

# **Finding the Roots of Adolescent Aggressive Behaviour: A Test of Three Developmental Pathways**

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## Abstract

Aggressive behaviors in adolescence often originate in early development. This study tested three longitudinal pathways starting in early childhood, in a sample of 325 Belgian participants (162 girls) assessed every 1 or 2 years from birth through age 14. Structural equation models supported the “mother early dissatisfaction” pathway toward adolescent aggression, but neither the “cognitive functioning” nor the “early aggressive behavior” pathway gained clear support. Mother’s early dissatisfaction with her child was the starting point of a series of negative perceptions of the child, which predicted physical and social aggression in adolescence. Children’s cognitive functioning and early aggression level were weakly correlated with mother’s perceptions. This finding suggests that explaining normative development to parents may improve mothers’ perceptions of their early experience as a mother, of their child, and of their subsequent interactions, which may reduce their child’s future aggressive behaviors.

*Keywords:* parental attitudes, mother–child relations, cognitive ability, aggression, developmental psychology

## Finding the Roots of Adolescent Aggressive Behavior: A Test of Three Developmental Pathways

Studying the developmental pathways leading to adolescent violence is a crucial step toward building a better society. In fact, violent acts may engender severe personal and economic costs for the victims (e.g., health care, property damage, loss in income, psychological trauma), but also for society (e.g., jails, prisons, rehabilitation programs, and climate of fear; Anderson, 1999; Macmillan, 2000). Social and physical aggression are two distinct types of aggressive behaviors that may arise in different circumstances (Wang, Iannotti, & Luk, 2010) and that can contribute independently to negative consequences experienced by the victims (Teicher, Samson, Polcari, & McGreenery, 2006).

### **Predictors of Aggressive Behavior**

Several researchers have argued that parenting contributes in important ways to the development of aggressive behaviors in childhood and adolescence (Loeber & Stouthamer-Loeber, 1986; Sampson & Laub, 1993). Other well-studied predictors of adolescent aggressive behavior include individual characteristics, such as cognitive characteristics and early signs of aggressive behavior. Some of the measures that have been used to document these predictors have a strong objective basis (e.g., standardized tests, observations from independent raters), whereas other measures that are frequently used are based on parent reports. It is commonly understood that mothers provide reliable reports of their young children's cognitive, affective, and relational functioning and adjustment. The goal of this study was to verify whether mothers' reports of their child's functioning that rely heavily on their perceptions of the child may in fact tap into relational factors that contribute to the development of adolescent aggressive behavior. We tested this hypothesis by using a longitudinal model that included not only measures of

mother perceptions, but also other measures of child aggressive behavior and cognitive functioning.

### **Control Variables from Early Childhood: Mother Education and Child Temperament**

As documented in numerous longitudinal studies (Côté, Vaillancourt, Leblanc, Nagin, & Tremblay, 2006; Tremblay, 2000; Tremblay & Nagin, 2005), the socioeconomic context in which children are born contributes heavily to their developmental pathways. The mother's level of educational attainment is a good indicator of whether or not the child was born in a disadvantaged sociocultural context (Shaw et al., 1998). Past research has shown that this sociodemographic variable is a consistent predictor of children's problem behavior in childhood and adolescence (Bradley & Crowyn, 2002; Côté et al., 2007). Mothers with more education are less likely to experience deprived neighborhood and home environments. They are also more likely to use efficient behavioral strategies to cope with stressful events, which can help them feel more efficient as a mother and better satisfied with their child at various stages of development. Higher levels of education can also help mothers provide a more stimulating home environment that will benefit the child's cognitive growth (Klebanov, Brooks-Gunn, & Duncan, 1994). Such familial predispositions are not, however, the only variables that may set children on a specific developmental pathway; in fact, children's own characteristics also play a role. To that effect, Guerin et al. (1997), Tremblay & Nagin (2005), and Lahey et al., (2008) have called attention to the crucial influence of temperament. The links between children's difficult temperament and problem behavior have been described in many longitudinal studies (Gjone & Stevenson, 1997; Loeber et al., 2001; Schmitz et al., 1999; Tremblay, Pihl, Vitaro, & Dobkin, 1994) and by a collective expert report conducted by Inserm (2005) about child and adolescent conduct disorder.

Family socioeconomic status and child temperament can set children on an early pathway toward adolescent violence. The specific mechanisms through which this developmental process unfolds are less clear, though. We have compared the contribution of three possible developmental pathways to adolescent aggressive behavior. The first one mainly involves the child's cognitive difficulties (including low intellectual ability and lack of executive control), the second involves early and persistent aggressive behavior, and the last one involves enduring maternal dissatisfaction toward the child.

### **Three Pathways to Aggressive Behaviors in Adolescence**

**Early aggressive behavior pathway.** Although many children use physical aggression during early childhood, by the time they enter primary school most have learned how to use alternative behaviors to reach their goals. In some cases, however, aggressive behaviors persist throughout childhood and may transform into serious violence during adolescence and adulthood (Tremblay, 2000; Tremblay et al., 2004). Past studies suggest that early child characteristics are predictive of later aggressive behavior (Nagin & Tremblay, 2001; Tremblay et al., 2004). Many studies that have established the existence of various developmental trajectories of aggressive behavior have not provided much information about the potential mechanisms that explain the persistence of aggressive behavior (Broidy et al., 2006; Côté et al., 2006; Olson, Bates, Sandy, & Lanthier, 2000). Thus, for our study we chose to model a simple, self-perpetuating chain of aggressive behavior from toddlerhood through adolescence, which we then compared to alternative mechanisms that may explain adolescent aggressive behavior.

