument is an adaptation of a subscale from the Child Report of Parental Behavior Inventory (CRPBI; Schludermann & Schludermann, 1988). The third and final measure was the Autonomy Support scale (8 items, e.g., "I take into account my son's or daughter's opinion on affairs that concern him or her") and was based on the Perceptions of Parents Scale (POPS; Grolnick, Ryan, & Deci, 1991) and the Research Assessment Package for Schools (RAPS; Institute for Research and Reform in Education, 1998).

The dimension *Proactive Control* (Cronbach's α at W1 = .85, W2= .83 , W3= .84, W4= .86, (mother) and W1= .85, W2= .85, W3= .85, W4= .87 (father)) was assessed using two measures, that is, the subscales Setting Parental Expectations for Behavior (6 items, e.g., "I expect my son or daughter to behave in a certain manner) and Parental Monitoring of Behavior (6 items, e.g., "I remind my son or daughter of the rules I made"). These subscales were selected from the Parental Regulation Scale (PRS-YSR; Barber, 2002), which was translated in Dutch by Soenens, Vansteenkiste, Luyckx, and Goossens (2006).

The dimension *Punitive Control* was assessed using the Punishment subscale (4 items, e.g. "If my son or daughter does something he or she was not supposed to, I punish him or her"; Cronbach's α at W1 = .88, W2 = .89, W3 = .89, W4= .92 (mother) and W1= .88, W2= .88 , W3= .88, W4= .91 (father)) from the Parental Behavior Scale – Short Form (PBS-S; Van Leeuwen et al., 2015).

The dimension *Harsh Punitive Control* was assessed using the subscale Harsh Punishment (5 items, e.g., "I hit my son or daughter in the face when he or she misbehaves"; Cronbach's α at W1 = .78, W2= .57, W3= .39, W4= .56 , (mother) and W1= .80, W2= .73, W3= .68, W4= .54 (father)) from the Parental Behavior Scale – Short Form (PBS-S; Van

Leeuwen et al., 2015).

The dimension *Psychological Control* (Cronbach's α at W1 = .84, W2= .84 , W3= .84 , W4= .84, (mother) and W1= .83, W2= .84, W3= .86, W4= .88 (father)) was assessed using two subscales. The subscale Psychological Control (8 items, e.g., "I do not talk to my son or daughter when he or she disappointed me until he or she pleases me again") was taken from the translated version of Barber's Psychological Control Scale (Barber, 1996; Soenens et al., 2006). One additional item for this subscale was based on a study by Soenens, Sierens, Vansteenkiste, Dochy, and Goossens (2012). The subscale Hostility (6 items, e.g., "I yell at my son or daughter when he or she misbehaves") was based on the Verbal Hostility Scale (Nelson & Crick, 2002), which was developed to assess intrusive parenting alongside corporal punishment.

All 64 items were rated by mothers and fathers on a 5-point scale ranging from 1= *(almost) never* to 5= *(almost) always*. Mothers and fathers reported on their own parenting behavior.

2.2.2 Adolescent Problem Behavior

Adolescents completed the externalizing subscales of the Youth Self Report (YSR; Achenbach 1991a). The second-order scale Externalizing Problem Behavior (31 items, Cronbach's α at W1 = .82, W2 = .84, W3 = .82, W4= .82) was decomposed into two subscales. Specifically, the two subscale were Aggressive behavior which physical aggression, as well as disruptive and non-compliant behaviors (17 items, e.g., "I destroy my own belongings"; Cronbach's α at W1 = .78, W2 = .80, W3 = .78, W4 = .77) and Rule-breaking behavior (14 items, e.g. ''I skip classes or I play truant''; Cronbach's α at W1 = .58, W2 = .66, W3 = .63, W4= .62). A three-point rating scale was used, ranging from 0 (*not true*) to 2 (*very true or often true*). For both subscales, the mean score was computed. Higher scores indicated more externalizing problem behavior.

2.3 Analysis Strategy

2.3.1 Attrition Analysis

To check for systematic dropout, independent samples t-tests were used to assess whether there was a significant difference in externalizing problem behavior and parenting (both maternal and paternal) at Wave k between adolescents that dropped out after this wave and adolescents who still participated at Wave $k + 1$.

2.3.2 Descriptive Statistics

Mean scores and variances of maternal and paternal parenting as well as externalizing problem behavior were calculated per time point. Furthermore, correlations between paternal and maternal parenting dimensions were computed per time point.

2.3.3 Latent Class Growth Analysis

To identify classes with distinct longitudinal trajectories for each parenting dimension, Latent Class Growth Analyses (LCGA) (Jung & Wickrama, 2008) were used. This special form of Growth Mixture Modeling (GMM) assumes that the individual growth trajectories are homogeneous within each trajectory class. In the search for an appropriate number of trajectory classes, multiple criteria were used, following Jung and Wickrama (2008). This approach enabled us to make a grounded decision in situations where a single criterion could not differentiate between two potential models. To arrive at a structured decision-making process, the criteria were considered in a specific order.

First, in order to keep the classes practically relevant and the model stable, the size of the smallest class should not fall below 1% of the total population (Jung & Wickrama, 2008). In other words, only the models in which the smallest class count was equal to or larger than 1% of the total sample were considered. Second, the Bootstrapped Likelihood Ratio Test (BLRT), which is the best performing fit index in indicating a suitable number of classes (Nylund, Asparouhov, & Muthen, 2007), was included to assess model fit. The BLRT compares the improvement in fit from a model with $k-1$ classes with a growth model with k classes. In the present study, the α-level for this statistic was set at .05. A significant ($< .05$) p-value indicates that a model with k classes yields a better fit than a model with $k-1$ classes. However, the BLRT involves a large computational burden and therefore is not requested by default. To deal with this issue, we followed Nylund (2007), who suggested to use the Lo, Mendell, and Rubin likelihood ratio test (LMR; Lo, Mendell, & Rubin, 2001) to pre-select a number of models, which can be re-analyzed with requesting the BLRT. Jung and Wickrama (2008) set an α-level of .05 for the LMR. However, because we considered our analysis to be exploratory, the present study used an α–level of .10. This value was selected to prevent excluding models prematurely. In other words, model fit was first assessed using LMR (α =.10). If the models showed significance for LMR, the analyses were run again by requesting the BLRT (α = .05). If the BLRT was also significant, model fit was considered to be good. Third, when there were still multiple eligible models, the model with the lowest Sample Size adjusted Bayesian Information Criterion (SS-BIC) was selected. Nylund (2007) has determined that SS-BIC is the second best

performing fit index after the BLRT referred to earlier on. Next, entropy was used to estimate classification accuracy. This index is based on posterior probabilities of classification and ranges from 0 (i.e., everybody has the same probability of being classified in a certain class) to 1 (i.e., each individual has been classified into a certain class with a posterior probability of 1) (Feldman, Masyn, & Conger, 2009). There is no specific cut-off score for entropy, but extremely low values indicate that classification accuracy is not adequate for a given model.

2.3.4 Growth Models

Growth models were fitted to assess the predictive value of trajectory classes based on the parenting dimensions reported by mother and father separately, for the growth parameters of rule-breaking behavior and aggressive behavior, reported by the adolescent. These analyses built on the trajectory classes per parenting dimension and per parent identified in the LCGA. In all, there were 20 possible growth models (i.e., 2 (variants of externalizing problem behavior) x 2 (informants) x 5 (parenting dimensions)). As suggested by Chen et al. (2008), three model fit indices were used to assess model fit of the growth models, that is, the Comparative Fit Index (CFI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Squared Residual Error (SRMR). Concerning the CFI, a value above .90 is deemed an acceptable fit, but a value above .95 is preferred. Concerning the RMSEA, a value below .08 indicates an acceptable fit, but a value below .05 is preferred. Concerning, the SRMR, a value below .08 is indicative of a good model fit (Browne & Cudeck, 1992; Hu & Bentler, 1999).

First, an unconditional growth model was fitted for rule-breaking behavior and aggressive behavior separately. In order to assess which growth parameters are needed to adequately represent the trajectory of both types of externalizing problem behavior three models were compared to each other (i.e., Model 1: intercept; Model 2: intercept + linear trend; Model 3: intercept + linear trend + quadratic trend). We based our decision on both overall better model fit and statistical significance of the growth parameters within a model in order to ensure that growth parameters are meaningful for subsequent analyses. To account for dependency between time points within one adolescent, the present paper used a Generalized Estimating Equation (GEE) approach (Hubbard et al., 2010), which corrects the standard errors accordingly. In a next step, gender and the trajectory classes of a parenting dimension were included. In these analyses, the largest trajectory class was used as the reference category. For each of the other trajectory classes of a parenting dimension, a dummy variable was created with '0' indicating that an individual was not a member of the trajectory class and '1' indicating

that he or she was a member. These dummy variables indicating trajectory class membership were considered as time-invariant categorical predictor variables in the growth models.

Normality tests per wave (i.e., Kolmogorov-Smirnov and Shapiro-Wilk) assessed whether the distribution of residuals of both rule-breaking behavior and aggressive behavior approximated a normal distribution. These tests indicated that this was not the case (See Table S1). This non-normality was handled in all subsequent analyses by using a robust estimator (robust maximum likelihood) (Finney & DiStefano, 2008). Given the large number of associations to be tested within a single growth model and the related elevated chance to make Type-I errors, a Bonferroni correction (Armstrong, 2014) was applied in the conditional growth models. More specifically, the α-level is adjusted for the number of statistical tests, which in the present study resulted in an α-level of (.05/13=) .004. The analyses were conducted in MPlus Version 7 (Muthén & Muthén, 2012). In MPlus missing data were handled using Full Information Maximum Likelihood (FIML) and robust maximum likelihood (MLR) was used as estimator.

3. Results

3.1 Attrition Analysis

The results of the attrition analysis showed that missing data were not Missing Completely At Random (MCAR), however, Sterne et al. (2009) suggest that the Missing At Random (MAR) assumption is plausible when a wide array of covariates that predict the attrition is available. The longitudinal dataset used in the present study comprises information on numerous demographic variables (e.g., ethnicity, gender, family situation, SES) and as such the assumption of MAR is deemed plausible. Assuming MAR, Full Information Maximum Likelihood (FIML) corrects the estimation of the individual growth parameters in growth curve analysis for systematic attrition (Assendorpf, van de Schoot, Denissen, & Hutteman, 2014). Detailed results are presented in Table S2.

3.2 Descriptive Statistics

Descriptive statistics of the five parenting dimensions as reported by mothers and fathers and of rule-breaking and aggressive behavior as reported by adolescents are presented in Table 7. Correlational analysis per wave of parenting dimensions as reported by mothers and fathers are includes in the Supplemental Materials (Table S3a through S3f).

Table 7

Descriptive Statistics of the Five Parenting Dimensions (Reported by Father and Mother) and Rule-Breaking and Aggressive Behavior (Reported by Adolescents) Across Six Time Points.

		M (S²)					
informant	Variable	Time point					
		T1	T2	T3	T4	T5	T6
Mother	Support	4.00	3.97	4.06	4.11	4.14	3.91
		(0.29)	(0.25)	(0.27)	(0.25)	(0.21)	(0.39)
	Proactive	4.05	4.00	4.05	4.04	4.00	3.84
	control	(0.38)	(0.26)	(0.30)	(0.27)	(0.31)	(0.34)
	Punitive	2.96	2.83	2.79	2.73	2.44	2.25
	control	(0.81)	(0.75)	(0.77)	(0.81)	(0.80)	(0.79)
	Harsh punitive	1.12	1.09	1.08	1.05	1.04	1.01
	control	(0.09)	(0.08)	(0.09)	(0.03)	(0.02)	(0.00)
	Psychological	1.96	1.91	1.84	1.81	1.77	1.75
	control	(0.27)	(0.26)	(0.24)	(0.24)	(0.25)	(0.36)
Father	Support	4.29	4.28	4.25	4.23	4.24	4.20
		(0.16)	(0.17)	(0.18)	(0.18)	(0.19)	(0.19)
	Proactive	4.23	4.17	4.14	4.09	4.05	3.81
	control	(0.28)	(0.26)	(0.25)	(0.26)	(0.29)	(0.31)
	Punitive	3.02	2.93	2.84	2.74	2.48	2.14
	control	(0.95)	(0.79)	(0.77)	(0.86)	(0.83)	(0.67)
	Harsh punitive	1.11	1.06	1.07	1.05	1.03	1.03
	control	(0.7)	(0.05)	(0.06)	(0.03)	(0.02)	(0.01)
	Psychological	1.87	1.82	1.84	1.81	1.77	1.58
	control	(0.26)	(0.24)	(0.27)	(0.25)	(0.24)	(0.18)
Adolescent	Rule breaking	0.20	0.21	0.23	0.23	0.21	0.19
	behavior	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
	Aggressive	0.29	0.28	0.28	0.27	0.26	0.22
	behavior	(0.06)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)

3.3 Determining the Number of Trajectory Classes

In order to establish a meaningful number of trajectory classes, the aforementioned fit indices were obtained (when available) for one up to five trajectory classes per dimension. In these analyses the first five time points were included (i.e., ages 12 to 17), because inclusion of the sixth time point led to convergence issues. More specifically, there were too few observations to initiate FIML, and thus also estimation, due to drop out as well as structural missingness. The fit indices are presented in Table 8a for mothers and Table 8b for fathers. The trajectory classes obtained were interpreted based on the size of the intercept, as well as the presence of a linear and/or quadratic trend. The estimates and their *p*-values of all the growth parameters are included in the (See Table S4).

A trajectory class was labelled "low" when the *intercept* was equal or lower than 2, "moderate" when the intercept was a value between 2 and 4, and "high" when the intercept was higher than or equal to 4. If multiple trajectory classes were in one of these three categories, additional labels were used to indicate their relative position (e.g., labels "moderately high" versus "moderately low" were used to indicate their relative position within the moderate range). The *linear trend* and *quadratic trend* were identified based on visual inspection of the plots. This decision was made due to the fact that labels based upon statistical significance are not always useful and/or relevant, and thus, make interpretations more difficult. A linear trend was considered to be increasing (decreasing) when there was at least a 0.5 difference between Time point 1 and Time point 5. A quadratic trend was considered to be U-shaped (inverse U-shaped) when an initial decrease of at least 0.5 was followed by an increase of at least 0.5.

Mothers. Three meaningful trajectory classes were identified for the dimensions support (i.e., very high-stable, moderate-stable, and high-stable; entropy = .74) and proactive control (i.e., high-stable, moderate-stable, very high-stable; entropy = .64), whereas for punitive (i.e., low-stable, high-decreasing, moderate high-decreasing, moderate low-decreasing; entropy = .60) and psychological control (i.e., low-stable, moderate high-decreasing, moderate low-stable, moderate-stable; entropy = .70) four trajectory classes could be distinguished. The entropy values indicated that the solution for maternal support had the greatest classification accuracy. The trajectory classes for these four parenting dimensions are presented in Figures 5a to 5d, respectively. For harsh punitive control, fit indices indicated that no meaningful trajectory classes, could be distinguished, which implied that the average trajectory was the most adequate representation of the whole sample. Consequently, harsh punitive control was not included in subsequent analyses.
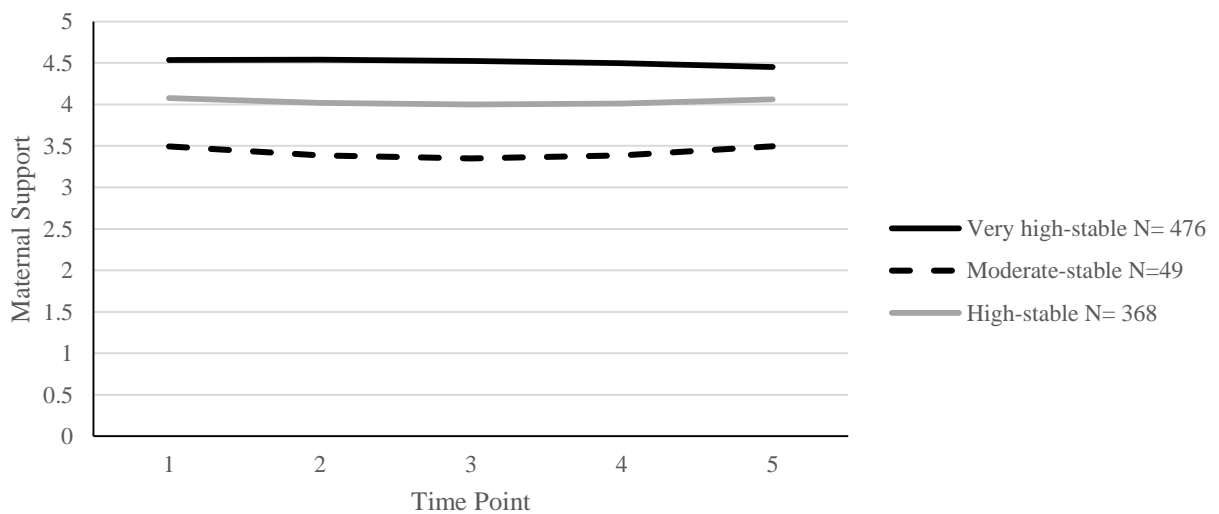
Figure 5a. Trajectory classes for parental support as reported by mothers across ages 12 to 17.
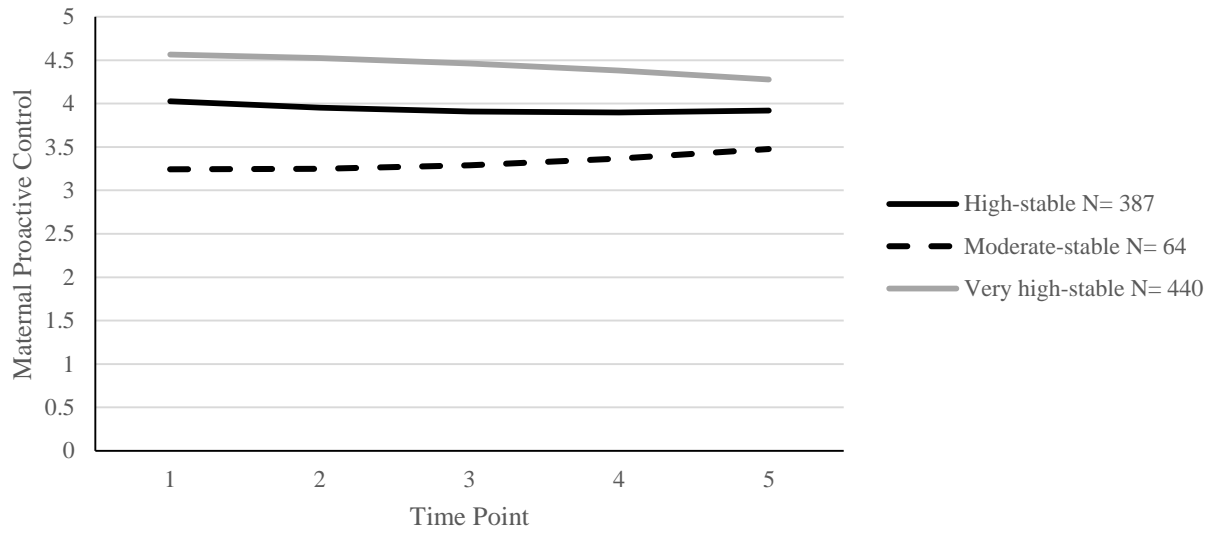
Figure 5b. Trajectory classes for proactive control as reported by mothers across ages 12 to 17.
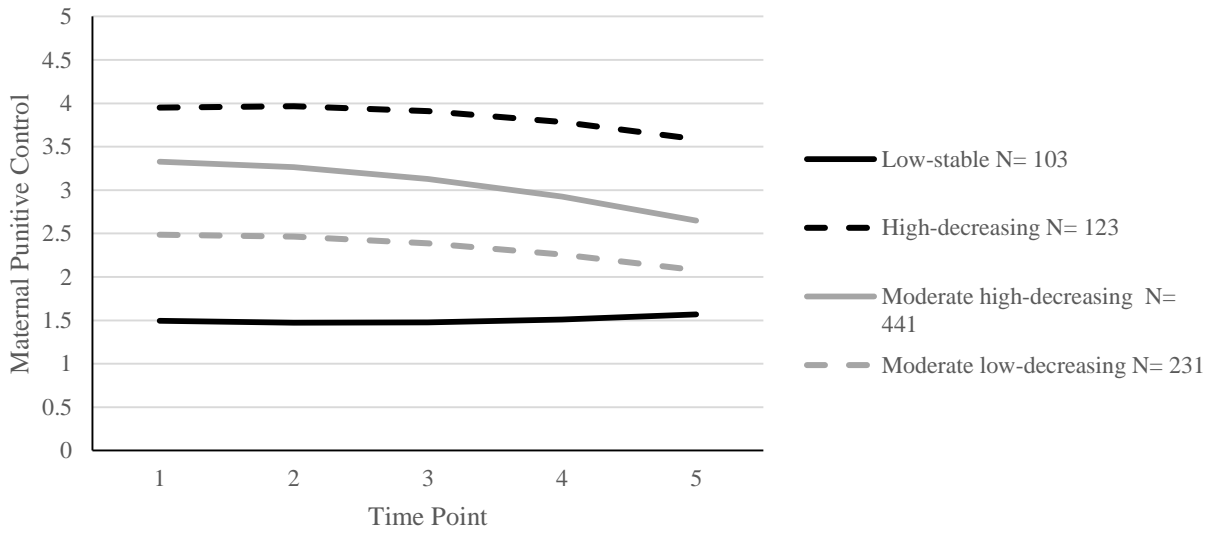
Figure 5c. Trajectory classes for punitive control as reported by mothers across ages 12 to 17.
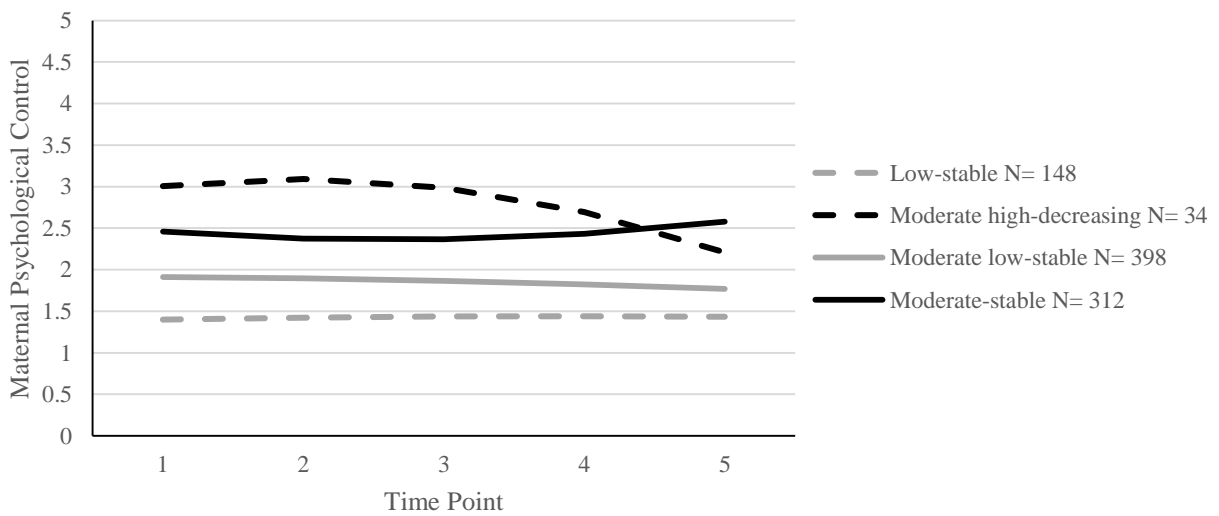
Figure 5d. Trajectory classes for psychological control as reported by mothers across ages 12 to 17.

Fathers. We distinguished two meaningful trajectory classes for paternal support (i.e., high -stable, moderate-increasing; entropy = .60), whereas four meaningful trajectory classes were distinguished for proactive control (i.e., moderate-increasing, very high-stable, high-stable, low-increasing-inverted U-shape; entropy = .75), punitive control (i.e., low-stable, moderate-decreasing, moderate-increasing-U-shape, high-decreasing; entropy = .60) and psychological control (i.e., low-stable, moderate low-stable, moderate high-U-shape, moderate high-inverted U-shape; entropy = .62). The entropy values for the classification of support, punitive control, and psychological control were lower than in mother reports, but were still clearly closer to 1 than to 0. The highest entropy value, also higher than the maternal counterpart, was found for paternal proactive control. The trajectory classes for these four parenting dimensions are presented in Figures 6a to 6d, respectively. In line with our results for the mother reports, no meaningful subclasses could be established for harsh punitive control. Note that the total number of adolescents that was allocated to the trajectory classes per parenting dimension can differ due to different patterns of missing data.
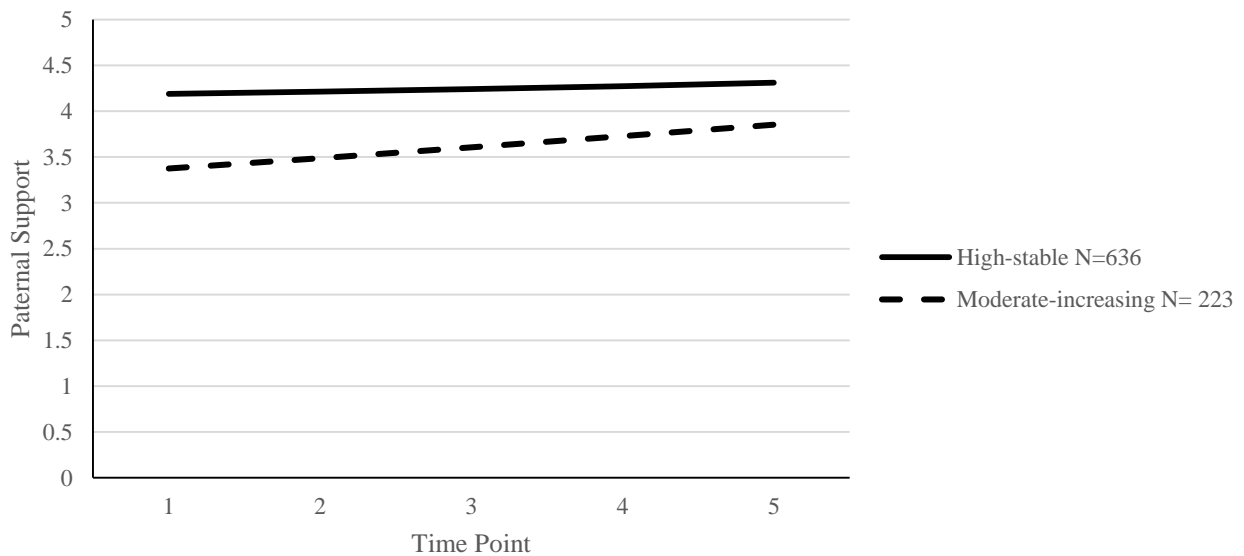
Figure 6a. Trajectory classes for parental support as reported by fathers across ages 12 to 17.
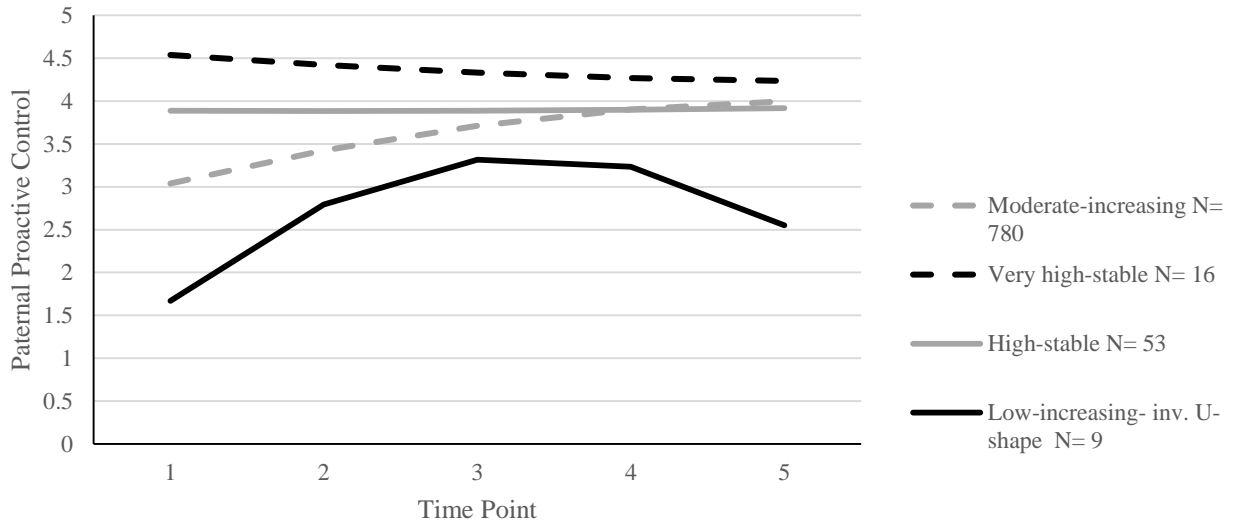
Figure 6b. Trajectory classes for proactive control as reported by fathers across ages 12 to 17.
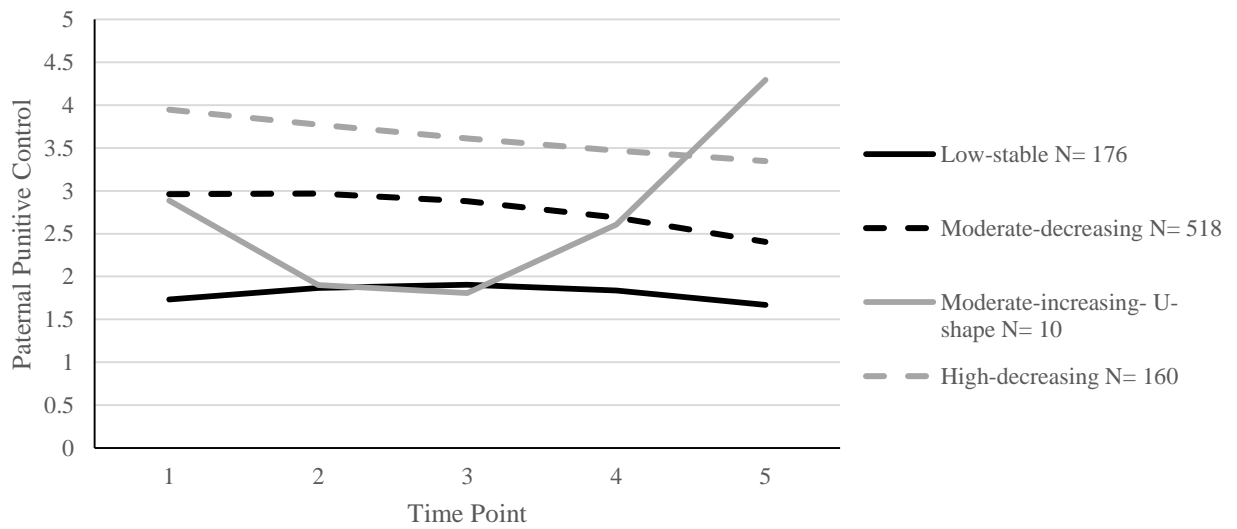
Figure 6c. Trajectory classes for punitive control as reported by fathers across ages 12 to 17.
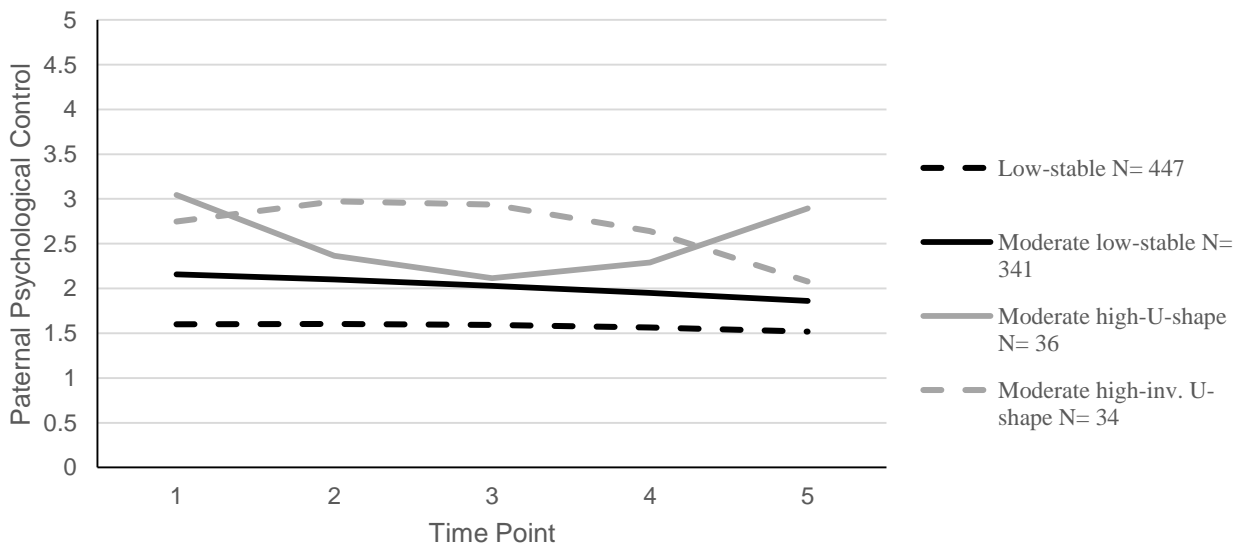
Figure 6d. Trajectory classes for psychological control as reported by fathers across ages 12 to 17.

