# CHAPTER 3

## CUMULATIVE EFFECTS OF MOTHERS' RISK AND PROMOTIVE FACTORS ON THEIR DAUGHTERS' DISRUPTIVE BEHAVIOR

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## ABSTRACT

Little is known about the ways in which the accumulation of maternal factors increases or reduces risk for girls' disruptive behavior during preadolescence. In the current study, maternal risk and promotive factors and the severity of girls' disruptive behavior were assessed annually among girls' ages 7-12 in an urban community sample (N = 2043). Maternal risk and promotive factors were operative at different time points in girls' development. Maternal warmth explained variance in girls' disruptive behavior, even after controlling for maternal risk factors and relevant child and neighborhood factors. In addition, findings supported the cumulative hypothesis that the number of risk factors increased the chance on girls' disruptive behavior disorder (DBD), while the number of promotive factors decreased this probability. Daughters of mothers with a history of Conduct Disorder (CD) were exposed to more risk factors and fewer promotive factors compared to daughters of mothers without prior CD. The identification of malleable maternal factors that can serve as targets for intervention has important implications for intergenerational intervention. Cumulative effects show that the focus of prevention efforts should not be on single factors, but on multiple factors associated with girls' disruptive behavior.

## INTRODUCTION

Quality of maternal caregiving plays an important role in the development of children's disruptive behavior. As early development of disruptive behavior is associated with further antisocial development (Moffitt, Caspi, Rutter, & Silva, 2001), childhood is an important period to study the influence of potential malleable factors on child's disruptive behavior. Etiological models have identified several maternal characteristics that increase disruptive behavior in offspring, including maternal lifestyle during pregnancy, maternal psychopathology and parenting practices (Loeber & Stouthamer-Loeber, 1986; Patterson, Reid, & Dishion, 1992; Petitclerc & Tremblay, 2009). Moreover, maternal factors have been suggested to be important for prevention purposes, as they can be used to identify children at risk for disruptive behavior at an early stage (Tremblay, 2010).

Traditionally, the majority of research on childhood disruptive behavior is based on male samples, as this behavior is less prevalent in girls (Bongers, Koot, van der Ende, & Verhulst, 2003). However, recent prospective research on the onset of Conduct Disorder (CD) in girls shows that CD symptoms incrementally increase from childhood to adolescence, providing evidence for the existence of a childhood onset rather than a pure adolescence onset (Keenan, Wroblewski, Hipwell, Loeber, & Stouthamer-Loeber, 2010). In this study, we aim to test the role of maternal characteristics on daughters' disruptive behavior in middle childhood (thus, at a relatively early age), while taking account of mother's multiple risk factors and factors promoting resilience, using data from a prospective longitudinal study of young girls.

Adverse maternal characteristics may impinge on childhood disruptive behavior at different points in development. For example, mothers' nicotine and alcohol use during pregnancy is associated with offspring's development of disruptive behavior by altering fetal brain development (Wakschlag, Pickett, Kasza, & Loeber, 2006). Maternal psychopathology can affect child development at the start of pregnancy through gene processes by the inheritance of specific temperamental characteristics and, as children grow older, by child's exposure to environmental adversity, such as exposure to less supportive and consistent parenting (Blatt-Eisengart, Drabick, Monahan, & Steinberg, 2009; Herndon & Iacono, 2005). Overall, maternal parenting styles tend to have an impact on offspring behavior from birth onwards. Both positive parenting behavior, such as maternal warmth, and negative parenting behavior, such as inconsistent discipline, are associated with disruptive behavior in offspring (Patrick, Snyder, Schrepferman, & Snyder, 2005; Snyder, Cramer, Afrank, & Patterson, 2005). Although the current study does not use a genetically informative design, we think it is significant to expand understanding of maternal characteristics that may affect girls' disruptive behavior at different points in development, because this knowledge can be incorporated in primary prevention programs, and used to identify girls in families at risk at an early stage.

Current research on the development of girls' disruptive behavior is focused, almost without exception, on risk factors, defined as factors that increase the probability of disruptive behavior, while protective and promotive factors associated with positive behaviors are often neglected (but see Hawkins, Graham, Williams, & Zahn, 2009). Protective factors can be seen as a subcategory of promotive factors that differ from promotive factors by way of reducing or neutralizing the impact of specific risk factors. In contrast, promotive factors have a main effect that decreases the probability of disruptive behavior, irrespective of particular risk factors (Farrington, Loeber, Joliffe, & Pardini, 2008; Loeber, Slot & Stouthamer-Loeber, 2006; Lösel & Bender, 2003). Past research has demonstrated main effects for various promotive factors, such as high academic achievement, older mother at age of first birth, and good relations with parents and peers, on a low probability of delinquent behavior in boys (for details see, Farrington et al., 2008; Luthar, Cicchetti, & Becker, 2000; Stouthamer-Loeber, Loeber, Wei, Farrington, & Wikström, 2002; van der Laan, Veenstra, Bogaerts, Verhulst, & Ormel, 2010). In comparison, empirical studies of promotive effects on girls' disruptive behavior are rare. The present paper begins to fill this gap by investigating both risk and promotive effects of maternal factors on girls' disruptive behavior.

Generally, studies examine risk factors with the aim of identifying unique effects while controlling for other risks (Appleyard, Egeland, Van Dulmen, & Sroufe, 2005). However, adverse maternal characteristics and parenting difficulties tend to cluster and it is likely that multiple, rather then single factors best explain risk for girls' disruptive behavior. The cumulative risk hypothesis suggests that the most detrimental effects on the child are caused when risk factors accumulate (Rutter, 1979; Sameroff, 1998; 2000). Previously cumulative risk studies demonstrated strong effects on disruptive behavior (e.g., Farrington et al., 2008; Loeber et al., 2006) and this applied to each gender (Appleyard et al., 2005; Deater-Deckard, Dodge, Bates, & Petit, 1998). Nevertheless, few studies have addressed the impact of cumulative maternal risk factors on girls' disruptive behavior. (Kroneman, Loeber, Hipwell, & Koot, 2009) Moreover, we are not aware of cumulative maternal risk studies on girls' disruptive behavior which also considered promotive factors. This is important because their potential ability to counterbalance the impact of risk factors.

Maternal factors operate early in life and many of them remain effective during childhood (Tremblay, 2010). Of course, maternal characteristics explain a major, but not the only role in child's development. Studies from a social-ecological perspective suggest that beyond the early years, accumulation of risk and promotive factors of other contexts, such as peer and neighborhood influences, increasingly exert influence on child's behavior. (Bronfenbrenner, 1979; Loeber et al., 2006; van der Laan et al., 2010). Therefore, we will also account for relevant non-maternal factors (e.g., child's academic achievement, peer delinquency, disadvantaged neighborhood) that may exert influence on girls' disruptive behavior.