**Cognitive pathway.** Executive functioning and intelligence are two of the cognitive factors that are most strongly related to conduct behavior problems (Nigg & Huang-Pollock, 2003). On the one hand, executive functions help self-regulate thought, action, and emotions, and

depend on the prefrontal cortex (Séguin & Zelazo, 2005). On the other hand, cognitive abilities can help promote verbal mediation and self-control (which underlie the ability to delay gratification) and communication skills, both of which may reduce the likelihood of negative interactions that could lead to violent behavior (Moffitt & Lynam, 1994). Many aspects of executive functioning have been linked to problem behavior (Moffitt & Bill, 1989), including concentration problems (Behar & Stringfield, 1974; Lee & Bates, 1985; Normandeau & Guay, 1998; Windle & Lerner, 1986), impulsivity (Oosterland, Logaan, & Sergeant, 1998; White et al., 1994), deficient inhibition (Toupin, Dery, Pauze, Mercier, & Fortin, 2000), and decreased mental flexibility (Bonino & Catellino, 1999; White et al., 1994). With regard to intelligence, Denno (1990) found that a low intellectual quotient (IQ) at ages 4 and 7 predicted the likelihood of being arrested for violent offense by age 22. In their review of past research, Clark, Prior, and Kinsella (2002) concluded that although intelligence and executive functioning can help explain conduct disorder, the latter probably plays a more important role.

**Mother early dissatisfaction pathway.** Mothers' perceptions of their child have a crucial influence on the child's early development (Berger, 2008). We hypothesized that even when controlling for measures of a child's early aggressive behavior and cognitive problems, mothers' early dissatisfaction with their child would predict aggressive behavior in adolescence, especially if this dissatisfaction is enduring and affects her perception of the child's interpersonal, cognitive, and behavioral difficulties. In fact, past research has shown that as children grow up, mothers' perceptions of their child as being difficult, demanding, and disobedient are related to an increased risk that the child will engage in externalizing behavior later on, even after controlling for established predictors of such behaviors (Bates, Maslin, & Frankel, 1985; Bates, Pettit, Dodge, & Ridge, 1998; see also Olson et al., 2000, for a review).

Furthermore, some researchers have suggested that early affective variables, such as the mother's feeling of efficiency (Martin, Linfoot, & Stephenson, 2000) and parental beliefs (Lee & Bates, 1985; Mills & Rubin, 1990), could be predictors of problem behavior in the child. In a review of studies about this topic, Olson et al. (2000) emphasized the importance of taking into account maternal cognitions as a predictor of the quality of mother-child interactions.

### **This Study**

We hypothesized that many parent reports of children's behavioral characteristics should be considered more a reflection of the specific interpersonal dynamics between the child and the parent rather than as objective measures of problem behavior and interpersonal difficulties. To test this hypothesis, we contrasted the relative contribution of three longitudinal pathways to social and physical aggression in adolescence. Specifically, in the parallel pathways model (Figure 1, top panel), we hypothesized that a developmental pathway reflecting a mother's perception of and satisfaction with her child's behavior (i.e., the mother early dissatisfaction pathway) would contribute to the development of aggressive behavior in adolescence beyond the significant contribution of objective, cognitive variables measured throughout childhood (the cognitive functioning pathway), and also beyond signs of enduring aggressive behaviors since early childhood (early aggressive behavior pathway). In an alternative model (Figure 1, bottom panel), we also explored the possibility that cross-pathway influences occur such that variables from one pathway could predict elements of other pathways. A secondary goal of this study was to verify whether these three pathways could be confirmed in boys and in girls.

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Figure 1 about here

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## Method

This research was carried out in the context of a longitudinal study called “Grandir en l’an 2000 [Growing up in the year 2000],” initiated in 1989 by the Department of Experimental Pedagogy, University of Liège, which took place in the Liège-Huy-Waremme region. All measures were administered in French, the first language of participating families.

### Participants

The initial sample included 397 youths and their families, recruited at random from the registers of birth of the greater Liège area’s communes to reflect various ecological niches. Included in this study were the 325 participants (163 boys, 162 girls) from whom we collected valid questionnaire data at each time point throughout the childhood period (21–22 months, 5 years, and 10 years old). Of those, 277 provided valid data at age 14, when the outcome variables were measured. Family composition by the time participants were 10 years old was distributed as follows: for 75% of families, both parents lived together; for 11% of families, parents were separated or divorced, and 12% of families were recomposed. Further details about the sampling procedure are available from De Landsheere et al., (2001).

### Procedure

From the time their child was born until age 14, mothers were interviewed at their home at least once every other year, and in most cases, yearly. Children were also administered the standardized tests or questionnaires described in the Measures subsection.

### Measures

Descriptive statistics for all measures are available from Table 1.

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Table 1 about here

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**Mother's education.** Mothers' reports about their own level of education revealed the following distribution: 3.1% did not finish elementary school; 9.2% finished elementary school only; 18.5% finished only the first or second cycle of secondary school; 20.3% obtained a technical or vocational secondary education diploma; 13.2% obtained a general secondary education diploma; and 35.7% graduated from a higher education program. A 6-point scale was created to represent each of these levels.

**Child's temperament in early childhood (age 22 months).** Although direct behavioral observations of children by independent observers are the ideal method by which to measure temperament, they are difficult and onerous to collect. According to Bates and Bayles (1984) and Bates (1986), the best alternative is to obtain mothers' reports. We used three indicators to create a latent construct reflecting difficult temperament. Mother reports of the child refusing to sleep and refusing to eat are usually recognized as good indicators of a difficult temperament (Tremblay & Nagin, 2005.; Vitaro & Gagnon, 2000; Windle & Lerner, 1986) and were thus used in this study. Our third indicator was based on two items reflecting nocturnal issues (wakes up at night, has nightmares,  $r = .85, p < .001$ ), as suggested by Windle and Lerner (1986). All three indicators were rated on a 4-point scale ranging from 0 (*never*) to 3 (*often*).

**Early aggressive behavior (age 22 months).** This variable was measured using two items that ask parents to report about two types of externalized behaviors, that is, whether their child screams and whether their child hits the floor with his or her feet. Items are significantly correlated ( $r = .32, p < .001$ ).