Table 8a

LCGA Model Fit Criteria for Mother-Reported Parenting Dimensions

Dimension	1	2	3	4	5
			Number of subclasses		
Support					
%		32	**5**	0	0
LMR		<.001	**.075**	.500	.914
BLRT		<.001	**<.001**		
SS-BIC	2092.678	1603.869	**1457.796**	1472.356	1403.508
Entropy		.707	**.743**	.796	.727
Proactive control					
%		31	**7**	0.7	0.7
LMR		<.001	**.066**	.001	.290
BLRT		<.001	**<.001**		
SS-BIC	3107.063	2815.970	**2751.060**	2708.112	2702.614
Entropy		.618	**.639**	.694	.692
Punitive control					
%		30	14	**11**	7
LMR		<.001	.027	**.002**	.394
BLRT		<.001	<.001	**<.001**	
SS-BIC	5653.783	5269.041	5180.883	**5158.535**	5158.715
Entropy		.667	.619	**.598**	.604
Psychological control					
%		23	9	**3**	0.5
LMR		<.001	.019	**.080**	.091
BLRT		<.001	<.001	**<.001**	
SS-BIC	3008.353	2541.682	2390.639	**2335.524**	2304.899
Entropy		.752	.691	**.694**	.735
Harsh punitive control					
%		4	2	0.3	0.7
LMR		.274	.754	.152	.431
BLRT					
SS-BIC	-687.742	-1706.864	-2454.819	-2641.420	-3072.777
Entropy		.990	.985	.988	.975

Note. SS-BIC = Sample Size adjusted Bayesian Information Criterion; % = proportion of smallest subclass; LMR = Lo-Mendell-Rubin test *p*-value; BLRT = bootstrap likelihood-ratio test. The model in bold is the preferred model.

Table 8b

LCGA Model Fit Criteria for Father-Reported Parenting Dimensions

	Number of subclasses				
Dimension	*1*	*2*	*3*	*4*	*5*
Support					
%		**25**	3	1	0.8
LMR		**.008**	.140	.124	.676
BLRT		**<.001**			
SS-BIC	2862.817	**2679.524**	2601.122	2556.207	2540.891
Entropy		**.596**	.659	.660	.685
Proactive control					
%		1	1	**1**	0.5
LMR		.554	.183	**.057**	.338
BLRT				**<.001**	
SS-BIC	2949.998	2907.543	2898.787	**2890.025**	2892.790
Entropy		.927	.867	**.748**	.741
Punitive control					
%		32	15	**1**	1
LMR		<.001	.047	**.036**	.253
BLRT		<.001	<.001	**<.001**	
SS-BIC	5018.893	4835.874	4803.278	**4792.938**	4792.979
Entropy		.552	.531	**.595**	.582
Psychological control					
%		20	9	**3**	2
LMR		<.001	.042	**.036**	.253
BLRT		<.001	<.001	**<.001**	
SS-BIC	2786.238	2618.335	2575.988	**2551.047**	2542.975
Entropy		.654	.563	**.622**	.635
Harsh punitive control					
%		3	2	1	0.2
LRMT		.106	.754	.282	.200
BLRT					
SS-BIC	-74.093	-900.882	-1363.058	-1609.274	-1724.760
Entropy		.993	.963	.952	.942

Note. SS-BIC = Sample Size adjusted Bayesian Information Criterion; % = proportion of smallest subclass; LMR = Lo-Mendell-Rubin test; BLRT = bootstrap likelihood-ratio test. The model in bold is the preferred model.

3.4 Growth Models

For both aggressive and rule-breaking behavior the unconditional growth model including an intercept, linear trend and quadratic trend showed the best overall model fit (See Table 9). However the quadratic term was non-significant ($p = .82$) for aggressive behavior, but significant ($p = .002$) for rule-breaking behavior. Thus, rule-breaking behavior was represented by a growth model including an intercept, linear trend, and quadratic trend, whereas aggressive behavior was represented by a growth model that included an intercept and linear trend.

Table 9

Model Comparison of Unconditional Growth Models for Aggressive and Rule-Breaking Behavior

Model		χ^2	df	SCF	$\Delta \chi^2$	Δdf	p
Aggressive behavior	Intercept	63.416	12	1.4299			
	Intercept + linear trend	23.314	9	1.4433	41.0372	3	<.001
	Intercept + linear trend + quadratic trend	5.250	5	1.3417	16.9427	4	.002
Rule-breaking behavior	Intercept	63.371	12	1.3117			
	Intercept + linear trend	34.723	9	1.3285	29.3302	3	<.001
	Intercept + linear trend + quadratic term	4.451	5	1.2856	29.2356	4	<.001

Next, 16 (i.e., 4 parenting dimensions x 2 parents x 2 variants of externalizing problem behavior) conditional growth models were fitted, which each comprised both gender and the dummy variables representing trajectory group membership for a single parenting dimension reported by a single parent. These conditional growth models all showed good model fit (CFI> .95, RMSEA <.06, SRMR <.08). A detailed overview of the model fit indices per conditional growth model is included in the Supplemental Materials (See Table S5a and Table S5b for maternal parenting and Table S6a and S6b for paternal parenting). Note that there was no conditional growth model for harsh punitive control, given the fact that no meaningful trajectory classes could be distinguished for this parenting dimension.

The proportions of explained variance for each conditional growth model are presented in Table 10a through 10d. Concerning maternal trajectory classes, the R^2's indicated that the trajectory classes of each parenting dimension explained a significant ($p < .05$) proportion of the variance in the intercept, but not the linear trend or quadratic trend, for both aggressive behavior and rule-breaking behavior. Approximately the same results were found concerning paternal trajectory classes. However, the proportion of the variance explained by the trajectory classes of support ($p = .059$) and proactive control ($p = .068$) was borderline significant.

Aggressive behavior. The results for the trajectory classes of support are presented in Table 10a, for proactive control in Table 10b, for punitive control in Table 10c and for psychological control in Table 10d. In general, there were no significant associations found concerning to gender. There does not seem to be a difference between boys and girls in the levels of aggressive behavior. In analyses with maternal parenting trajectory groups as predictors, the intercept of the growth model of aggressive behavior was higher in the

'moderate-stable' trajectory class of support, compared to the reference category. Likewise, the 'high-stable' support trajectory class also showed more aggressive behavior at age 12. It should be noted that the 'high-stable' group showed lower levels of support than the reference group, which is 'very high-stable'. In other words, the lower the levels of support, the higher the levels of aggressive behavior at age 12. This pattern of findings indicated that a relative lack of maternal support is related to more initial aggressive behavior, despite the fact that the lower levels are still in the "high" and "moderate" range. The trajectory classes of proactive control did not differ in intercept or growth for aggressive behavior. Concerning punitive control, the 'low-stable' trajectory class showed less initial aggressive behavior, compared to the trajectory class with high levels of punitive control. Finally, the 'low-stable' trajectory class for psychological control was positively associated with the intercept of aggressive behavior in comparison to the reference trajectory class 'moderate low-stable'. This finding suggested that very low levels of psychological control predict more aggressive behavior, but not that high levels predict less, because no positive association was found with trajectory classes that show higher levels of psychological control in comparison to the reference trajectory class with moderate levels. For paternal parenting, the 'moderate-increasing' trajectory class of support was associated with a higher intercept of aggressive behavior in comparison to a reference trajectory class with higher levels of parental support. This finding was similar to the findings for maternal support, more specifically, that relative lack of support was associated with higher levels of aggressive behavior at age 12, even though the levels are still high and even increasing. Similar to the findings for maternal parenting, there was no significant association between paternal proactive control and punitive control, on the one hand, and the intercept or linear trend for aggressive behavior, on the other hand. The 'moderate low-stable' and 'moderate high-inverted U-shape' trajectory class of psychological control showed higher initial levels of aggressive behavior than the trajectory class with the lowest levels of psychological control. This pattern of findings seemed to indicate that paternal psychological control is associated with higher levels of aggressive behavior. It should be noted that this is inconsistent with the findings on maternal psychological control.

Rule-breaking behavior. The results for the trajectory classes of support are presented in Table 10a, for proactive control in Table 10b, for punitive control in Table 10c and for psychological control in Table 10d. Concerning gender, girls showed lower levels of rule-breaking behavior at age 12. For maternal parenting, there were no significant associations observed concerning the support dimension. Furthermore, the 'high-stable' trajectory class of proactive control showed less rule-breaking at age 12 than the trajectory class with very high

levels of proactive control, whereas the 'moderate-stable' trajectory class did not show this significant negative association. This finding suggested that proactive control could limit rule-breaking behavior when it is applied with moderation. Concerning punitive control, the 'low-stable' and 'moderate low-decreasing' trajectory class showed a significant negative association with the intercept of rule-breaking behavior in comparison to moderate levels of punitive control. This finding indicated that lower levels of punitive control were associated with lower levels of rule-breaking behavior. There were no significant associations with the trajectory classes of maternal psychological control. Concerning paternal parenting, there were no significant associations with the trajectory classes for paternal support, proactive control, punitive control, or psychological control.

Table 10a

Results of the Conditional Growth Models of Aggressive (AB) and Rule-Breaking Behavior (RBB) on the Trajectory Classes of Support

Outcome (adolescent report)	R^2 (p)	Support (mother report)	β	p	R^2 (p)	Support (father report)	β	p
Intercept AB	.062	Gender	-0.040	.360	.038	Gender	-0.062	.165
	(.006)	**Very high-stable**			(.042)	**High stable**		
		Moderate-stable	0.180	.002		Moderate increasing	0.187	<.001
		High-stable	0.202	.000				
Linear trend AB	.018	Gender	0.052	.399	.007	Gender	0.078	.235
	(.328)	**Very high-stable**			(.511)	**High stable**		
		Moderate-stable	-0.117	.113		Moderate increasing	-0.036	.581
		High-stable	-0.057	.360				
Intercept RBB	.123	Gender	-0.241	.001	.091	Gender	-0.290	<.001
	(.037)	**Very high-stable**			(.059)	**High stable**		
		Moderate-stable	0.215	.008		Moderate increasing	0.088	.214
		High-stable	0.155	.016				
Linear trend RBB	.015	Gender	-0.022	.755	.031	Gender	-0.015	.839
	(.472	**Very high-stable**			(.300)	**High stable**		
		Moderate-stable	-0.050	.609		Moderate increasing	0.176	.038
		High-stable	0.098	.176				
Quadratic trend RBB	.011	Gender	-0.038	.583	.022	Gender	-0.039	.579
	(.511)	**Very high-stable**			(.321)	**High stable**		
		Moderate-stable	0.019	.851		Moderate increasing	-0.143	.061
		High-stable	-0.096	.166				

Note. Gender coded as female = 1 and male = 0; The respective reference group was indicated in bold.

Table 10b

Results of the Conditional Growth Models of Aggressive (AB) and Rule-Breaking Behavior (RBB) on the Trajectory Classes of Proactive Control

Outcome (adolescent report)	R^2 (p)	Proactive control (mother report)	β	p	R^2 (p)	Proactive control (father report)	β	p
Intercept AB	.003	Gender	-0.059	.187	.006	Gender	-0.059	.193
	(.509)	**Very high-stable**			(.342)	**Moderate-increasing**		
		High stable	0.002	.957		Low-increasing-inv. U-shape	-0.042	.123
		Moderate-stable	0.010	.860		Very high-stable	0.009	.844
						High-stable	0.008	.875
Linear trend AB	.007	Gender	0.051	.410	.016	Gender	0.082	.210
	(.533)	**Very high- stable**			(.268)	**Moderate-increasing**		
		High stable	0.002	.971		Low-increasing-inv. U-shape	.064	.183
		Moderate- stable	0.060	.382		Very high-stable	-0.062	.212
						High-stable	-0.035	.596
Intercept RBB	.111	Gender	-0.230	.001	.095	Gender	-0.282	<.001
	(.033)	**Very high- stable**			(.068)	**Moderate-increasing**		
		High stable	-0.200	.002		Low-increasing-inv. U-shape	0.059	.202
		Moderate- stable	-0.095	.092		Very high-stable	0.103	.449
						High-stable	-0.043	.415
Linear trend RBB	.032	Gender	-0.039	.577	.004	Gender	-0.013	.862
	(.271)	**Very high- stable**			(.812)	**Moderate-increasing**		
		High stable	-0.062	.370		Low-increasing-inv. U-shape	-0.002	.982
		Moderate- stable	0.159	.048		Very high-stable	-0.058	.661
						High-stable	0.008	.922
Quadratic trend RBB	.021	Gender	-0.026	.703	.004	Gender	-0.044	.516
	(.340)	**Very high- stable**			(.690)	**Moderate-increasing**		
		High stable	0.072	.280		Low-increasing-inv. U-shape	-0.013	.842
		Moderate- stable	-0.114	.106		Very high-stable	0.033	.742
						High-stable	0.040	.631

Note. Gender coded as female = 1 and male = 0; The respective reference group was indicated in bold.

Table 10c

Results of the Conditional Growth Models of Aggressive (AB) and Rule-Breaking Behavior (RBB) on the Trajectory Classes of Punitive Control

Outcome (adolescent report)	R^2 (p)	Punitive control (mother report)	β	p	R^2 (p)	Punitive control (father report)	β	p
Intercept AB	.026	Gender	-0.037	.398	.027	Gender	-0.049	.281
	(.045)	**Moderate high-decreasing**			(.078)	**Moderate-decreasing**		
		Low-stable	-0.119	.002		Low-stable	-0.088	.041
		High-decreasing	0.023	.668		Moderate-increasing-U-shape	-0.029	.273
		Moderate low-decreasing	-0.112	.010		High-decreasing	0.104	.051
Linear trend AB	.018	Gender	0.041	.506	.022	Gender	0.074	.256
	(.269)	**Moderate high-decreasing**			(.290)	**Moderate-decreasing**		
		Low-stable	0.084	.121		Low-stable	0.060	.338
		High-decreasing	0.072	.322		Moderate- increasing -U-shape	0.039	.360
		Moderate low-decreasing	0.114	.079		High-decreasing	-0.083	.284
Intercept RBB	.125	Gender	-0.207	.003	.141	Gender	-0.280	<.001
	(.036)	**Moderate high-decreasing**			(.034)	**Moderate-decreasing**		
		Low-stable	-0.194	.001		Low-stable	-0.093	.114
		High-decreasing	0.048	.556		Moderate- increasing - U -shape	-0.019	.757
		Moderate low-decreasing	-0.192	.004		High-decreasing	0.187	.031
Linear trend RBB	.012	Gender	-0.055	.428	.021	Gender	-0.014	.860
	(.398)	**Moderate high-decreasing**			(.423)	**Moderate-decreasing**		
		Low-stable	0.089	.192		Low-stable	0.081	.292
		High-decreasing	-0.032	.699		Moderate- increasing - U -shape	0.038	.639
		Moderate low-decreasing	0.042	.560		High-decreasing	-0.095	.295
Quadratic trend RBB	.010	Gender	-0.013	.847	.020	Gender	-0.043	.562
	(.484)	**Moderate high-decreasing**			(.401)	**Moderate-decreasing**		
		Low-stable	-0.090	.200		Low-stable	-0.118	.126
		High-decreasing	0.032	.660		Moderate- increasing - U -shape	-0.014	.834
		Moderate low-decreasing	0.001	.994		High-decreasing	0.036	.639

Note. Gender coded as female = 1 and male = 0.

Table 10d

Results of the Conditional Growth Models of Aggressive and Rule-Breaking Behavior on the Trajectory Classes of Psychological Control

Outcome (adolescent report)	R^2 (p)	Psychological control (mother report)	β	p	R^2 (p)	Psychological control (father report)	β	p
Intercept AB	.059	Gender	-0.041	.352	.058	Gender	-0.044	.335
	(.013)	**Moderate low-stable**			(.001)	**Low-stable**		
		Moderate-stable	-0.088	.043		Moderate low-stable	0.184	<.001
		Moderate high-decreasing	0.099	.090		Moderate high-U-shape	0.099	.083
		Low-stable	0.172	.002		Moderate high- inv. U-shape	0.173	.005
Linear trend AB	.009	Gender	0.049	.429	.020	Gender	0.076	.247
	(.500)	**Moderate low-stable**			(.323)	**Low-stable**		
		Moderate-stable	0.021	.739		Moderate low-stable	0.006	.928
		Moderate high-decreasing	0.046	.562		Moderate high-U-shape	-0.014	.868
		Low-stable	-0.055	.482		Moderate high- inv. U-shape	-0.117	.129
Intercept RBB	.119	Gender	-0.223	.001	.139	Gender	-0.280	<.001
	(.045)	**Moderate low-stable**			(.036)	**Low-stable**		
		Moderate-stable	-0.188	.010		Moderate low-stable	0.134	.051
		Moderate high-decreasing	0.021	.801		Moderate high- U -shape	0.119	.060
		Low-stable	0.101	.163		Moderate high -inv. U-shape	0.186	.027
Linear trend RBB	.041	Gender	-0.049	.479	.001	Gender	0.002	.979
	(.283)	**Moderate low-stable**			(.832)	**Low-stable**		
		Moderate-stable	0.117	.143		Moderate low-stable	0.025	.734
		Moderate high-decreasing	0.165	.098		Moderate high- U -shape	-0.020	.824
		Low-stable	-0.034	.665		Moderate high- inv. U-shape	0.001	.992
Quadratic trend RBB	.041	Gender	-0.014	.840	.004	Gender	-0.053	.450
	(.286)	**Moderate low-stable**			(.710)	**Low-stable**		
		Moderate-stable	-0.098	.193		Moderate low-stable	-0.011	.860
		Moderate high-decreasing	-0.141	.112		Moderate high- U -shape	0.018	.860
		Low-stable	0.085	.317		Moderate high- inv. U-shape	-0.017	.836

Note. AB= Aggressive behavior; RBB= Rule-breaking behavior. Gender coded as female = 1 and male = 0

4. Discussion

The present study adds to the literature by associating membership to parenting trajectory groups, which provides information on longitudinal patterns of parenting, and aggressive (i.e., aggression, disruptive, and non-compliant behaviors) and rule-breaking behavior. This gives a more detailed picture of these associations since we assessed the evolution of subgroups based on parenting across adolescence. For four years, a large sample of adolescents from Grades 7 to 9 and their parents were annually invited to fill out questionnaires on parenting and externalizing problem behavior. This study (a) investigated whether there were meaningful trajectory classes distinguishable within the five measured parenting dimensions, and (b) assessed the association between trajectory class membership and the development of externalizing problem behavior between the ages of 12 and 17.

4.1 Person-Centered Approach of Parenting

Concerning support, the classes of mothers and fathers all fell in the moderate to very high range, which indicates that in a community sample parents perceive their own parenting as warm and supportive. This finding is in line with previous studies on how parents rate their own parenting (Laible et al., 2000; Pettit et al., 2001). We observed two classes of fathers, whereas three classes were found for maternal parenting. This may indicate that there are fewer inter-individual differences in paternal parenting (according to fathers) concerning support. The group of fathers that described their parenting as 'moderately' supportive was proportionally larger (25% of fathers) than the group of mothers that rated themselves as 'moderately' supportive (5% of mothers).

Regarding proactive control, the three classes of mothers were stable across adolescence, whereas two (out of four) classes of fathers showed a more variable trajectory. For instance, the largest group of fathers showed increasing levels of proactive control over the course of adolescence. A conclusive explanation for this trend is not readily available but it does indicate that there are larger differences in paternal parenting than in maternal parenting concerning proactive control.

Concerning punitive control, for both mothers and fathers, there were stable trajectories falling in the low, moderate, or high range. There was one smaller, fluctuating trajectory class of fathers, which showed an initial decline and a subsequent stronger increase in non-physical punishment. This finding of a variable paternal trajectory class is in line with the finding on proactive control.

Finally, regarding psychological control, the trajectory classes for mothers and fathers were similar, however the distribution differed slightly. Most fathers described their parenting as 'low' in psychological control, whereas most mothers fell in the 'moderate' range.

4.2 Concurrent Changes between Parental Trajectory Classes and Externalizing Problem Behavior

A first general remark is that all the observed associations between parenting trajectory classes and externalizing problem behavior relate to the initial levels (i.e., at age 12) of aggressive and rule-breaking behavior, and not to the change across adolescence of aggressive and rule-breaking behavior. In this regard, there was no difference between maternal of paternal parenting. One possible explanation is the fact that the outcome variables were stable across adolescence. Although the decrease for aggressive behavior and the increase for rule-breaking behavior was significant, the changes across adolescence (i.e., slope) appeared to be small for both types of externalizing problem behavior. Consistent with the literature, aggressive behavior seemed to be slightly more stable across adolescence than rule-breaking behavior (Niv, Tuvblad, Raine, & Baker, 2013), which potentially can be explained by a larger heritability as suggested by Burt et al. (2009).

Aggressive behavior across adolescence. The two trajectory classes of mothers of adolescents who exhibited more aggressive behavior at age 12 reported less support, which is consistent with previous studies (Hanisch et al., 2014; Laible et al., 2000). It should be noted that the term 'less' is relative in this case given that scores of the lowest trajectory class are around 3.5 on a 5-point scale, which is still high in comparison with scores on other parenting dimensions. The observation that all three trajectory classes reported moderate to high support may be an indication of its importance. Concerning punitive control, our findings indicated that the trajectory classes of mothers who reported lower levels of punitive control have adolescents that showed less aggressive behavior at age 12. However, we did not observe that adolescents from mothers in the trajectory class characterized by higher punitive control exhibited more initial aggressive behavior. Furthermore, we also did not observe a significant association with the changes of aggressive behavior across adolescence, which is consistent with previous studies (Brenner & Fox, 1998; Stormshak, et al., 2000). The findings concerning psychological control were inconsistent with the literature and suggested that adolescents who reported more aggressive behavior at age 12 had mothers who belonged to the trajectory class characterized by very low levels of psychological control, whereas we expected more aggression to be associated with more psychological control (Ahmad et al., 2013; Mabbe et al., 2016). However,

there was no evidence that the mother trajectory class characterized by high levels of psychological control had adolescents that exhibited lower initial levels of aggressive behavior. In this context, it should be noted that not everyone is equally sensitive to manipulation of thoughts and emotions. Some people may experience a request from their mother as emotional blackmail, whereas others may consider it as a general request. This may lead to differences in what is considered psychological control, and thus be differently associated with adolescent behavior. In other words, it is possible that the low levels of psychological control that were found to be associated with lower levels of aggressive behavior at age 12 are not experienced as manipulative by everyone. It would be interesting to obtain more information on the subjective experience of psychological control by adolescents.

The findings on father reports of support and aggressive behavior were similar to the findings based on mother reports. Adolescents who reported more aggressive behavior at age 12 had fathers that belonged to the trajectory class characterized by lower levels of support. The same remark can be made here, that 'lower' levels of support still comprise a considerable amount of supportive behaviors. In contrast to maternal parenting, adolescents who reported more aggressive behavior at age 12 had fathers whose trajectory class was characterized by higher levels of psychological control, which is in line with the literature (Ahmad et al., 2013; Mabbe et al., 2016). Psychological control is a form of parental control, and as such it may prove useful in obtaining compliance of the adolescent. However, the literature generally suggests that psychological control is associated with higher levels of aggressive behavior (Ahmad et al., 2013; Mabbe et al., 2016). Further research is needed to clarify the function of psychological control and the apparent differences between mothers and fathers concerning this parenting practice.

Rule-breaking behavior across adolescence. Consistent with the literature (e.g. Bongers et al., 2004), there was a gender effect on rule-breaking behavior, more specifically, girls showed significantly lower levels at age 12. Concerning parenting, when mothers belonged to the trajectory class that reported high, but not very high levels of proactive control, adolescents reported less rule-breaking behavior age 12. The extent of proactive control and rule-breaking behavior do not show a linear relationship, since adolescents of the trajectory class of mothers characterized by even lower proactive control, do not exhibit significantly less rule-breaking. There seems to be an optimum concerning the level of maternal proactive control: although some rules are needed, the environment of the adolescent should not be "over-regulated". This way, adolescents could experience enough freedom to explore and to develop themselves. An alternative explanation is that the group of mothers characterized by high proactive control,

does so, because their adolescent exhibits more rule-breaking behavior. However, the present study does not allow for causal conclusions. When mothers belonged to the trajectory class characterized by lower levels of punitive control, their adolescents showed less rule-breaking behavior at age 12. It has to be noted that the trajectory class of mothers that report higher levels of punishment is not linked with adolescents exhibiting more rule-breaking behavior. This finding is consistent with the findings on aggressive behavior. A causal interpretation of this finding is difficult. It may suggest that low levels of punishment are useful in limiting externalizing problem behavior at age 12 or that adolescents show less problem behavior and therefore, there is less need for parents to use punitive control (cfr. proactive control). In other words, does punitive control elicit externalizing problem behavior, vice versa, or both.

Concerning paternal parenting, there were no significant findings for rule-breaking behavior and support, which may indicate that small differences in paternal support are not associated with differences in rule-breaking behavior, whereas this is the case for maternal support. It is possible that adolescents are more sensitive to maternal support than to paternal support, in the context of rule-breaking behavior. Concerning paternal proactive control and punitive control, there were no significant associations with rule-breaking behavior. This is similar to the findings on aggressive behavior. In contrast to the findings on aggressive behavior, the findings on paternal psychological control and rule-breaking behavior did not show significant associations. This raises the question why paternal psychological control did predict aggressive behavior, but did not predict rule-breaking behavior. One possible explanation is that fathers are less involved in everyday rule setting, but get more involved when adolescents show more serious misbehavior, such as aggressive behavior.

4.3 Combining a Person-Centered and Variable-Centered Approach

The use of a combination of LCGA and conditional growth models in the current study provided additional information on parenting. The person-centered approach of LCGA offers the opportunity to distinguish groups of individuals in their use of certain parenting practices. In the current study, the person-centered approach is particularly interesting because it distinguishes groups longitudinally during a period in which parents have to adapt their parenting practices to the developing adolescent. Using this research design, it is not possible to establish whether the evolution of parenting practices causes or is caused by other factors, such as the behavior of the adolescent. An interesting future avenue for research is to investigate the parenting trajectory classes in more detail and to assess whether they differ on other variables, for instance, family composition, socioeconomic status, or the type of parenting their

own parents used. Additionally, future research can address the issue of directionality. Specifically, does parenting evoke problem behavior, vice versa or both. Assessing the unique associations with externalizing problem behavior of subpopulations for each of these five parenting dimensions separately can assist in understanding the mechanisms through which developmental outcomes are positively or negatively affected by parenting practices. Such insights, in turn, can inspire clinical practice. Interventions can be designed to specifically target a subpopulation for a specific parenting dimension.

4.4 Clinical Implications

The findings of the present study provided support for a family-based approach in prevention and intervention of externalizing problem behavior. Both mothers and fathers seem to play a role in the development of problem behavior in their children, however, we found that maternal and paternal parenting practices show different associations with problem behavior. Future prevention and intervention programs should involve both mothers and fathers in order to attain optimal results. In line with previous studies, taking into account the degree of discrepancy/agreement in the perspectives on parenting between informants (i.e., mother and father and/or parent and adolescent) is crucial in designing effective parenting programs (Moens et al., 2018; Van Roy, Groholt, Heyerdahl, & Clench-Aas, 2010). Moreover, when both parents take responsibility in childrearing, it may be advisable to ask to what extent they support each other's parenting. Furthermore, the results refuted some assumptions on associations between certain parenting practices and problem behavior, which can have practical implications. For instance, proactive control is generally considered to be a positive parenting practice, but the present study showed that it can become problematic when parenting becomes too stringent. Our findings also provided information on the timing of prevention and intervention efforts. Specifically, it is important to address parenting practices early in adolescence and consistently across time in order to limit externalizing problem behavior in adolescence.