In the context of multiple maternal risk, we will focus specifically on the subgroup of adult women who had childhood CD, because this category of women often have multiple impairments which tend to gradually emerge over time, such as low educational attainment, substance dependence, criminal charges, young age at first birth, and adverse parenting skills (Olino, Seeley, & Lewinsohn, 2010; Pajer, 1998). These characteristics are themselves, all known maternal predictors of children's disruptive behavior. Therefore, in addition to a putative genetic heritability (Bornovalova, Hicks, Iancono, & McGue, 2010; van den Oord, Verhulst, & Boomsma, 1996), daughters of mothers with a history of CD may be exposed to a higher quantity of adverse environmental influences. This will put them at increased risk to develop disruptive behavior, compared to daughters of mothers with no childhood CD. Moreover, besides accumulated risk factors, mothers with a history of CD may have had limited access to non-deviant opportunities (Caspi & Moffitt, 1995), such as high educational attainment or an advantaged socioeconomic context, which may also mean that a child is exposed to fewer promotive factors. To expand our understanding on cumulative effects on girls' disruptive behavior, we will compare daughters of mothers with and without a history of CD in terms of their exposure to risk and promotive factors.

In summary, few studies have addressed mothers' cumulative risk and promotive effects on the development of daughters' disruptive behavior. Next to existing studies on unique risk factors, it may provide important additive knowledge for prevention and intervention to learn whether accumulated maternal factors impinge on girls' disruptive behavior. Therefore the first aim of this study is to determine which maternal predictors operate as risk factors, as promotive factors or as both, in the prediction of young girls' disruptive behavior. We have selected maternal factors that operate at different points in development. The second aim is to determine the most important independent maternal promotive and risk factors for girls' disruptive behavior over time. As a stringent test, we will account for relevant child, peer and neighborhood factors. Third, we will investigate whether the cumulative effects of maternal predictors relate to an increased likelihood of daughters' disruptive behavior disorder. Therefore we will test dose-response relationships between: a) the number of risk factors and the probability of girls' DBD; and b) the number of promotive factors and the probability of girls' DBD. Our final aim is to determine whether daughters' of mothers with childhood CD are differentially exposed to levels of promotive and risk effects compared to daughters' of mothers without prior CD.

## METHODS

### Participants

Participants were girls in the Pittsburgh Girls Study (PGS), an ongoing longitudinal study on 2451 inner city girls who were recruited into the study between 1999-2000 by means of a city-wide survey of 103,238 households. Disadvantaged neighborhoods were oversampled

to increase the likely prevalence of girls' externalizing behavior. The PGS sample consists of four age cohorts: 5 (wave 1 N = 588), 6 (N = 630), 7 (N = 611) and 8 (N = 622). Follow-up assessments occur yearly and information is gathered using child, primary caregiver and teacher reports (for further details, see Hipwell et al., 2002; Keenan et al., 2010).

For this study we used data from annual assessment waves 1 to 8 spanning girls' ages 7 to 12 years. The total N at age 7 differed from ages 8-12 due to the accelerated longitudinal design comprising three cohorts compared to four cohorts at the other ages (see Figure 1).

**Figure 1.** Design of current study (restricted to biological mothers) by age, age blocks and wave.

| Assessment wave | Age | | | | | |
|---|---|---|---|---|---|---|
| | Block 7-8 | | Block 9-10 | | Block 11-12 | |
| | 7 | 8 | 9 | 10 | 11 | 12 |
| 1 | Cohort7 | Cohort 8 | | | | |
| 2 | Cohort 6 | Cohort 7 | Cohort 8 | | | |
| 3 | Cohort 5 | Cohort 6 | Cohort 7 | Cohort 8 | | |
| 4 | | Cohort 5 | Cohort 6 | Cohort 7 | Cohort 8 | |
| 5 | | | Cohort 5 | Cohort 6 | Cohort 7 | Cohort 8 |
| 6 | | | | Cohort 5 | Cohort 6 | Cohort 7 |
| 7 | | | | | Cohort 5 | Cohort 6 |
| 8 | | | | | | Cohort 5 |
| N | 1551 | 2043 | 1999 | 1972 | 1934 | 1909 |

Retention rates ranged from 95.6% at age 7 to 91.2% at age 12, reflecting very low attrition. Because of our focus on maternal characteristics, we restricted analyses to the data of the girls whose reported caregiver was the biological mother (participation was 85.6% at age 7). The majority of girls were African American (53.0%) and 41.2% were European American. The mean age at first birth of the mothers was 22.3 years (SE = 5.9). At girls' age 7, 51.8% of the mothers had received more than 12 years of education, 41% were single mothers, and about 40% of the families were receiving public assistance. There were no differences between girls of biological mothers compared to girls of other caregivers on parental education level ($\chi^2 = 0.29$, df = 1, $p = .59$), single parenthood ($\chi^2$ (1) = 0.16, $p = .69$), minority race distribution ($\chi^2(1) = 2.66$, $p = .10$) and girls' disruptive behavior score ($t = 1.09$, df = 1780, $p = .28$). Biological mothers however, were more likely to receive welfare (34.5%) than were other types of primary caregivers (3.9%; $\chi^2(1) = 8.13$, $p < 0.01$). Cohort 8 showed the same pattern at girls' age 8.

## Procedure

All study procedures were approved by the University of Pittsburgh Institutional Review Board. Informed consent from the caregiver and verbal assent from the child were obtained prior to data collection. Interviews were conducted separately at home with mother and daughter by trained interviewers and lasted about 2-3 hours each. The participants were reimbursed for their involvement in the study.

## Measures

To reduce the problems of shared method variance, we used maternal reports of girls' disruptive behavior, but girls' reports of most of the mothers' parenting practices. However, maternal reports on consistency in discipline and emotional warmth were used, because girls reported on these questions only at older ages in the study.

*Girls' disruptive behavior.* Mothers reported yearly on items from the Child Symptom Inventory-4 (CSI-4; Gadow & Sprafkin, 1994) that assessed Diagnostic and Statistical Manual of Mental Disorders – fourth edition (DSM-IV; American Psychiatric Association, 1994) symptoms of Oppositional Defiant Disorder (ODD) and CD. Each symptom was scored on a 4-point scale and ranged from 0 (never) to 3 (all the time). All eight DSM-IV ODD items were assessed. In waves 1-3, two CD symptoms (truancy and running away) were not assessed because they were not deemed age appropriate. These two items were treated as if they were not present (score = 0). From wave 4 onwards, all 15 DSM-IV CD symptoms were assessed. Because prior analyses showed that CD and ODD load onto the same factor in preadolescent girls (Loeber et al., 2009), we created a total disruptive behavior score by summing all ODD and CD symptoms scores. Cronbach's $\alpha$ ranged from 0.85 at age 7 to 0.87 at age 12.