**Mother's dissatisfaction toward the child (age 22 months).** Mothers were presented with eight items that described various personal characteristics that can be displayed by toddlers

(i.e., dynamic, safe, calm, quick-tempered, disobedient, active, affectionate, aggressive). They were asked to rate their level of satisfaction toward their child for each characteristic. The stem of each item was “I wish my child were...,” followed by three conclusions from which mothers had to choose: *just as much*, *more*, or *less*. Items that were answered by either *more* or *less* represented an area of dissatisfaction and were scored 1; a score of 0 was given when the mother answered *just as much* (Boët, 2003). Cronbach’s alpha for this scale was .71.

**Mother’s perception of the child’s interpersonal difficulties (age 5 years).** This scale reflects aggressive–dominant characteristics of the child, as described by Montagner (1989). Mothers were presented with five items and asked if the behaviors described were similar to those they usually observed in their own child (Boët & Born, 2001). These items described some behaviors that children may exhibit toward their peers and their self-control abilities in interpersonal situations (e.g., disrupts other children’s games; has a tendency to engage in fights). Each item was rated on a 4-point Likert scale ranging from 0 (*my child is not at all like this*), to 3 (*my child is very much like this*). Cronbach’s alpha for this scale was .70.

**Mother’s perception of the child’s problem behavior (age 10 years).** Mothers reported about their child’s transgressions of social and legal norms, including coarse language, oppositional and disobedient behavior with adults, and physical aggression toward objects or people. This questionnaire was developed by Boët (2003) and was based on a literature review of deviant behavior in this age group and on consultations with local teachers who described problem behaviors commonly observed in their students. Two types of items were created. The first type described behaviors that children may adopt in specific situations (e.g., “When you deny your child something he or she wants,” with potential answers including *sulking*, *getting angry*, *complaining*). The second type included items that asked about the frequency of various

behaviors toward other people (e.g., “Using inappropriate language with siblings, friends, or parents” rated on a 3-point scale, with potential answers including *never*, *sometimes*, or *often*).

Cronbach’s alpha for this scale was .75.

**Mother’s perception of the child’s concentration problems (age 10 years).** Eight questions from the Cognitive Self-Control Scale (Kendal & Wilcox, 1979) were selected to assess the child’s cognitive abilities, including attention, evaluation, planning, and problem solving (e.g., “Does the child think before he or she acts?” “Does the child jump or switch from activity to activity rather than sticking to one thing at a time?”). The total score reflects an aspect of executive functioning close to the concept of “distraction–persistence” proposed by Windle and Lerner (1986) and is computed as a sum of all items, each rated on a 7-point Likert scale. Cronbach’s alpha for this scale was .77.

**Child’s intellectual quotient (IQ; age 5 years).** Children’s intelligence was measured using the Weschler Preschool and Primary Scale of Intelligence-Revised, designed for children ages 4 to 6.5 years. This test battery includes many subtests that comprise increasingly difficult items. A total IQ score was computed.

**Child’s cognitive inhibition (age 10 years).** This variable was measured using the Stroop test (Stroop, 1935), in which participants must substitute a new answer to another one that was previously practiced and made automatic.

**Child’s mental flexibility (age 10 years).** The Trail Making Test (Gaudino, Geisler, & Squires, 1995; Reitan, 1958) is a neuropsychological test of visual attention and task switching. It requires children to use their concentration and their ability to initiate, intervene, and interrupt a complex, goal-directed behavior sequence.

**Child's social and physical aggression (ages 10 and 14 years).** Participants were asked to report about how often they have engaged in three instances of social aggression, including making fun of other people, using inappropriate language with other people, and spreading rumors, on a 3-point scale (*never, once or twice, or three or more times*). Each question was asked in relation to adults and then in relation to other children.

Participants were also asked to report about how often they have engaged in four instances of physical aggression, including using force to take somebody else's money or property, fighting with one or several people, or using a weapon, on a 3-point scale (*never, once or twice, or three or more times*). Participants rated how often they engaged in such behaviors with their friends and how often it happened when they were alone.

Self-reported measures of social and physical aggression are commonly used and have proven to be reliable and valid (Huizinga & Elliott, 1984; Junger-Tas et al., 2010; Junger-Tas, Terlouw, & Klein, 1994; Klein, 1989). For the specific instruments used in this study, we obtained Cronbach's alpha values of .68 for social aggression and .75 for physical aggression. These values are comparable to those we obtained in a previous survey conducted among a representative sample of 3,000 secondary school students in Belgium (Lecocq et al., 2003).

### **Missing Data**

Missing values were present in the dataset because of the longitudinal nature of the research design. Only the 325 participants from the original sample who had complete questionnaire data from age 22 months to 10 years were included (81.7%). Even though we were unable to track some of these participants either for standardized testing or to administer questionnaires at ages 10 and 14 years, we were able to include 277 participants (85.2% of the

325 who were followed throughout childhood; 69.8% of the original sample). Patterns of missingness are further described in the Results section.

For the primary analyses (SEM), missing data were managed with the full information maximum likelihood (FIML) procedure in Mplus version 6. This method has been shown to be very efficient when analyzing data from samples with moderate levels of missing values, and it is adequate even when data are not missing completely at random, as long as the predictors of missingness are included in the model (Widaman, 2006). In this sample ( $N = 325$ ), covariance coverage was high (.79–1.00), and although the pattern of missing data is unlikely to be “missing completely at random” (MCAR), the assumption of data missing “at random” is very plausible, thus making FIML an adequate procedure. When using FIML, the estimation of each parameter is made on the basis of all available information from each participant. Consequently, we can retain in the analysis all 325 participants because even those with occasional missing data can contribute to model estimation.

## Results

### Preliminary Analyses

**Missing data.** We conducted a missing-value analysis using SPSS software version 19, and the Little’s MCAR test conducted on all measures (excluding the categorical variable “gender”) revealed that the pattern of missing values was not completely random,  $\chi^2(112) = 189.94, p < .001$ . We thus conducted further analyses to understand the missing data patterns by creating a variable representing the number of observed variables and indicators used in the models for which we had no valid data (an occasional failure from any informant to answer one question within a scale was not counted as missing data, because scale scores were computed). Most participants (75.7%) had complete data, and none had more than three missing values.