4.5 Limitations

A number of limitations should be noted concerning this study. First, an important limitation is the fact that adolescent reports are used to assess the level of externalizing problem behavior. It is possible that social desirability plays a role and that adolescents underreport their aggressive behavior and rule-breaking behavior, which in turn would attenuate the associations with externalizing problem behavior that were observed in the present study. Related to this point is that a combination of observational data and questionnaire data could have provided a more detailed view on parenting and externalizing problem behavior. However, observational

data have their own limitations, such as observer effects and the fact that they only provide information about one, particular moment. Second, it is unknown to what extent mothers and fathers are involved in the upbringing of their child. This study asked them about their parenting practices, while it is possible that one of the parents is less involved in parenting. This could be a potential source of noise in the data. However, it is very difficult, if not impossible, to map these differences in involvement. On a related note, it would be interesting to investigate to what extent parents agree or disagree on their parenting behaviors and whether this disagreement is associated with problem behavior of the adolescent. Third, gender was included as a control variable in the prediction of externalizing problem behavior. A number of other factors may also prove interesting in the context of externalizing problem behavior in adolescence. A few examples are Social Economic Status (SES), family composition, or living situation. However, it should be noted that including separate demographic variables as predictors of externalizing problem behavior may prove difficult. Instead of a single variable, it is rather the interplay of a large number of variables that influence the emergence and maintenance of externalizing problem behavior. Fourth, previous studies (Fanti & Henrich, 2010; Ingoldsby et al., 2006) suggested a robust co-occurrence of externalizing and internalizing problem behavior. However, ratings of YSR internalizing behaviors were not available in the present study, therefore it was not possible to investigate co-occurring trajectories of internalizing and externalizing problems. Fifth, the present study did not take into account externalizing problem behavior in childhood. The literature suggests that developmental changes in parent-child relationship quality differ for different types of offenders (Keijsers, Loeber, Branje, & Meeus, 2012). Future additional research on the transition from childhood into adolescence may prove interesting for intervention and prevention purposes. Finally, it should be noted that some of the trajectory classes showed small sample sizes (e.g., $N = 9$), and thus we should be cautious when drawing conclusions about these classes of parents. However, although these small classes seem to represent less common -or even rare- cases within a community sample, they may be more common in clinical samples (e.g., parents showing problematic parenting; being 'at risk' groups) and thus they are worthwhile to consider.

5. Conclusion

In conclusion, several trajectory classes can be distinguished in the longitudinal perceptions by mothers and fathers of their parental behavior (i.e., parental support, proactive control, punitive control, harsh punitive control, and psychological control). Paternal parenting dimensions seem to be less stable than maternal parenting dimensions. However, it should be noted that the largest trajectory classes are similar but that in father reports more variable trajectory classes can be found. Overall, the beneficial effects of support are confirmed across parents. It appears that relatively small differences in support are already associated with differences in aggressive behavior. Concerning maternal proactive control, our results suggest that there is an optimal level for setting rules and monitoring adolescent behavior. Proactive control seems to be useful to provide a stable environment for adolescents, but not when it over-regulates their lives and constrains their freedom. Furthermore, the group of mothers that frequently uses non-physical punishment has adolescents that exhibit more rule-breaking behavior, but not aggressive behavior. This finding is not replicated in the father reports. Finally, our results suggest that when the father belongs to a trajectory class that uses more psychological control, the adolescents exhibits more aggressive behavior at age 12. However, when mother is using psychological control, the association with aggressive behavior seems to be more complex (i.e., non-linear). All observed associations concerned externalizing problem behavior at age 12, our results showed no associations with the change of externalizing problem behavior across adolescence.

6. Supplemental Materials

Table S1

Results from the Normality Tests Per Wave for Aggressive Behavior and Rule Breaking

Outcome	Wave	Kolmogorov-Smirnov	df	p	Shapiro-Wilk	df	p
Aggressive	1	.161	1095	<.001	.892	1095	<.001
behavior	2	.152	989	<.001	.888	988	<.001
	3	.141	879	<.001	.903	879	<.001
	4	.145	498	<.001	891	498	<.001
Rule-breaking	1	.148	1095	<.001	.913	1095	<.001
behavior	2	.141	988	<.001	.891	988	<.001
	3	.148	879	<.001	.901	879	<.001
	4	.161	498	<.001	889	498	<.001

Table S2

Attrition Analysis Assessing Systematic Attrition

Variables at Wave k	t	df	p	$M \Delta$	$SE \Delta$	Δ at Wave $k +1$	
						95% CI Lower	95% CI Upper
A Rule-breaking W1	3.23	1093	.001	0.05	0.02	0.02	0.09
A Aggressive behavior W1	1.50	1093	.134	0.03	0.02	-0.01	0.08
M Support W1	-1.74	825	.082	-0.09	0.05	-0.20	0.01
F Support W1	-0.34	710	.734	-0.02	0.07	-0.17	0.12
A Support W1	-3.14	1093	.002	-0.20	0.06	-0.33	-0.08
M Proactive control W1	-0.50	825	.616	-0.03	0.07	-0.17	0.10
F Proactive control W1	-2.34	711	.020	-0.17	0.07	-0.31	-0.03
A Proactive control W1	-2.97	1093	.003	-0.18	0.06	-0.31	-0.06
M Psychological control W1	.254	825	.800	0.02	0.07	-0.11	0.14
F Psychological control W1	-1.23	710	.220	-0.08	0.07	-0.21	0.05
A Psychological control W1	2.54	1092	.011	.0161	0.06	0.04	0.29
M Punitive control W1	1.17	831	.242	0.14	0.12	-0.09	0.37
F Punitive control W1	0.40	715	.689	0.05	0.12	-0.19	0.29
A Punitive control W1	-1.09	1092	.274	-0.11	0.10	-0.31	0.09
M Harsh punitive control W1	3.13	833	.002	0.11	0.04	0.04	0.18
F Harsh punitive control W1	0.68	715	.497	0.03	0.04	-0.05	0.11
A Harsh punitive control W1	0.99	1093	.322	0.05	0.05	-0.05	0.16

Note. A: Adolescent reported; M: Mother reported; F: Father reported

Table S3a

Pearson Correlations at Time Point 1 Among Parenting Dimensions Reported by Mother and Father

	1	2	3	4	5	6	7	8	9	10
M Support T1 (1)	1									
F Support T1 (2)	.455***	1								
M Proactive control T1 (3)	.476***	.153*	1							
F Proactive control T1 (4)	.237***	.544***	.437***	1						
M Punitive control T1 (5)	-.077	-.244***	.162**	.094	1					
F Punitive control T1 (6)	-.052	-.134*	.138*	.176**	.575***	1				
M Harsh punitive control T1 (7)	-.283***	-.319***	-.082	-.270***	.075	-.019	1			
F Harsh punitive control T1 (8)	-.323***	-.379***	-.174**	-.328***	.090	.022	.632***	1		
M Psychological control T1 (9)	-.347***	-.295***	.089	-.092	.286***	.060	.316***	.387***	1	
F Psychological control T1 (10)	-.262***	-.385***	-.007	-.031	.237***	.168**	.236***	.370***	.383***	1

Note. ***: $p < .001$; **: $p < .01$; *: $p < .05$; M: Mother reported; F: Father reported

Table S3b

Pearson Correlations at Time Point 2 Among Parenting Dimensions Reported by Mother and Father

	1	2	3	4	5	6	7	8	9	10
M Support T2 (1)	1									
F Support T2 (2)	.342***	1								
M Proactive control T2 (3)	.435***	.113*	1							
F Proactive control T2 (4)	.144**	.420***	.311***	1						
M Punitive control T2 (5)	-.028	-.076	.172***	.121*	1					
F Punitive control T2 (6)	-.119*	-.014	.023	.248***	.443***	1				
M Harsh punitive control T2 (7)	-.220***	-.116*	-.063	-.082	.169***	.037	1			
F Harsh punitive control T2 (8)	-.066	-.137**	-.013	-.110*	.129**	.121**	.471***	1		
M Psychological control T2 (9)	-.413***	-.204***	.057	-.036	.168***	.152**	.274***	.226***	1	
F Psychological control T2 (10)	-.209***	-.394***	.069	.120*	.180***	.210***	.210***	.252***	.380***	1

Note. ***: $p < .001$; **: $p < .01$; *: $p < .05$; M: Mother reported; F: Father reported

Table S3c

Pearson Correlations at Time Point 3 Among Parenting Dimensions Reported by Mother and Father

	1	2	3	4	5	6	7	8	9	10
M Support T3 (1)	1									
F Support T3 (2)	.540***	1								
M Proactive control T3 (3)	.426***	.277***	1							
F Proactive control T3 (4)	.238***	.511***	.545***	1						
M Punitive control T3 (5)	.003	.019	.205***	.184***	1					
F Punitive control T3 (6)	-.016	.014	.146**	.253***	.669***	1				
M Harsh punitive control T3 (7)	-.222***	-.031	-.022	-.028	.127**	.047	1			
F Harsh punitive control T3 (8)	-.108*	-.164**	-.029	-.035	.018	.088*	.344***	1		
M Psychological control T3 (9)	-.289***	-.170***	.119**	.065	.171***	.119**	.351***	.236***	1	
F Psychological control T3 (10)	-.173***	-.256***	.130**	.146***	.199***	.252***	.257***	.343***	.678***	1

Note. ***: $p < .001$; **: $p < .01$; *: $p < .05$; M: Mother reported; F: Father reported

Table S3d

Pearson Correlations at Time Point 4 Among Parenting Dimensions Reported by Mother and Father

	1	2	3	4	5	6	7	8	9	10
M Support T4 (1)	1									
F Support T4 (2)	.694***	1								
M Proactive control T4 (3)	.421***	.304***	1							
F Proactive control T4 (4)	.296***	.450***	.720***	1						
M Punitive control T4 (5)	.026	.064	.279***	.273***	1					
F Punitive control T4 (6)	.043	.074	.301***	.373***	.775***	1				
M Harsh punitive control T4 (7)	-.087	-.026	.041	-.007	.121**	.010	1			
F Harsh punitive control T4 (8)	-.032	-.036	.037	.061	.077	.127**	.563***	1		
M Psychological control T4 (9)	-.324***	-.246***	.094*	.039	.177***	.181***	.196***	.129**	1	
F Psychological control T4 (10)	-.223***	-.384***	.074	.047	.135**	.237***	.063	.174***	.678***	1

Note. ***: $p < .001$; **: $p < .01$; *: $p < .05$; M: Mother reported; F: Father reported

Table S3e

Pearson Correlations at Time Point 5 Among Parenting Dimensions Reported by Mother and Father

	1	2	3	4	5	6	7	8	9	10
M Support T5 (1)	1									
F Support T5 (2)	.732***	1								
M Proactive control T5 (3)	.374***	.287***	1							
F Proactive control T5 (4)	.221**	.404***	.737***	1						
M Punitive control T5 (5)	-.019	-.043	.269***	.224**	1					
F Punitive control T5 (6)	-.064	.023	.234***	.308***	.798***	1				
M Harsh punitive control T5 (7)	-.254***	-.280***	-.041	-.097	.113	.048	1			
F Harsh punitive control T5 (8)	-.228**	-.280***	-.046	-.075	.106	.118	.850***	1		
M Psychological control T5 (9)	-.405***	-.270***	.089	.062	.182**	.216**	.303***	.266***	1	
F Psychological control T5 (10)	-.315***	-.374***	.070	.115	.187**	.231***	.304***	.365***	.776***	1

Note. ***: $p < .001$; **: $p < .01$; *: $p < .05$; M: Mother reported; F: Father reported

Table S3f

Pearson Correlations at Time Point 6 Among Parenting Dimensions Reported by Mother and Father

	1	2	3	4	5	6	7	8	9	10
M Support T6 (1)	1									
F Support T6 (2)	.390**	1								
M Proactive control T6 (3)	.236	.091	1							
F Proactive control T6 (4)	.104	.159	.420**	1						
M Punitive control T6 (5)	-.093	-.135	.302*	.308*	1					
F Punitive control T6 (6)	.028	-.190	.348**	.418**	.613***	1				
M Harsh punitive control T6 (7)	-.261*	-.065	.080	.047	.287*	.289*	1			
F Harsh punitive control T6 (8)	-.048	-.014	.052	.117	.380**	.214	.692***	1		
M Psychological control T6 (9)	-.431***	-.167	.277*	.181	.197	.194	.309**	.039	1	
F Psychological control T6 (10)	-.176	-.567***	.034	.234	.185	.469***	.182	.050	.405**	1

Note. ***: $p < .001$; **: $p < .01$; *: $p < .05$; M: Mother reported; F: Father reported

Table S4

Description of the Growth Parameters of the Trajectory Classes

Informant	Father				Mother			
Trajectory class	1	2	3	4	1	2	3	4
Support								
Mean intercept	4.188***	3.375***			4.536***	3.493***	4.078***	
Mean linear trend	0.021	0.111			0.011	-0.145	-0.076*	
Mean quadratic trend	0.002	0.002			-0.008	0.036	0.018	
Proactive control								
Mean intercept	1.671***	4.540***	3.889***	3.039***	4.028***	3.243***	4.565***	
Mean linear trend	1.426**	-0.130*	-0.007	0.434	-0.093*	-0.012	-0.030	
Mean quadratic trend	-0.302**	0.014	0.004	-0.048	0.016	0.018	-0.011	
Punitive control								
Mean intercept	1.732***	2.961***	2.886***	3.948***	1.494***	3.951***	3.327***	2.486***
Mean linear trend	0.187	0.057	-1.430*	-0.186	-0.036	0.051	-0.028	0.003
Mean quadratic trend	-0.051	-0.049*	0.446**	0.009	0.014	-0.035	-0.035*	-0.026
Psychological control								
Mean intercept	2.158***	1.600***	3.044***	2.747***	2.457***	3.005***	1.911**	1.399***
Mean linear trend	-0.053	0.012	-0.891	0.357	-0.121	0.182	-0.009	0.029
Mean quadratic trend	-0.005	-0.008	0.213	-0.131	0.038*	-0.095*	-0.007	-0.005

Note. * $p < .05$. ** $p < .01$. *** $p < .001$; Empty cells indicate that no estimates are available, because these trajectory classes are not a part of the selected model.

Table S5a

Model Fit Indices for the Growth Modeling Concerning Aggressive Behavior and Maternal Parenting Predictors

Model	χ^2	p	df	CFI	RMSEA	SRMR
Unconditional	23.314	.005	9	.982	.038	.063
Controlled for gender + support	37.448	.005	18	.978	.036	.045
Controlled for gender + proactive control	36.735	.006	18	.980	.035	.045
Controlled for gender + punitive control	44.613	.002	21	.977	.037	.042
Controlled for gender + psychological control	41.809	.004	21	.979	.034	.043

Table S5b

Model Fit Indices for the Growth Modeling Concerning Rule-Breaking Behavior and Maternal Parenting Predictors

Model	χ^2	p	df	CFI	RMSEA	SRMR
Unconditional	4.451	.487	5	1	.000	.058
Controlled for gender + support	17.207	.102	11	.992	.026	.033
Controlled for gender + proactive control	19.484	.053	11	.990	.030	.033
Controlled for gender + punitive control	23.082	.041	13	.988	.030	.029
Controlled for gender + psychological control	21.757	.059	13	.989	.028	.031

Table S6a

Model Fit Indices for the Growth Modeling Concerning Aggressive behavior and Paternal Parenting Predictors

Model	χ^2	p	df	CFI	RMSEA	SRMR
Unconditional	23.314	.005	9	.982	.038	.063
Controlled for gender + support	28.366	.019	15	.984	.033	.051
Controlled for gender + proactive control	40.691	.006	21	.981	.034	.043
Controlled for gender + punitive control	41.498	.005	21	.980	.035	.044
Controlled for gender + psychological control	34.870	.029	21	.984	.029	.043

Table S6b

Model Fit Indices for the Growth Modeling Concerning Rule-Breaking Behavior and Paternal Parenting Predictors

Model	χ^2	p	df	CFI	RMSEA	SRMR
Unconditional	4.451	.487	5	1	.000	.058
Controlled for gender + support	14.809	.096	9	.992	.028	.038
Controlled for gender + proactive control	16.060	.246	13	.996	.017	.035
Controlled for gender + punitive control	24.339	.028	13	.987	.033	.032
Controlled for gender + psychological control	24.585	.026	13	.985	.033	.034

Chapter 4

Investigating the Interplay Between Adolescent Personality, Parental Control, and Externalizing Problem Behavior Across Adolescence

Abstract

This study explored transactional associations among adolescent personality (i.e., conscientiousness and agreeableness), parental control (i.e., proactive, punitive, and psychological control), and externalizing problem behavior (i.e., aggressive or rule-breaking behavior). A three-wave longitudinal study across a two-year time span provided questionnaire data from 1,116 adolescents (M_{age} Wave 1= 13.79, 51% boys), 841 mothers, and 724 fathers that was used in random intercept cross-lagged panel models. At the between-person level, adolescent personality, parental control, and externalizing problem behavior were significantly associated. Concerning the within-person level, conscientiousness showed reciprocal associations with externalizing problem behavior (negative), with agreeableness (positive) and punitive control (negative). Our findings observed a reciprocity between adolescent personality and externalizing problem behavior, but also suggest a role for parental control in this interplay.

1. Introduction

Externalizing problem behavior is highly prevalent in adolescence with more than 60% of adolescents getting involved in some kind of problem behavior (Reitz, Deković, & Meijer, 2005). Despite high co-occurrence of several types of externalizing problem behavior, such as rule-breaking and aggressive behavior (Bartels et al., 2003), they are considered to be separate concepts (Achenbach, 1991a, 1991b; Rothbaum & Weisz, 1994). Aggressive behavior refers to physical (e.g., assault) as well as verbal aggression (e.g., insulting), whereas rule-breaking behavior denotes behaviors such as missing curfew or truancy. Besides this behavior being problematic for the environment of the adolescent, externalizing problem behavior is associated with numerous personal psychosocial outcomes such as academic underachievement (Ansary & Luthar, 2015) or work incapacity in adulthood (Narusyte, Ropponen, Alexanderson, & Svedberg, 2017). Therefore, the development of externalizing problem behavior has been extensively investigated (e.g., Laird et al., 2001; Roskam, 2018) guided by theoretical models, such as Lerner's developmental contextual model (Lerner, Rothbaum, Boulous, & Castellino, 2002) which emphasizes the transactional interplay between the person (e.g., temperament) and its environment (e.g., parenting) in behavioral development. The present study will use multiple temperament factors and parenting dimensions to investigate this interplay in detail using state-of-the-art statistical techniques.

Previous studies have suggested bidirectional relationships between parenting practices, such as parental control, and externalizing problem behavior in adolescence (Anderson, 1986; De Haan, et al., 2012; Huh, Tristan, Wade, & Stice, 2006; Keijsers, et al.,2012; Reitz et al., 2006). Parental control is an umbrella term encompassing different kinds of parenting behaviors to promote socialization, the process in which children and adolescents acquire norms, habits and behaviors to function in a way that is acceptable in their culture or society. In most studies two types of parental control are investigated, namely behavioral control and psychological control (Barber, Olsen, & Shagle, 1994; Kakihara & Tilton-Weaver, 2009). A study by Janssens et al. (2015), however, suggests that parental behavioral control can be further split up into a reactive component, for example punishment, and a proactive component, for example setting rules. Together with psychological control, there are three control dimensions. First, *proactive control* is a preventive parenting technique that anticipates undesirable adolescent behavior by providing a stable and regulated environment (Janssens et al., 2015). This parenting practice is generally effective in preventing externalizing problem behavior in adolescence (Galambos, Barker, & Almeida, 2003; Grolnick & Pomerantz, 2009). Second*, punitive control* refers to

non-physical punishment, such as to lecture the adolescent after unwanted behavior, to give a time-out or to ground the adolescent (Janssens et al., 2015). Third, *psychological control* aims at obtaining compliance through manipulation and domination of the adolescent, for instance, through love withdrawal or guilt induction (Barber, 1996; Barber, Xia, Olsen, Mcneely, & Bose, 2012).

Research has primarily devoted attention to the association between adolescent problem behavior and each of these parental control dimensions separately, and has shown significant associations with externalizing behavior. Previous studies suggested that proactive control decreased externalizing problem behavior (e.g., Galambos, Barker, & Almeida, 2003; Gray & Steinberg, 1999; Pettit et al., 2001). Concerning punitive control, a meta-analysis by Larzelere and Kuhn (2005) showed the effectiveness of non-physical punishment in reducing problem behavior, but also emphasized the role of the context in which the punishment occurs. For example, non-physical punishment is found to be more effective when the punishment is consistent and when the reason is explained to the child. Psychological control is associated with suboptimal adolescent development, primarily with internalizing problem behavior, but also with externalizing problem behavior (Barber, Olsen, & Shagle, 1994; Laird, Pettit, Bates, & Dodge, 2003). Studies have stressed the importance of distinguishing different parental control dimensions in the context of child development (Bates, Schermerhorn, & Petersen, 2012; Kiff, Lengua, & Zalewski, 2011) given their differential links to problem behavior.

Concerning the association between parenting and externalizing problem behavior, it is important to acknowledge the role of heritability. A meta-analysis by Burt (2013) suggested a large genetic influence in the etiology of externalizing problem behavior, which means that parents are associated with adolescent problem behavior through genetics (i.e., individual characteristics) as well as parenting practices (i.e., environmental characteristics). It should be noted that it is likely that this genetic and environmental factor are associated (i.e., rGE; Scarr & McCartney, 1983). There is also evidence for bio-ecological interactions. Specifically, previous studies found that externalizing problem behavior was more heritable when mothers were more affectionate (Burt, Klarh, Neale, & Klump, 2013; Button et al., 2008). These findings urge to draw conclusions cautiously, since there are multiple factors to take into account when the associations between parenting and externalizing problem behavior are considered.

A second factor that has been investigated in the context of adolescent externalizing problem behavior is adolescent personality. A number of hypotheses have been proposed to frame this association between personality and problem behavior, or more general

psychopathology (Durbin & Hicks, 2014; Tackett, 2006). For instance, the predisposition hypothesis states that an individual's personality increases the risk for psychopathology, whereas the scar or complication hypothesis states that it is the psychopathology that changes the personality. Furthermore, the pathoplasty or exacerbation hypothesis entails that the individual's personality does not directly cause the psychopathology, but does influence how this psychopathology presents itself (Durbin & Hicks, 2014). The spectrum hypothesis states that personality and psychopathology are on opposite sides of one continuum, which implies (some) common etiological factors. Finally, the continuity hypothesis (De Bolle et al. (2012) contends that personality and problem behavior covary within and across time without pronouncing on the causality of this covariation. De Bolle et al. (2012) found support for the continuity hypothesis and suggested that particular combinations of personality and psychopathology are conceptually closer. For instance, earlier studies have indicated that conscientiousness (i.e., to being well-organized and showing self-discipline; Prinzie et al., 2010; Tackett, 2006) and agreeableness (i.e., being empathetic and supportive towards others; Prinzie et al., 2010; Tackett, 2006), which are part of the Five Factor Model of personality (Caspi, Roberts, & Shiner, 2005), are consistently negatively associated with externalizing problem behavior. Furthermore, De Bolle et al. (2012) also put forward the possibility of a 'third variable' playing a role in the association between adolescent personality and externalizing problem behavior. In this context, the present study explores parental control as a potential 'third variable'.

Literature suggests that parenting and personality are also associated with each other (Caspi et al., 2005). Studies focusing on parental control confirmed the reciprocal relationship between different forms of parental control (i.e., behavioral control and psychological control separately) and temperament in childhood (Bates, Schermerhorn, & Petersen, 2012; Kiff, Lengua, & Zalewski, 2011), which is closely related to personality (Shiner & DeYoung, 2013). The contribution of the present study is twofold, namely that three parental control dimensions (i.e., proactive , punitive, and psychological control) are investigated simultaneously and the focus is on adolescence rather than childhood (cfr. Kiff, Lengua, & Zalewski (2011).

Furthermore, studies exploring the interplay between externalizing problem behavior, parenting, and child personality observed significant associations among all three variables (Prinzie et al., 2003, 2010; Van Leeuwen et al., 2004, 2007). Specifically, the study by Prinzie et al. (2003) included both mother and father reports and suggested that the associations between child personality (e.g., conscientiousness or agreeableness) and externalizing problem behavior were partially mediated by negative parenting practices. In other words, when parents

rated their child as conscientious or agreeable, they were less inclined to use negative parenting practices, which in turn predicted less adolescent externalizing problem behavior. These previous studies assumed a certain direction in the relationship between variables (parenting and personality predicting problem behavior), and did not take into account possible bidirectional associations over time, despite the fact that other studies suggested this reciprocity (De Haan et al., 2012; Huh et al., 2006; Keijsers et al., 2012; Reitz et al., 2006).

1.1 The Present Study

The present study used Random Intercept Cross-Lagged Path Models (RI-CLPM; Hamaker, Kuiper, & Grasman, 2015) to examine transactional and indirect associations among parental control, personality, and two subtypes of externalizing problem behavior, namely, rule-breaking behavior and aggressive behavior, using a three-wave longitudinal design across adolescence. Adolescents reported on their own aggressive and rule-breaking behavior, whereas we computed composite scores (combining mother and father reports) of proactive, punitive, and psychological control, which are dimensions in the five-factor parenting model identified by Janssens et al. (2015). Similar composite scores were used for parent-reported adolescent Big Five personality dimensions.

Based on the literature (Mervielde et al., 2005; Prinzie et al., 2010; Tackett, 2006; Van Leeuwen et al., 2004, 2007), we hypothesized that higher levels of conscientiousness or agreeableness were associated with lower levels of both rule-breaking behavior and aggressive behavior and also lower levels of parental control. It was also assessed whether there was an indirect association between adolescent personality and externalizing problem behavior via parental control. Concerning parental control, we hypothesized that both punitive and psychological control were associated with more aggressive and rule-breaking behavior (Barber, 1996; Janssens et al., 2015; Laird et al., 2003). Proactive control was expected to be negatively associated with aggressive and rule-breaking behavior (Galambos et al., 2003; Grolnick & Pomerantz, 2009). It was also assessed whether there was an indirect association between parenting practices and externalizing problem behavior via adolescent personality. Because the literature indicated that the relationship between parenting and externalizing problem behavior is bidirectional (De Haan et al., 2012; Huh et al., 2006; Keijsers et al., 2012; Reitz et al., 2006), the present study assessed both the predictive value of the parental control dimensions for subsequent problem behavior, and the predictive value of problem behavior for subsequent parenting. More specifically, we expected that more rule-breaking and aggressive behavior was associated with more negative parenting practices (e.g., psychological control and

punitive control) (Huh et al., 2006). The effect of adolescent sex was also assessed. Consistent with the literature (Pettit et al., 2001), we expected that the associations between the parental control dimensions and externalizing problem behavior would be stronger for girls.

The present study adds to the literature by examining transactional associations between different parental control dimensions, adolescent personality and adolescent externalizing problem behavior across adolescence. The use of a RI-CLPM allows us to investigate these associations at both the between- and within-person level and without assuming a certain direction in the associations.

2. Method

2.1 Participants and Procedure

Data were collected within the STRATEGIES project. This longitudinal study annually questioned adolescents and their parents in Flanders, the Dutch-speaking part of Belgium. They were selected through a randomized multistage sampling approach. In a first stage, Flemish secondary schools were invited to take part in the study. Stratification was used to include students from general, technical, and vocational tracks. In the second stage 121 classes in the seventh, eighth, and ninth grade were selected from the nine schools who agreed to participate in the study. Within these classes, 2,254 students and their parents were invited to participate. The sample at Wave 1 comprised 1,116 adolescents ($M_{age} = 13.79$, $SD = 0.93$, 51% boys), 841 mothers ($M_{age} = 43.54$, $SD = 4.54$), and 724 fathers $M_{age} = 45.45$, $SD = 4.76$). The retention rate in Wave 2 was 89% for adolescents, 75% for mothers, and 72% for father. In Wave 3, the retention rate decreased to 79% for adolescents, 66% for mothers and 63% for fathers. Family characteristics were representative for the general population $\chi^2(2) = 2.78$, $p = .25$, with 82% two-parent families, 7% single-parent families, and 11% blended families (Janssens et al., 2017; King Baudouin Foundation, 2008). The educational level (EDU) and employment activity level (ACT) of parents differed for both mothers (EDU: $\chi^2(3) = 30.34$, $p < .001$; ACT: $\chi^2(1) = 15.87$, $p < .001$) and fathers (EDU: $\chi^2(3) = 34.19$, $p < .001$; ACT: $\chi^2(1) = 15.13$, $p < .001$) with bachelor degrees and active employees being slightly overrepresented (Janssens et al., 2017; Research Department of the Flemish Government, 2010, 2011). Despite this small deviation, it can be concluded that participants represent all categories for socioeconomic status. The STRATEGIES project used an accelerated longitudinal design, which implies that in each wave an age range is covered that overlaps with the age range of the next wave. This overlap leads to structural missing data, which is handled (cfr. regular missing data) through Full Information

Maximum Likelihood (FIML). Across the three waves, adolescents' age ranged from 11 to 17 years.

2.2 Measures

All measures for both adolescents and parents were in Dutch, the native language of the participants. Most scales were adaptations of well-known American instruments.

2.2.1 Parenting behavior.

Parenting was rated by mothers and fathers on a selection of subscales from multiple questionnaires, which were included based on their availability in Dutch, theoretical relevance, adequate psychometric properties, and prior use in parenting research. A confirmatory factor analysis (CFA) on these questionnaires resulted in the five-factor parenting model mentioned in the Introduction (Janssens et al., 2015). Measurement invariance of this five-factor model was established across adolescence as well as across informants (i.c., mother and father) by Van Heel et al. (2017), which makes this model suitable to address the research questions.

