

Temperament, environment, and antisocial behavior in a population sample of preadolescent boys and girls

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Antisocial behavior can be triggered by negative social experiences and individuals' processing of these experiences. This study focuses on risk-buffering interactions between temperament, perceived parenting, socio-economic status (SES), and sex in relation to antisocial behavior in a Dutch population sample of preadolescents ($N = 2230$). Perceived parenting (overprotection, rejection, emotional warmth) was assessed by the EMBU (a Swedish acronym for My Memories of Upbringing) for children, temperament (effortful control and frustration) by the parent version of the Early Adolescent Temperament Questionnaire-Revised, SES by information on parental education, occupation, and income, and antisocial behavior by the Child Behavior Checklist (parent report) and the Youth Self-Report (child report). All parenting and temperament factors were significantly associated with antisocial behavior. The strongest risk-buffering interactions were found for SES which was only related to antisocial behavior among children with a low level of effortful control or a high level of frustration. Furthermore, the associations of SES with antisocial behavior were more negative for boys than for girls. Thus, the effects of SES depend on both the temperament and sex of the child.

Keywords: antisocial behavior; childrearing practices; preadolescence; sex differences; socio-economic status; temperament

Introduction

For the study of antisocial behavior of children and adolescents, both temperament and parenting have been shown to be important. Central to investigations that frame only main effects of temperament and parenting is the notion that children are similarly affected by the same parenting experiences. Contextual theorists (Bronfenbrenner & Morris, 1998) have argued that such a frame is incomplete. Environmental factors may vary in their developmental influence as a function of attributes of the child. Research has also shown that how parents rear their children is partially shaped by the parents' own characteristics and partially by the characteristics of the children that they bring up. Thus, a difficult temperament does not necessarily lead to antisocial behavior by itself; it does so in conjunction with particular environments (Bates, Dodge, Pettit, & Ridge, 1998; Collins, Maccoby, Steinberg, Hetherington, & Bornstein, 2000; Maccoby, 2000). Thomas and Chess (1977) called this a goodness of fit between an individual's temperament and the expectations and resources of specific contexts. Others talked about "risk-buffering" effects with regard to temperament-by-environment interactions (for example Belsky, Hsieh, & Crnic [1998]). The current study deals with such risk-buffering effects for pre-

adolescents on antisocial behavior, and the following paragraphs will explain why we believe such a study is necessary.

The home environment of children, with as important indicators the parenting style and the socio-economic status, has a profound impact on the development of children (Maccoby, 2000). It has been suggested that research that focuses on the interaction effects of parenting and child temperament might do more justice to the complexity of child development (Hinde, 1989; Magnusson & Stattin, 1998). Important recent studies on temperament-by-parenting interactions have been done by, amongst others, Kochanska (1995, 1997) and Belsky, Hsieh, and Crnic (1998). For example, Kochanska (1995, 1997) studied the development of conscience in young children, and discovered that for shy, temperamentally-fearful children, parental power-assertion does not appear to promote conscience development. Gentler techniques are called for with such slow-to-warm-up children. But with bold assertive children, effective parenting involves firmness, along with maternal responsiveness and the formation of a close emotional bond with the child. Belsky et al. (1998) concluded that children with a difficult temperament are most susceptible to parenting practices. Bates et al. (1998) investigated the interaction effect of the child's temperamental resistance to control and parents' restrictive control at an

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early age on externalizing behavior at ages 7 to 11 years. A robust finding was that early resistance to control predicted later externalizing behavior better when the mother had been relatively low in control actions, which fits with Kochanska's (1995, 1997) findings for toddlers. Given high resistance to control, the risk of later externalizing behavior by the child seems to be buffered by high control actions by the mother. Most research on such temperament-by-environment interactions has been done with toddlers and young children, and the question is whether and to what extent we can generalize the results of such studies to late childhood or adolescence.

There are a number of studies that have examined temperament-by-environment interactions in late childhood or adolescence and it is worthwhile having a look at their results. For example, Stice and Gonzales (1998) found in a sample of 631 adolescents aged 16–19 years that temperament interacted with perceived parenting in their effects on antisocial behavior. Effective parenting (i.e., maternal control) was most important for youths that were temperamentally at risk (i.e., high on behavioral undercontrol). They argued that because youth who evidence behavioral undercontrol show more variability in problem behaviors, parenting may have a greater opportunity to operate. Furthermore, Stice and Gonzales (1998) reasoned that adolescents who are behaviorally controlled are unlikely to evidence problem behaviors, regardless of the parenting they experience.