Participants with higher numbers of missing values had less-educated mothers, they had lower IQ at age 5, they displayed higher levels of concentration difficulties and lower levels of mental flexibility at age 10, and they were more likely to be males,  $t(323) = 1.99, p < .05$ . Still, correlations between the number of missing values and the continuous variables were small ( $r$  ranging from .17 to .22).

**Differences across genders.** Gender differences in all observed variables and indicators to be used in the main analyses were tested using a series of  $t$ -tests (see Table 1). Four measures differed significantly across genders. Specifically, boys had a higher score on the Stroop test, which means that they had lower levels of cognitive inhibition than girls did. Mothers of boys perceived higher levels of problem behavior and concentration problems than mothers of girls did. Last, boys reported higher levels of physical aggression at age 14 than girls did. In addition, four measures were marginally different across genders. Mothers of boys were slightly more likely to report that their child refused to sleep and had other nocturnal issues than mothers of girls did. Boys had higher scores on the Trail Making Test, which means that they had marginally lower levels of mental flexibility than girls did. Also, boys reported marginally higher levels of physical aggression at age 10 than girls did. Because several gender differences were found, Table 1 presents means and standard deviations not only for the overall sample, but also for girls and boys separately.

**Correlations.** Table 2 presents correlations among all measured variables. Most correlations were in the expected direction, with the notable exception of child's IQ at age 5, which had a small but positive relationship with social aggression at age 14.

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Table 2 about here

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### **Primary Analyses**

To test our hypotheses about developmental pathways, we used SEM (Mplus software version 6), including tests of indirect effects. We used the sandwich estimator (MLR option in Mplus) to estimate maximum likelihood parameters. This estimator provides standard errors and a chi-square statistic that are robust with respect to the lack of normality in the distribution of some variables (e.g., mother education). The chi-square difference test with scaling correction (Satorra & Bentler, 2001) was used for all model comparisons. According to Kline (2005), indices of adequate model fit include a nonsignificant chi-square value, comparative fit index (CFI) and Tucker-Lewis index (TLI) values at .90 or more, root mean square error of approximation (RMSEA) values at .08 or less, and standardized root mean square residual (SRMR) values at .10 or less.

**Analytic strategy.** Our analytic plan consisted in first testing our hypothesized “parallel pathways” model on the overall sample. In this model, variables assigned to a specific pathway were allowed to predict future outcomes only within the same pathway. As a second step, we tested an alternative “cross-pathway” model, in which variables assigned to one of the three pathways were allowed to influence future outcomes in a different pathway. Because this alternative model is much less parsimonious than the initial model, the third step was to adjust the cross-pathway model by removing newly added paths that were not significant. Each time a new model was computed, we verified whether this model fit the data better than the previous one had, by comparing the chi-square values of the two models. After identifying the best fitting model, we ran multiple-group analyses to verify if the model that we built using the overall sample could generalize to both genders.



**Testing and comparing the hypothesized parallel pathways and the cross-pathway models on the overall sample.** We first ran the parallel pathways model on the overall sample, and the fit was adequate according to most indices, except for the chi-square, which should be nonsignificant,  $\chi^2(87) = 121.04$ ,  $p < .01$ , CFI = .94, TLI = .92, RMSEA = .04, SRMR = .06. We then ran the cross-pathway model and found that its fit was adequate according to all indices,  $\chi^2(76) = 72.03$ ,  $p = .61$ , CFI = 1.00, TLI = 1.00, RMSEA = .01, SRMR = .00. The improvement from adding 11 cross-pathway paths was significant,  $\Delta\chi^2(11) = 48.49$ ,  $p < .001$ . Yet, this does not mean that all 11 new paths are needed to yield a significant improvement in model fit.

**Testing the adjusted, more parsimonious model on the overall sample.** Path coefficients that were added only in the cross-pathway model were inspected and those that were not significant were removed from the model one by one. Each time one path was removed, the model was run again and the significance of remaining cross-pathway path coefficients was reexamined. For theoretical reasons, none of the paths estimated in the initial (parallel pathway) model were removed, regardless of their significance. The final model included only 4 cross-pathway coefficients out of 11. They included (a) a path from child aggression (22 months) to mother perception of child interpersonal difficulties (age 5), (b) a path from child aggression (22 months) to mother perception of child cognitive and behavioral problems (10 years), (c) a path from mother perception of child interpersonal difficulties (5 years) to child physical aggression (10 years), and (d) a path from child IQ (5 years) to child physical aggression (10 years). This new model fit the data well,  $\chi^2(83) = 83.48$ , *ns*; CFI = 1.00, TLI = 1.00, RMSEA = .00, SRMR = .05, and significantly better than did the original (parallel pathways) model,  $\Delta\chi^2(4) = 38.09$ ,  $p < .001$ . In addition, the fit of this parsimonious model did not deteriorate, as did the fit of the original (more complex) cross-trajectory model,  $\Delta\chi^2(7) = 11.31$ ,  $p = .13$ . We thus adopted this

last iteration as our final model (i.e., parallel model with four additional cross-pathway coefficients). Standardized coefficients obtained for this final model are presented in Figure 2.

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Figure 2 about here

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Regression paths from the parallel pathway model (Figure 1, top panel) that were estimated in the model but did not reach significance are identified with the *ns* abbreviation in Figure 2. Regression paths from the cross-pathway model (Figure 1, bottom panel) that were not significant were trimmed out and therefore not depicted in Figure 2. Correlations among variables that were measured at the same time point were omitted from Figure 2 to enhance its clarity, but they were nonetheless estimated in the model. Some of them were significant, including the correlation between total IQ and mother's perception of child's interpersonal difficulties at age 5 ( $r = -.15, p < .01$ ), the correlations between mother's perception of child's problems at age 10 and concurrent measures of physical and social aggression ( $r = .29$  and  $r = .35, p < .001$ ), and the correlation between both measures of aggression at age 10 ( $r = .50, p < .001$ ) and at age 14 ( $r = .30, p < .001$ ).