The dimension *Proactive Control* (Mother Cronbach's α at W1 = .86, W2 = .83, W3 = .85; Father Cronbach's α at W1 = .86, W2 = .86, W3 = .87) comprised two subscales, that is Setting Parental Expectations for Behavior (6 items, e.g., "I expect my son or daughter to behave in a certain manner") and Parental Monitoring of Behavior (6 items, e.g., "I remind my son or daughter of the rules I made"). These subscales were selected from the Parental Regulation Scale (PRS-YSR; Barber, 2002), which was translated into Dutch by Soenens, Vansteenkiste, Luyckx, and Goossens (2006). The dimension *Punitive control* (Mother α at W1 = .88, W2 = .89, W3 = .89; Father α at W1 = .88, W2 = .88, W3 = .88) comprised the Punishment subscale (4 items, e.g. "If my son or daughter does something he/she was not supposed to, I punish him/her") from the Parental Behavior Scale – Short Form (PBS-S; Van Leeuwen et al., 2013). The dimension *Psychological Control* (Mother α at W1 = .84, W2 = .84, W3 = .89; Father α at W1 = .83, W2 = .84, W3 = .86) comprised two subscales. The subscale Psychological Control (8 items, e.g., "I do not talk to my son or daughter when he/she disappointed me until he/she pleases me again") was taken from the Dutch version of Barber's Psychological Control Scale (Barber, 1996; Soenens et al., 2006). One additional item from this subscale was based on a study by Soenens, Sierens, Vansteenkiste, Dochy, and Goossens (2012). The subscale Hostility (6 items, e.g., "I yell at my son or daughter when he/she misbehaves") was based on the Verbal Hostility Scale (Nelson & Crick, 2002). All items were rated by mothers on a 5-point scale ranging from 1 *(almost) never* to 5 *(almost) always*. For all three dimensions, scores were averaged across items.

2.2.2 Adolescent personality.

Mothers and fathers rated their adolescent's personality by filling out the Quick Big Five (QBF; Vermulst & Gerris, 2005). The QBF comprised 30 items with each factor of the Big Five personality factors being represented by six items. The present study only included conscientiousness and agreeableness. Examples of items are "systematic" (conscientiousness: mother α at W1 = .91, W2 = .92, W3 = .92; father α at W1 = .91, W2 = .92, W3 = .92) and "friendly" (agreeableness: mother α at W1 = .87, W2 = .87, W3 = .88; father α at W1 = .88, W2 = .86, W3 = .89). Each item was rated on a 7-point Likert scale, ranging from 1 (*completely incorrect*) to 7 (*completely correct*). For both personality variables, scores were averaged across items. The Differential Item Functioning (DIF) of this questionnaire was assessed in order to investigate whether the included personality items showed difference in response probabilities across parents per wave and across waves per parent. For this purpose, the procedure suggested by Raykov, Marcoulides, Lee, and Chang (2013) was used. There was no more than one item per DIF test that showed differential functioning (i.e., a significant association with wave number or informant). Given the fact that subscales contained an already limited number of items and none of the items consistently exhibited DIF, it was decided to use the original subscales for the personality dimensions, agreeableness and conscientiousness. The results concerning DIF tests are presented in Table S7 and Table S8 in the supplementary materials.

2.2.3 Composite score.

The present study used composite scores for both parental control and adolescent personality. All three parenting practices and both personality dimensions were represented by a separate composite score, which was an average of the ratings from mother and father. When the report from one parent was missing, the report from the other parent was used. Composite scores are thought to counteract the common method bias (i.e., the use of a single informant) and to be more nuanced, since they use multiple sources of information (Podsakoff, Scott, Mackenzie, & Podsakoff, 2003).

2.2.4 Adolescent problem behavior.

Adolescents rated their own externalizing problem behavior by filling out the Youth Self Report (YSR; Achenbach 1991a). The broad-band scale Externalizing Behavior (YSR: 31 items, α at W1 = .82, W2 = .84, W3 = .82) can be further divided into two subscales that target aggressive behavior (YSR: 17 items, α at W1 = .78, W2 = .80, W3 = .78) and rule-breaking behavior (YSR: 14 items, α at W1 = .58, W2 = .66, W3 = .63), respectively. Example items are:

''I destroy my own belongings'' and ''I skip classes or I play truant'', respectively. A 3-point rating scale was used, ranging from 0 (*not true*) to 2 (*very true or often true*). For both subscales, scores were averaged across items. Higher scores indicated more externalizing problem behaviors. Measurement invariance of the YSR across adolescence was established by Fonseca-Pedrero et al. (2012).

2.3 Analysis Strategy

Two RI-CLPM's were fitted for aggressive behavior and rule-breaking behavior separately to examine transactional and indirect associations with parenting (i.e., proactive control, punitive control, psychological control) and personality (i.e., conscientiousness and agreeableness), while accounting for within-time correlations and stability coefficients. In other words, two models were fitted, one for aggressive behavior and one for rule-breaking behavior, in which the parenting and personality variables were identical. The use of RI-CLPM was suggested by Hamaker, Kuiper, and Grasman (2015) in order to adequately represent both the within-person associations and between-person associations. All the analyses were conducted in MPlus version 7 (Muthén & Muthén, 2012). The robust Maximum Likelihood Estimator (MLR) was used to account for non-normality and Full Information Maximum Likelihood estimator (FIML) was used to handle missing data. Three indices were used to examine overall model fit. First, a lower Satorra-Bentler chi square (S-Bχ^2) indicated better overall fit. Second, a high Comparative Fit Index (CFI), more specifically above .90, indicated acceptable model fit. Third, a low Mean Square Error of Approximation (RMSEA), more specifically below .08, indicated acceptable fit. In order to compare nested models, the Satorra-Bentler scaled chi-square difference test (ΔS-Bχ^2) was used with an α of .05 (Hu & Bentler, 1999).

The within-person portion of the models was built using a 2-step modelling strategy (Janssens et al., 2017). In a first phase, models were tested without constraining any parameters. In a second phase, parameters were constrained across waves to assess a model that showed good overall fit, but also was more parsimonious. A first unconstrained model (Model 1) included all stability paths between time points as well as within-time correlations. A second unconstrained model (Model 2) included the cross-lagged paths involving aggressive behavior/rule-breaking behavior. A third unconstrained model (Model 3) included the cross-lagged paths that originate in conscientiousness and agreeableness and end in the parental control dimensions. The cross-lagged paths between the two personality types were also included in order to control the model for this association. A fourth and last unconstrained model (Model 4) included the cross-lagged paths that originate in proactive control, punitive

control, and psychological control and end in the personality factors. The cross-lagged paths between the three parenting dimensions were also included in order to control the model for these associations. A significant ΔS-Bχ^2 (α = .05) indicates that the extended model showed a significantly better fit. This model was then compared with the next, extended model (e.g., if Model 2 showed a significantly better fit than Model 1 then Model 2 was compared to Model 3). A second phase, in which the model was simplified, began with constraining the stability path (Model 5) to be equal across waves. A second constraint (Model 6) additionally held the within-time correlations equal across waves. These constrained models were tested against the best fitting unconstrained model. A non-significant ΔS-Bχ^2 test indicated that the constrained model did not show a significantly worse model fit, and thus that the parameters could be considered equal across waves.

When the best fitting model was established, it was assessed whether the model significantly differed between boys and girls. The Satorra-Bentler chi-square difference test was used to compare a multi-group SEM model which constrained the parameters across adolescent sex with a model that allowed the parameters to vary across adolescent sex. Depending on the results of this test, the final model was discussed for boys and girls separately or as one general model.

3. Results

3.1 Rule-Breaking Behavior

Detailed results on the model selection procedure concerning rule-breaking behavior are presented in Table S9. Model 5 was the best fitting model for the interplay including rule-breaking behavior (S-Bχ^2(27) = 69.908; CFI= .992; RMSEA= .020) and did not significantly differ across adolescent gender (ΔS-Bχ^2 =19.484, Δdf = 28, p= .883). This finding indicated that there was no need for separate models for boys and girls. Thus, the final model was Model 5, which included the within-time correlations, cross-lagged paths, and stability paths that were constrained across waves.

Correlations between random intercepts are presented in Table 11. In the rule-breaking model at the between-person level, the random intercepts of the parental control dimensions showed weak negative associations with the random intercepts of the two other parental control dimensions and weak to moderate positive associations with the random intercepts of agreeableness, conscientiousness, and rule-breaking behavior. The correlations with rule-breaking behavior were significant, but weak. The random intercepts of agreeableness and

conscientiousness were strongly negatively correlated with each other and weakly positively associated with the random intercept of rule-breaking behavior.

Within-person correlations are presented in Table 12. The within-person stability paths were all significant ($p < .01$), except for the stability paths of psychological control. The standardized regression coefficients ranged from 0.14 (psychological control W1 (W2) to W2 (W3)) to 0.47 (conscientiousness W2 to W3). Concerning, within-person cross-lagged paths, negative reciprocal relation between conscientiousness and punitive control was observed, whereas conscientiousness showed a positive reciprocal association with agreeableness. Punitive control and rule-breaking behavior also showed a positive reciprocal association, but only between Wave 2 and Wave 3. Furthermore, conscientiousness at Wave 1 was negatively associated with rule-breaking behavior at W2, which, in turn, was negatively associated with conscientiousness at Wave 3. Agreeableness at Wave 1 was negatively associated with proactive control, which, in turn, was negatively associated with agreeableness at Wave 3. Proactive control predicted a relative increase in psychological control at the next wave, although this association was not observed from psychological control to proactive control. All the estimates of all the cross-lagged paths are presented in Table 13 and Figure 7 provides a visual representation of the significant cross-lagged and stability paths.

Finally, there were no indirect associations between personality traits (i.e., conscientiousness or agreeableness) at Wave 1 and rule-breaking behavior at Wave 3 via parental control (i.e., proactive control, punitive control, or psychological control) or between parental control (i.e., proactive control, punitive control, or psychological control) at Wave 1 and rule-breaking behavior at Wave 3 via adolescent personality (i.e., conscientiousness or agreeableness). Detailed results concerning the indirect associations are presented in Table S10.

Table 11

Pearson Correlations Among Random Intercepts of the Best Fitting Model Concerning Rule-Breaking Behavior and Aggressive Behavior Respectively

Rule-breaking model	1	2	3	4	5	6
1.Proactive control	1					
2.Punitive control	-.13***	1				
3.Psychological control	-.11***	-.16***	1			
4.Agreeableness	.27***	.36***	.14***	1		
5.Conscientiousness	.38***	.56***	.24***	-.45***	1	
6.Rule-breaking behavior	.04***	-.06***	-.03***	.06***	.09***	1
Aggressive behavior model	1	2	3	4	5	6
1.Proactive control	1					
2.Punitive control	-.12***	1				
3.Psychological control	-.11***	-.16***	1			
4.Agreeableness	.27***	.37***	.14***	1		
5.Conscientiousness	.33***	.56***	.25***	-.46***	1	
6.Aggressive behavior	-.06***	-.09***	-.04***	.07***	.13***	1

Note. $^{*} p < .05.$ $^{**} p < .01.$ $^{***} p < .001.$

Table 12

Within-Person Pearson Correlations Among Variables of the Best Fitting Model Concerning Rule-Breaking Behavior

	Wave 1						Wave 2						Wave 3					
Rule-breaking behavior model	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
1.Proactive control	1						1						1					
2.Punitive control	.56***	1					.23**	1					.38***	1				
3.Psychological control	.60***	.67***	1				.30***	.24*	1				.13*	.24**	1			
4.Agreeableness	-.56***	-.67***	-.72***	1			-.10	-.02	-.31***	1			-.08	-.15*	-.25**	1		
5.Conscientiousness	-.64***	-.72***	-.72***	.81***	1		-.03	-.15	-.14	.43***	1		-.13*	-.20**	-.20**	.32***	1	
6.Rule-breaking behavior	.50***	.58***	.61***	-.69***	-.65***	1	.04	.05	-.01	-.12	-.12	1	.02	.08	.01	-.11	-.19**	1
Aggressive behavior model	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
1.Proactive control	1						1						1					
2.Punitive control	.56***	1					.24**	1					.38***	1				
3.Psychological control	.60***	.68***	1				.30***	.23*	1				.13	.22**	1			
4.Agreeableness	-.56***	-.68***	-.72***	1			-.09	-.01	-.31***	1			-.07	-.13*	-.25**	1		
5.Conscientiousness	-.62***	-.72***	-.73***	.82***	1		-.02	-.15	-.15*	.46***	1		-.13	-.18**	-.19**	.31***	1	
6.Aggressive behavior	.47***	.59***	.63***	-.70***	-.69***	1	.11**	.18*	.12	-.21*	-.20*	1	.04	.16*	.01	-.17	-.22**	1

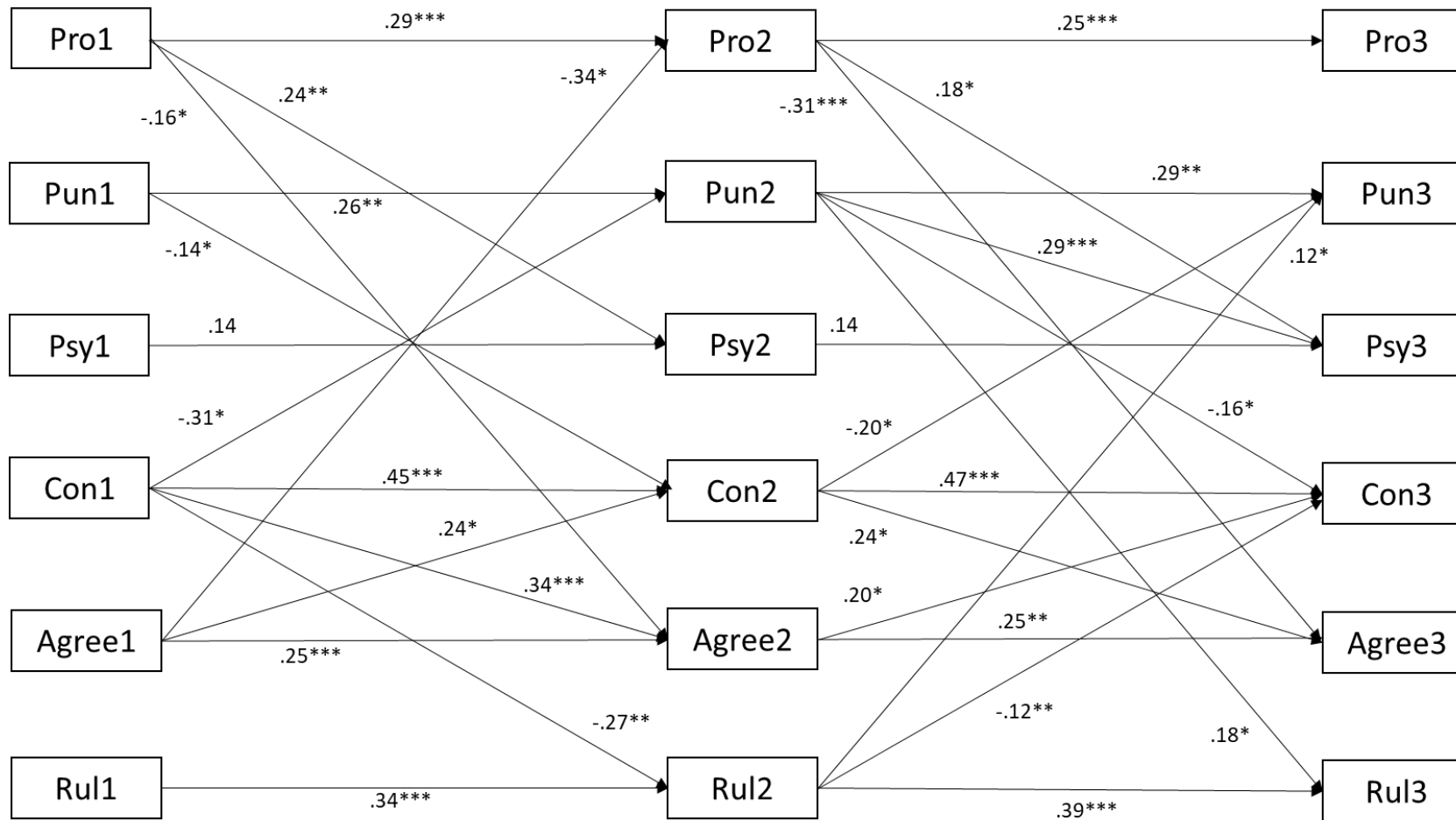*Note.* * $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 7. Significant cross-lagged and stability paths of the final model concerning rule-breaking behavior.

Note. Pro = Proactive Control; Pun = Punitive Control; Psy = Psychological Control; Con = Conscientiousness; Agree = Agreeableness; Rul = Rule-breaking behavior; * *p* < .05. ** *p* < .01. *** *p* < .001.

Table 13

Parameter Estimates for the Cross-Lagged Paths in the Rule-Breaking Behavior Model

Outcome	Predictor	β	*p*	Outcome	Predictor	β	*p*	Outcome	Predictor	β	*p*
Pro con W2	Cons W1	0.043	.766	Pun con W2	Cons W1	-0.310	.018	Psy con W2	Cons W1	-0.088	.569
	Agree W1	-0.346	.017		Agree W1	-0.155	.206		Agree W1	-.242	.086
	Pun con W1	0.121	.152		Pro con W1	-0.012	.856		Pro con W1	0.236	.002
	Psy con W1	0.041	.673		Psy con W1	0.104	.245		Pun con W1	0.095	.316
	Rul W1	0.121	.181		Rul W1	0.062	.458		Rul W1	0.089	.343
Agree W2	Cons W1	0.340	.001	Cons W2	Agree W1	0.225	.017	Rul W2	Cons W1	-0.265	.008
	Pro con W1	-0.156	.011		Pro con W1	-0.097	.115		Agree W1	-0.058	.550
	Pun con W1	-0.006	.937		Pun con W1	-0.144	.038		Pro con W1	0.031	.618
	Psy con W1	-0.107	.186		Psy con W1	0.015	.845		Pun con W1	0.032	.667
	Rul W1	-0.066	.348		Rul W1	-0.038	.550		Psy con W1	0.031	.676
Pro con W3	Cons W2	-0.068	.509	Pun con W3	Cons W2	-0.197	.025	Psy con W3	Cons W2	-0.121	.255
	Agree W2	-0.151	.210		Agree W2	-0.095	.326		Agree W2	-0.178	.109
	Pun con W2	0.147	.094		Pro con W2	0.159	.086		Pro con W2	0.184	.030
	Psy con W2	0.142	.114		Psy con W2	0.091	.306		Pun con W2	0.289	.001
	Rul W2	0.114	.092		Rul W2	0.119	.041		Rul W2	0.045	.397
Agree W3	Cons W2	0.237	.017	Cons W3	Agree W2	0.199	.013	Rul W3	Cons W2	-0.173	.063
	Pro con W2	-0.313	.001		Pro con W2	-0.140	.082		Agree W2	0.023	.823
	Pun con W2	-0.039	.665		Pun con W2	-0.159	.017		Pro con W2	0.161	.058
	Psy con W2	-0.087	.387		Psy con W2 W2	0.083	.284		Pun con W2	0.173	.032
	Rul W2	-0.076	.348		Rul W2	-0.119	.008		Psy con W2	0.017	.832

Note. Pro con = Proactive control; Pun con = Punitive control; Psy con = Psychological control; Cons = Conscientiousness; Agree = Agreeableness; Rul = Rule-breaking behavior.

3.2 Aggressive Behavior

Detailed results on the model selection procedure concerning aggressive behavior are presented in Table S11. Model 5 was the best fitting model for the interplay including aggressive behavior (S-Bχ^2(27) = 64.727; CFI= .993; RMSEA= .020) and did not significantly differ across adolescent gender (ΔS-Bχ^2 =19.484, Δdf = 28, p= .883). This finding indicated that there was no need for separate models for boys and girls. The final model included the within-time correlations, cross-lagged paths, and the stability paths that were constrained across waves.

Correlations among random intercepts are presented in Table 11. At the between-person level, the random intercepts in the model concerning aggressive behavior showed a similar pattern as in the model concerning rule-breaking behavior. There was one difference, namely that the random intercept of proactive control was weakly negatively associated with the random intercept of aggressive behavior.

Within-person correlations per wave are presented in Table 12. The within-person stability paths were all significant at $p < .01$, except for the stability paths of psychological control. The standardized regression coefficients ranged from 0.13 (psychological control W2 to W3) to 0.44 (conscientiousness W2 to W3. The stability paths of aggressive behavior were significant, but weaker than the stability paths of rule-breaking behavior. Concerning within-person cross-lagged paths, the positive reciprocal association between conscientiousness and agreeableness across waves was replicated. Also similar to the model concerning rule-breaking behavior was the positive association from proactive control with psychological control at the next wave and the observation that agreeableness at Wave 1 predicted a relative decrease in proactive control at Wave 2, which, in turn, predicted a relative decrease in agreeableness at Wave 3. Punitive control and aggressive behavior showed a positive reciprocal association, but only between Wave 2 and Wave 3. Conscientiousness at Wave1 predicted a relative decrease of aggressive behavior at Wave 2, which, in turn, predicted a relative decrease in conscientiousness at Wave 3. A similar pattern was found for conscientiousness and punitive control. All the estimates of all the cross-lagged paths are presented in Table 14 and Figure 8 provides a visual representation of the significant cross-lagged and stability paths.

Finally, there were no indirect associations between personality traits (i.e., conscientiousness or agreeableness) at Wave 1 and aggressive behavior at Wave 3 via parental control (i.e., proactive control, punitive control, or psychological control) or between parental control at Wave 1 and aggressive behavior at Wave 3 via personality (See Table S12).
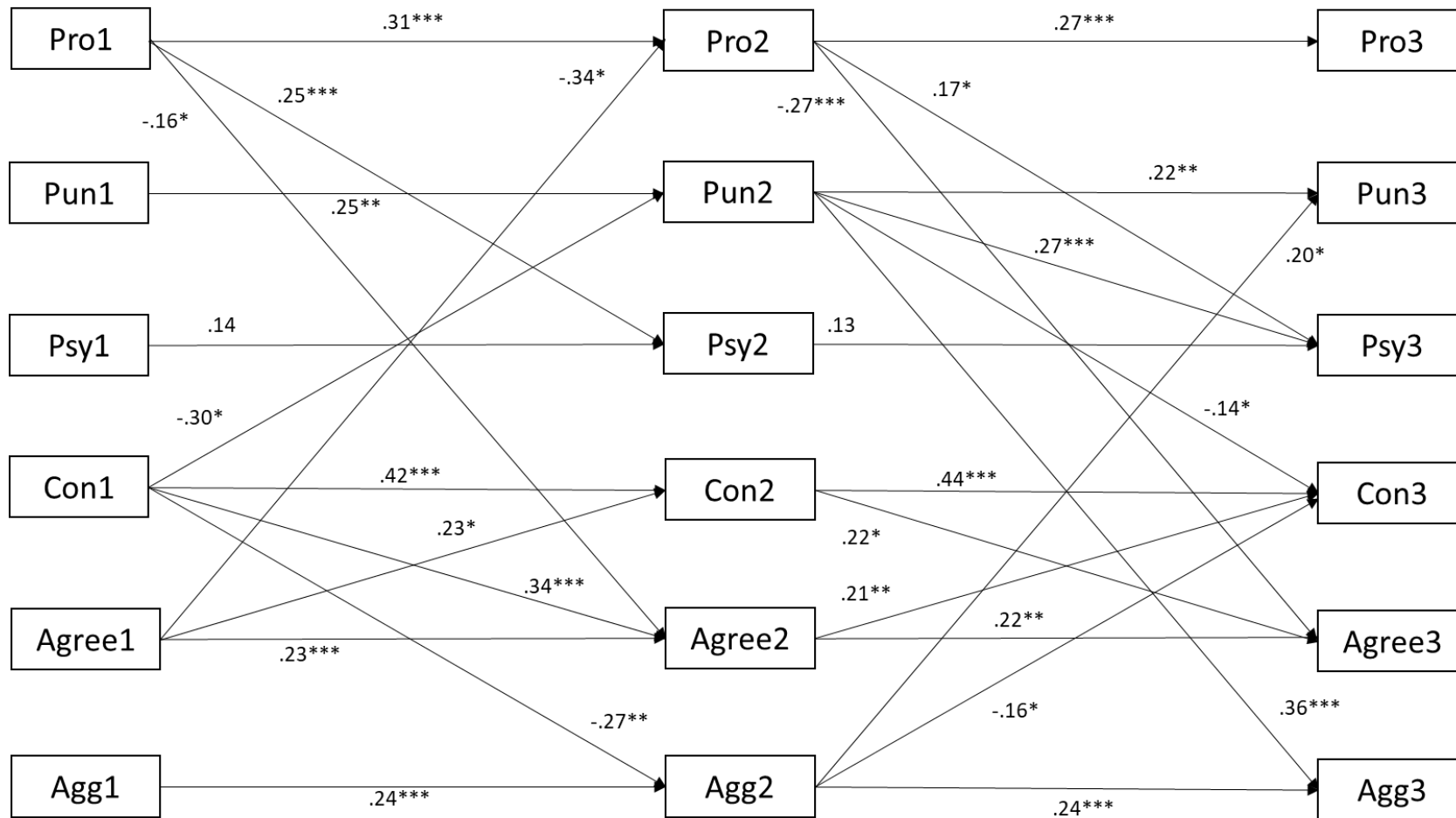
Figure 8. Significant cross-lagged and stability paths of the final model concerning aggressive behavior.

Note. Pro = Proactive Control; Pun = Punitive Control; Psy = Psychological Control; Con = Conscientiousness; Agree = Agreeableness; Agg = Aggressive Behavior; * *p* < .05. ** *p* < .01. *** *p* < .001

Table 14

Parameter Estimates for the Cross-Lagged Paths in the Aggressive Behavior Model

Outcome	Predictor	β	*p*	Outcome	Predictor	β	*p*	Outcome	Predictor	β	*p*
Pro con W2	Cons W1	0.069	.652	Pun con W2	Cons W1	-0.301	.026	Psy con W2	Cons W1	-0.104	.525
	Agree W1	-0.347	.018		Agree W1	-0.158	.201		Agree W1	-0.220	.121
	Pun con W1	0.119	.162		Pro con W1	0.007	.919		Pro con W1	0.246	.001
	Psy con W1	0.046	.659		Psy con W1	0.104	.251		Pun con W1	0.082	.374
	Agg W1	0.100	.306		Agg W1	0.061	.412		Agg W1	0.105	.218
Agree W2	Cons W1	0.369	<.001	Cons W2	Agree W1	0.237	.014	Agg W2	Cons W1	-0.266	.029
	Pro con W1	-0.160	.009		Pro con W1	-0.099	.110		Agree W1	-0.211	.061
	Pun con W1	-0.005	.945		Pun con W1	-0.130	.063		Pro con W1	0.035	.575
	Psy con W1	-0.101	.222		Psy con W1	0.014	.864		Pun con W1	0.053	.432
	Agg W1	-0.065	.341		Agg W1	-0.073	.205		Psy con W1	0.052	.454
Pro con W3	Cons W2	-0.051	.622	Pun con W3	Cons W2	-0.151	.094	Psy con W3	Cons W2	-0.110	.314
	Agree W2	-0.172	.173		Agree W2	-0.101	.305		Agree W2	-0.176	.120
	Pun con W2	0.149	.100		Pro con W2	0.147	.098		Pro con W2	0.169	.045
	Psy con W2	0.128	.164		Psy con W2	0.069	.432		Pun con W2	0.274	.001
	Agg W2	0.069	.473		Agg W2	0.195	.014		Agg W2	0.092	.204
Agree W3	Cons W2	0.222	.026	Cons W3	Agree W2	0.213	.008	Agg W3	Cons W2	-0.061	.589
	Pro con W2	-0.272	.004		Pro con W2	-0.131	.105		Agree W2	-0.175	.153
	Pun con W2	-0.018	.839		Pun con W2	-0.143	.039		Pro con W2	0.122	.228
	Psy con W2	-0.078	.413		Psy con W2	0.090	.245		Pun con W2	0.359	<.001
	Agg W2	-0.181	.051		Agg W2	-0.160	.014		Psy con W2	-0.018	.837

Note. Pro con = Proactive control; Pun con = Punitive control; Psy con = Psychological control; Cons = Conscientiousness; Agree = Agreeableness; Agg = Aggressive behavior.

4. Discussion

The present study investigated the transactional associations between different aspects of adolescent personality, parental control, and externalizing problem behavior in adolescence. A Random intercept cross-lagged panel model was used because it distinguishes the time-invariant between-person effects and the time-specific within-person effects, which allows to accurately investigate transactional associations across adolescence. At the between-level, the strongest associations were observed involving the personality dimensions. Specifically, high levels of parent-reported conscientiousness or agreeableness were associated with high levels of parent-reported proactive and punitive control. Furthermore, the two personality dimensions were negatively associated with each other. Concerning within-person transactional associations, the hypothesis that high levels of conscientiousness or agreeableness would be associated with a relative decrease in externalizing problem behavior was supported for conscientiousness, which showed reciprocal negative links with both rule-breaking and aggressive behavior. Furthermore, our findings indicated that there were no indirect associations between parental control and externalizing problem behavior (via adolescent personality) or between adolescent personality and externalizing problem behavior (via parental control). Concerning parenting behaviors, we expected that high levels of punitive or psychological control would be associated with a relative increase of externalizing problem behavior, whereas proactive control was expected to be associated with a relative decrease. This hypothesis was only and inconsistently confirmed for punitive control. In contrast to our hypothesis, models for rule-breaking and aggressive behavior were not found to be significantly different for boys as compared to girls.

4.1 Links Among Rule-Breaking Behavior, Personality, and Parental Control

In contrast to a previous study by Pettit et al. (2001), sex did not appear to play a significant role in the interplay between rule-breaking behavior and parental control. It is possible that sex effects become more apparent when specific associations are considered rather than an extensive model on parenting, personality and problem behavior. Furthermore, another difference with the study by Pettit et al. (2001) is that they investigated delinquent behavior, which can be considered more severe since it implies breaking the law. Sex may become more important when problem behavior grows more severe, but more research is needed to explore its role in more detail.

At the between-person level, high levels of punitive control were associated with low levels of proactive and psychological control and high levels of proactive control were associated with low levels of psychological control. This may indicate that when parents often use one parenting practice, other practices may be used less. However, this does not mean parents use only one parenting practice. High levels of the parental control dimensions were associated with higher levels of the two personality dimensions, agreeableness and conscientiousness, which may be interpreted as parents perceiving their parenting as effective. When parents obtain compliance from their adolescent through the use of these parenting practices, they rate the adolescents as more agreeable and more conscientious. A somewhat counterintuitive finding is the observation that high levels of conscientiousness were associated with low levels of agreeableness. This finding can be interpreted in light of every dimension of the Big Five having positive and negative aspects. High levels of conscientiousness can be reflected in a perfectionistic attitude and lack of spontaneity. It is possible that these characteristics lead to individuals being perceived as uncooperative and less agreeable. It has to be noted that this association was observed at the population level, but not at the intra-individual level. Finally, high levels of rule-breaking behavior were weakly associated with high levels of proactive control, agreeableness, and conscientiousness, but low levels of punitive and psychological control. The findings concerning punitive (Brenner & Fox, 1998; Stormshak, Bierman, McMahon, & Lengua, 2000) and psychological control (Ahmad, Vansteenkiste, & Soenens, 2013; Mabbe et al., 2016) as well as concerning agreeableness and conscientiousness (Asendorpf, Caspi, & Hofstee, 2002) were consistent with the literature. The finding that rule-breaking behavior was positively associated with proactive control is not in line with the literature (Galambos, Barker, & Almeide, 2003; Gray & Steinberg, 1999). One possible explanation is that parents assume that because of risky behaviors inherent in adolescence, an adolescent needs more proactive control (increasing rules and supervision), but that these parenting practices are counterproductive, eliciting more rule-breaking. More research is needed to investigate how proactive control is experienced by adolescents and how they respond to it.