Consistently, other studies found that ineffective parenting was least harmful for youths that were not temperamentally at risk. For example, Wills, Sandy, Yaeger, and Shinar (2001) found in a sample of 1810 participants (mean age 11.5 years at the baseline) that the impact of parental risk factors, i.e. parent-child conflict and parental tobacco and alcohol use, on adolescent substance abuse decreased with higher task attention (focusing on tasks and persisting until finished) and positive emotionality (generally being in a cheerful mood and smiling frequently) of the preadolescent. Wills et al. (2001) argue that these temperamental factors promote adaptation through reducing reactivity to aversive stimuli, a resilience effect. Wills and Dishion (2004) say that, for example, the emergence of good self-control can serve as a resilience factor. Maziade et al. (1990) found that only the combination of difficult temperament and dysfunctional parenting (in particular inadequate behavioral control) in childhood was associated with an increased risk of developing psychiatric disorders in adolescence. Van Leeuwen, Mervielde, Braet, and Bosmans (2004) utilized data from a 3-year longitudinal study of 600 children (aged 7 to 15 at the baseline). They found that negative parental control was more related to externalizing behavior for undercontrollers (i.e., low on conscientiousness and benevolence and around the mean on imagination, extraversion, and emotional stability) than for resilient (i.e., high on imagination, conscientiousness, extraversion, benevolence, and emotional stability). Similar results have been found with young children (Rubin, Hastings, Chen, Stewart, & McNichol, 1998; Shaw et al., 1998). Sanson, Hemphill, and Smart (2004) concluded that the combination of irritable, difficult child temperament with poor, especially punitive, parenting adds to the prediction of antisocial behavior beyond their independent effects.

Most of the studies on temperament-by-environment interactions concerning preadolescents or adolescents have focused on parental control as environmental factor. This still leaves us with the question of whether the temperament-by-environment

interactions for externalizing behavior can also be found for other environments than parental control in adolescence. An answer to this question would be an important further step in the investigation of temperament-by-environment interactions and the present study is dedicated to this task. In our study, we will focus on preadolescent boys and girls (around age 11) and three parental environments (as perceived by the child) that have been found to have important direct effects on antisocial behavior: rejection, overprotection, and emotional warmth. A meta-analysis of Loeber and Stouthamer-Loeber (1986) has shown that not only lack of parental control but also parental rejection and parent-child involvement (i.e. emotional warmth) are powerful predictors of antisocial behavior of children and adolescents. Overprotection was not included in the meta-analysis of Loeber and Stouthamer-Loeber (1986). However, strong associations between overprotection and antisocial behavior have been found in recent cross-sectional and longitudinal research (Mak, 1994; Pedersen, 2000).

The study

To do more justice to the complexity of child development (Hinde, 1989; Magnusson & Stattin, 1998), we focus not only on main effects of sex, temperament, and environment but also on risk-buffering interactions between temperament and environment in relation to antisocial behavior. We define antisocial behavior as behavior that inflicts physical or mental harm or property loss or damage on others. It is behavior that intends to lower the well-being of other persons that may or may not constitute the breaking of criminal laws (Coie & Dodge, 1998; Loeber & Schmalzing, 1985; Rutter, Giller, & Hagell, 1998). It is a problem behavior that is at the forefront of current concerns about youths (Loeber, Farrington, Stouthamer-Loeber, & Van Kammen, 1998).

Environment

We will make use of perceived parenting rather than observed or parent-reported parenting. There is a good reason for this. Research shows that children are influenced by the rearing behavior of their parents through their mental representations of this behavior (Main, Kaplan, & Cassidy, 1985; Steinberg, Lamborn, Dornbusch, & Darling, 1992). Therefore, when investigating the role of parental practices, it is important to capture the child's perception of the upbringing.

The choice of perceived parenting styles included in our study has been inspired by the fact that several studies have found them to be strongly linked to antisocial behavior. It has been found that *perceived rejection* (characterized by hostility, punishment, derogation, and blaming of subject), and *perceived overprotection* (characterized by fearfulness and anxiety for the child's safety, guilt engendering, and intrusiveness) are both positively linked, whereas *perceived emotional warmth* (characterized by affection, attention, and support) is negatively linked to antisocial behavior (Bugental & Goodnow, 1998; Carlo, Roesch, & Melby, 1998; Dekovic, Janssens, & Van As, 2003; Farrington, 1990; Loeber & Stouthamer-Loeber, 1986).

In addition to the three perceived parental environments, we will also consider SES of the parents as an (objective) environment of the child. SES is a proxy for a number of important

aspects of parenting, and to our knowledge it has not yet been studied in interaction with temperament for preadolescents. SES has proven to be an important proxy for effects of social, cultural, and financial capital on child development that cannot easily be unpacked into factors such as parenting styles (Bradley & Corwyn, 2002). Duncan, Yeung, Brooks-Gunn, and Smith (1998) made clear that socioeconomic conditions in childhood have a big impact on the life chances of children. Heimer (1997) found that lower SES-youths were more likely than higher SES-youths to engage in violent delinquency. Dodge, Pettit, and Bates (1994) also found a relation of low SES to children's problem behavior, and Pinderhughes, Bates, Dodge, Pettit, and Zelli (2000) argue that lower SES parents have fewer cultural and educational resources to deal with children's problem behavior. Researchers also point to the impact of other SES aspects, i.e. occupational level and income (Beyers, Bates, Pettit, & Dodge, 2003; Farrington, 1990; Rutter et al., 1998). For example, the higher the occupational level of parents the higher their autonomy. This autonomy is related to other characteristics of the family, such as the lifestyle, the parenting style, and the aspirations of themselves and their children. Parents with a high occupational level educate their children more authoritatively, whereas parents with a low occupational level educate their children more restrictively (Kessler, Price, & Wortman, 1985; Kohn & Schooler, 1978, 1982). Thus, SES can be seen as a proxy for the human, cultural, and financial capital of a family that will not quite be made superfluous by parenting style.