*Maternal psychopathology* was assessed using several measures. Mothers responded retrospectively on their conduct problems prior to age 15 in PGS assessment wave 3, using the Structured Clinical Interview for DSM-III-R, Conduct Disorder (SCID-CD; First, Spitzer, Gibbon, & Williams, 1996). A total score was created by summing all 15 CD symptoms. A proxy for *maternal CD* was created using 3 symptoms as a cut-off point, the necessary number for a diagnosis specified by DSM-IV (American Psychiatric Association, 1994). Cronbach's $\alpha$ was 0.79. The presence and intensity of *maternal depression* over the past two weeks was measured each year using the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996). The scale included 21 items on a 4-point scale ranging from 0 (absent) to 3 (severe) and were summed to a total score. Cronbach's $\alpha$ ranged 0.92 at age 7 to 0.93 at age 12. Mothers' current alcohol use was assessed yearly with the Alcohol Use Disorders Identification Test (AUDIT; Babor, de la Fuente, Saunders, & Grant, 1992). The scale included 10 items (e.g., 'Have you or someone else been injured as a result of your drinking?') scored on 4-point scales. Higher scores on the sum of these items indicated more severe alcohol problems. Cronbach's $\alpha$ ranged 0.72 at age 12 to 0.75 at age 11. Frequency of parental *drug*

*use* (marijuana, cocaine, stimulants, sedative-hypnotics, opioids and hallucinogens) during the past year was assessed using a sum of six items scored on 5-point scales ranging from 0 (never) to 4 (4 or more times a week/daily) of the Parent Substance Use Inventory (SUI; White, Hipwell, & Mizelle, 2002). Due to a negatively skewed distribution, the data were reduced to a binary variable indicating the use of any drugs. Both alcohol and drug use were assessed only from wave 3 onwards. As a result, analyses on these variables were executed on smaller Ns at ages 7-9: age 7 (N = 490), 8 (N = 1008) and 9 (N = 1494), but on regular Ns at ages 10-12.

*Parenting practices* were also assessed with several measures. *Positive parenting* was measured yearly by girls reporting on the Positive Parenting Scale (PPS; Loeber, Farrington, Stouthamer-Loeber, & van Kammen, 1998). Following the introductory stem: 'When you have done something your mother likes…', the girl rated the frequency of seven affirming and encouraging maternal behaviors (e.g., 'your mother gives you a hug', 'says something nice'). Frequency was assessed on 3-point scales 1 (almost never) to 3 (a lot). Cronbach's $\alpha$ ranged from 0.65 at age 7 to 0.81 at age 12. *Harsh punishment* was assessed each year using girls' report on the Conflicts Tactics Scale: Parent-Child version (CTSPC; Straus, Hamby, Finkelhor, Moore, & Runyan, 1998). The construct was created by combining 5 items of the Psychological Aggression subscale (e.g., 'when you do something that you are not allowed to, how often does your mother scream or yell?') and a single item on spanking. All 6 items were scored on a 3-point scale ranging from 1 (never) to 3 (often). Cronbach's $\alpha$ ranged from 0.71 at age 8 to 0.75 at age 12. *Discipline* was measured each year by maternal report on the Discipline Scale (Loeber et al., 1998). The scale assessed the degree to which the mother was persistent and consistent in disciplining her daughter using 4 questions (e.g., 'If a punishment has been decided upon, can your daughter change it by explanations, arguments, or excuses?') scored on 3-point scales ranging from 0 (almost never) to 2 (almost always). Cronbach's $\alpha$ ranged from 0.61 at age 7 to $\alpha$ = 0.64 at age 10. *Low maternal warmth* was measured each year via maternal report on the Parent-Child Relationship Scale (PCRS; Loeber et al., 1998) using six questions (e.g., 'how often have you thought your daughter was a difficult child?') scored on 3-point scales ranging from 1 (almost never) to 3 (often). Cronbach's $\alpha$ ranged from 0.70 at age 7 to $\alpha$ = 0.76 at age 12.

We included a number of covariates concerning the family, child, peer and neighborhood domains in the analyses, because they are also indicative of children's disruptive behavior (e.g., Loeber et al., 2006). Mothers reported on the following maternal and family characteristics: *maternal age at first child* (assessed only in PGS wave 2), *maternal educational level* (total years of education), *single mothe*r (yes/no), *welfare* (yes/no receipt of public assistance) and *family size* (total amount of children under 18 years old, other than the girl herself) each assessed annually. In addition, mothers reported on *alcohol* (0/week, 1-2/week, >2/week) *and nicotine use* (0 /day, 1-2/day, or >2 a day) *during the pregnancy* of the participating girl,

using the Pre- and Perinatal Risk Factors scale (PPRF; Keenan, & Stouthamer-Loeber, 2000) in PGS wave 2. *Girls' academic achievement* was assessed each year by mothers' evaluation on the following four items on a 4-point scale: reading, math, writing and spelling. Cronbach's $\alpha$ ranged from 0.84 at age 10 to 0.88 at age 12. *Peer delinquency* was measured yearly by girls' report on participation of friends engaging in various deviant behaviors (e.g., shoplifting, vandalism) in the last six months using the Peer Delinquency Scale (Loeber et al., 1998). The number of deviant behaviors in which there was peer involvement was summed to generate a total peer delinquency score. Cronbach's $\alpha$ ranged from 0.86 at age 10 to 0.88 at age 7. *Neighborhood impression* was measured by maternal perceptions of neighborhood features, using the 17-item Your Neighborhood questionnaire, developed by the institute of Behavioral Science, Boulder, Colorado, and previously used in the Pittsburgh Youth Study (Loeber et al., 1998). Neighborhood characteristics (e.g., vandalism, gang activity, presence of prostitutes, or drug dealers) were rated on 3-point scales from 1 (not a problem) to 3 (a big problem). Cronbach's $\alpha$ ranged from 0.94 at age 7 to 0.96 at age 11.