At the within-person level, the cross-lagged paths indicated a negative reciprocal association between rule-breaking behavior and conscientiousness. In other words, when parents described their adolescent as more conscientious, the adolescent reported less rule-breaking behavior one year later, and vice versa, which is consistent with our hypotheses. If an adolescent is conscientious, it is less likely that the adolescent will exhibit problem behavior. This reciprocity, in line with De Bolle et al. (2012) and Shiner (2000) can be framed within the

continuity hypothesis which states that personality and externalizing problem behavior covary within and across time, but could also be interpreted within the scar/complication hypothesis, stating that psychopathology predicts personality, or the predisposition hypothesis, stating that personality predicts psychopathology. Based on the present findings, it is impossible to distinguish between these three hypotheses. More research is needed to explicitly test the different hypotheses.

Prinzie et al. (2003) suggested that parental control may play a role in the association between personality and problem behavior. However, there was no support for indirect associations between adolescent personality and externalizing problem behavior via parental control. We also observed that conscientiousness predicted agreeableness, and vice versa. Consistent with the literature (Ones, Viswesvaran, & Reis, 1996), this finding seems to indicate that when a parent thinks of the adolescent as being more cooperative and agreeable, he/she will see him/her as more conscientious. However, being conscientious does not necessarily implies being agreeable, which is reflected in the two personality types showing different observations with parenting practices. Conscientiousness consistently predicted a reduction in punitive control, and vice versa, whereas agreeableness was reciprocally negatively associated with proactive control. The finding concerning conscientiousness and punitive control is consistent with the findings of Schofield et al. (2012) and seems intuitive. If an adolescent is more conscientious, it is less likely that he or she will show unwanted behavior. Therefore, there is no need for punitive control to obtain compliance. One interpretation of the finding concerning agreeableness and proactive control is that when clear rules are in place, adolescents know what is expected from them and behave accordingly, which lead to parents rating adolescents as more cooperative and agreeable. Furthermore, we also found that high levels of proactive control consistently predicted higher levels of psychological control, whereas psychological control did not predict proactive control. This association is somewhat surprising since proactive control is considered a positive and psychological control a negative parenting practice. One possible explanation is that parents who posit rules (proactive control) use psychological control to make sure the adolescents abide them. In this case, the intention of providing a well-structured environment for the adolescent can escalate into limiting their autonomy by using psychological control. The parental control dimensions seem to play a more limited role in the interplay with adolescent personality and rule-breaking behavior. This finding, however, does not minimalize the importance of parenting, and more specific parental control. It may indicate a more general role for parenting, socializing the adolescent and shaping its personality to adequately function in a social environment (Grusec & Davidov, 2010). This

is in line with suggestions for designing parent-based interventions for externalizing problem behavior by Jaccard and Levitz (2013). They propose a strategy that focuses not only on the problem behavior itself, but also on a more general positive development of the adolescent. Focusing on more general constructs such as social, emotional, or moral development could also lead to lower levels of problem behavior.

4.2 Links Among Aggressive Behavior, Personality, and Parental Control

Similar to the interplay including rule-breaking, the modelling strategy indicated that the interplay did not significantly differ for boys and girls. At the between-person level, the findings in the interplay including aggressive behavior were similar to the findings in the model including rule-breaking behavior. One difference is the finding that high levels of proactive control were associated with lower levels of aggressive behavior. This finding is in line with research that proactive control reduces externalizing problem behavior (Galambos, Barker, & Almeide, 2003; Gray & Steinberg, 1999. It would be interesting to further investigate this difference between the two types of externalizing problem behavior, since it could provide information on which parenting practices are effective in reducing different types of externalizing problem behavior.

At the within-person level, the cross-lagged paths in the model for aggressive behavior, were similar to the findings for the rule-breaking behavior model. This similar pattern of associations can be explained by the co-occurrence of rule-breaking and aggressive behavior, which is estimated to be 50-60% (Bartels et al., 2003). However, we also found some differences, but they concern the strength and not the direction of the association. The positive association between punitive control and aggressive behavior was smaller than between punitive control and rule-breaking behavior. This finding is in line with previous research suggesting differences in interpersonal correlates (e.g., association with negative affect; Burt, Mikolajewski, & Larson, 2009). Furthermore, literature suggests differences in etiological, genetic as well as environmental, factors (Burt, 2013). It is likely that the importance of genetic characteristics is not limited to the etiology of both types of externalizing problem behavior or the heritability of personality traits linked to problem behavior (De Fruyt et al., 2006), but that they also differentially interact with environmental influences (Burt, Klarh, Neale, & Klump, 2013; Button et al., (2008).

4.3 Limitations

A number of limitations can be noted concerning the present study. First, the data that were derived from adolescent- and parent-reports. Especially on sensitive topics such as

externalizing problem behavior, punitive, and psychological control, it is possible that there is an effect of social desirability. This could have led to an underreporting of externalizing problem behavior by the adolescent and of psychological and punitive control by parents. Second, the Cronbach's alpha of the rule-breaking behavior subscale is rather low, but improves over time. Nonetheless, this urges us to be cautious in our conclusions concerning rule-breaking behavior. Third, in order to limit model complexity, the present study made a selection of the personality characteristics that are included. It is possible that other aspects of adolescent personality, or more broadly, other personal characteristics, also play a role in the interplay with externalizing problem behavior. Fourth, given the limited number of waves (i.e., three waves spanning a two-year period) and the wide range of ages included per wave, conclusions pertaining to developmental trends should be drawn with caution. Adolescence is a period with major changes for both the adolescent and the parents, and, as such, it is likely that a sample that is more heterogeneous in terms of age and that covers a larger part of the adolescence provides better opportunities to investigate specific developmental trends in the interaction between adolescents and parents.

5. Conclusion

At the population level, the findings indicate that externalizing problem behavior, parental control, conscientiousness, and agreeableness are significantly associated across adolescence. At the individual level, our findings suggest that conscientiousness plays an important role. Specifically, conscientiousness predicts changes in externalizing problem behavior (i.e., rule-breaking and aggressive behavior) and shows reciprocal associations with agreeableness (positive) and punitive control (negative). Furthermore, proactive control predicts a relative increase in psychological control as well as in agreeableness. There were no indirect effects of parental control (via adolescent personality) or of adolescent personality (via parental control) on externalizing problem behavior. The present study shows that externalizing problem behavior is the result of and acts in a complex interaction between the individual and its environment. Specifically, we found a reciprocity between personality and problem behavior, but we also observed an important role for parental control. Our findings also showed the added value of including multiple dimensions of personality (i.e., conscientiousness and agreeableness) or parental control (i.e. proactive, punitive, and psychological control), since these appear to play distinct role in the interplay with externalizing problem behavior.

6. Supplemental Materials

Table S7

Differential Item Functioning Test Using MIMIC Model of Agreeableness and Conscientiousness Between Mothers and Fathers Per Wave.

	Agreeableness					
item	Wave 1		Wave 2		Wave 3	
	β	*p*	β	*p*	β	*p*
QBF1	-0.0108	.076	0.017	.414	-0.023	.096
QBF10	-0.001	.953	0.050	.017	0.069	.161
QBF15	-0.035	.231	0.007	.719	-0.016	.720
QBF19	0.006	.731	0.051	.009	0.076	.004
QBF22	-0.005	.754	-0.015	.429	-0.040	.300
QBF28	0.000	.984	-0.066	.001*	-0.478	<.001*
Adjusted α	<.001		.001		<001	
	Conscientiousness					
item	Wave 1		Wave 2		Wave 3	
	β	*p*	β	*p*	β	*p*
QBF4	-0.017	.272	0.000	.981	-0.017	.327
QBF8	-0.016	.261	-0.061	<.001*	-0.050	.005
QBF12	-0.020	.090	0.002	.906	-0.022	.163
QBF16	0.01	.486	0.006	.704	-0.047	.005
QBF25	0.032	.013	0.050	.001	0.012	.439
QBF27	0.016	.336	-0.033	.115	0.548	<.001*
Adjusted α	<.001		<.001		<.001	

Note. QBF= Quick Big Five Questionnaire followed by the item number in the original questionnaire.
*: Significant results compared to the adjusted α level. The α level was adjusted using the Benjamin-Hochberg procedure (nominal α = .05) as suggested by Raykov et al. (2013).

Table S8

Differential Item Functioning Test Using MIMIC Model of Agreeableness and
Consciousness Between Waves Per Parent.

	Agreeableness			
item	Mother		Father	
	β	*p*	β	*p*
QBF1	-0.019	.232	-0.026	.131
QBF10	-0.025	.195	0.021	.219
QBF15	0.001	.942	0.056	.001
QBF19	0.005	.731	0.052	.001
QBF22	0.017	.277	0.056	.001
QBF28	0.008	.602	-0.368	<.001[*]
Adjusted α	<.001		<.001	
	Consciousness			
item	Mother		Father	
	β	*p*	β	*p*
QBF4	-0.028	.303	0.030	.115
QBF8	0.000	.997	-0.036	.016
QBF12	-0.021	.059	-0.031	.011
QBF16	0.065	.012	-0.008	.584
QBF25	0.004	.871	-0.014	.261
QBF27	0.042	.007	0.443	<.001[*]
Adjusted α	<.001		<.001	

Note. QBF= Quick Big Five Questionnaire followed by the item number in the original questionnaire.
*: Significant results compared to the adjusted α level. The α level was adjusted using the Benjamin-Hochberg procedure (nominal α = .05) as suggested by Raykov et al. (2013).

Table S9

Model Fit Indices for Rule-Breaking Behavior

Model	S-Bχ²	df	p	SCF	Δ S-Bχ²	Δdf	p	CFI	RMSEA
Phase 1: Unconstrained models									
Model 1	379.537	81	<.001	1.0968				.942	.058
Model 2	259.257	61	<.001	1.0679	117.655	20	<.001	.961	.039
Model 3	183.515	45	<.001	0.9742	73.665	16	<.001	.973	.036
Model 4	69.713	23	<.001	.9575	112.972	22	<.001	.991	.020
Phase 2: Simplifying Model 3									
Model 5	**69.908**	**27**	**<.001**	**1.0484**	**4.163**	**4**	**.384**	**.992**	**.021**
Model 6	360.138	57	<.001	1.1183	278.910	30	<.001	.941	.042

Note. The model in bold shows the best model fit.

Table S10

Indirect Associations Between Rule-Breaking Behavior and Personality Traits Mediated by Parental Control

Outcome	Predictor	Mediator	β	*p*
Rule-breaking behavior W3	Conscientiousness W1	Proactive control W2	.007	.757
		Punitive control W2	-.054	.147
		Psychological control W2	-.002	.851
Rule-breaking behavior W3	Agreeableness W1	Proactive control W2	-.056	.084
		Punitive control W2	-.027	.240
		Psychological control W2	-.004	.829
Rule-breaking behavior W3	Proactive control W1	Conscientiousness W2	-.017	.212
		Agreeableness W2	-.004	.824
Rule-breaking behavior W3	Punitive control W1	Conscientiousness W2	.025	.139
		Agreeableness W2	.000	.942
Rule-breaking behavior W3	Psychological control W2	Conscientiousness W2	-.003	.847
		Agreeableness W2	-.002	.826

Table S11

Model Fit Indices for Aggressive Behavior

Model	S-Bχ²	df	p	SCF	Δ S-Bχ²	Δdf	p	CFI	RMSEA
Phase 1: Unconstrained models									
Model 1	374.612	81	<.001	1.1179				.945	.038
Model 2	224.423	61	<.001	1.0722	141.696	20	<.001	.969	.041
Model 3	133.910	45	<.001	1.0579	88.962	16	<.001	.983	.034
Model 4	63.977	23	<.001	0.9910	69.391	22	<.001	.992	.018
Phase 2: Simplifying Model 3									
Model 5	**64.727**	**27**	**<.001**	**1.0437**	**3.085**	**4**	**.544**	**.993**	**.020**
Model 6	368.881	57	<.001	1.1270	289.668	30	<.001	.942	.041

Note. The model in bold shows the best model fit.

Table S12

Indirect Associations Between Aggressive Behavior and Personality Traits Mediated by Parental Control

Outcome	Predictor	mediator	β	*p*
Aggressive behavior W3	Conscientiousness W1	Proactive control W2	.008	.661
		Punitive control W2	-.108	.063
		Psychological control W2	.002	.840
Aggressive behavior W3	Agreeableness W1	Proactive control W2	-.042	.277
		Punitive control W2	-.057	.226
		Psychological control W2	.004	.840
Aggressive behavior W3	Proactive control W1	Conscientiousness W2	.006	.602
		Agreeableness W2	.028	.182
Aggressive behavior W3	Punitive control W1	Conscientiousness W2	.005	.584
		Agreeableness W2	.001	.945
Aggressive behavior W3	Psychological control W2	Conscientiousness W2	-.001	.871
		Agreeableness W2	.018	.337

Chapter 5
Parenting, Effortful Control, and Externalizing Problem Behavior: Moderation by Dopaminergic Genes

Abstract

The literature has suggested that parenting and temperamental effortful control are associated with externalizing problem behavior (i.e., rule-breaking behavior and aggressive behavior). More recently, GxE studies showed that the association between externalizing problem behavior and environment is moderated by dopaminergic genes. The present study aimed at building on this finding by including the role of dopaminergic genes, in addition to positive parenting and negative parenting and effortful control. More specifically, we examined (a) associations between parenting, effortful control, and externalizing problem behavior, and (b) whether dopaminergic genes moderate the aforementioned associations. In the present paper, two samples were used. Across a two-year period, study 1 assessed a community sample of 494 adolescents (M_{age}= 15.74 years), which reported on their own effortful control and externalizing problem behavior and mothers which reported on their own parenting. Across a three-year period, study 2 also used a community sample of 490 adolescents (M_{age}= 11.81 years) that filled out the same measures as in Study 1, whereas parenting was assessed through observations. A Biologically Informed Multilocus Profile Score (BIMPS) was computed to represent the genetic base of dopamine signaling across four polymorphisms (i.e., DAT1, DRD2, DRD4, and COMT). Based on these scores, the adolescents were allocated to a 'low', 'intermediate', or 'high' group. Multigroup structural equation modeling was used to test moderated mediation, separately for rule-breaking and aggressive behavior. Results revealed that the association between more parental support and less rule-breaking and aggressive behavior could not be explained by effortful control. These associations differed across BIMPS groups, but only a subset was significantly moderated by dopamine activity. The results suggest that positive as well as negative parenting were significantly associated with future externalizing problem behavior and effortful control. However, the genetic base of dopamine signaling appears to moderate some associations, albeit inconsistently. This moderation differs between rule-breaking and aggressive behavior, which may suggest an etiological difference in the genetic characteristics of the adolescent.

1. Introduction

Given the multiple changes in adolescence (e.g. puberty, identity formation, cognitive development) it is a vulnerable period in which many adolescents exhibit some kind of externalizing problem behavior (Reitz, Deković, & Meijer, 2005) and for a small portion of this group this will lead to delinquent behavior later in life (Moffitt, 1993). These findings stress the need for research on which factors play a role in the development of externalizing problem behavior. Therefore, the present study investigated the role of environmental (i.e., parenting) as well as individual characteristics (i.e., temperament, genetic make-up) in association with externalizing problem behavior (i.e., rule-breaking and aggressive behavior; Achenbach, 1991a, 1991b).

1.1 Parenting and Adolescents' Externalizing Problem Behavior: Temperament as a Mediator

The literature on parenting adolescents has provided extensive evidence for the association between parenting practices, such as parental support, psychological control, or parental criticism and numerous developmental outcomes, such as externalizing problem behavior in adolescence (Barber, 1994, 1996; Hanisch et al., 2014; Laible, Carlo, & Raffaelli, 2000, Narusyte et al., 2011). Parental support refers to the warm and affectionate bond between children and their parents. When children or adolescents feel supported, they will be less likely to show aggressive or rule-breaking behavior (Tuggle, Kerpelman, & Pittman, 2014). In contrast, the levels of aggressive and rule-breaking behavior appear to increase when parents exert negative parenting, such as psychological control (Barber, 1996) or criticism (Narusyte et al., 2011).

The associations between parenting and problem behavior may appear straightforward, but other factors, such as individual differences (e.g., child temperament), also play a role. One temperamental trait that has been investigated extensively is effortful control, that is, the capacity to direct one's attention and to regulate emotions and behaviors (Rothbart & Bates, 2006). Previous studies suggested that effortful control moderates the association between parenting and externalizing problem behavior (de Haan, Prinzie, & Deković, 2010; Pitzer, Jennen-Steinmetz, Esser, Schmidt, & Laucht, 2011) in that individuals with lower effortful control respond more strongly to parenting practices. However, a recent meta-analysis by Slagt, Dubas, Deković, and van Aken (2016) did not consistently find this moderation by effortful

control. These mixed results indicate the need to consider alternatives for the moderating role of temperament.

One possible alternative is a mediation model. Some studies suggested that the association between parenting and externalizing problem behavior is partially mediated by effortful control (Belsky, Fearon, & Bell, 2007; Chang, Olson, Sameroff, & Sexton, 2011; Eisenberg et al., 2005). Specifically, these studies found that effortful control partly explained the association between parental support or the use of corporal punishment, on the one hand, and externalizing problem behavior, on the other hand. For instance, parental support was associated with lower levels of externalizing problem behavior, but when effortful control was taken into account, the associations between support and problem behavior were less pronounced. Therefore, the present study will investigate a possible mediating role of effortful control.

1.2 Parenting and Adolescents' Externalizing Problem Behavior: Dopaminergic Genes as a Moderator

In addition to the long-standing interest in temperament, researchers are increasingly exploring gene-by-environment (G x E) interactions in externalizing problem behavior (Weeland et al., 2015). This type of interaction implies that genetic characteristics moderate the association between parenting and externalizing problem behavior. The dopaminergic pathway, that is, the entire set of genes related to the neurotransmitter dopamine, is widely believed to contribute to externalizing problems (Beauchaine, 2009, 2010; Davies, Cicchetti, & Hentges, 2015; Weeland et al., 2015). The systematic review by Weeland et al. (2015) showed that single genes in that pathway such as DRD4, DRD2, DAT1, and COMT act as a moderator in the association between parenting and externalizing problem behavior. The findings by Weeland et al. (2015) were mixed regarding whether these single genes amplified or weakened the association between parenting and externalizing problem behavior.

Current work on G x E interactions involving the dopaminergic system could be expanded upon in two important ways. First, relying on single genes in so-called candidate gene studies could lead to erratic results. A polygenic score, that is, a combined index of genetic risk across different genes offers a broader representation of the underlying genetic pathway (i.e., the dopaminergic pathway). Using such a score could lead to stronger and more consistent genetic moderation effects. Second, once gene-environment interactions are firmly established, the question remains which possible mechanism underlies these G x E effects.

1.3 Toward a Comprehensive Model: Examining the Interplay Among Parenting, Effortful Control, and Genetics

Temperamental traits, such as effortful control, could be linked to G x E interactions and could in fact provide a potential underlying mechanism for them. Temperament has a biological basis and is related to the dopaminergic system, among other systems. This biological link raises the possibility that parenting, genetics, and temperament jointly affect externalizing problem behaviors in a complex process that can be uncovered using more sophisticated models such as mediated moderation or moderated mediation. One study, for instance, examined a mediated moderation model involving parenting, uninhibited temperament (i.e., the opposite of effortful control), and a dopamine-related gene to predict children's externalizing problem behavior. The genetic factor moderated the association between parenting and externalizing problem behavior and uninhibited temperament partially explained or mediated that moderating effect (Davies et al., 2015).

The present study expands on that earlier work. We do not aim to provide a conclusive and definitive answer to the question how genetics interact with parenting and temperament in the development of externalizing problem behavior. Such an answer is unlikely, because very little is known about the association between genetics and temperament. Some authors (e.g., Robbins, 2018) caution against making conclusive statements about this association, especially because there is little support for a one-on-one relation between genes and temperament from genetic studies (Munafo et al., 2003). They argue that psychological, behavioral, and genetic research in humans should be complemented with research on the neural basis of behavior in animal models. Rather, we aim to provide support for theoretical frameworks that stress the importance of including multiple levels of analysis, such as environment (i.e., parenting), temperament (i.e., effortful control), and genetics (i.e., dopaminergic system) in the investigation of problem behavior.

One such model that could act as a theoretical framework for the current study is the Biosocial Developmental Model (BDM; Beauchaine & Gatzke-Kopp, 2012). The BDM stresses the importance of both adolescent characteristics (i.e., impulsivity and emotion regulation skills) and their environment in the development of externalizing problem behavior. Individuals with high impulsivity, which is linked to reduced dopamine activity, are more susceptible to the environment (e.g., parenting). More specifically, impulsivity is heritable, but it can be altered by repeated exposure to environmental stimuli. For instance, when parents react to adolescent impulsivity with firm limit setting and de-escalation of the impulsivity,

adolescents' emotion regulation skills, such as effortful control, will be reinforced, which in turn leads to less externalizing problem behavior. However, when parents react to adolescent impulsivity with coercive control and negative reinforcement of the impulsivity, adolescents' emotion regulation skills will not develop optimally, leading to more externalizing problem behavior (Beauchaine & Gatzke-Kopp, 2012). This line of reasoning can be summarized by means of a moderated mediation model. The mediation model implies that parenting is associated with effortful control, which in turn predicts externalizing problem behavior. Genetic moderation of this mediation model implies that the extent to which adolescents are susceptible to parenting depends in part on their genetic characteristics (Beauchaine & Gatzke-Kopp, 2012). All three levels of analysis, that is, the environment, temperament, and genetics, are represented in the model.

1.4 The Current Studies

In the present paper, we examined (a) whether the longitudinal association between parenting and externalizing problem behavior was mediated by adolescents' effortful control, and (b) whether the genes that code for the dopaminergic system moderated this mediation model. These associations were examined in two multi-informant, three-wave longitudinal studies. In both studies, parenting was measured at Time 1, effortful control at Time 2, and externalizing problem behavior at Time 3. Identical measures of effortful control and externalizing problem were used in both cases. In each study, one positive and one negative aspect of parenting was examined. However, different methods were used to do so. Mothers reported on their own support and psychological control in Study 1, whereas parental support and parental criticism were observed during parent-adolescent interaction in Study 2. Separate models were fitted for two types of externalizing problem behavior.

Regarding genetics, we moved beyond the traditional candidate gene approach in both studies by using a cumulative polygenic score. This score, referred to as the Biologically Informed Multilocus Profile Score (BIMPS; Nikolova et al., 2011), captures and integrates polymorphisms in multiple genes (i.e., DRD4, D2, DAT1, and COMT) within the dopamine system.

We expected the association between parenting and externalizing problem behavior to be partially mediated by effortful control. Specifically, negative parenting was expected to be positively associated with both types of externalizing problem behavior (i.e., aggressive and rule-breaking behavior). Similarly, concerning positive parenting, we expected a negative association with externalizing problem behavior and a mediation of this association by effortful

control. Since the moderation by the dopaminergic polygenic score may not be linear, we adopted a categorical approach. Specifically, we compared the aforementioned mediation model across three groups based on the BIMPS score (i.e., low, intermediate, and high). We expected the direct associations between the parenting practices and externalizing problem behavior to be stronger for adolescents with lower dopamine activity (Beauchaine & Gatzke-Kopp, 2012). The associations involving effortful control were hypothesized to weaken when levels of dopamine activity were low, because effortful control is related to the dopaminergic system, among other systems (Li et al., 2016).

2. Method Study 1

2.1 Participants

Data were collected within the STRATEGIES project (i.e., Studying Transactions in Adolescence: Testing Genes in Interaction With Environments). Permission for the STRATEGIES project was obtained from the institutional review board of the Faculty of Medicine at the University of Leuven (ML7972). This longitudinal study annually surveyed adolescents and their parents in Flanders, the Dutch-speaking part of Belgium. They were selected through a randomized multistage sampling approach. In a first stage, Flemish secondary schools were invited to take part in the study. Stratification was used to include students from general, technical, and vocational tracks. In the second stage, nine schools participated in the study, from which 121 classes in Grades 7, 8, and 9 were selected. Within these classes, 2,254 students and their parents were invited to participate. The final sample consisted of 1,116 adolescents, 841 mothers, and 724 fathers. Family characteristics were representative for the general population $\chi^2(2) = 2.78$, $p = .25$, with 82% two-parent families, 7% single-parent families, and 11% blended families (Janssens et al., 2017; King Baudouin Foundation, 2008). The educational level (EDU) and employment activity level (ACT) of parents differed for both mothers (EMP: $\chi^2(3) = 30.34$, $p = .00$; ACT: $\chi^2(1) = 15.87$, $p = .00$) and fathers (EMP: $\chi^2(3) = 34.19$, $p = .00$; ACT: $\chi^2(1) = 15.13$, $p = .00$) with bachelor degrees and active employees being slightly overrepresented (Janssens et al., 2017; Research Department of the Flemish Government, 2010, 2011). Despite this small deviation, it can be concluded that participants represented all categories of socioeconomic status. The present study used mother-reported data from Wave 3 (parenting), whereas adolescents reported on effortful control at Wave 4 (effortful control) and on externalizing problem behavior in Wave 5 (externalizing problem behavior) of the STRATEGIES project. At Wave 3, the sample

consisted of 494 adolescents with a mean age of 15.74 years old (minimum-maximum= [13.44; 19.09]) and 552 mothers. At Wave 4, the sample consisted of 498 adolescents with a mean age of years 16.87 years old (minimum-maximum= [14.75; 19.73]) and 310 mothers. At Wave 5, the sample consisted of 494 adolescents with a mean age of 17.48 years old (minimum-maximum= [15.57; 19.59]) and 223 mothers.

Researchers visited the school and invited the adolescents to fill out the questionnaires. In concert with the school, adolescents were provided two hours during classes to fill out the questionnaires. When they did not finish the questionnaires within these two hours, they were allowed to finish the questionnaires at home and hand them in later using specially designated boxes. Adolescents who left the school or graduated were invited through e-mail and received an online version of the questionnaires. Parents could either fill out their questionnaires online or on paper. The latter was provided through the adolescents and could also be handed in using the designated boxes.

2.2 Measures

2.2.1 Parental Practices (Time 1)

Parental Support (Cronbach's α Wave 3 = .90) was reported by mothers and was measured using three parenting measures (Janssens et al., 2015). The first one was the Positive Parenting subscale (8 items, e.g., "If my child wants to tell something, I take my time to listen to me") from the Parental Behavior Scale- Short Form (PBS-S; Van Leeuwen et al., 2013). The second one was the Responsivity subscale (7 items, e.g., "I can make my child feel better when he/she is feeling upset") from the Louvain Adolescent Perceived Parenting Scale (LAPPS; Delhaye et al., 2012) This is an adaptation of a subscale from the Child Report of Parental Behavior Inventory by Schludermann and Schludermann (CRPBI; Schludermann & Schludermann, 1988). The third and final measure was the Autonomy Support scale (8 items, e.g., "I take into account the opinion of my child on affairs that concern him/her"), which was based on the Perceptions of Parents Scale (POPS; Grolnick, Ryan, & Deci, 1991) and the Research Assessment Package for Schools (RAPS; Institute for Research and Reform in Education, 1998). All 23 items were rated by adolescents on a 5-point scale ranging from 1 = *(almost) never* to 5 = *(almost) always*. An average score of the 23 items was calculated, with a high score referring to more maternal support.

Psychological control (Cronbach's α Wave 3 = .84) was reported on by mothers and used two subscales (Janssens et al., 2015). For the subscale Psychological Control (9 items, e.g., "I do not talk to my child when he/she disappointed me until he/she pleases me again"), 8

items were taken from the translated version of Barber's Psychological Control Scale (Barber, 1996; Soenens et al., 2006) and an additional item from a study by Soenens, Sierens, Vansteenkiste, Dochy, and Goossens (2012). The subscale Hostility (6 items, e.g., "I yell at my child when he/she misbehaves") was based on the Verbal Hostility Scale (Nelson & Crick, 2002), which was developed to assess intrusive parenting alongside corporal punishment. All 15 items were rated by adolescents on a 5-point scale ranging from 1 = *(almost) never* to 5 = *(almost) always*. An average score of the 15 items was calculated, with a high score referring to more maternal psychological control.

2.2.2 Effortful Control (Time 2)

Adolescents reported on their own temperament by filling out a Dutch version of the Adult Temperament Questionnaire (ATQ; Evans & Rothbart, 2007). The present study solely used the dimension effortful control (Cronbach's α Wave 4 = .81), which comprised the subscales Activation Control (7 items, e.g., "I am often late for appointments" (reverse scored)), Attentional Control (5 items, e.g., "I often find it difficult to switch between different tasks" (reverse scored)), and Inhibitory Control (7 items, e.g., "I often find it difficult to resist my urge for drinks and food" (reverse scored)). All 19 items were rated by adolescents on a 7-point scale ranging from 1= *(almost) never* to 7= *(almost) always*. An average score was calculated with a high score referring to more effortful control.

2.2.3 Externalizing Problem behavior (Time 3)

Adolescents rated their own externalizing problem behavior by filling out a Dutch version of the Youth Self Report (YSR; Achenbach 1991a). Externalizing problem behavior consisted of two subscales, that is Aggressive behavior (17 items, e.g., "I destroy my own belongings"; Cronbach's α Wave 5 = .81) and Rule-breaking behavior (14 items, e.g. ''I skip classes or I play truant''; Cronbach's α Wave 5 = .72). A three-point rating scale was used, ranging from 0 to 2 (0 = *not true*, 1 = *somewhat or sometimes true*, to 2 = *very true or often true*). For both subscales, the mean score was computed. Higher scores indicated more externalizing problem behavior.