**Test of indirect effects.** We used the test of indirect effect provided by the Mplus software to test for the hypothesized indirect pathways from the parallel model. This test supported the mother perception pathway because it revealed a significant indirect effect from mother's dissatisfaction with her child at age 22 months to physical aggression at age 14, through mother's perception of her child's interpersonal difficulties at age 5 and her perception of cognitive and behavioral problems at age 10 ( $\beta = .02, p < .05$ ). This mother perception pathway also represented a marginally significant indirect path toward social aggression at age 14 ( $\beta = .01, p = .07$ ).

Tests of indirect effects also supported the hypothesis that cross-pathway influences occurred. In fact, significant indirect effects emerged from child early aggression at 22 months to social aggression ( $\beta = .02, p < .05$ ) and physical aggression ( $\beta = .03, p < .05$ ) at 14 years through mother's perception of cognitive and behavioral problems at age 10 and of child interpersonal difficulties at age 5. Indirect effects also emerged from child aggression at 22 months to social aggression ( $\beta = .07, p < .01$ ) and physical aggression ( $\beta = .10, p < .001$ ) at 14 years through mother's perception of cognitive and behavioral problems at age 10 only.

**Test of gender differences.** To verify if the regression paths and correlations differed across gender, we converted the final model (see Figure 2) into a multiple-group "unconstrained" model, in which all regression and correlation coefficients were free to vary across genders. Then, we ran a multiple-group "constrained" model, in which those coefficients were constrained to equality across genders. A chi-square difference test comparing the fit of the unconstrained model,  $\chi^2(174) = 185.59, ns$ , and the constrained model,  $\chi^2(204) = 221.89, ns$ , revealed that the unconstrained model did not fit the data significantly better than the constrained model did,  $\Delta\chi^2(30) = 38.30, ns$ . This means that, overall, there were no significant gender differences in this model.

## Discussion

The main goal of this study was to test the relative contribution of three parallel developmental pathways to predicting physical and social aggression in adolescence (age 14), after controlling for early life predictors (temperament, mother education). The cognitive functioning pathway was based on objective cognitive measures, the mother early dissatisfaction pathway was based on a mother's subjective perceptions and satisfaction with her child's behavior, and the early aggressive behavior pathway included measures of aggression in

toddlerhood and early adolescence. The strategy of testing for three parallel pathways contrasts with the current practice observed in many longitudinal studies of adolescent violence, in which various predictors are integrated into a single developmental trajectory (e.g., Alink et al., 2006; Bates et al., 1985; Dodge, Greenberg, Malone, & CPPRG, 2008). Our approach is innovative in that we instead identified competing developmental pathways, each of which included a different family of predictors, which enabled us to contrast their relative importance in predicting adolescent aggressive behaviors. We then explored the possibility of cross-pathway influences in a subsequent model. This approach allowed us to find support for the mother perception pathway, but not for the cognitive functioning pathway, because cognitive factors at age 10 were not directly linked to adolescent aggression at age 14. The developmental pathway from early aggression to physical aggression in adolescence was marginally significant, and not significant for social aggression in adolescence.

With regard to cross-pathway influences, our results supported the hypothesis that the mother early dissatisfaction pathway develops independently from the cognitive functioning pathway. However, we found some support for cross-pathway influences between the mother early dissatisfaction pathway and the early aggressive behavior pathway. In fact, early aggressive behavior predicted mothers' perceptions when their children were 5 and 10 years old. We also found that mother perceptions and cognitive measures at 5 years old predicted physical violence at age 10, thus suggesting that persistent aggressive behaviors throughout childhood may be reinforced by cognitive problems and by the mother-child dynamics.

### **Contrasting Three Parallel Developmental Pathways**

Similar to findings in a study by Johnston (2011), the cognitive functioning pathway in which lower intellectual abilities predict weaker executive functioning at age 10 does not

culminate in violent behaviors in adolescence. As hypothesized, better educated mothers were less likely to engage in a pathway of negative perceptions, in that they reported less dissatisfaction with their toddler. We hypothesized that mothers who have reached higher education levels have more highly developed mental abilities that help them decode, understand, and adapt their reactions to their child's difficult behavior, rather than become caught up in negative perceptions of the child. Because a mother's level of education is tightly related to levels of social familial adversity, it is also possible that more highly educated mothers have access to more environmental support to help them interpret and react appropriately to their child's difficult behaviors. Relevant to the early aggressive behavior pathway, we found that mothers who had more education reported less aggressive behavior in their 22-month-old toddlers. Mother's education was also positively related to child's IQ, which was part of the cognitive functioning pathway. It seems reasonable to hypothesize that mothers with more education encourage the development of stronger cognitive abilities and higher levels of executive functioning in their children, which can facilitate the process of child socialization (Boët, 2003). Alternatively, lower levels of environmental stress that characterize the life of more highly educated women could foster healthy cognitive development in their offspring.

It is noteworthy that the measures we used to assess the subjective perceptions from the mother are typically used as objective data that are assumed to provide an unbiased account of the longitudinal progression of child problem behavior (e.g., Lacourse et al., 2002; Tremblay, 2000). Our study is innovative in that mother's report of the child's interpersonal, cognitive, and behavioral problems are not assumed to be objective data, but rather a subjective report from the mother that is influenced by her own dissatisfaction about her child's behavior. It would be prudent to empirically contrast this pathway with other pathways that are measured using

objective cognitive testing of executive functions and that would reflect a lack of self-control in childhood and adolescence, or that reflect a mere continuity of aggressive behavior over time.

The existence of significant cross-pathway indirect effects also suggests that beyond the impact of their initial satisfaction with their child or lack thereof, mothers' unfolding relationship with their child is also influenced by their child's behavior. In fact, dissatisfied mothers who had an aggressive toddler developed a more negative perception of their child at ages 5 and 10 years than mothers who were dissatisfied at the beginning of the study but who did not have an aggressive toddler.

### **Potential Mechanisms Involved in the Mother Early Dissatisfaction Pathway**

Our study results suggest that patterns of parent-child interaction must be considered as potential explanations for these findings. Several hypotheses are explored in turn.