## Statistical analyses

We conducted analyses in four steps. First, we used an empirically based method to establish which potential maternal predictors had risk, promotive or both risk and promotive effects. To facilitate analyses for subsequent steps, we also examined the effects of non-maternal factors. This method is well described in previous research (e.g., Farrington et al., 2008; Stouthamer-Loeber et al., 2002). The independent variables were trichotimized as closely as possible at the 25$^{th}$ and 75$^{th}$ percentiles to create potentially promotive, neutral, and risk categories. Chi-square tests were used to establish which variables significantly acted as a risk predictor for girls' disruptive behavior, by comparing individuals in the risk range (highest 25%) to individuals in the neutral range (middle 50%, between 25$^{th}$ and 75$^{th}$%). To establish this for promotive effects, individuals in the promotive range (lowest 25%) were compared to those in the neutral range. Variables that could only be examined dichotomously (e.g., receipt or otherwise of welfare) were labeled risk factors. Three age blocks were created (Figure 1) to facilitate analyses to detect possible differences during the examined age period. Data on potential predictors and girls' disruptive behavior were summarized over two subsequent ages (i.e., ages 7 and 8, 9 and 10, and 11 and 12) to enable comparisons between early childhood effects (factors at girls' age 7-8 predicting girls' disruptive behavior at age 9-10) and late childhood effects (factors at girls' age 9-10 predicting girls' disruptive behavior at age 11-12). Univariate logistic regression analyses were performed to examine the strength of effects of the identified risk and promotive predictors by calculating odds ratios (ORs). To optimize the use of all data points, promotive and risk predictors were entered as binary variables in analyses, contrasting the highest 25% to the other 75% (instead of 25% contrasting with the middle 50%, used for the determination of risk and promotive effects).

Second, we distinguished the strongest independent maternal promotive and risk predictors across ages 7-12 using generalized estimating equation (GEE; Zeger, & Liang, 1986) regression analyses. For these analyses, data across the ages 7 to 12 was merged. GEE analyses were used in order to account for autocorrelations between data points and to permit the analysis of multiple, successive waves of independent and dependent variables. Incidence rate ratios (IRR's) were calculated, defined as the amount of change in girls' disruptive behavior across ages 7- 12 per unit change in a predictor. A time-lagged model was used in which independent variables (including prior girls' disruptive behavior) were lagged by one year (T-1) in relation to the dependent variable assessed at time T (Twisk, 2003). At least 80% of the repeated measurements of the dependent variable needed to be present and reported by the biological mother within each subject, to be included in analyses (8.8% was excluded because of this criterion). To examine whether maternal promotive factors remained independently predictive in the presence of maternal risk effects, a block with control variables (cohort and girls' disruptive behavior T-1) and maternal promotive predictors was entered first, followed by a block with maternal risk predictors. Next, child, peer and neighborhood promotive and risk factors were added to the model to provide a stringent test of the examined maternal factors. Because we were specifically interested in girls of mothers with childhood conduct problems, maternal CD was entered into the model in the last step.

Third, we examined dose-response relationships for risk factors and promotive factors to test their cumulative effects with girls' disruptive behavior. Because a dichotomous outcome is needed for these analyses, we used the CSI-4 cutoff score (Gadow & Sprafkin, 1994) indicating clinical Disruptive Behavior Disorders (DBD; no ODD or CD = 0, ODD or CD = 1). Total risk and promotive scores were plotted to examine whether the likelihood of girls' DBD increased when the number of risk factors increased, and decreased when the number of promotive factors increased. An overall promotive-risk effect was calculated, after assigning -1 to promotive factors and 1 to risk factors, to test whether the sum of promotive and risk factors incrementally predicted girls' DBD. Analyses were performed on all significant factors detected in this study (including maternal, child, peer and neighborhood factors) and repeated for maternal factors only, to investigate whether patterns were parallel to each other. To indicate the accuracy of the cumulative predictions the area under the curves (AUC) of receiver operating curves (ROC) were calculated (maximum value of AUC = 1 and the chance value is 0.5). Finally, to examine whether daughter of mothers with childhood CD are exposed to a different degree of risk and promotive effects, we compared mean accumulation scores to daughters of mothers with no childhood CD.

Because of the multiple tests conducted, we selected $p < .01$ rather than $p < .05$ to indicate statistical significance. Variables with the lowest $\beta$ were excluded from the multivariate GEE analyses, when the number of significant findings in the bivariate analysis was above 10%

of the sample size (the maximum number of variables that can be reliably entered into a regression analysis). Predictors were tested for multicollinearity, which proved not to be a problem. For all analyses using logistic regression, we used SPSS version 16.0 (2007). For the GEE analyses, we used STATA software (version 11, StataCorp, 2009).

## RESULTS

Table 1 shows the results of determining the risk or promotive effect of maternal and non-maternal (family, child, peer and neighborhood) variables. Of the 18 potential predictors, 6 had both risk and promotive effects (e.g., maternal depression, family size), indicating that high scores on these factors increased girls' disruptive behavior while low scores reduced the girls' disruptive behavior. Note that for ease of explanation, we will refer to maternal warmth when low maternal warmth is low or absent. Maternal alcohol use, harsh punishment, maternal education, and girls' academic achievement had only risk effects, indicating that high scores on these factors are related to an increase in girls' disruptive behavior. Positive parenting and maternal age at first birth had no risk or promotive effects and were not included in further analyses. Six variables were dichotomous (illegal substance use, prenatal nicotine use, prenatal alcohol use, girls' race, single mother, and welfare,) and were therefore categorized as risk factors. Most of the 16 risk effects predicted girls' disruptive behavior consistently across early childhood (predictors at ages 7-8 to girls' disruptive behavior at ages 9-10) and later childhood effects (predictors at age 9-10 to girls' disruptive behavior at ages 11-12), except for inconsistent discipline ($\beta$ = 1.09, 95$^{th}$ CI = 0.65 – 1.53) and girls' peer delinquency ($\beta$ = 0.98, 95$^{th}$ CI = 0.51 – 1.44) which only had later risk effects. Girls' race and single motherhood failed to reach significance for early or late childhood effects of girls' disruptive behavior. Four of the six promotive effects (i.e., low maternal depression, low maternal warmth, consistent discipline, and mothers' positive neighborhood impression) were consistent across both age blocks. Early promotive effects were found for no delinquent friends ($\beta$ =- 0.73, 95$^{th}$ CI = -1.18 – -0.28) and small family size ($\beta$ =- 1.39, 95$^{th}$ CI = -1.95 - 0.83).

Next, in order to determine the most important independent maternal risk and promotive factors for girls' disruptive behavior over time, we selected the significant predictors from across early and later childhood effects, and data were analyzed using a hierarchical multivariate GEE model (Table 2). First, maternal promotive factors were entered, with cohort and earlier disruptive behavior (T-1) included in the base model. The results of the GEE analyses showed that the maternal promotive factors, except consistent discipline, independently predicted daughters' disruptive behavior. Thus low maternal depression (IRR = 0.94, $p < .001$) and maternal warmth (IRR = 0.76, $p < .001$) at time T-1, were associated with an increase of girls' disruptive behavior at time T.