2.2.4 Biologically Informed Multilocus Profile Scores (BIMPS)

At Wave 1 of data collection for the STRATEGIES project, a saliva sample was collected from 1,103 adolescents using Oragene DNA kits (DNA Genotek, Ontario, Canada). The present study only used genetic data for non-related participants. (Out of each of the 63 first- or second-degree relatives pairs one adolescent was randomly selected). Using the

approach of Nikolova et al. (2011), a BIMPS score was computed for each adolescent based on four dopaminergic polymorphisms. These genetic variants comprised two variable number of tandem repeats (VNTRs), that is, the 40-bp VNTR in the DAT1 gene and the 48-bpVNTR in the DRD4 gene, and two single nucleotide polymorphisms (SNPs), that is, the DRD2 Taq1A polymorphism (rs1800497) and the COMT Val/Met polymorphism (rs4680). Nikolova et al. (2011) also used a fifth polymorphism, the DRD2-141C Ins/Del polymorphism (rs1799732), but this genetic marker was not available in the present dataset.

Nikolova et al. (2011) assigned a score of 1 to genotypes associated with relatively high striatal dopamine signaling and/or reward-related ventral striatum reactivity, a score of 0.5 to intermediate genotypes, and a score of 0 to low genotypes (See Table S13). The BIMPS was computed by summing all the scores, which resulted in a continuous variable. Previous studies that used this type of polygenic index score (Changur & Weeland et al., 2017; Janssens et al., 2017) adopted a person-centered approach by creating groups based on this score. Following their suggestion, we divided the continuous BIMPS score into three categories, taking into account the sample sizes of the three categories. So we distinguished between a 'Low' (BIMPS ≤ 1.5; $n = 135$), 'Intermediate' ($1.5 < \text{BIMPS} < 2.5$; $n = 179$), and 'High' category ($2.5 < \text{BIMPS}$; $n = 114$).

2.3 Statistical Analyses

2.3.1 Descriptive Statistics and Group Differences

First, in order to get information on the participants in the aforementioned groups, descriptive statistics were provided and one-way ANOVAs were conducted to assess whether participants in the aforementioned BIMPS groups differed significantly on one or more of the variables. In order to draw valid conclusions based on the multi-group SEM approach, it was established in what aspects the three BIMPS group differed besides the dopamine activity. Second, in order to assess the power of the mediation model, a power analysis was conducted using MedPower, (Kenny, 2017). The power was computed for the smallest BIMPS group, which is the 'high' group ($N = 114$), and assuming medium effect sizes ($d = .30$; based on Chang et al., 2015), because for the larger groups, the power will be at least as large. In the present study, the power threshold of .80 was used, in line with the suggestion by Cohen (1988).

2.3.2 Moderated Mediation Model

First, four mediation models were tested for each combination of positive/negative parenting and aggressive behavior/rule-breaking behavior (See Figure 9). In each model,

adolescent-reported effortful control was included as a mediator. Parenting and effortful control were controlled for adolescents' age and gender, whereas externalizing problem behavior was additionally controlled for externalizing problem behavior at the previous wave.

Second, a multi-group structural equation approach was used to assess whether the mediation models (See Figure 9) were moderated by the BIMPS score. In other words, we checked whether the association between parenting practices and externalizing problem behaviors, as mediated by effortful control, differed across BIMPS groups. The coefficients of these mediation models were compared pair-wise across the 'low', 'intermediate', and 'high' BIMPS groups. All analyses were conducted in MPlus version 7 (Muthén & Muthén, 2012). Missing values were handled with the Full Information Maximum Likelihood (FIML) method.
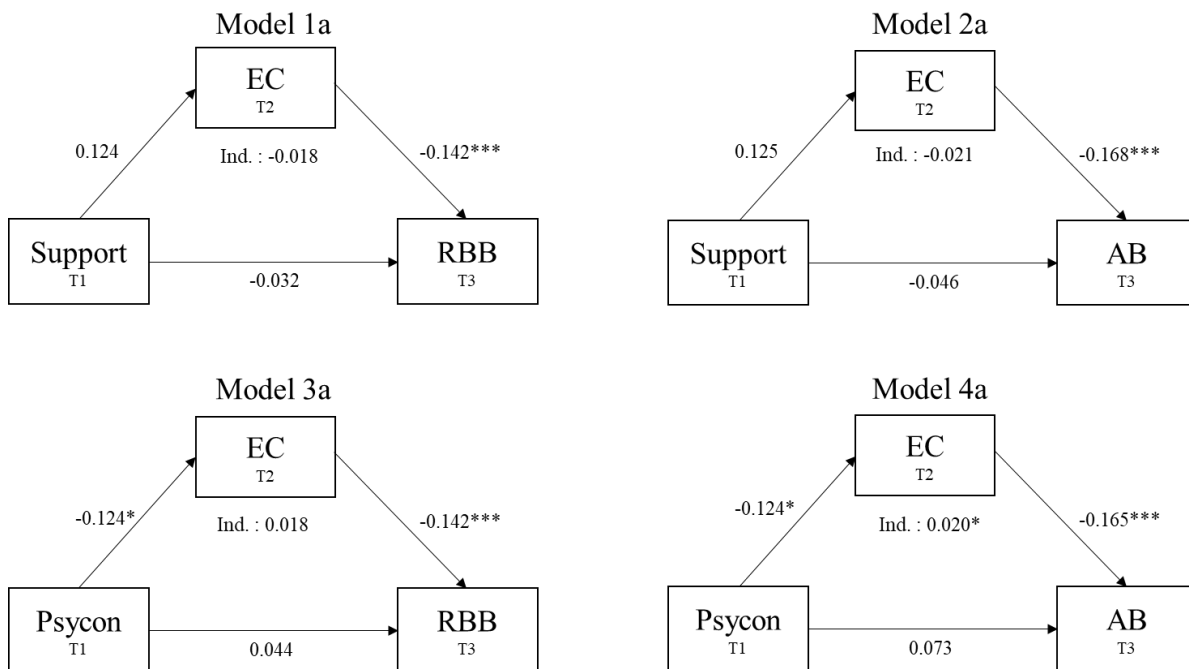
Figure 9. The four mediation models Study 1

Note. EC= Effortful Control; RBB = Rule-Breaking Behavior; AB = Aggressive Behavior

*** $p < .001$; ** $p < .01$; * $p < .05$

3. Results Study 1

3.1 Descriptive Statistics and Group Differences

Descriptive statistics on the variables per BIMPS group and in the total sample are presented in Table 15. None of the included variables differed significantly across BIMPS groups. The ANOVA analyses therefore suggested that differences across BIMPS groups in

subsequent analyses were not attributable to mean differences in other variables. Detailed results of the one-way ANOVAs are presented in Table S14.

Table 15

Descriptive Statistics of the Included Variables Per BIMPS Group and Total

		Study 1		Study 2	
Variable		*M*	*SD*	*M*	*SD*
Positive parenting (T1)	Low	4.31	0.41	2.80	1.05
	Intermediate	3.90	0.58	2.86	1.13
	High	4.02	0.45	2.97	1.17
	Total	3.93	0.56	2.86	1.10
Negative parenting (T1)	Low	1.77	0.45	2.05	1.05
	Intermediate	1.84	0.50	2.05	1.06
	High	1.72	0.50	2.05	1.17
	Total	1.79	0.48	2.01	1.08
Effortful Control (T2)	Low	4.33	0.77	3.54	0.58
	Intermediate	4.35	0.74	3.48	0.62
	High	4.26	0.71	3.55	0.51
	Total	4.32	0.74	3.53	0.57
Rule-breaking (T3)	Low	0.23	0.22	0.16	0.21
	Intermediate	0.25	0.22	0.15	0.17
	High	0.20	0.15	0.15	0.20
	Total	0.23	0.21	0.16	0.20
Aggressive behavior (T3)	Low	0.25	0.21	0.19	0.25
	Intermediate	0.27	0.26	0.18	0.21
	High	0.24	0.17	0.20	0.24
	Total	0.26	0.22	0.19	0.24

Note. T = time point; Low= Low BIMPS group, Intermediate= Intermediate BIMPS group, High= High BIMPS group.

3.2 Power Analyses for Multi-Group SEM

Given an α of .05, a sample size of 114 (i.e., smallest group size in Study 1), and assuming medium effect sizes, the power for the association between the parenting practice and externalizing problem behavior as well as for the association between effortful control and externalizing problem behavior was .93. The power of the association between the parenting practice and effortful control was .91, whereas the power of the indirect association between the parenting practice and externalizing problem behavior was .84. In conclusion, there was sufficient power (i.e., > .80) in the smallest BIMPS group to detect medium effect sizes.

3.3 Moderated Mediation Models

3.3.1 Model 1: Maternal Support and Rule-Breaking Behavior

In Model 1a, without distinguishing between the three BIMPS groups (See Table 16 and Figure 9), only the negative association between effortful control and rule-breaking behavior was significant ($p = .002$). There was no evidence of mediation by effortful control. When we distinguished between BIMPS groups (i.e., Model 1b), a significant proportion ($p < .05$) of the variance in rule-breaking was explained in each BIMPS group, whereas the explained variance concerning effortful control was non-significant in each BIMPS group (See Table 16). The directions of the significant association were consistent with the hypotheses (See Figure 10). Parental support was significantly positively associated with effortful control, but only in the low BIMPS group. Pairwise comparison of the coefficients showed that this association was significantly different between the low and high BIMPS group (See Table 17). Effortful control was significantly negatively associated with rule-breaking, but only in the intermediate and high BIMPS group. Finally, in none of the BIMPS groups did effortful control mediate the association between parental support and rule-breaking behavior.

3.3.2 Model 2: Maternal Support and Aggressive Behavior

In Model 2a, without distinguishing between the three BIMPS groups (See Table 16 and Figure 9), only the negative association between effortful control and aggressive behavior was significant ($p = .001$). There was no evidence of mediation by effortful control. When we distinguished between the three BIMPS groups (i.e., Model 2b), a significant proportion ($p < .05$) of the variance in aggressive behavior was explained in each BIMPS group, whereas the explained variance concerning effortful control was non-significant in each BIMPS group (See Table 16). The findings per group were consistent with the findings in Model 1b (See Figure 11). The association between parental support and effortful control weakened as dopamine activity increased. This association differed significantly between the low and high BIMPS group (See Table 17). The association between support and aggressive behavior was, in contrast to the hypothesis, positive in the low BIMPS group, but was negative, as hypothesized, in the intermediate and high BIMPS group. This association differed significantly between the high and intermediate and low BIMPS group, respectively. The association between effortful control and aggressive behavior was only significant ($\alpha = .001$) in the intermediate BIMPS group, but did not significantly differ across groups (See Table 17). Finally, there was no evidence of mediation of the association between support and aggressive behavior by effortful control.

Table 16

R² and P-Values of the Variables Per BIMPS Groups in Each Model in Study 1 and Study 2

	Study 1															
	Model 1b				Model 2b				Model 3b				Model 4b			
	Total	Low	Interm.	High	Total	Low	Interm.	High	total	Low	Interm.	High	Total	Low	Interm.	High
EC	.026	.103	.016	.012	.026	.097	.015	.012	.026	.055	.017	.021	.026	.068	.017	0.021
	(.180)	(.127)	(.488)	(.587)	(.182)	(.136)	(.497)	(.578)	(.122)	(.137)	(.425)	(.539)	(.123)	(.110)	(.426)	(.538)
RBB	.411	.541	.462	.379					.414	.535	.459	.411				
	(<.001)	(<.001)	(<.001)	(<.001)					(<.001)	(<.001)	(<.001)	(.205)				
AB					.325	.532	.386	.486					.333	.596	.370	0.421
					(<.001)	(<.001)	(<.001)	(<.001)					(<.001)	(<.001)	(<.001)	(.007)
	Study 2															
	Model 1b				Model 2b				Model 3b				Model 4b			
	Total	Low	Interm.	High	total	Low	Interm.	High	Total	Low	Interm.	High	Total	Low	Interm.	High
EC	.116	.139	.175	0.154	.117	.138	.176	.151	.126	.172	.131	.135	.132	.165	.130	.135
	(<.001)	(.002)	(.008)	(.071)	(<.001)	(.002)	(.008)	(.074)	(<.001)	(.002)	(.012)	(.048)	(<.001)	(.002)	(.012)	(.048)
RBB	.193	.452	.583	.322					.238	.463	.583	.350				
	(.052)	(<.001)	(<.001)	(.004)					(.001)	(<.001)	(<.001)	(.004)				
AB					.374	.466	.552	.696					.375	.480	.550	.681
					(.002)	(<.001)	(<.001)	(<.001)					(.002)	(<.001)	(<.001)	(<.001)

Note. BIMPS = Biologically Informed Multilocus Profile Score; EC= Effortful Control; RBB= Rule-Breaking Behavior: AB= Aggressive Behavior; Interm. = Intermediate.
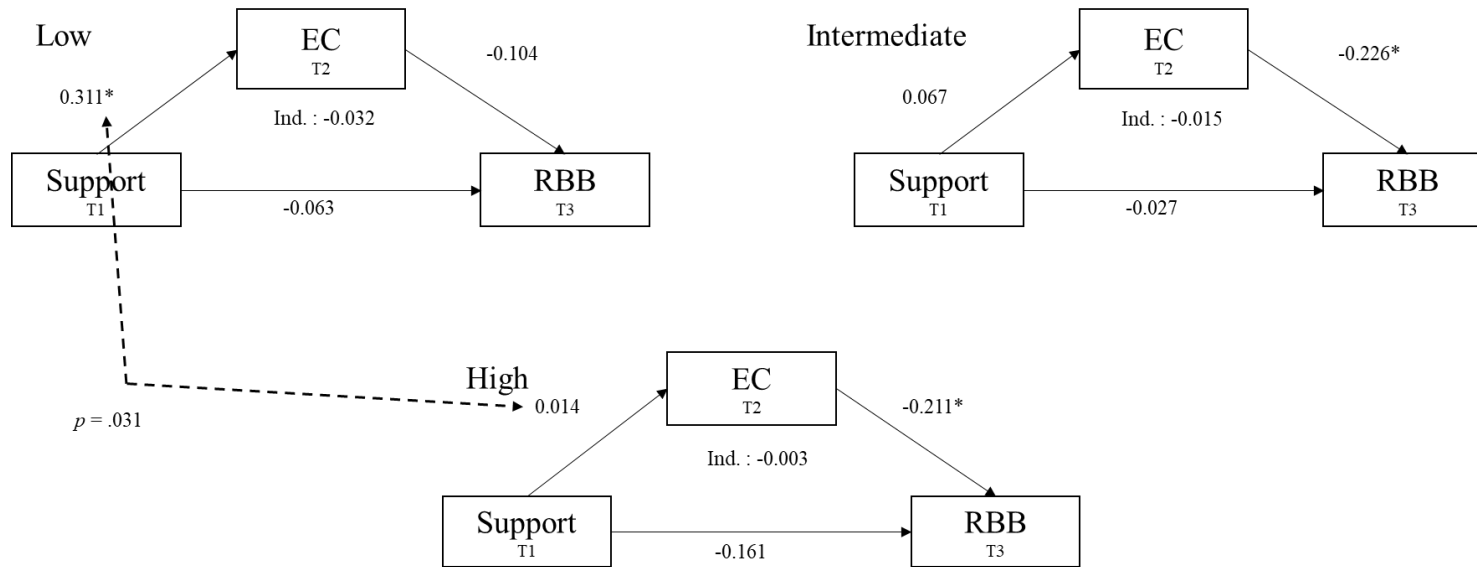
Figure 10. Model 1b results in the 'low', 'intermediate', and 'high' BIMPS group (Study 1).
Note. *** $p < .001$; ** $p < .01$; * $p < .05$; EC= effortful control, RBB= rule-breaking behavior; Dotted lines indicate significant difference between associations.
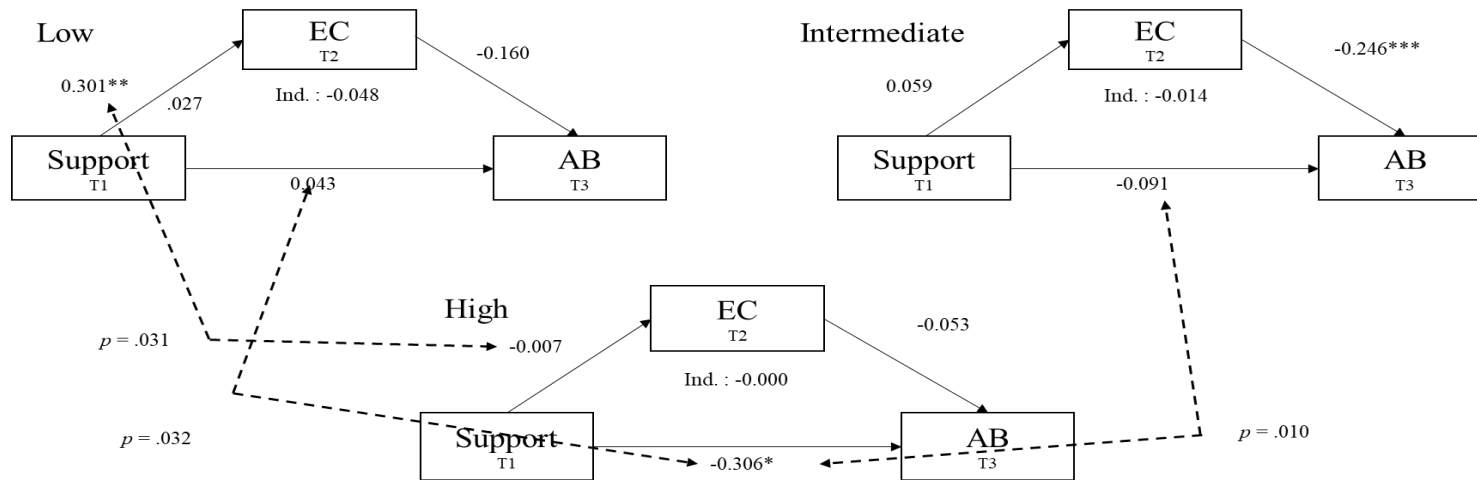

Figure 11. Model 2b results in the 'low', 'intermediate', and 'high' BIMPS group (Study 1).
Note. *** $p < .001$; ** $p < .01$; * $p < .05$; EC= effortful control, AB = aggressive behavior; Dotted lines indicate significant difference between associations.

3.3.3 Model 3: Psychological Control and Rule-Breaking Behavior

In Model 3a without distinguishing between the three BIMPS groups (See Table 16 and Figure 9), both the associations between psychological control and effortful control ($p = .021$) and between effortful control and rule-breaking behavior ($p = .001$) were significantly negative. There was no evidence of mediation by effortful control. When we distinguished between BIMPS groups (i.e., Model 3b), a significant ($p < .05$) proportion of the variance in rule-breaking behavior was explained in the low and intermediate BIMPS group, whereas the explained variance of effortful control was non-significant in each BIMPS group (See Table 16). The association between psychological control and effortful control was negative, consistent with the hypothesis, but only reached significance in the low BIMPS group (See Figure 12). These associations were not significantly different across groups (See Table 17). The association between psychological control and rule-breaking was non-significant across groups and did not significantly differ between the BIMPS groups. Furthermore, the association between effortful control and rule-breaking behavior was significantly negative in the intermediate and high BIMPS group, but did not significantly differ between BIMPS groups. Finally, there was no evidence of mediation of the association between psychological control and rule-breaking behavior by effortful control in any of the BIMPS groups.

3.3.4 Model 4: Psychological Control and Aggressive Behavior

In Model 4a without distinguishing between the three BIMPS groups (See Table 16 and Figure 9), both the associations between psychological control and effortful control ($p = .021$) and between effortful control and aggressive behavior ($p = .001$) were significantly negative, which is in line with the findings in Model 3. Effortful control mediated the association between psychological control and aggressive behavior. When we distinguished between BIMPS groups (i.e., Model 4b), a significant ($p < .05$) proportion of the variance in aggressive behavior was explained in each BIMPS group, whereas the explained variance of effortful control was non-significant in each BIMPS group (See Table 17). The direction of the associations among the variables were as hypothesized, but only few reached significance (See Figure 13). There was a significantly positive association between psychological control and aggressive behavior. Furthermore, the association between psychological control and effortful control as well as the association between effortful control and aggressive behavior were significantly negative. Pair-wise comparisons showed that only the association between effortful control and aggressive behavior differed significantly between the intermediate and high BIMPS group (See Table 17). When we distinguished between BIMPS groups, the mediation of the association between psychological control and aggressive behavior by effortful control was no longer observed.
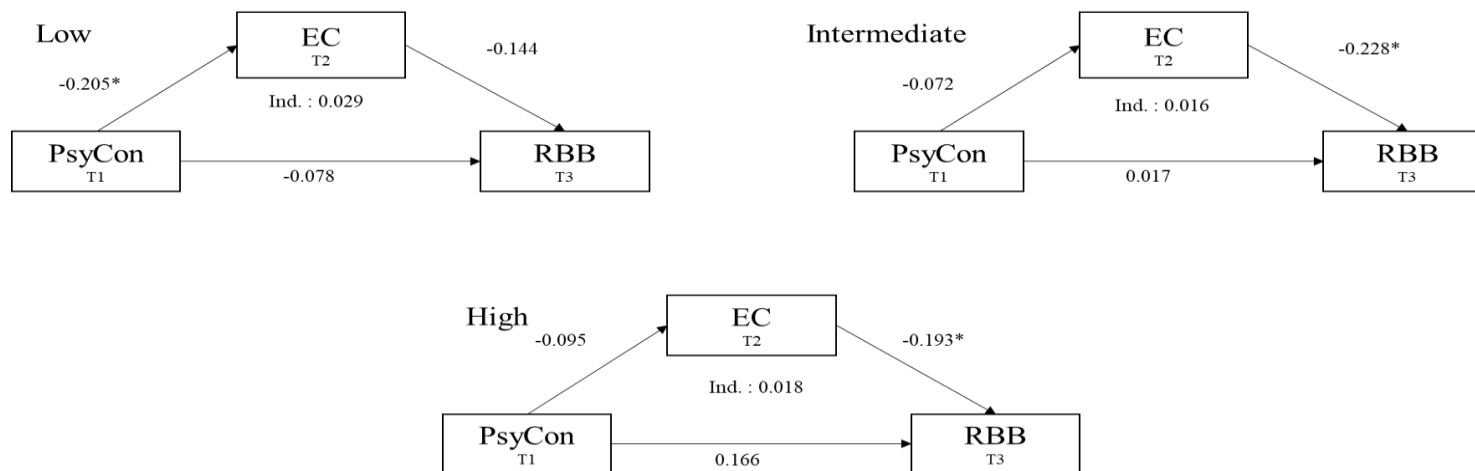
Figure 12. Model 3b results in the 'low', 'intermediate', and 'high' BIMPS group (Study 1).

Note. *** $p < .001$; ** $p < .01$; * $p < .05$; PsyCon = psychological control, EC= effortful control, RBB= rule-breaking behavior.
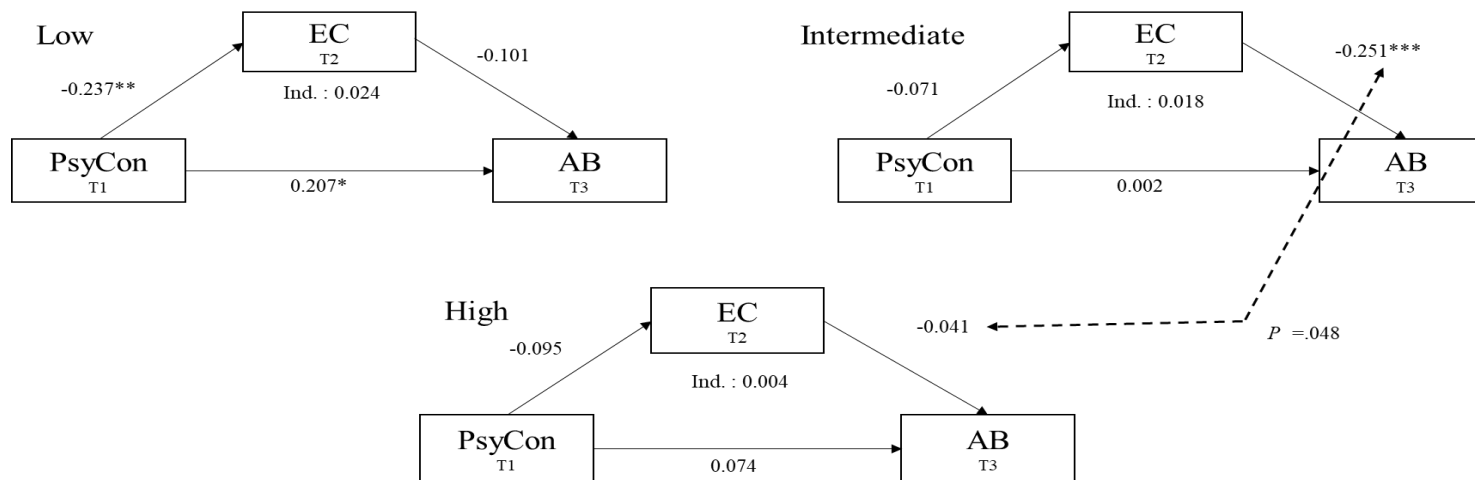

Figure 13. Model 4b results in the 'low', 'intermediate', and 'high' BIMPS group (Study 1).

Note. *** $p < .001$; ** $p < .01$; * $p < .05$; PsyCon = psychological control, EC= effortful control, AB = aggressive behavior; Dotted lines indicate significant difference between associations.

Table 17

Results of the Pairwise Contrasts of Coefficients Between the BIMPS Groups in Study 1

Model	Contrast	Wald test	df	p	Model	contrast	Wald test	df	p
Model 1b	$a_{low} - a_{int}$	0.401	1	.527	Model 3b	$a_{low} - a_{int}$	0.135	1	.713
	$a_{low} - a_{high}$	0.104	1	.748		$a_{low} - a_{high}$	0.004	1	.951
	$a_{int} - a_{high}$	0.217	1	.641		$a_{int} - a_{high}$	0.327	1	.567
	$b_{low} - b_{int}$	0.070	1	.791		$b_{low} - b_{int}$	0.351	1	.554
	$b_{low} - b_{high}$	0.044	1	.834		$b_{low} - b_{high}$	1.630	1	.202
	$b_{int} - b_{high}$	0.417	1	.518		$b_{int} - b_{high}$	0.845	1	.358
	$c_{low} - c_{int}$	3.254	1	.071		$c_{low} - c_{int}$	1.455	1	.228
	$c_{low} - c_{high}$	4.621	1	.032		$c_{low} - c_{high}$	0.597	1	.440
	$c_{int} - c_{high}$	0.144	1	.705		$c_{int} - c_{high}$	0.062	1	.803
	$d_{low} - d_{int}$	0.295	1	.587		$d_{low} - d_{int}$	0.295	1	.587
	$d_{low} - d_{high}$	0.710	1	.400		$d_{low} - d_{high}$	0.267	1	.607
	$d_{int} - d_{high}$	0.190	1	.663		$d_{int} - d_{high}$	0.001	1	.973
Model 2b	$a_{low} - a_{int}$	0.950	1	.330	Model 4b	$a_{low} - a_{int}$	2.169	1	.141
	$a_{low} - a_{high}$	0.643	1	.423		$a_{low} - a_{high}$	0.244	1	.621
	$a_{int} - a_{high}$	3.459	1	.063		$a_{int} - a_{high}$	3.895	1	.048
	$b_{low} - b_{int}$	0.133	1	.715		$b_{low} - b_{int}$	2.938	1	.087
	$b_{low} - b_{high}$	4.620	1	.032		$b_{low} - b_{high}$	0.689	1	.406
	$b_{int} - b_{high}$	6.640	1	.010		$B_{int} - b_{high}$	0.198	1	.656
	$c_{low} - c_{int}$	3.121	1	.077		$c_{low} - c_{int}$	2.138	1	.144
	$c_{low} - c_{high}$	4.904	1	.027		$c_{low} - c_{high}$	0.966	1	.326
	$c_{int} - c_{high}$	0.216	1	.642		$c_{int} - c_{high}$	0.061	1	.805
	$d_{low} - d_{int}$	0.556	1	.456		$d_{low} - d_{int}$	0.032	1	.859
	$d_{low} - d_{high}$	1.860	1	.173		$d_{low} - d_{high}$	0.708	1	.400
	$d_{int} - d_{high}$	0.316	1	.574		$d_{int} - d_{high}$	0.305	1	.581

Note. BIMPS = Biologically Informed Multilocus Profile Score.

4. Methods Study 2

4.1 Participants

Participants were recruited at two sites, namely the University of Denver (Colorado) and Rutgers University (New Jersey). Families with a child in 3rd, 6th, or 9th grades in the broader Denver and central New Jersey areas were sent a letter to inform and invite them to participate in the study. Of these families, 1108 parents called the laboratory to ask for additional information. It was established that both the parent and the child were fluent in English. Furthermore, it was established that the child did not have an autism spectrum disorder, psychotic disorder, or intellectual disability. Of these 1108 families, 665 (60%) qualified as study participants. The remaining 498 (40%) were not retained for the study for the following reasons: 4 (1%) were excluded because the parents reported that their child had an autism spectrum disorder or low IQ; 13 (3%) were non-English speaking families; 330 (71%) declined after learning about the study's requirements; 113 (25%) did get an appointment but did not show up for assessment. Parents provided informed (written) consent for their child's participation, whereas the child provided written assent. Data were collected over a period of three years with an 18-month interval between successive waves. For more details see Hankin et al. (2015). At Wave 1, the present study included 537 parent-child dyads of which the children (M= 11.81, SD= 2.37) were between 7 and 16 years old at the first measuring point. At the second time point, 537 children filled out the questionnaires and this number decreased to 343 children at the third time point.

4.2 Measures

4.2.1 Parenting Practices (Time 1)

Independent raters coded parental support, responsiveness, conflict, and criticism during the parent-child interaction task at Wave 1. Global codes for each aforementioned parenting construct were assigned on a scale of 1 to 5 (1 = "*not at all characteristic of the parenting behavior during the interaction*" and 5 = "*highly characteristic of the parenting behavior during the interaction*"). These codes were based on validated parent-child coding systems and reflect theoretically grounded parenting dimensions (Melnick & Hinshaw, 2000; NICHD Early Child Care Research Network, 1999). Parents rated high on parental support were engaged and affirming in their interaction with the child. Examples are providing validating comments (e.g., "I can see that") or praise their child. Parental criticism consisted of behaviors such as

expressing disapproval or insulting the child, as well as blaming or inappropriately criticizing the child. Codes are consistent with prior work assessing positive and negative parenting (Chi & Hinshaw, 2002; Corona et al., 2005; Davidov & Grusec, 2006). About 20% of observations were videotaped and double coded. Intraclass correlations between the two independent coders ranged from .71 to .85 on all subscales in this study, indicating good interrater reliability.