**Mother initial dissatisfaction.** A clear strength of our study lies in our measure of mother's subjective dissatisfaction with her child at a very early age (22 months). This variable is certainly influenced in part by the child's temperament, as shown by the moderately strong path from child temperament to mother dissatisfaction at 22 months. Nevertheless, our results still support a chain of indirect effects that starts from mother's early perceptions and culminates in violent behavior. In fact, we found a significant indirect path from mother early dissatisfaction to social and physical aggression in adolescence, via mother perception of interpersonal difficulties and of cognitive and behavioral problems in middle childhood. The role of mother's dissatisfaction in this model suggests that some mothers may hold an idealized view of how their child should behave, and they may develop negative feelings toward the child if he or she presents temperamental or behavioral difficulties. These negative feelings, which emerge mostly from expectations that may not always be realistic for such a young child, are very likely to

affect the mother's interaction with her toddler (Bowlby, 1980; Prior, 1992). Our findings are congruent with those presented by Lahey et al. (2008), who found that after controlling for important demographic variables, the interaction between maternal responsiveness and child temperament was significant in predicting conduct problems. Similarly, our data showed that early dissatisfaction with the child is the starting point of a series of negative perceptions from the mother that can be measured again at child age 5 and 10 years, which reliably predicts the child's aggression, possibly as a reaction to ongoing and accumulating negative mother-child interactions.

It seems plausible that a mother's dissatisfaction manifests in parenting practices and interactions that lack maternal warmth, and this pattern has been related to long-term developmental outcomes (Bates & Bayles, 1988; Booth, Rose-Krasnor, McKinnon, & Rubin, 1994; Lahey et al., 2008). This possibility is also consistent with the "nurturance hypothesis" proposed by Dishion and Bullock (2002) that we tested in a previous study (Boët & Born 2001), whereby parents' positive attention, emotional investment, and behavioral management combine in ways that forecast children's developmental pathways.

It is important to keep in mind that children with certain predispositions elicit particular reactions from their parents (Patterson, Reid, & Dishion, 1992; Pettit, 1997). For example, a child who is temperamentally fussy may lead her parents to react impulsively and to respond with harsh discipline. Such negative feedback from parents tends to amplify behavior problems, which may strengthen the mother's initial negative perception of her child and eventually increase the risk of that the child will engage in antisocial behavior later in life. Some evidence for these parent-child dynamics is revealed in our findings by a significant cross-pathway

indirect effect from child's early aggressive behavior to mother perception of interpersonal, cognitive, and behavioral problems, to adolescent aggression in early and middle adolescence.

**Development of a perceptual bias stemming from initial dissatisfaction with the child.** It is noteworthy that, in this study, children's objective cognitive functioning at ages 5 and 10 is weakly correlated with mother's evaluations of their functioning. It appears that mother's negative perceptions of their child may be excessively influenced by the child's externalizing problems, while other developmental difficulties may go unnoticed. It is possible that over time, the disconnection between children's objective difficulties and the mother's perception of them becomes more important. Yet, only mother's perceptions predicted future aggression. Objective cognitive difficulties at age 10 were not significant predictors. Levels of aggression at age 10 were either non significant or marginally significant predictors. These results are consistent with those reviewed by Farrington (1997), who made the point that there is generally a stability of diagnosed conduct disorder over time, but no such continuity of aggressive behaviors, for which a declining trend is observed (see also Pinzie & all, 2006). We can hypothesize that parent-child interactions are crucial to the progression toward aggression in adolescence, and children's involvement in violent behavior could be explained by the mother's labeling and by her pessimistic feedback to the child, stemming from her own biased perceptions. The mother's negative perception may increase the likelihood that the mother engages in top-down processing of her child's behavior. She would then apply a biased filter to any new information about the child, in the same way as children's negative reputations can be maintained over time within their peer group even when other measures suggest that their behavior has changed (e.g., Dodge, 1980, Dodge & Frame, 1982; Dodge & Somberg, 1987; Dweck & Leggett, 1988). Still, we know that when parents are faced with their child's behavioral issues, in particular aggressive behavior,



a cycle of coercive interactions may emerge between parents and their child, thus exacerbating the child's behavior problems.

### **Gender Differences**

Even though gender differences were found on several measures (mother perceptions at age 10, executive functions at age 10, physical aggression), the final model was consistent across genders. We thus conclude that mother-child relationship throughout childhood influences the progression to violent behavior in essentially the same way for boys as for girls, and prevention or treatment programs targeting the risk factors identified in this study (discussed in greater detail in the following section) would most likely be as efficient for children of both genders.

### **Conclusion**

**Strengths and limitations.** The very early measure of mother's dissatisfaction with her toddler is a clear strength of this study because it can be particularly hard to recruit a representative sample of families before children are reachable through the schools. The fact that this sample was followed for 14 years is also exceptional. The use of standardized testing for child's intelligence and executive functions in childhood is another noteworthy strength of this study. In fact, longitudinal data investigating the link between strong, objective measures of cognitive functioning and later outcomes is rather infrequent because of the additional expenses related to the time and training required to administer them.

This study's limitations are in part related to the fact that longitudinal studies are conducted over many years, such that theories and measures may become dated or less sophisticated than those that have evolved between study design and data analysis. A multi-informant measure of early temperament would have been preferable to a mother-reported measure, but this method was too costly for this project. The same is true for our measures of

social and physical aggression. Such measures had the limitation of being exclusively self-reported (in adolescence) or parent reported (in early childhood), and the brevity of the measure may explain a reliability that is not quite ideal. This may have contributed to a lack of stability in the measure of social aggression at ages 10 to 14 years old. In addition, in spite of considerable efforts to maintain participation over time, about 18% of the initial sample had to be excluded from analyses because of attrition. Because of the research team's serious concern about this issue from the beginning of the study, we still achieved a very good level of retention compared with that of other longitudinal studies. Last, the complexity of the model to be tested limited our ability to expand beyond the exploration of indirect effects. Future studies should probe interaction effects between variables representing mother perceptions and those representing child's cognitive functioning. The study by Lahey et al. (2008) cited earlier suggests that significant interaction effects could inform parenting practices.