**Table 1.** Risk and Promotive Predictors of Girls' Disruptive Behavior.

| | Predictors at age 7-8 to girls' disruptive behavior at ages 9-10 | | | Predictors at age 9-10 to girls' disruptive behavior at ages 11-12 | | |
|---|---|---|---|---|---|---|
| | *B* | SE | 95% C.I. | *B* | SE | 95% C.I. |
| **Maternal risk** | | | | | | |
| High depression | 2.48*** | 0.23 | (2.03, 2.92) | 2.64*** | 0.23 | (2.20, 3.09) |
| High alcohol use | 1.76*** | 0.33 | (1.11, 2.40) | 1.03*** | 0.24 | (0.56, 1.51) |
| Illegal substance use | 1.23***. | 0.38 | (0.50, 1.97) | 1.67***. | 0.27 | (1.15, 2.20) |
| Low maternal warmth | 4.37*** | 0.21 | (3.96, 4.78) | 4.96*** | 0.21 | (4.54, 5.38) |
| Harsh punishment | 0.86*** | 0.24 | (0.39, 1.32) | 1.50*** | 0.23 | (1.05, 1.95) |
| Inconsistent discipline | - | - | - | 1.09*** | 0.22 | (0.65, 1.53) |
| Low maternal education | 1.15*** | 0.27 | (0.63, 1.67) | 1.48*** | 0.28 | (0.93, 2.02) |
| Prenatal nicotine use | 1.30*** | 0.22 | (0.88, 1.73) | 1.31*** | 0.22 | (0.88, 1.74) |
| Prenatal alcohol use | 1.49*** | 0.38 | (0.74, 2.24) | 1.39*** | 0.39 | (0.63, 2.15) |
| **Non maternal risk** | | | | | | |
| Girls minority race | n.s. | | | n.s. | | |
| Girls' low academic achievement | 1.37*** | 0.23 | (0.92, 1.81) | 1.82*** | 0.23 | (1.37, 2.26) |
| High peer delinquency | - | - | - | 0.98*** | 0.24 | (0.51, 1.44) |
| Single mother | n.s. | | | n.s. | | |
| Welfare | 1.05*** | 0.20 | (0.65, 1.44) | 1.18*** | 0.20 | (0.79, 1.58) |
| Large family size | 1.12*** | 0.23 | (0.67, 1.57) | 1.12*** | 0.24 | (0.65, 1.59) |
| Bad neighborhood impression | 1.23*** | 0.23 | (0.78, 1.68) | 1.13*** | 0.24 | (0.67, 1.60) |
| **Maternal promotive** | | | | | | |
| Low depression | -1.99*** | 0.23 | (-2.44, -1.54) | -2.07*** | 0.24 | (-2.53, -1.61) |
| Maternal warmth | -3.24*** | 0.23 | (-3.69, -2.78) | -3.87*** | 0.22 | (-4.30, -3.45) |
| Consistent discipline | -1.12*** | 0.24 | (-1.60, -0.64) | -1.20*** | 0.25 | (-1.68, -0.72) |
| Non maternal promotive | | | | | | |
| No delinquent friends | -0.73** | 0.23 | (-1.18, -0.28) | - | - | - |
| Small family size | -1.39*** | 0.29 | (-1.95, -0.83) | - | - | - |
| Positive neighborhood impression | -1.11*** | 0.24 | (-1.58, -0.64) | -0.99*** | 0.24 | (-1.46, -0.53) |

*Note.* The following age blocks were examined: age 7-8, age 9-10, age 11-12. ** $p < .01$, *** $p < .001$

**Table 2.** Multivariate GEE Model of Girls' Disruptive Behavior combining Risk and Promotive Maternal Predictors.

| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
|---|---|---|---|---|---|---|---|---|
| **Predictors** | **IRR** | **95% CI** | **IRR** | **95% CI** | **IRR** | **95% CI** | **IRR** | **95% CI** |
| Cohort[b] | 1.00 | (0.99, 1.01) | 1.01 | (0.99, 1.02) | 1.00 | (0.99, 1.02) | 1.00 | (0.99, 1.02) |
| Girls' disruptive behavior T-1[b] | 1.10*** | (1.10, 1,11) | 1.10*** | (1.09, 1.10) | 1.10*** | (1.09, 1.10) | 1.10*** | (1.09, 1.10) |
| **Maternal promotive** | | | | | | | | |
| Low depression | 0.94*** | (0.91, 0.97) | 0.95 | (0.91, 0.99) | 0.94 | (0.91, 0.99) | 0.95 | (0.91, 0.99) |
| Maternal warmth | 0.76*** | (0.74, 0.79) | 0.79*** | (0.76, 0.83) | 0.79*** | (0.76, 0.83) | 0.79*** | (0.75, 0.82) |
| Consistent discipline | 0.96 | (0.93,.1.00) | 0.98 | (0.94, 1.02) | 0.98 | (0.94, 1.02) | 0.98 | (0.94, 1.02) |
| **Adding maternal risk** | | | | | | | | |
| High depression | | | 1.03 | (1.00, 1.07) | 1.04 | (1.00, 1.08) | 1.04 | (1.00, 1.08) |
| High alcohol use | | | 1.01 | (0.97, 1.05) | 1.01 | (0.97, 1.05) | 1.01 | (0.97, 1.04) |
| Illegal substance use | | | 1.03 | (0.98, 1.08) | 1.03 | (0.98, 1.08) | 1.02 | (0.97, 1.07) |
| Low maternal warmth | | | 1.08*** | (1.04, 1.12) | 1.08*** | (1.04, 1.12) | 1.07*** | (1.04, 1.11) |
| Harsh punishment | | | 1.03 | (0.97, 1.06) | 1.03 | (0.99, 1.07) | 1.03 | (0.99, 1.06) |
| Low maternal education | | | 1.01 | (0.97, 1.06) | 1.01 | (0.96, 1.05) | 0.99 | (0.95, 1.04) |
| Prenatal nicotine use | | | 1.08*** | (1.04, 1.12) | 1.08*** | (1.04, 1.12) | 1.07*** | (1.03, 1.11) |
| Prenatal alcohol use | | | 1.01 | (0.95, 1.07) | 1.00 | (0.94, 1.06) | 1.03 | (0.99, 1.06) |
| **Adding non-maternal** | | | | | | | | |
| Positive neighborhood impression | | | | | 1.00 | (0.96, 1.04) | 1.00 | (0.96, 1.04) |
| Large family size | | | | | 1.03 | (0.99, 1.07) | 1.03 | (0.99, 1.07) |
| Welfare | | | | | 0.98 | (0.94, 1.02) | 0.97 | (0.93, 1.01) |
| Girls' low academic achievement | | | | | 1.06*** | (1.02, 1.10) | 1.07*** | (1.03, 1.10) |
| Bad neighborhood impression | | | | | 1.01 | (0.97, 1.05) | 1.01 | (0.97, 1.05) |
| **Adding maternal CD** | | | | | | | 1.09*** | (1.05, 1.14) |

*Note*. Base model includes cohort and girls' disruptive behavior at T-1. [a] IRR represent the amount of change in girls' disruptive behavior across ages 7-12 per unit change in maternal factor. ** $p < .01$, ***$p < .001$.