4.2.2 Effortful Control (Time 2)

Adolescents reported on their own temperament by filling out an English version of the Adult Temperament Questionnaire (ATQ; Evans & Rothbart, 2007). The subscale of effortful control showed adequate reliability (Cronbach's α = .78). The same measure for effortful control was used as in Study 1.

4.2.3 Externalizing Problem Behavior (Time 3)

Adolescents rated their own externalizing problem behavior by filling out an English version of the Youth Self Report (YSR; Achenbach 1991a). The subscale of aggressive behavior showed good reliability (Cronbach's α = .84), whereas the subscale of rule-breaking behavior showed adequate reliability (Cronbach's α = .72). The same measure for externalizing problem behavior was used as in Study 1.

4.2.4 Biologically Informed Multilocus Profile Scores (BIMPS)

The computation of the BIMPS score was identical to the one in Study 1. Similar to Sudy 1, we divided the continuous BIMPS score into three categories, taking into account the sample sizes of the three categories. So we distinguished between a 'Low' (BIMPS ≤ 1.5; $n= 210$), 'Intermediate' ($1.5 < BIMPS < 2.5$; $n = 95$), and 'High' category ($2.5 < BIMPS$; $n = 88$).

4.3 Statistical Analyses

The analysis plan was identical to the one adopted in Study 1.

5. Results

5.1 Descriptive Statistics and Group Differences

Descriptive statistics on the variables per BIMPS group and the total sample are presented in Table 15. Furthermore, similar to Study 1, none of the included variables differed significantly across BIMPS groups (See Table S15).

5.2 Power Analyses for Multi-Group SEM

Given an α of .05, a sample size of 88 (i.e., smallest BIMPS group in Study 2), and assuming medium effect sizes, the power for the association between the parenting practice and externalizing problem behavior as well as for the association between effortful control and externalizing problem behavior was .85. The power of the association between the parenting practice and effortful control was .82, whereas the power of the indirect association between the parenting practice and externalizing problem behavior was .70. In conclusion, there was sufficient power (i.e., > .80) in the smallest BIMPS group to detect medium effect sizes of direct associations, but the study may have been underpowered to adequately detect the indirect association between parenting and externalizing problem behavior through effortful control.

5.3 Moderated Mediation Models

5.3.1 Model 1: Parental Support and Rule-Breaking Behavior

In Model 1a without distinguishing between the three BIMPS groups (See Table 16 and Figure 14), none of the associations reached significance and there was no evidence of mediation by effortful control. When we distinguished between the BIMPS groups (i.e., Model 1b), a significant proportion ($p < .05$) of the variance in rule-breaking was explained in each BIMPS group, whereas the explained variance concerning effortful control was significant in the low and intermediate BIMPS group (See Table 17). In the low BIMPS group, none of the associations were significant (See Figure 15). However, it was noteworthy that the direction was opposite to what was hypothesized. In the intermediate and high BIMPS group, the directions of the associations were consistent with the hypothesis, but only the association between support and effortful control in the intermediate BIMPS group reached significance. None of the associations significantly differed between BIMPS groups (See Table 18) and there was no evidence for mediation of the association between support and rule-breaking behavior by effortful control.

5.3.2 Model 2: Parental Support and Aggressive Behavior

In Model 2a without distinguishing between the three BIMPS groups (See Table 16 and Figure 14), none of the associations reached significance and there was no evidence of mediation by effortful control. When we distinguished between the BIMPS groups (i.e., Model 2), a significant proportion ($p < .05$) of the variance in aggressive behavior was explained in each BIMPS group, whereas the explained variance concerning effortful control was significant in the low and intermediate BIMPS group (See Table 16). The results were similar to the

findings in Model 1 (See Figure 16). In Model 2, pairwise comparison of coefficients (See Table 18) showed that the association between effortful control and aggressive behavior differed significantly between the low and high BIMPS group. There was no evidence of mediation of the association between support and aggressive behavior by effortful control.
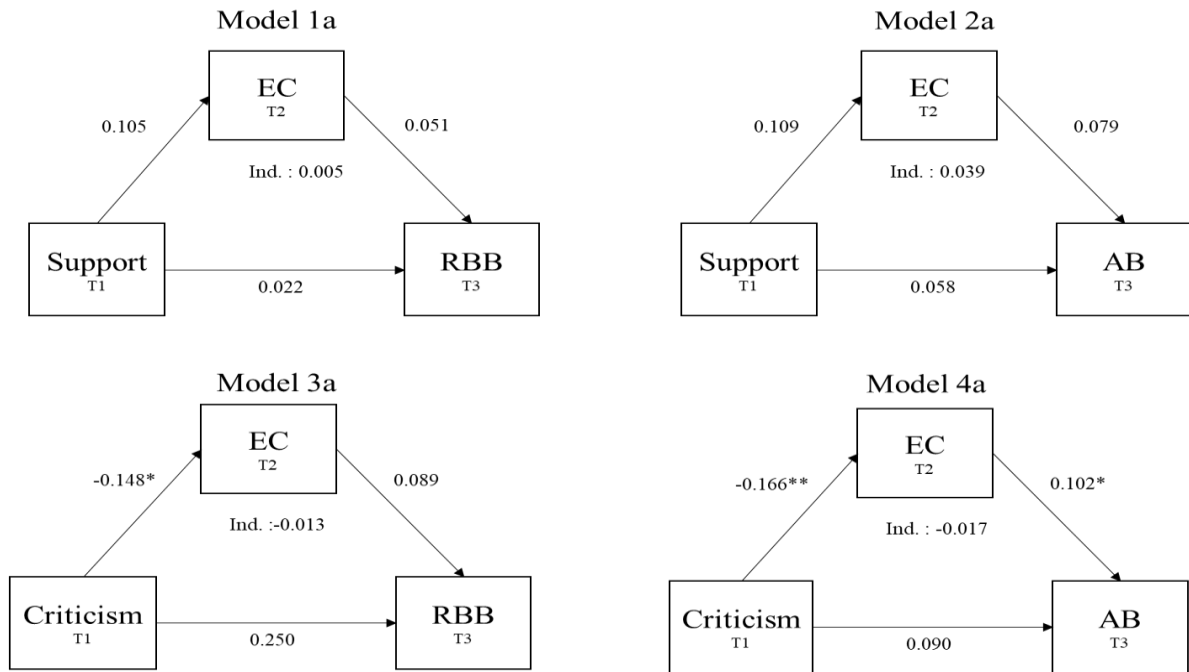

Figure 14. The four mediation models Study 2

Note. EC= Effortful Control; RBB = Rule-Breaking Behavior; AB = Aggressive Behavior
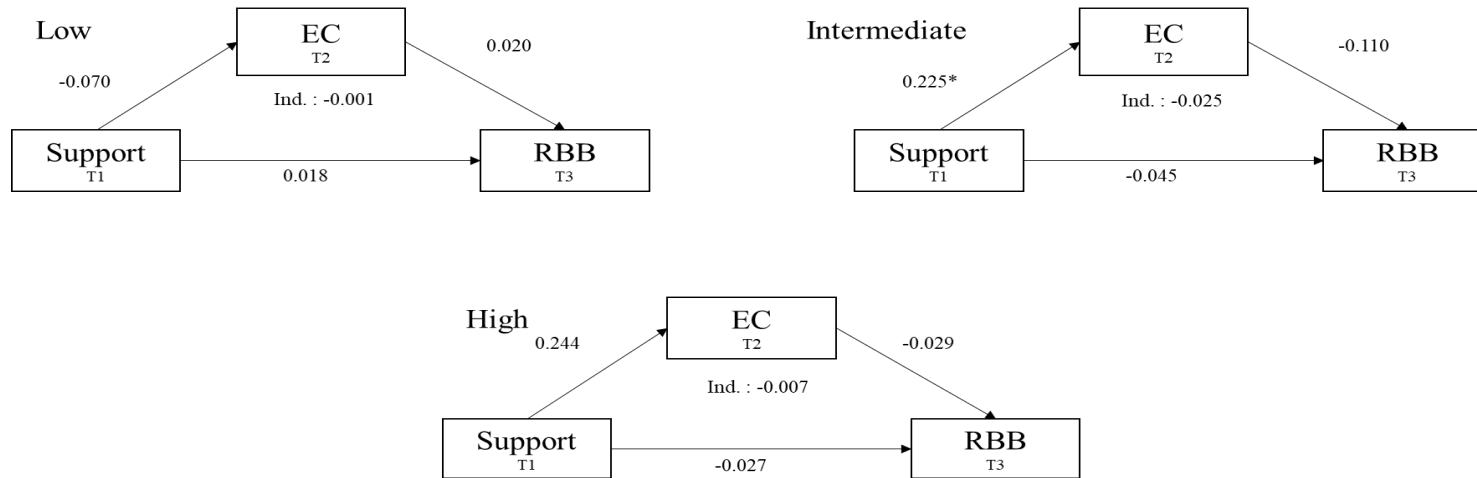
*** $p < .001$; ** $p < .01$; * $p < .05$

Figure 15. Model 1b results in the 'low', 'intermediate', and 'high' BIMPS group (Study 2).
Note. *** $p < .001$; ** $p < .01$; * $p < .05$; EC= Effortful control, RBB= rule-breaking behavior

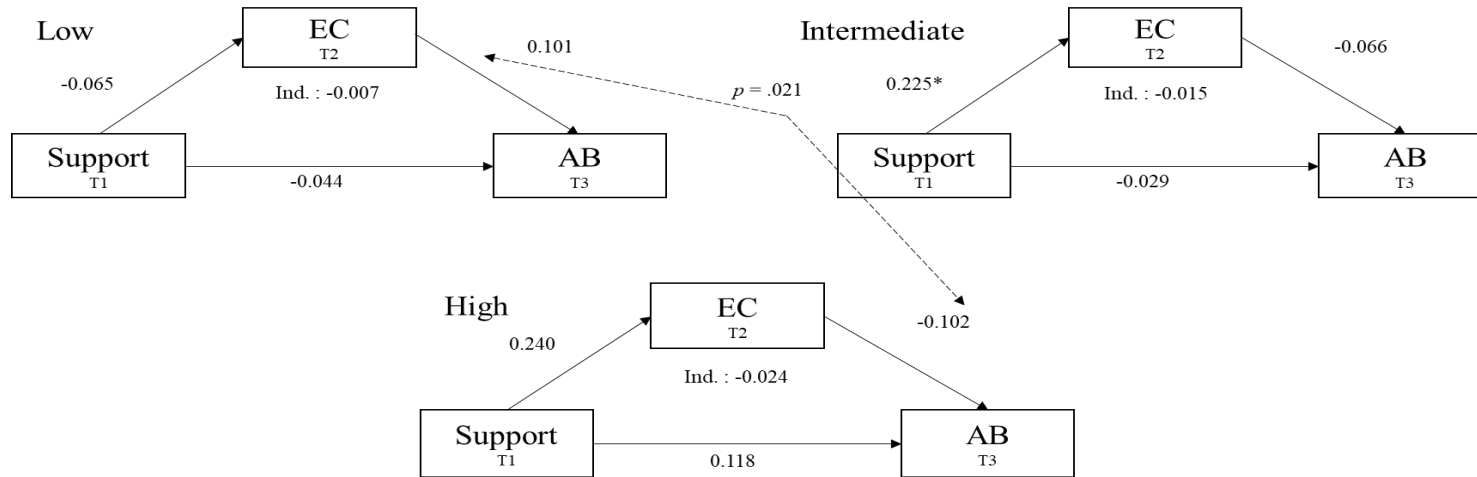*Figure 16.* Model 2b results in the 'low', 'intermediate', and 'high' BIMPS group (Study 2).
Note. *** $p < .001$; ** $p < .01$; * $p < .05$; C= Effortful control, AB= aggressive behavior ; Dotted lines indicate significant difference between associations.

5.3.3 Model 3: Parental Criticism and Rule-Breaking Behavior

In Model 3a without distinguishing between the three BIMPS groups (See Table 16 and Figure 14), only the negative association between parental criticism and effortful control was significant ($p = .013$). There was no evidence of mediation by effortful control. When we distinguished between the BIMPS groups (i.e., Model 3b), a significant proportion ($p < .05$) of the variance in rule-breaking and effortful control was explained in each BIMPS group (See Table 16). The association between parental criticism and effortful control was in the hypothesized direction, but was only significant in the low BIMPS group (See Figure 17). The association between parental criticism and rule-breaking behavior was significantly positive in the low BIMPS group. This association was observed to be negative in the high BIMPS group, albeit non-significantly. The association between effortful control and rule-breaking behavior failed to reach significance across BIMPS groups. There was no evidence of significant different associations between BIMPS groups (See Table 18) or of mediation of the association between parental criticism and rule-breaking behavior by effortful control.

5.3.4 Model 4: Parental Criticism and Aggressive Behavior

In Model 4a without distinguishing between the three BIMPS groups (See Table 16 and Figure 14), both the negative association between parental criticism and effortful control ($p < .001$) and the positive association between effortful control and aggressive behavior were significant ($p = .018$). The latter finding was inconsistent with our hypothesis. There was no evidence of mediation by effortful control. When we distinguished between the BIMPS groups (i.e., Model 4b), a significant proportion ($p < .05$) of the variance in aggressive behavior and effortful control was explained in each BIMPS group (See Table 16). In general, the directions of the associations were consistent with the hypotheses, except for the positive association between effortful control and aggressive behavior in the low BIMPS, which was the only association that reached significance (See Figure 18). This association also differed significantly between the low and high BIMPS group. Finally, there was no evidence of mediation of the association between parental criticism and aggressive behavior by effortful control.
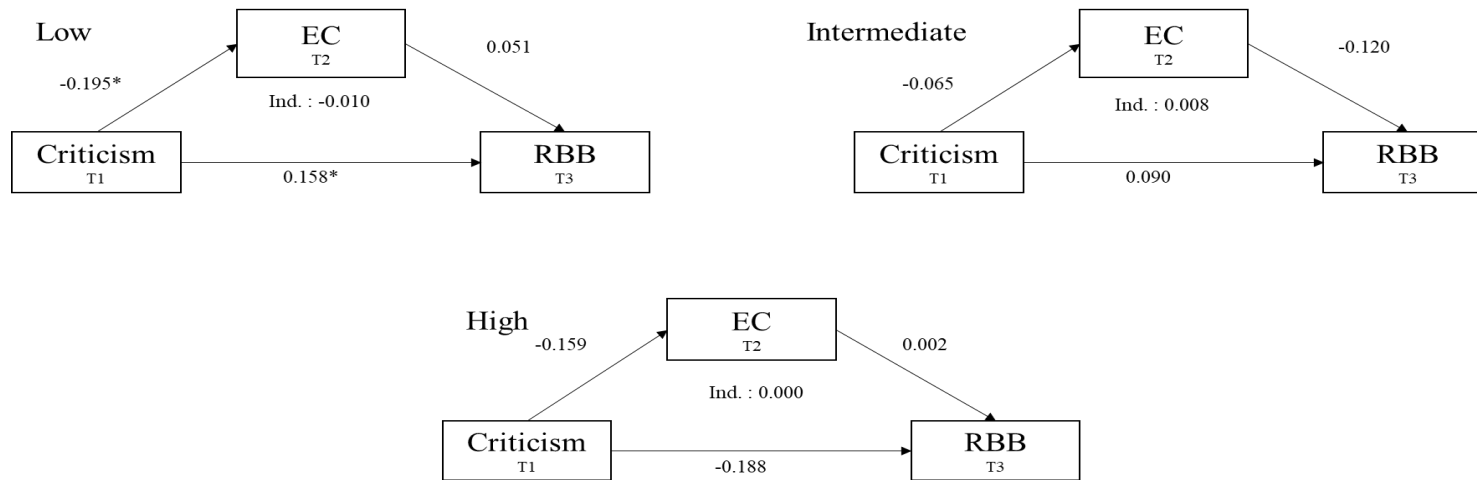
Figure 17. Model 3b results in the 'low', 'intermediate', and 'high' BIMPS group (Study 2).

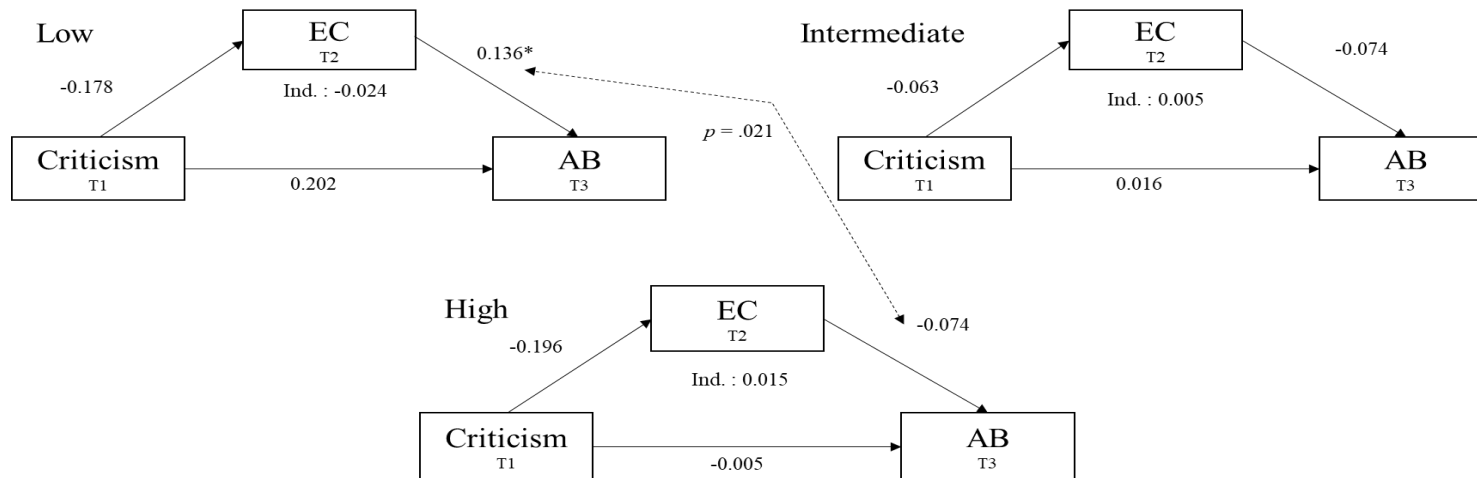*Note.* *** $p < .001$; ** $p < .01$; * $p < .05$; EC= Effortful control, RBB= rule-breaking behavior

Figure 18. Model 4b results in the 'low', 'intermediate', and 'high' BIMPS group (Study 2).

Note. *** $p < .001$; ** $p < .01$; * $p < .05$; EC= Effortful control, AB= aggressive behavior; Dotted lines indicate significant difference between associations.

Table 18

Results of the Pairwise Contrasts of Coefficients Between the BIMPS Groups in Study 2

Model	Contrast	Wald test	df	p	Model	contrast	Wald test	df	p
Model 1b	a_{low} - a_{int}	1.253	1	.263	Model 3b	a_{low} - a_{int}	2.371	1	.124
	a_{low} - a_{high}	0.167	1	.683		a_{low} - a_{high}	0.129	1	.719
	a_{int} - a_{high}	0.137	1	.711		a_{int} - a_{high}	0.447	1	.504
	b_{low} - b_{int}	0.306	1	.580		b_{low} - b_{int}	0.416	1	.519
	b_{low} - b_{high}	0.156	1	.693		b_{low} - b_{high}	0.010	1	.920
	b_{low} - b_{high}	0.008	1	.929		b_{low} - b_{high}	0.339	1	.561
	c_{low} - c_{int}	3.323	1	.068		c_{low} - c_{int}	0.498	1	.481
	c_{low} - c_{high}	2.745	1	.098		c_{low} - c_{high}	0.080	1	.777
	c_{int} - c_{high}	0.031	1	.860		c_{int} - c_{high}	0.263	1	.608
	d_{low} - d_{int}	0.955	1	.328		d_{low} - d_{int}	0.788	1	.375
	d_{low} - d_{high}	0.048	1	.827		d_{low} - d_{high}	0.171	1	.679
	d_{int} - d_{high}	0.181	1	.670		d_{int} - d_{high}	0.088	1	.767
Model 2b	a_{low} - a_{int}	2.192	1	.139	Model 4b	a_{low} - a_{int}	3.047	1	.081
	a_{low} - a_{high}	5.327	1	.021		a_{low} - a_{high}	5.346	1	**.021**
	a_{int} - a_{high}	0.348	1	.556		a_{int} - a_{high}	0.054	1	.816
	b_{low} - b_{int}	0.369	1	.544		b_{low} - b_{int}	1.731	1	.188
	b_{low} - b_{high}	0.348	1	.555		b_{low} - b_{high}	2.085	1	.149
	b_{low} - b_{high}	1.674	1	.196		b_{low} - b_{high}	0.025	1	.874
	c_{low} - c_{int}	3.263	1	.071		c_{low} - c_{int}	0.350	1	.554
	c_{low} - c_{high}	2.623	1	.105		c_{low} - c_{high}	0.020	1	.888
	c_{int} - c_{high}	0.040	1	.842		c_{int} - c_{high}	0.262	1	.609
	d_{low} - d_{int}	0.048	1	.827		d_{low} - d_{int}	1.651	1	.199
	d_{low} - d_{high}	0.545	1	.460		d_{low} - d_{high}	2.341	1	.126
	d_{int} - d_{high}	0.168	1	.682		d_{int} - d_{high}	0.292	1	.589

Note. BIMPS = Biologically Informed Multilocus Profile Score.

6. General Discussion

The present paper investigated (a) whether the longitudinal association between parenting and externalizing problem behavior was mediated by effortful control, and (b) whether this mediation model was moderated by a polygenic score based on dopaminergic genes. Concerning the genetic moderation, this paper goes beyond the widely used candidate gene approach used in previous G x E studies by using a polygenic index score to represent the dopaminergic pathway. Our findings showed that the associations between parenting (at Time 1) and externalizing problem behavior (i.e., rule-breaking and aggressive behavior) (at Time 3) were consistent with previous findings and that effortful control (at Time 2) did not consistently mediate this association. Furthermore, we observed that the longitudinal associations between

parenting and externalizing problem behavior and between effortful control and aggressive behavior are different, albeit inconsistently, depending on dopamine activity. The fact that we did not find a similar result for the association between rule-breaking behavior and aggressive behavior may indicate an etiological difference between the two types of externalizing problem behavior, which is in line with previous research (Burt & Klump, 2013). Finally, the findings from the two studies (i.e., questionnaire versus observational data for parenting, different cultures, different languages) both indicate a moderation by dopamine activity. However, the patterns of moderation were different in the two studies.

6.1 The Mediating Role of Effortful Control in the Link Between Parenting and Externalizing Problem Behavior

When we do not take the genetic characteristics of the adolescent into account, the direct associations among the variables were consistent with our hypotheses, although not always significantly so. For instance, the significant negative association between negative parenting (i.e., psychological control or parental criticism) and effortful control was observed in both studies, which, given the different types of data, makes it a robust finding. The hypothesis that effortful control predicts a decrease in externalizing problem behavior over time, was only confirmed in Study 1. One possible explanation is that the adolescents in the Study 1 were somewhat older. Older adolescents may have more experience in successfully implementing self-regulation skills related to effortful control, whereas younger children/adolescents may be more in a process of matching their self-regulations skills to an increasingly complex social environment (Pérez-Edgar, 2015).

Furthermore, we observed that effortful control only mediated the association between psychological control and aggressive behavior in Study 1. So in general, our findings provided very limited evidence for the mediation model suggested by previous research (Belsky, Fearon, & Bell, 2007; Chang et al., 2011; Eisenberg, et al., 2005). Together with the mixed findings concerning a moderation model in the study by Slagt et al. (2016), it seems that the role of effortful control in the association between parenting and externalizing problem behavior is more complex than just a mediator or just a moderator. It is possible that effortful control functions as a moderator and mediator simultaneously or switches between these two functions. More research is needed on which factors (i.e., individual characteristics or environmental factors) affect the role of effortful control.

6.2 Dopaminergic Moderation

There was some evidence for associations that significantly differed between the groups based on dopamine activity. Parental support, assessed through questionnaires, showed different associations with effortful control and aggressive behavior, respectively. The link with effortful control weakened when dopamine activity increased, which is consistent with our hypothesis (Beachaine & Gatzke-Kopp, 2012). By contrast, the link with aggressive behavior grew stronger when dopamine activity increased, which is not in line with our hypothesis. These findings were not replicated when observational measures were used to assess parenting. One possible explanation for this discrepancy between studies is that observational measures may tap into different aspects of parental support. Furthermore, observations were made during a limited time frame, whereas the questionnaires asked parents about their parenting practices in general. In general, the present paper provides mixed evidence for dopaminergic moderation of the association between parenting and externalizing problem behavior. In line with Weeland et al. (2015), our findings were mixed concerning the consistency as well as the direction of this moderation. The use of different measures for parenting and problem behavior across studies as well as a limited number of dopaminergic genes may partially explain the mixed findings in this context.

The negative association between effortful control and aggressive behavior was also moderated by the dopaminergic polygenic score in both studies. Specifically, this association differed between the group characterized by low dopamine activity and the group characterized by high dopamine activity. This finding indicates the importance of the role of genetic characteristics in this association and also indicates a difference with the other type of externalizing problem behavior, that is rule-breaking behavior. It is possible that because aggressive behavior victimizes another individual, people are more inclined to inhibit this type of externalizing problem behavior, leading to a stronger association between effortful control and aggressive behavior. The finding that the association between effortful control and aggressive behavior was moderated by dopamine, whereas the association between effortful control and rule-breaking behavior was not, is in line with previous research suggesting that genetic characteristics contribute more strongly to aggressive behavior compared with rule-breaking behavior. Environmental influences, on the other hand, appeared to play a more important role in rule-breaking behavior (Burt & Klump, 2013). More research is needed on the effects and the interplay of individual and contextual factors in the development of different types of externalizing behaviors, such as rule-breaking and aggressive behavior.

Finally, we hypothesized that associations involving effortful control would decrease linearly across the genetic liability groups (Li et al., 2016), but our findings did not confirm this hypothesis. This may be explained by the fact that effortful control is subject to genetic pathways other than dopamine, which were not taken into account in the present study. As mentioned in the introduction, although the present study goes beyond the candidate gene approach, it does not allow to make decisive claims about G x E interactions, and more specifically the interplay between parenting, effortful control, and externalizing problem behavior. The present studies do provide evidence of genetic moderation of this interplay, but more research using alternative methods, such as a genome-wide approach, is needed to get detailed information on these G x E interactions.

6.3 Limitations and Future Research

Despite the strengths of the present study (e.g., two independent samples from different cultures with different languages, longitudinal data, and both observational and questionnaire data on parenting), the two studies also have some limitations. First, most of the data were self-report measures, which could lead to social desirability bias. This may especially be the case for sensitive topics, such as problem behavior or parenting practices in Study 1. Second, although power analyses indicated sufficient power, it is possible that the hypothesized effects are smaller than the medium effect sizes used in our power analyses, which would require a larger sample size to have an adequate probability to be detected. Third, the present study uses a polygenic index score based on four genes, which is already a more comprehensive approach than a candidate gene approach. However, four genes still provide a relatively limited representation of a genetic pathway. Related to this issue, it would be interesting if multiple pathways were included. Genetic pathways other than the dopamine system, and the serotonin pathway in particular, might also play a role in the interplay between parenting, effortful control, and externalizing problem behavior. Future research should try to develop valid and comprehensive measures of an individual's genetic characteristics.

7. Conclusion

The present paper used two adolescent/late childhood samples from two three-wave longitudinal studies and investigated (a) whether effortful control mediated the longitudinal association between parenting and externalizing problem behavior and (b) whether this mediation model was moderated by the dopaminergic pathway. Our findings replicated

previous findings in several ways. Positive parenting was positively associated with effortful control 12 (i.e., Study 1) or 18 months (i.e., Study 2) later and negatively with externalizing problem behavior 24 (i.e., Study 1) or 36 (i.e., Study 2) months later. Similarly, negative parenting was negatively associated with effortful control and positively with externalizing problem. Effortful control was negatively associated with externalizing problem behavior 12 (i.e., Study 1) or 18 (i.e., Study 2) months later. The present studies did not find consistent mediation of the association between parenting and externalizing problem behavior by effortful control, but did observe that the associations among these variables differed depending on dopamine activity as assessed by a polygenic index score. This genetic moderation was inconsistent, but these findings imply that it is important to take into account the genetic characteristics of an individual when examining externalizing problem behaviors. Moreover, the present study shows that the development of externalizing problem behavior is subject to factors that lie both within the individual, such as genetic characteristics and temperament, and in the environment, such as parenting practices.

8. Supplemental Materials

Table S13

Composition and Distribution of Biologically Informed Multilocus Profile Score (BIMPS)

Polymorphism	Genotype	N (%)	Score
DAT1 40-bp VNTR	9R carriers	45.6	High (1)
	10R/10R	54.4	Low (0)
DRD2 Taq1A	A2/A2	62.0	High (1)
	A1/A2	33.8	Intermediate (0.5)
	A1/A1	4.2	Low (0)
DRD4 48-bp VNTR	7R carriers	34.5	High (1)
	7R non-carriers	65.5	Low (0)
COMT Val158Met	Met/Met	26.0	High (1)
	Val/Met	47.8	Intermediate (0.5)
	Val/Val	26.2	Low (0)

Note. The scoring system of Nikolova et al. (2011) is used to compute a biologically informed multilocus profile score (BIMPS) representing four dopamine polymorphism. Genotypes associated with high dopamine signaling received a score of 1, low genotypes a score of 0, and intermediate genotypes a score of 0.5.

Table S14

Results of the One-Way ANOVA Across BIMPS Groups in Study 1

Variable		Sum of Squares	df	Mean Square	F	p
Support (T1)	Between	0.431	2	0.216	1.361	.257
	Within	75.561	477	0.158		
	Total	75.993	479			
Psychological control (T1)	Between	1.002	2	.501	2.151	.118
	Within	111.132	477	.233		
	Total	112.134	479			
Effortful Control (T2)	Between	0.534	2	.267	.482	.618
	Within	231.785	418	.555		
	Total	232.319	420			
Rule-breaking (T3)	Between	0.139	2	0.069	1.645	.195
	Within	13.440	319	0.042		
	Total	13.578	321			
Aggressive behavior (T3)	Between	0.052	2	0.026	0.522	.594
	Within	15.964	319	0.050		
	Total	16.016	321			

Note. BIMPS = Biologically Informed Multilocus Profile Score; T = time point.