**Prevention implications.** Past research has already shown that to decrease the prevalence of adolescent aggression, it is crucial to involve mothers (Tremblay, 2008). Our study suggests that helping them develop positive perceptions of their child very early in childhood would be an important target for the prevention of adolescent aggression. To this end, providing parents with reliable information about age-appropriate behaviors for young children would be especially important for those with lower levels of educational attainment. This information could help parents identify their child's strengths and weaknesses in a more objective way, which in turn would enable them to seek help for truly problematic areas of development. At the same time, parents who have a better knowledge of normative development should be better at identifying areas of strengths in their child and feel proud of these aspects of their child's unique personality. Adequate information coupled with professional support for more problematic

aspects of the child's development can form a strong foundation for building a loving relationship in which mutually rewarding interactions can take place.

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Table 1

*Descriptive Statistics for Each Variable and t-Tests for Gender Differences*

Variable	Full sample		Girls		Boys		<i>t</i> -test for gender differences
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>t</i> ( <i>df</i> )
Mother's education	3.38	1.50	3.43	1.47	3.34	1.55	-0.49 (323)
Child refuses to sleep (22 mo.)	1.18	1.01	1.29	1.06	1.08	.96	-1.88 (323) †
Child refuses to eat (22 mo.)	1.27	1.00	1.28	1.04	1.26	.97	-0.18 (323)
Nocturnal issues (22 mo.)	2.44	1.51	2.29	1.54	2.60	1.46	1.83 (323) †
Early aggressive behavior (22 mo.)	3.18	1.80	3.17	1.81	3.18	1.80	0.09 (323)
Mother's dissatisfaction (22 mo.)	2.37	1.94	2.25	1.91	2.50	1.97	1.16 (323)
Mother's perception, interpersonal difficulties (5 yr.)	4.90	3.29	4.65	3.05	5.15	3.51	1.35 (323)
Mother's perception, problem behavior (10 yr.)	15.83	6.04	15.07	5.89	16.59	6.12	2.28 (323)*
Mother's perception, concentration problem (10 yr.)	25.25	8.55	24.11	8.47	26.37	8.50	2.40 (323)*
Child's IQ (5 yr.)	101.09	14.90	101.88	14.09	100.30	15.67	-0.95 (315)
Child's cognitive inhibition (10 yr.)	158.30	37.55	153.40	34.53	163.33	39.90	2.32 (302)*
Child's mental flexibility (10 yr.)	101.33	34.79	97.96	32.62	104.88	36.71	1.74 (302) †
Child's social aggression (10 yr.)	2.45	1.35	2.41	1.40	2.48	1.30	0.49 (323)
Child's social aggression (14 yr.)	6.84	3.15	6.60	3.30	7.10	2.97	1.31 (275)
Child's physical aggression (10 yr.)	3.16	2.10	2.92	2.01	3.33	2.17	1.78 (323) †
Child's physical aggression (14 yr.)	2.14	1.69	1.82	1.55	2.48	1.77	3.25 (275)***

*Note.* \* $p < .05$ , \*\* $p < .01$ \*\*\* $p < .001$ , † $p < .10$ ; 1 = males, 2 = females.

Table 2

*Correlations Among All Variables*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1. Mother education	–															
2. Child refuses to sleep (22 mo.)	.03	–														
3. Child refuses to eat (22 mo.)	.00	.26***	–													
4. Nocturnal issues (22 mo.)	.03	.31***	.12*	–												
5. Mother dissatisfaction (22 mo.)	-.18***	.13*	.12*	.15**	–											
6. Early aggressive behavior (22 mo.)	-.13*	.10†	.02	-.01	.15**	–										
7. Mother’s perception of interpersonal difficulties (5 yr.)	-.09†	.01	.01	.00	.16**	.22***	–									
8. Mother’s perception of problem behavior (10 yr.)	-.14**	.00	.00	-.01	.21***	.23***	.35***	–								
9. Mother’s perception of concentration (10 yr.)	-.21***	.04	.04	.00	.09	.22***	.30***	.47***	–							
10. IQ (5 yr.)	.26***	-.06	-.02	.02	-.08	-.09†	-.17**	-.11†	-.21***	–						
11. Child’s cognitive inhibition (10 yr.)	-.14*	.00	-.01	.06	.00	.01	.10†	.10†	.12*	-.16**	–					
12. Child’s mental flexibility (10 yr.)	-.19***	.03	.00	-.02	.05	.03	.15**	.17**	.11*	-.32***	.36***	–				
13. Child’s social aggression (10 yr.)	-.14**	-.01	-.01	-.05	.06	.21***	.12*	.30***	.22***	-.10†	.09	.11†	–			
14. Child’s social aggression (14 yr.)	-.02	.02	-.03	-.06	.06	.16**	.11†	.21***	.17**	.12*	.05	-.01	.18**	–		
15. Child’s physical aggression (10 yr.)	-.11†	.02	.03	.03	.03	.17**	.16**	.26***	.19***	.06	.04	.09	.51***	.15**	–	
16. Child’s physical aggression (14 yr.)	-.19**	.03	-.02	.00	.12*	.15*	.21***	.26***	.34***	-.11†	.16**	.05	.24***	.38***	.25***	–

Note. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ , † $p < .10$ .