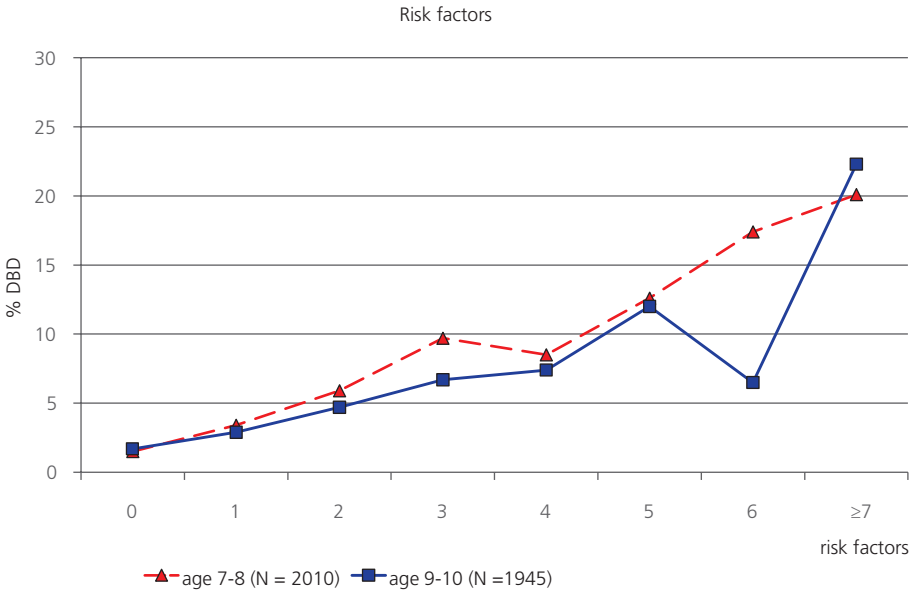
In the second step, we entered maternal risk factors to the equation. Low warmth (IRR = 1.08, $p < .001$), and prenatal nicotine use (IRR = 1.08, $p < .001$) showed independent risk effects. Prior promotive effect maternal warmth remained significant, but not low depression that was counteracted by adding maternal risk effects. For a stringent test of these effects, non-maternal factors were then added to the model. Results demonstrated that of these non-maternal factors, girls' low academic achievement (IRR = 1.06, $p < .001$) predicted higher disruptive behavior in the following year. Prior maternal risk and promotive effects remained significant.

Finally, maternal CD was entered into the model to examine whether it had had an independent effect on girls' disruptive behavior, even when other maternal and non-maternal factors were taken into account. Maternal CD added significantly to the model (IRR = 1.09, $p < .001$). Prior promotive and risk factors remained significant. This indicates that after controlling for girls' disruptive behavior at time T-1, girls' disruptive behavior between age 7 and 12 was negatively associated with maternal warmth, but positively predicted by low maternal warmth, prenatal nicotine use, girls' low academic achievement and maternal CD.

To test the third question, we analyzed cumulative effects of risk and promotive factors on girls' DBD (both at age 9-10 and 11-12 = 8.5%) using dose-response curves. Figure 2 shows that the higher the number of risk factors, the higher the likelihood of girls' DBD, for both the early and later childhood effects. Receiver operating curves (ROC) analyses of this dose-response relationship showed comparable predictive accuracy for both age blocks ($AUC^{7\text{-}8} = .69$, $p < .001$, $AUC^{9\text{-}10} = .72$, $p < .001$). Accumulation of promotive factors lowered probabilities of girls' DBD. Again, the predictive accuracy showed similar results for both dose-response curves ($AUC^{7\text{-}8} = .67$, $p < .001$, $AUC^{9\text{-}10} = .66$, $p < .001$). Note that for these analyzes of promotive factors, the presence of girls' DBD was inverted (from 0 to 1 and vice versa), to facilitate comparisons with the ROC values of risk factors.

To produce a net scale, promotive factors were given a weighting of -1 and risk factors of +1. The probability of girls' DBD accelerated when the sum of promotive factors (negatively scored) and risk factors increased ($AUC^{7\text{-}8} = .71$, $p < .001$, $AUC^{9\text{-}10} = .72$, $p < .001$). Results of the analyses that were limited to maternal factors only, showed a similar pattern for risk factors ($AUC^{7\text{-}8} = .70$, $p < .001$, $AUC^{9\text{-}10} = .72$, $p < .001$), promotive factors ($AUC^{7\text{-}8} = .66$, $p < .001$, $AUC^{9\text{-}10} = .66$, $p < .001$) and the net scale of risk minus promotive factors ($AUC^{7\text{-}8} = .72$, $p < .001$, $AUC^{9\text{-}10} = .73$, $p < .001$).

**Figure 2.** Accumulation of risk and promotive factor and sum (- promotive + risk) predicting girls' disruptive behavior disorder