Table S15

Results of the One-Way ANOVA Across BIMPS Groups in Study 2

Variable		Sum of Squares	df	Mean Square	F	p
Support (T1)	Between	1.003	2	0.501	0.410	.664
	Within	273.876	224	1.223		
	Total	274.879	226			
Criticism (T1)	Between	0.437	2	0.219	0.184	.832
	Within	265.545	224	1.185		
	Total	265.982	226			
Effortful Control (T2)	Between	0.326	2	0.163	0.493	.611
	Within	149.349	452	0.330		
	Total	149.674	454			
Rule-breaking (T3)	Between	0.022	2	0.011	0.278	.757
	Within	16.202	418	0.039		
	Total	16.223	420			
Aggressive behavior (T3)	Between	0.028	2	0.014	0.240	.787
	Within	24.398	418	0.058		
	Total	24.426	420			

Note. BIMPS = Biologically Informed Multilocus Profile Score; T = time point.

Chapter 6
General Discussion

Abstract

The present dissertation aimed at investigating the interplay of adolescent characteristics (i.e., personality, temperament, genetic make-up) and parenting in the development of externalizing problem behavior (i.e., rule-breaking and aggressive behavior). We decided to focus on the microsystem of the parents (Lerner et al., 2002), given that a large body of research established a strong reciprocal association between parenting and adolescent externalizing problem behavior (De Haan et al., 2012; Hoeve et al., 2009; Huh et al., 2006; Reitz, Deković, & Meijer, 2006). In this chapter we will summarize the research findings as well as suggest some future research avenues. Furthermore, this chapter will also include a discussion of the relevance of current findings to the clinical practice.

1. Introduction

The first research aim of this dissertation concerned the investigation of a five-factor parenting model. Specifically, we assessed whether the five parenting dimensions (i.e., support, proactive control, punitive control, harsh punitive control, and psychological control) of this parenting model could be validly used across different contexts, such as across multiple informants or across adolescence (i.e., age 12 to 18 years old). The second research aim was to investigate heterogeneity in parenting across adolescence in mothers and fathers by establishing different trajectory groups and whether groups differed in the development of externalizing problem behavior across adolescence. The third and fourth research aim go beyond the association between externalizing problem behavior and parenting by including adolescent characteristics. Research aim three was to examine transactional associations between parental control, adolescent personality (i.e., agreeableness and conscientiousness), and externalizing problem behavior across early and middle adolescence. Research aim four was to investigate whether the association between parenting and externalizing problem behavior was mediated by adolescent effortful control and what the role of the adolescent's genotype (i.e., dopaminergic pathway) was.

2. Integrative Summary

2.1 The Five-Factor Parenting Model for Mother, Father, and Adolescent Across Adolescence

Chapter 2 in the present dissertation focused on the five-factor parenting model conceptualized by Janssens et al. (2015) using a data-driven approach. This model comprised parental support, proactive control, punitive control, harsh punitive control, and psychological control. Chapter 2 further examined this five-factor parenting model and established its measurement invariance across informants. In other words, we checked whether this model could be validly used to represent the perspective on parenting practices of mothers, fathers, and adolescents. There are three levels of measurement invariance that are often assessed. Configural invariance indicates that the same number and pattern of latent factors (i.c., parenting subscales) underlie a given concept (i.c., parenting dimension), whereas metric invariance entails that the parenting dimension is measured in the same manner, which also means that differences in scores are reflective of actual differences in responses. Finally, if scalar invariance is established, the scores on the parenting dimensions can be meaningfully

compared.

Our results indicated that scores on the parenting questionnaires could be compared (i.e., scalar invariance) between these three informants, which is indispensable for future research using this parenting model. Research on parenting can only be meaningful when the perspectives of all the actors involved are adequately represented. A parenting model that is valid for multiple informants is valuable, given that previous studies already indicated that perceived parenting differences are also associated with the efficacy of prevention programs (De Los Reyes et al., 2012; De Los Reyes & Kazdin, 2005; Laird & De Los Reyes, 2013).

Furthermore, chapter 2 also established longitudinal (partial) scalar invariance of the five-factor model by Janssens et al. (2015). Specifically, the five parenting dimensions can be used across early, middle, and late adolescence. This finding is less self-evident than it may seem, since parents may adapt their parenting practices to the developing adolescent. For instance, a 12-year-old will be monitored by his/her parents, whereas a 18-year-old will not tolerate extensive parental monitoring. Therefore, the establishing of measurement invariance is an important finding in that it allows to investigate parenting practices throughout adolescence. Together with the finding of measurement invariance across informants, chapter 2 provides a solid basis for further research and the following chapters in the current dissertation using the five-factor parenting model by Janssens et al. (2015). Although often overlooked, assessing measurement invariance is an essential step in research using multiple informants or across longer periods of time. This dissertation is innovative in that it is the first time, to the best of our knowledge, that longitudinal measurement invariance is assessed for a parenting model.

Chapter 2 also provided an important description of a five-factor parenting model across adolescence (i.e., 12 to 18 years old). For instance, an interesting finding is the differential continuity of the parenting model as reported by mothers, fathers, and adolescents. This continuity implies that the rank-order among individuals stays more or less the same. In other words, if an individual scores relatively high/low at the first measuring point, he/she will also score relatively high/low at the subsequent measuring points. There was one exception, namely with respect to harsh punitive control as reported by the parents. The reports on this parenting dimension did show variability in late adolescence. One possible explanation involves the nature of this parenting dimension, that is physical punishment. Physical punishment around age 16 through 18 may not be common anymore and if it does occur, this may be an indication of a more abusive parent-adolescent relationship.

We observed that harsh punitive control is at its lowest point in late adolescence, but

growth models across the whole of adolescence showed that physical punishment is consistently reported at very low levels for mothers, fathers, and adolescents (i.e., 1 to 1.5 on a 5-point scale). Growth models for the remaining four parenting dimensions revealed that the levels of psychological control as reported by all three informants were also low (i.e., 1.5 to 2.5 on a 5-point scale). Furthermore, the levels of punitive control were slightly higher (i.e., 2.0 to 3.0 on a 5-point scale) and decreased across adolescence. This is not surprising given the fact that adolescents gain more autonomy in this period, which limits the parents' possibility to punish their child. Finally, parental support and proactive control showed the highest levels (i.e., 3.5 to 5.0 on a 5-point scale) across adolescence for all three informants. In conclusion, given the fact that parental support and proactive control are associated with positive developmental outcomes (Bronstein et al., 2007; Chang, Shaw, Dishion, Gardner, & Wilson, 2015; Tang & Davis-Kean, 2015) and that harsh punitive control and psychological control are often linked to less favorable developmental and academic outcomes (Barber et al., 1994; Bender et al., 2007; Chang et al., 2003; Pettit et al., 2001), high scores on support and proactive control as well as low scores on harsh punitive control and psychological control can be interpreted as a reflection of generally adequate parenting in the community sample of the STRATEGIES project.

2.2 Heterogeneity in Parenting Practices: The Association With Externalizing Problem Behavior

Chapter 2 provided interesting descriptions of the five parenting dimensions across adolescence and made the assumption that the average trajectory is an adequate representation for the whole sample. This assumption is common and is made in almost all previous studies that used a variable-centered approach in investigating the association between parenting and externalizing problem behavior (De Haan et al., 2012; Hanish et al., 2014; Pettit, Bates, & Dodge, 1997; Reef, Diamantopoulou, van Meurs, Verhulst, & van der Ende, 2010). In order to take into account potential heterogeneity, we used a person-centered approach to investigate the five parenting dimensions before investigating the association (i.e., variable-centered approach) between parenting and externalizing problem behavior.

Chapter 3 established heterogeneity in parenting for mothers and fathers separately. Specifically, we found different trajectory classes for support, proactive control, punitive control, and psychological control, but not for harsh punitive control. Concerning harsh punitive control, the average trajectory provided the best representation of the sample as a whole. Wang and Kenny (2014) suggested a vicious cycle between harsh punitive control and externalizing

problem behavior, that over time can lead to detrimental developmental outcomes for the adolescent. Therefore, the finding of overall low levels of harsh punitive control in our sample is positive. However, it should be noted that in the STRATEGIES data set, attrition across waves led to a relative decrease of adolescents exhibiting externalizing problem behavior. The fact that we found different trajectory classes for both mother and father in the remaining four parenting dimensions shows that is important to take into account this heterogeneity. It is also important to note that the number and course of these trajectory classes differed between mothers and fathers. In general, the smaller trajectory classes of fathers were often less stable than those of maternal parenting. However, the larger, stable trajectory classes had similar courses for mothers and fathers.

Furthermore, acknowledging heterogeneity in parenting dimensions is not only important in the investigation of parenting as is, but also in examining the association between parenting and externalizing problem behavior. In line with Okado and Haskett (2015) as well as Luyckx et al. (2011), chapter 3 combined a person-centered with a variable-centered approach to examine whether trajectory classes in the four parenting dimensions (i.e., support, proactive control, punitive control, and psychological control) differed regarding the development of rule-breaking and aggressive behavior across adolescence. Specifically, we examined the association between parenting and externalizing problem behavior at age 12 (i.e., intercept) and its development across adolescence (i.e., slope from age 12 to 17 years old). A first interesting finding is that the significant associations were exclusively with externalizing problem behavior at age 12. In other words, the trajectory classes did not show differences regarding the development of problem behavior across adolescence. One possible explanation is that rule-breaking as well as aggressive behavior appeared to be rather stable across adolescence so that (the variance in) the development is too limited to be significantly explained by the parenting dimensions. Since in chapter 3 development was represented as a single value, that is the slope, there is only information on the general development across adolescence without more specific information on potential associations within this time period.

Concerning the differences regarding initial levels of externalizing problem behavior and associations between the trajectory classes in parenting dimensions, we found that small differences in parental support (i.e., similar for mother and father) already were associated with differences in aggressive behavior at age 12. Maternal, and not paternal, proactive control showed significant associations with rule-breaking behavior. Specifically, our findings indicated that there was an optimum level for setting rules and monitoring the adolescent. Trajectory class characterized by low, but also very high levels of proactive control were

associated with higher initial rule-breaking behavior. Despite the fact that proactive control is generally considered to be a positive parenting practice with negative associations with externalizing problem behavior (Galambos et al., 2003; Gray & Steinberg, 1999; Pettit et al., 1997), the association does not seem to be linear. Concerning punitive control, the group of mothers characterized by high levels of non-physical punishment had adolescents exhibiting higher levels of rule-breaking behavior. Similar to proactive control, this association was only found in maternal parenting. Finally, concerning psychological control, we observed a difference between mother and father. In line with other research (Ahmad, Vansteenkiste, & Soenens, 2013; Mabbe et al., 2016), the groups of fathers characterized by more psychological control, have adolescents that exhibit more aggressive behavior at age 12. The association between maternal psychological control and externalizing problem behavior is more complex and seems to be non-linear in nature. The observation of differences regarding the development of externalizing problem behavior between the trajectory classes of four parenting dimensions stress the importance to not overlook heterogeneity and to not blindly assume that the average is an adequate representation for the whole sample.

Despite the fact that a large body of research highlights the significance of parenting in the development of externalizing problem behavior, and moreover the reciprocal nature of this association (De Haan et al., 2012; Hoeve et al., 2009; Huh et al., 2006; Reitz, Deković, & Meijer, 2006), we did not observe significant associations between parenting dimensions and the development of externalizing problem behavior. As mentioned before, the approach to investigate development across a large time span, such as the adolescence, as a whole may not be the most suitable approach. The reciprocal nature of this association may require a more detailed assessment that includes multiple measuring points within adolescence.

2.3 The Role of Parenting in the Co-Variation of Externalizing Problem Behavior and Adolescent Personality

Chapter 4 focused on the transactional associations among adolescent personality (i.e. conscientiousness and agreeableness), parental control (i.e., proactive control, punitive control, and psychological control), and externalizing problem behavior (i.e., rule-breaking and aggressive behavior) across and within early and middle adolescence. Specifically, we aimed to investigate which role parenting played in the co-development of adolescent personality and problem behavior. To reach this goal, we used a state-of-the-art statistical technique, that is Random Intercept Cross-Lagged Panel Modelling (RI-CLPM), on three time points across a two-year span. This multilevel approach allows us to investigate these associations at the

between-individual level as well as at the within-individual level.

At the between-individual level, all associations were significant, although some effect sizes were rather small. The strongest associations involved the two personality dimensions, but the parental control dimensions still showed significant associations with both types of externalizing problem behavior. This indicates that, even when adolescent personality is taken into account, parental control is still linked to externalizing problem behavior across adolescence. It has to be noted that the between-individual level refers to the stable, trait-like components across early and middle adolescence of the informants' reports. Concerning the within-individual level (i.e., state-like), we observed an important role for adolescent conscientiousness in the interplay among parenting, adolescent personality, and externalizing problem behavior. Specifically, high levels of conscientiousness predicted less externalizing problem behavior at the next time point, which in turn predicted lower levels of conscientiousness and also showed reciprocal associations with agreeableness (i.e., positive) and punitive control (i.e., negative). It should also be noted that we did not observe indirect associations with externalizing problem behavior. The observed associations are in line with the expectations in that when adolescents exhibit less problem behavior, whether or not following parental punishment, they are likely to be rated more conscientious by their parents and when they are rated conscientious, it is less likely that they will exhibit problem behavior, and thus, there is also no need for punishment. These associations on their own are not surprising and are in line with the literature (Janssens et al., 2015; Laird et al., 2003; Mervielde et al., 2005; Prinzie et al., 2010; Tackett, 2006; Van Leeuwen et al., 2004, 2007), but they do provide interesting information on the interplay among the three concepts.

Concerning theoretical perspectives, chapter 4 showed a reciprocity between adolescent personality and externalizing problem behavior. However, our findings do not provide conclusive support for one of the hypotheses on the link between personality and psychopathology (i.e., the predisposition/vulnerability hypothesis, the complication/scar hypothesis, the continuity hypothesis). Further research is needed to be able to distinguish between these three hypotheses. Our findings add to the literature, in that they indicate that in addition to this reciprocity, there is still a role to play for parenting, and more specifically parental control. This is an important finding in that parenting is a potential target for future prevention or intervention programs to reduce externalizing problem behavior. Furthermore, chapter 4 also provided support for the added value of including multiple dimensions of parental control and adolescent personality, since these separate dimensions appear to play distinct roles in the interplay as a whole. This can benefit the clinical practice as well as the development or

refinement of theoretical frameworks. Clinical practice benefits from concepts that are well-defined and distinct, since they provide interesting opportunities as targets for prevention and intervention studies. Concerning the theoretical perspective, our findings indicated a stronger link between adolescent conscientiousness and externalizing problem behavior then between adolescent agreeableness and externalizing problem behavior. It is clear that the development of externalizing problem behavior is rooted in a complex interplay in which both individual differences as environmental factors play a major role.

2.4 The Dopaminergic Moderation of the Associations Among Parenting, Effortful Control, and Externalizing Problem Behavior

The fifth chapter in the present dissertation included environmental (i.e., parenting practices) and phenotypic variables (i.e., personality dimensions) as well as genotypic variables (i.e., polygenic score representing the dopaminergic pathway). In line with the Biosocial Developmental Model (BDM) by Beauchaine and Gatzke-Kopp (2012), we investigated whether effortful control mediates the longitudinal association between parenting and externalizing problem behavior, and whether this mediation model is moderated by the polygenic index score of the adolescent. This chapter has several methodological strengths (e.g., three waves of data, two large samples, polygenic score, multiple informants) and provided interesting insights in the role of the dopaminergic pathway in the interplay between parenting, adolescent temperament, and externalizing problem behavior.

Our findings showed that both parenting (time point 1) and effortful control (time point 2) can predict externalizing problem behavior (time point 3), which is in line with the BDM model by Beachaine and Gatzke-Kopp (2012). Furthermore, there is little support for mediation by effortful control of the association between parenting and externalizing problem behavior. When we also take into account the mixed findings on effortful control as a moderator by Slagt, Dubas, Deković, and van Aken (2016), one possible conclusion can be that other factors, such as the time span in which associations are investigated, may influence the role of effortful control. In chapter 3, we also did not find any indirect associations between parenting and externalizing problem behavior. It should be noted that, despite relative stability of personality and temperamental traits (De Fruyt et al., 2006; McCrae et al. 2000), numerous psychosocial changes occur in adolescence which may make it hard to indicate a consistent mediator for the association between the individual and parenting practices.

Chapter 5 also assessed the moderating role of the dopaminergic pathway in the aforementioned mediation model. Although inconsistent, there was some evidence of

moderation of the associations involving positive, but not negative, parenting (i.e., associations with effortful control and aggressive behavior respectively) or effortful control (i.e., association with aggressive behavior). The latter was found in the two separate samples, which makes it a robust finding. The finding that the polygenic score based on dopaminergic genes moderates associations involving positive parenting was only observed when parenting was assessed through questionnaires. This may indicate that different methods for assessing parenting may capture different aspects of included concepts, which may urge future research to include different methods. An interesting observation was the discrepancy between the findings concerning rule-breaking behavior and aggressive behavior. There was some support for the dopaminergic moderation of associations involving aggressive behavior, whereas this was not the case for rule-breaking behavior. This finding is in line with previous research (Burt & Klump, 2013) that suggested that aggressive behavior may show a stronger link with one's genetic characteristics. In contrast, environmental influences seemed to be more important in rule-breaking behavior. Differences in results between positive and negative parenting or between two types of externalizing problem behavior (i.e., rule-breaking and aggressive behavior) also urges to nuance our conclusions and indicates that not one single mechanism underlies the development of externalizing problem behavior.

Chapter 5 indicated the need for including factors at several levels of analyses. For instance, our findings showed that factors relating to the individual (i.e., genetics or temperament) as well as the environment (i.e., parenting practices) are important in the development of adolescent behavior, and more specifically externalizing problem behavior. The current dissertation, and thus also this fourth chapter, only focused on the adolescent (characteristics) and his/her parents, so we did not take into account other important (proximal or distal) factors that play a major role in the development of individual (e.g., peers). General models, such as the developmental contextual model by Lerner et al. (2002), do acknowledge this complexity and therefore, may prove to be a valuable guide to investigate any other factors within the microsystem of the parents as well as in other microsystems and even, meso-, exo-, macro-, and chronosystems. Finally, in line with Robbins (2018), we argue that it is an added value to complement animal research on the neural basis of behavior with psychological, behavior, and genetic research in human samples.

3. Future Research

This dissertation has investigated the development of externalizing problem behavior and has focused on adolescent characteristics and parenting practices. The four previous

chapters did not only provide new insights on this topic, but also indicated interesting avenues for future research. In the following paragraphs we will discuss interesting potential research directions for the future.

In chapter 1, we established that the perspectives of mothers, fathers, and adolescents on the five-factor parenting model are comparable. Whereas the current dissertation used one informant or a composite score of two informants, investigating informant discrepancies can have important theoretical (e.g., Attribution Bias Context; De Los Reyes & Kazdin, 2005) and practical implications (e.g., family-based intervention programs). These informant discrepancies represent an aspect of the parent-adolescent relationship that cannot be captured by a single report and are also important in predicting externalizing problem behavior (De Los Reyes et al., 2010; Laird & De Los Reyes, 2013). There are some previous studies concerning this topic, but these often do not distinguish between the mother-adolescent dyad and father-adolescent dyad or even do not include father reports at all. Building further on chapter 1, and more specifically the longitudinal invariance of the parenting model, a longitudinal examination of potential informant discrepancies can provide interesting insights in the changing relationship between adolescent and parent. Previous research (e.g., Grotevant & Cooper, 1986; Masten et al., 2009) suggests that the influence of the parents decreases whereas the influence of peers increases across adolescence. Assessing how parent-adolescent discrepancies develop across a large time span with numerous major changes, such as adolescence, may be useful to optimize family-based prevention and/or intervention studies.

Concerning chapter 2, where we assessed how heterogeneity in parenting across adolescence was related to the development of externalizing problem behavior, an interesting research avenue is to also take into account heterogeneity in trajectories of externalizing problem behavior. A study by Bongers, Koot, van der Ende, and Verhulst (2004) already showed that children (i.e., aged four to 18 years old) showed different developmental trajectories of several types of externalizing problem behavior. Instead of holding on to a variable-centered approach to investigate the association between parenting and externalizing problem behavior (cfr., chapter 2), an alternative research direction is to adopt a person-centered approach. This enables not only to investigate heterogeneity within parenting or externalizing problem behavior separately, but could be used to assess how these variables are related. For instance, it can be investigated whether adolescents belonging to a group with high levels of problem behaviors have parents that belong to the group showing high physical punishment and/or low support. This will provide information on a more descriptive level, but can be valuable as well in that potential concurring variations in the trajectories can indicate defining

periods in the parent-adolescent relationship.

Concerning chapter 2, 3, 4, it should be noted that the STRATEGIES data set showed signs of somewhat selective dropout relating to externalizing problem behavior. Adolescents who dropped out at a certain wave, showed more externalizing problem behavior in the previous wave. State-of-the-art statistical techniques can (partly) counteract the bias arising from this drop out, but it still urges us to be cautious in formulating definite conclusions. It is also an important suggestion for future studies to pay attention to participant selection and drop out across time. It is essential to invest in retaining as much participants as possible and assess the representativeness of a sample across time.

The chapter 3 containing the investigation of the interplay of parental control, adolescent personality, and externalizing problem behaviors using random intercept cross-lagged panel models also showed some interesting possibilities for future research. Chapter 3 focused on parental control, but it would also be interesting to see how parental support functions in the co-variation between externalizing problem behavior and personality. Similarly, based on literature (Mervielde et al., 2005; Prinzie et al., 2010; Tackett, 2006; Van Leeuwen et al., 2004, 2007), we only focused on two personality traits (i.e., agreeableness and conscientiousness), whereas an individual's personality contains elements of all five personality traits (cfr., McCrae & Costa, 1987). It would be interesting to revisit the aforementioned interplay while taking into account personality profiles (e.g., overcontrolling, undercontrolling, resilient; Asendorpf, Borkenau, Ostendorf, & Van Aken, 2001) rather than separate dimensions. This has the drawback that it becomes less clear which aspects of a personality profile drive certain associations. Future research can also go beyond the scope of the parent-child relationship and include, for example, peer-relationships. Since the influence of peers (Masten et al., 2009) increases during adolescence, including this variable may reveal valuable findings on the interplay between adolescents, peer, and parents. RI-CLPM analyses allow to examine transactional associations, thus this approach would allow to further investigate the shifting of parental and peer influences and its impact on the adolescent and its behavior.

Concerning the dopaminergic moderation of associations involving parenting, adolescent, temperament, and/or externalizing problem behavior in chapter 5, there were some limitations that could be addressed in future research. First, more research should address the role of adolescent temperament (i.c., effortful control) in the association between parenting and externalizing problem behavior. For instance, collecting data in different time frames (e.g., across one day versus across a one year) may aid in disentangling the moderating and mediating effect of effortful control. A second important improvement would be including a wider

selection of genetic characteristics. In other words, to investigate multiple genetic pathways instead of focusing solely on the dopaminergic pathway. This is a logical next step in that it is obvious that adolescent characteristics, such as effortful control, are not exclusively influenced by the dopaminergic pathway (Li et al., 2016). The serotonergic pathway would be an interesting addition in that previous research also established its association with externalizing problem behavior (Chung et al., 2014; Cools, Roberts, & Robbins, 2008). Several approaches could be used to accomplish this. For instance, Nelemans, et al. (2018) used a principal covariates regression to include multiple genetic pathways. Another possibility is adopting a genome wide approach by including an individual's genetic characteristics as a whole. Despite the fact that this is an interesting method with great potential (e.g., computing a general genetic sensitivity score), it has the drawback that it will lose some details about specific pathways and their associations. Future research should draw on the strengths of interdisciplinary research teams and studies to adequately tackle complex topics such as gene-environment interaction in order to ensure not only its quality, but also its insightfulness and usefulness.

Whereas previous suggestions for future research were rather mainly directly related to the four chapters in the present dissertation, future research should also aim at including the numerous factors that fall outside the scope of this dissertation. The developmental systems theory by Lerner et al. (2002) suggests several important contexts in which (problem) behavior develops. This dissertation as well as an abundance of earlier research has clearly established the complexity of the interplay in which externalizing problem behavior develops. An important issue for future research will be to include multiple levels of analyses. It is important to keep in mind that the investigation of the development of externalizing problem behavior is not solely for academic purposes, but that it has important practical implications as well.

4. Practical Implications

The findings of the present dissertation can be translated to practical recommendations. For instance, the measurement invariance of the five-factor parenting model established in chapter 1 means that the parenting questionnaire can be an instrument in the assessment of efficacy of parenting programs. Mothers, fathers and adolescents can fill out these questionnaires before and after the program to investigate whether their parenting practices have changed. Since measurement invariance was established across adolescence (i.e., 12 to 18 years of age), this model and related questionnaires can also be used in long term programs. In general, we want to plea for a careful selection of questionnaires in a practical setting. It is crucial that all measures are valid and reliable in order to gain accurate information on the

(perspective of the) individual and his/her environment. Especially regarding topics such as problem behavior in adolescence, it is indispensable to ask about externalizing problem behavior that can be expected for the specific age range in order to ensure that the questionnaire items are adequate for the adolescent's age. The fact that this model adequately represents the perspectives of mothers, fathers, and adolescents provides opportunities to map these different perspectives and use these questionnaires in family-oriented programs.

Besides an important role for parenting practices, chapter 4 and 5 also indicated a significant association between adolescent temperament/personality and externalizing problem behavior. Parenting can be a sensitive topic in the context of adolescent problem behavior and when the focus in programs is exclusively on parenting practices, parents may be less inclined to seek support. Therefore, our findings suggest that family-based approach should be complemented by a focus on adolescent temperament/personality, which can aid the adolescent in getting more insight in his/her behavior. Temperament-based programs, such as INSIGHTS (McClowry, Snow, & Tamis-LeMonda, 2005), have shown to be effective in reducing aggressive behavior, although such programs often focus on young children. Furthermore, there should be invested in psychoeducation addressing the development of externalizing problem behaviors. This can help all the people involved (i.e., adolescent, parents, teachers) understand this complex interplay and show that it is impossible to indicate one causal factor.

Chapter 2 showed evidence of heterogeneity in parenting and, moreover, that subgroups of parents were differentially linked with externalizing problem behavior. This heterogeneity should also be taken into account in parenting programs with so called selective programs. These programs are not offered universally, but only to families selected on certain characteristics (Smedler, Hjern, Wiklund, Anttila, & Petterson, 2015). ParentSteps (Jalling et al., 2016) and Triple P (Sanders, 1999) are examples of such programs. Besides a more tailored approach, these programs also take a family-based approach to reduce externalizing problem behavior. Our findings concerning both mothers and fathers also support a family-based approach (i.e., involve mothers, fathers, and adolescents), since it is highly likely that both parents are involved in the development of the adolescent to some extent. Specifically, we observed that some parenting practices, such as proactive control or maternal psychological control may not show a linear association with externalizing problem behavior. Most studies considered proactive control to be a positive parenting practice, but our findings indicate that there is an optimum and that too much rule-setting and monitoring can turn out adversely. This makes the case for not a priori assuming that a parenting practice predicts positive or negative outcomes, but to focus on how the parenting practice is experienced by the adolescent.

Chapter 3 observed a reciprocal association between adolescent personality and externalizing problem behavior, but also stressed the importance of the role of parenting practices. The fact that parenting remains important even when adolescent personality is taken into account provides strong support for a family-based approach, which is in line with chapter 2. Given the fact that adolescent personality is rather stable across adolescence (De Fruyt et al., 2006), parenting practices may even prove to be a more feasible (initial) target of programs focusing on externalizing problem behavior. Furthermore, chapter 3 also pleas for distinguishing several aspects of behavioral control. The difference in findings concerning the associations involving proactive, punitive, or psychological control suggests that we need this nuance and that the general concept of behavior control may be too general.

Similar to chapter 2 and 3, chapter 4 also provided support for a tailored approach. Specifically, the finding that effortful control and genetic characteristics play a role in the development of externalizing problem behavior stresses the importance of individual differences. It also indicates that some factors, such as genetic characteristics, do play a role but are not possible or feasible targets for prevention or intervention programs. Furthermore, chapter 5 also showed the importance of assessment measures. Using observations or questionnaires to assess parenting practices yields some (small) differences in findings concerning the associations with externalizing problem behavior. Using multiple methods provides a more nuanced image of the topic at hand. It should be noted that not only multiple methods are useful, but also including multiple informants is an added value. Especially concerning sensitive topics such as externalizing problem behavior, the influence of social desirability bias may become too strong.

5. General Conclusion

The present dissertation adds to the literature by examining the interplay of genes, parenting, and personality/temperament characteristics in the development of externalizing problem behavior in adolescence. To this purpose, we used data from multiple informants (i.e., mothers, fathers, and adolescents) across adolescence (i.e., 12 to 18 years of age). To fully exploit the richness of the present data set, we used state-of-the-art statistical techniques (e.g., latent class growth models, random intercept cross-lagged panel models, moderated mediation models). The previous chapters address significant gaps in the existing literature.

First, the present dissertation established measurement invariance of the five-factor parenting model by Janssens et al. (2015) across informants and across adolescence, which means that reports from multiple informants can be meaningfully compared cross-sectional as

well as longitudinal. This is an important finding since it ensures the valid use of the aforementioned parenting model in future research. Second, our findings stressed the importance of taking into account heterogeneity in parenting practices in mothers and fathers separately and showed that this heterogeneity is important in associations with the development of externalizing problem behavior. We distinguished different trajectory classes in parental support, proactive control, punitive control, psychological control, but not harsh punitive control. Furthermore, we found difference between these trajectory classes concerning the development of aggressive and rule-breaking behavior. Third, we found a reciprocal association between personality and problem behavior across early and middle adolescence. Our findings were innovative in showing that parenting, and more specifically parental control, also plays a role in this interplay. This is an important finding in that it highlights the importance of both individual differences and environmental factors in the development of externalizing problem behavior in adolescence. Fourth, we did not found a consistent mediation of adolescent effortful control in the association between parenting and externalizing problem behavior, but we did observe some evidence of moderation of this association by dopaminergic activity. The present dissertation went beyond the widely used candidate gene approach by using a polygenic index score, but it remains difficult, if not impossible, to make conclusive statements about the role of genetic characteristics in the interplay of parenting, adolescent temperament, externalizing problem behavior. This finding does add to the literature by stressing the importance of including several levels of analyses when examining the development of externalizing problem behavior.

To conclude, the present dissertation highlights the need of an extensive approach in the investigation of the development of externalizing problem behavior. Such an approach should comprise individual differences, such as personality, temperament, or genetic characteristics, as well as environmental factors, such as parenting. Besides taking into account several levels of analyses, it is also paramount to pay attention to both normative and idiosyncratic processes in the development of externalizing problem behavior.

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