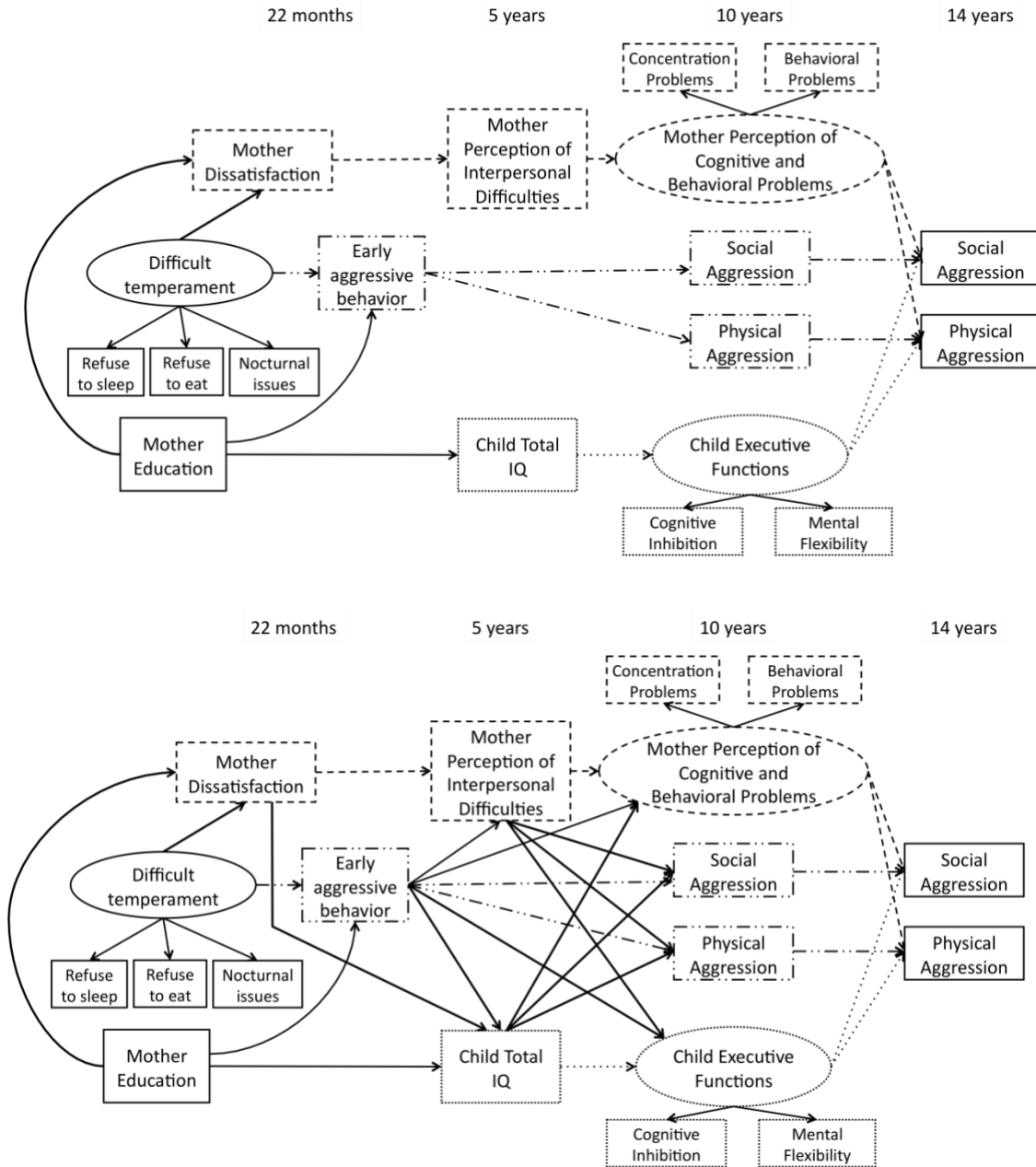


Figure 1. Hypothesized parallel pathways model (top panel) and alternative cross-pathway model (bottom panel). Variables with a dashed outline are part of the mother perception pathway toward violent behavior, variables with a combined dashed and dotted outline are part of the early aggressive behavior pathway, and variables with a dotted outline are part of the cognitive functioning pathway. Variables with a solid outline are not assigned to any specific pathway.

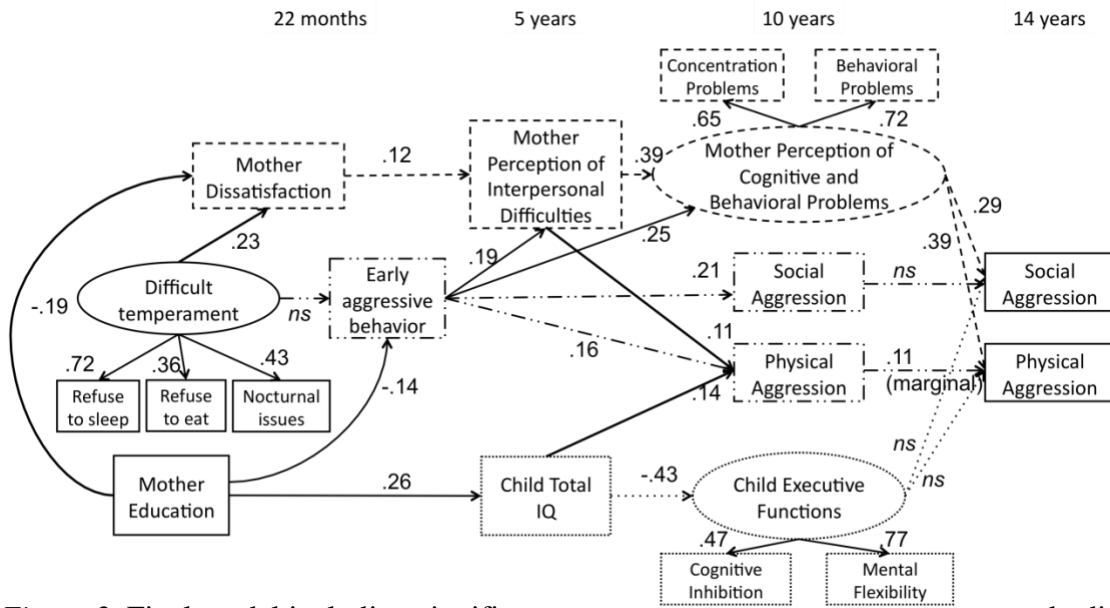


Figure 2. Final model including significant, standardized

coefficients. Variables with a dashed outline are part of the mother perception pathway toward violent behavior, variables with a combined dashed and dotted outline are part of the early aggressive behavior pathway, and variables with a dotted outline are part of the cognitive functioning pathway. Variables with a solid outline are not assigned to any specific pathway.