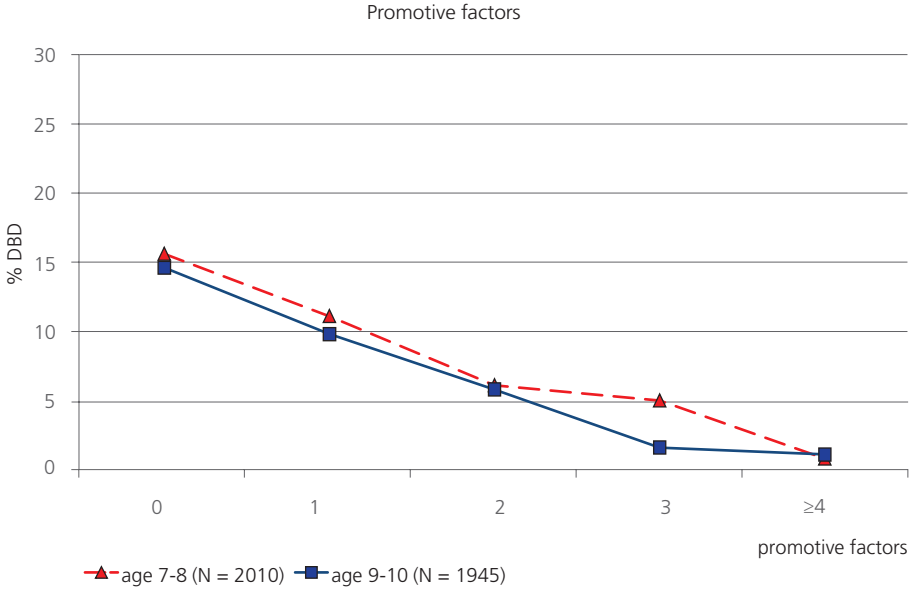
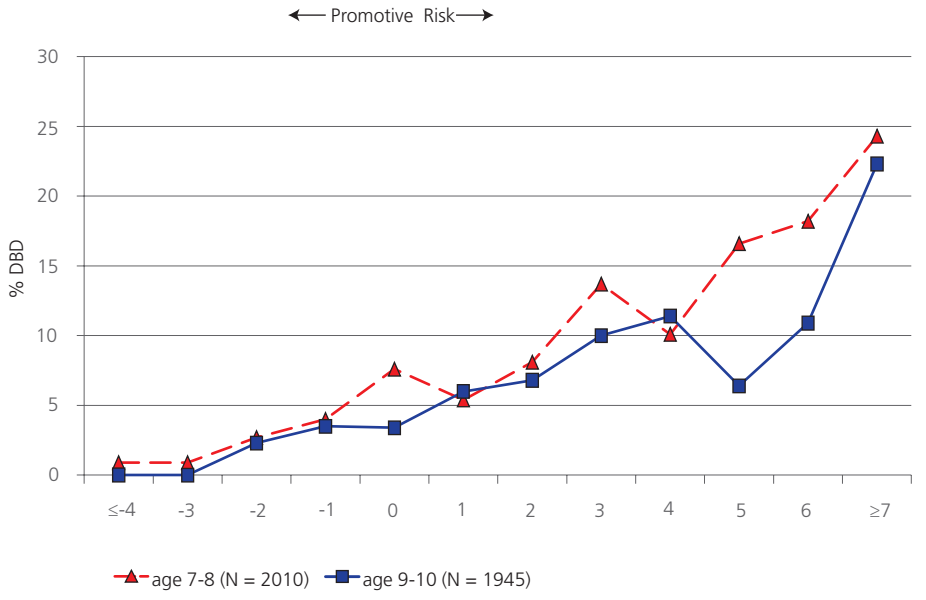



**Figure 2.** Accumulation of risk and promotive factor and sum (- promotive + risk) predicting girls' disruptive behavior disorder *(Continued)*




*Note.* Accumulation effects restricted to maternal factors yield similar patterns of results

Finally, we examined whether daughters of mothers with childhood CD (age 7-8 = 21.7%, N = 428, age 9-10: 21.7%, N = 416) were differentially exposed (Table 3) to early and later promotive and risk effects compared to mothers with no prior CD. For these analyses, we examined maternal factors separately from non-maternal factors. Compared to daughters of mothers with no prior CD, girls of mothers with a history of CD were exposed to fewer promotive maternal ($t^{7\text{-}8}$ = 7.96, df = 1974, $p < .001$ and $t^{9\text{-}10}$= 7.25, df = 1916, p < .001), and non-maternal factors ($t^{7\text{-}8}$ = 5.44, df = 1974, p < .001 and $t^{9\text{-}10}$= 6.39, df = 1911, p < .001), and more risk maternal (respectively $t^{7\text{-}8}$= -11.94, df = 1973, $p < .001$ and $t^{9\text{-}10}$= -13.29, df = 1914, $p < .001$), and non-maternal factors (respectively $t^{7\text{-}8}$= -9.20 , df = 1972, $p < .001$ and $t^{9\text{-}10}$= -9.46, df = 1915, $p < .001$). There were no differences in significance between the results for early and late childhood effects. Thus, daughters of mother with childhood CD were exposed to more risk factors as well as fewer promotive factors compared to daughters of mothers with no history of CD.

## DISCUSSION

The aim of this study was to examine the impact of maternal characteristics on subsequent disruptive behavior among young girls. We extended existing work on girls' disruptive behavior by focusing on cumulative maternal risk and promotive effects in a large sample of girls, using a prospective longitudinal design. In line with recent research (van der Laan et al., 2010; Stouthamer-Loeber et al., 2002), most of the maternal factors had both risk and promotive effects (e.g., maternal depression, discipline), whereas some factors had either risk or promotive effects (e.g., high alcohol use, harsh punishment). These results confirm the notion that both risk and promotive factors have main effects, as certain promotive factors were associated with better outcomes, irrespective of risk (Luthar et al., 2000).

Findings are consistent with prior research on maternal predictors of childhood disruptive behavior (Tremblay, 2010), in that some of the maternal factors are operative early in life and effects tend to persist over time (e.g., prenatal nicotine use, maternal childhood CD), while other factors will have their impact later (e.g., maternal alcohol use, harsh punishment). This corroborates the importance of variance of timing of maternal predictors on girls' disruptive behavior. There was little variation in the effects of non-maternal factors across the studied time frame. To examine whether the importance of specific contexts increase or decease in their influence on girls' disruptive behavior (Bronfenbrenner, 1979), a larger time frame may need to be studied including girls' adolescence age.

The present multivariate results regarding the most important independent maternal factors show that only maternal warmth had a promotive effect on girls' disruptive behavior in the presence of maternal risk factors and after accounting for girls' earlier disruptive behavior. Thus, maternal warmth appeared capable of reducing daughters' disruptive behavior even in the presence of several other significant adversities, such as found in high risk families (e.g., low maternal education, household receipt of welfare, neighborhood dissatisfaction). Overall, the results of the final multivariate model suggest that both immutable fixed factors (i.e., maternal childhood CD) as well as dynamic process factors (i.e., mothers' prenatal nicotine use, maternal warmth, and girls' low academic achievement) explain unique variance in girls' disruptive behavior.

Results of cumulative effects on girls' disruptive behavior are in line with the cumulative risk hypothesis, assuming that the most detrimental effects are caused when multiple risk factors act on a child compared to individual risk factors (Rutter, 1979; Sameroff, 1998). Cumulative effects were also found for promotive factors, indicating that an increase in promotive factors goes along with a decreased probability of girls' disruptive behavior disorder. In addition, we found that the probability of girls' DBD accelerated when the sum of cumulative risk and promotive factors increased. This shows that the impact of risk effects on the probability of girls' disruptive behavior can be lowered by raising levels of promotive factors. These findings are consistent with past research demonstrating cumulative effects for

**Table 3.** Mean Number of Promotive and Risk Predictors for Girls´ Disruptive Behavior

| | Age 7-8 | | | | Age 9-10 | | |
|---|---|---|---|---|---|---|---|
| | No maternal CD M (SD) | Maternal CD M (SD) | *T* | | No maternal CD M (SD) | Maternal CD M (SD) | *T* |
| **Sum promotive predictors** | | | | **Sum promotive predictors** | | | |
| Maternal (0-3) | 0.76 (0.87) | 0.44 (0.68) | 7.96*** | Maternal (0-3) | 0.78 (0.87) | 0.48 (0.70) | 7.25*** |
| Non-maternal (0-3) | 0.66 (0.73) | 0.47 (0.64) | 5.44*** | Non-maternal (0-1) | 0.27 (0.45) | 0.14 (0.35) | 6.39*** |
| **Sum risk predictors** | | | | **Sum risk predictors** | | | |
| Maternal (0-8) | 1.42 (1.30) | 2.34 (1.43) | -11.94*** | Maternal (0-9) | 1.69 (1.49) | 2.98 (1.82) | -13.29*** |
| Non-maternal (0-4) | 1.10 (1.06) | 1.65 (1.10) | -9.20*** | Non-maternal (0-5) | 1.30 (1.18) | 1.93 (1.30) | -9.46*** |

** $p < .01$, ***$p < .001$

both risk and promotive factors on violent and delinquent behavior in boys (e.g., Farrington et al., 2008; Stouthamer-Loeber et al., 2002; van der Laan et al., 2010).

Our results confirm that mothers with childhood CD compared to mothers without CD have a higher risk of their daughters developing disruptive behavior. Mothers childhood CD appeared to be a powerful predictor of girls' disruptive behavior, explaining significant variance even when accounting for many relevant promotive and risk factors. Taking into account these environmental influences, the remaining effect of maternal CD on daughters' disruptive behavior may be due to genetic influences. Recent studies show a highly heritable liability for the transmission of disruptive behavior from mother with a history of CD to preadolescent children (e.g., Bornovalova et al., 2010). Nonetheless, the results of this paper confirmed that transmission may also operate via environmental factors. Daughters of mothers with childhood CD had more accumulated risk factors compared to daughters of mothers without prior CD, supporting the suggestion that maternal adverse behaviors often cluster in mothers with a history of CD (Zoccolillo, 1993). Moreover, findings complement existing research by demonstrating that daughters of mothers with childhood CD were exposed to fewer promotive effects. Thus, girls of mothers with childhood CD appear to be a vulnerable subgroup within the normal population, due to a unique pattern of risk and promotive factors.

Several limitations should be noted. First, we may have neglected other important predictors that explain variance in girls' disruptive behavior, which might have altered the results. Although we have taken account of some key maternal, neighborhood, child and family factors, other relevant characteristics such as attachment relationships (Madigan, Moran, Schuengel, Pederson, & Otten, 2007) or parental partner violence (Moffitt et al., 2001) may also play a role. Second, to enable our analyses, variables were categorized, and this may have led to a loss of information. However, prior research has demonstrated that dichotomizing variables does not greatly affect significant findings compared to using continuous variables (Farrington & Loeber, 2000). Third, we focused on *within* gender differences, because compared to boys, there are few studies that have examined the impact of maternal factors on girls' disruptive behavior. However, it may also be important to consider *between* gender differences in future research. For example, it is suggested that gender differences exist in transactional relation patterns between mothers and offspring due to socialization processes (Blatt-Eisengart et al., 2009; Webster-Stratton, 1996). Fourth, we only used mothers and daughters as informants, while inclusion of multiple respondents is recommended in the assessment of child psychopathology to provide more accurate and reliable data (Verhulst, 1995). For example, depressed mothers may overestimate their daughter's disruptive behavior, and including teachers or fathers as additional respondents may help to avoid this rater bias. However, we have used maternal reports of daughters' disruptive behavior, and daughters' reports of most of the mothers' parenting practices to

avoid shared method variance as much as possible. Finally, by examining cumulative effects we did not account for the possibility that the independent variables account for different degrees of variance in disruptive behavior. Moreover, specific variables may interact together or magnify the impact of each other (Kerns, Siemer, & Bremariu, 2011). Nonetheless, our results demonstrate that cumulative effects have a clear additional value in the prediction of girls' disruptive behavior, even without taking account of the strength of each individual factor. Future research should build on this knowledge by examining specific interactions between risk and promotive factors predictive for girls' disruptive behavior.

In conclusion, the results have several implications for future research and clinical practice. Results provided evidence that several promotive and risk factors identified girls at risk for disruptive behavior. Knowledge on malleable (maternal) characteristics in particular (e.g., prenatal nicotine use, maternal warmth), provides important information for clinical interventions, since these factors can be targeted for prevention and therapeutic purposes. In addition, non-malleable factors can be used to identify families at risk, such as families with mothers with childhood CD. We also found that maternal characteristics operated at different point in girls' development of disruptive behavior, providing evidence for timing and focus of prevention of girls' disruptive behavior. However, most prevention programs are directed at parenting skills, while it may be important to provide guidance to mothers much earlier in their daughters' life. For example, mother's provision of a responsive parenting style, such as maternal warmth, is known to play a vital role in the development of secure attachment already during the early years of life (Bowlby, 1951; Madigan et al., 2007). In addition, mother's prenatal nicotine use appeared as a powerful predictor, which can be targeted already at the start of the mother's pregnancy. In summary, early intervention on malleable factors may be essential, as it can prevent girls from escalating to disruptive behavior.

In addition, the focus of prevention efforts of girls' disruptive behavior should not be on single but on multiple factors as result showed that any risk factor that can be reduced can make a difference in the reduction of child's disruptive behavior. For example, interventions should be directed at improving familial financial status, monitoring maternal mental health and encouraging responsive and consequent parenting styles. To be the most effective, the aim of interventions should be to both eliminating risk and enhance promotive factors, as results of this study showed that these effects counterbalance in the prediction of girls disruptive behavior. Thus, it may pay off to stimulate promotive effects for girls in order to prevent disruptive behavior disorders, even in contexts of risk. As a result, it may be possible to reduce the effect of relatively difficult malleable risk factors (for example, mothers' childhood CD), by increasing girls' exposure to promotive effects. As maternal warmth was the only effective promotive factor in the presence of various maternal and contextual adversities, it may be valuable to add this constructive parenting style to preventive approaches of girls' disruptive behavior in families at risk.

Advances in studies of gene-environment interplay have demonstrated the importance of genetic influences in the transmission of disruptive behavior. However, it is suggested that (maternal) contextual characteristics also impinge on the child, through effects on gene expression (Bornovalova, 2011; Tremblay, 2010), which underlines the importance of broadening our understanding about malleable contextual factors. Results of this study indicate that girls of mothers with a history of CD appear to be doubly impoverished by being exposed to higher levels of contextual risk factors relative to promotive factors. This makes them an especially vulnerable subgroup for developing disruptive behavior within the general population of girls, in need of intensive and extended preventive interventions from birth onwards. For example, prior research demonstrated that girls growing up in families with high-risk mothers could benefit from prenatal and infancy home visitation, which could reduce the proportion of girls entering the criminal justice system (Eckenrode et al., 2010).