Temperament

We have focused on two temperamental aspects – effortful control and frustration. Effortful control, denoting the ability to regulate attention and behavior, is believed to make major contributions to social development (Kochanska, Murray, & Harlan, 2000). Children with low effortful control are less likely to consider the possible consequences of their actions, especially consequences that are likely to be long-delayed. The inability to restrain undesirable, hedonic urges is positively associated with antisocial behavior (Caspi et al., 1995; Rothbart & Putnam, 2002; Sanson et al., 2004; Wills & Dishion, 2004). Frustration is a temperament feature characterized by negative affect related to goal blocking or an interruption of ongoing tasks. In other words, children with a high level of frustration react strongly and aversively to obstacles that prevent them from doing what they want. Frustration has been found to affect antisocial behavior positively (Caspi et al., 1994). A low level of frustration may be protective, leading to resilience (Sanson et al., 2004).

Potential confounders

Interpretation of associations between family circumstances and (risk factors for) antisocial behavior is hampered by potential confounders, including sex (Moffitt, Caspi, Rutter, & Silva, 2001) and genetic disposition (Heath, Neale, Kessler, Eaves, & Kendler, 1992; Molenaar, Boomsma, & Dolan, 1993).

Genetic risk factors may have a (direct) effect on both temperament and antisocial behavior, which could mean that observed associations between the two are spurious. In addition, the effect of genetic risk can be indirect, through gene-environment correlations. In other words, what seems to

be the effect of poor parenting behavior may actually be the effect of susceptibility genes, or vice versa (Kendler et al., 1995; Plomin, 1995; Rutter, 2002). To assess possible confounding, we included a proxy of genetic risk, that is, an index of familial externalizing psychopathology, in the analyses.

Hypotheses

Our first three hypotheses to be tested are straightforward. For the environment and temperament variables and for sex, we expect to replicate the direct effects on antisocial behavior already found in the literature. Thus, our *environment hypotheses* are that rejection and overprotection will be positively associated with antisocial behavior and that emotional warmth and SES will be negatively associated with antisocial behavior.

For temperament, we also expect to replicate the direct effects on antisocial behavior found in the literature. Thus, our *temperament hypotheses* are that effortful control will be negatively and frustration positively associated with antisocial behavior.

The activity level and the tendency to approach novel situations is higher for boys than for girls (Oldehinkel, Hartman, De Winter, Veenstra, & Ormel, 2004). Compared to girls, boys have less preference for close emotional communication, intimacy, and responsiveness within interpersonal relationships (Cyranowski, Frank, Young, & Shear, 2000; Rose & Rudolph, 2006). Boys tend to focus more on themselves and less on others (Feingold, 1994). For all these reasons, boys are more at risk of developing antisocial behavior (Eme, 1992; Gualtieri & Hicks, 1985; Shaw et al., 1998). Our *sex hypothesis* states that the risk of antisocial behavior will be higher for boys than for girls.

With regard to the temperament-by-environment interaction, we base our hypotheses on a *risk-buffering model*, which implies that we mix the perspectives of the environment effects being moderated by temperament and the effect of temperament being moderated by the environment. The major theoretical idea is the following. In the context of developmental psychology, *problem behavior* can be seen as behavior that clashes with the expectations of relevant others, irrespective of the motivation of the child. By contrast, *antisocial behavior* is problematic behavior with the self-reported or imputed intent to inflict harm on others. Certain risk factors (in our case a problematic temperament or parenting style) increase the likelihood of problem behavior – the more so, the higher the risks are. In turn, the higher the frequency of problem behavior, the higher the chance that it will lead to a path dependent development of antisocial behavior. Buffers are protective factors that reduce this chance of a path dependent development. The more frequent the problem behavior, the more the presence or absence of buffers will make a difference with regard to the likelihood that problem behavior will turn into antisocial behavior. The predicted interaction between risks and protective factors is thus the presumed result of buffers that lower the slope of the regression line between risks and antisocial behavior. Risk-buffering may involve both mitigation of the negative effects of a difficult temperament (or sex) by an effective environment (Stice & Gonzales, 1998) or mitigation of the negative effects of an ineffective environment by a favorable temperament (Wills, Sandy, Yaeger, & Shinar, 2001). In the former case environment and in the latter case temperament

serves to promote adaptation through reducing reactivity to aversive stimuli.

Our *protective environment hypotheses* are that the environment protective factors (emotional warmth and SES) will help reduce the more antisocial behavior where the child is temperamentally more at risk (low effortful control and high frustration). The same should hold for the higher risk due to sex. Boys can be expected to profit more than girls from environmental protection against undesirable, hedonic urges that result in antisocial behavior (see also: Sanson et al., 2004).

Our *protective temperament hypotheses* are that the temperamental protective factors (high effortful control and low frustration) will help reduce antisocial behavior more where the environment (overprotection, rejection) puts the child more at risk.

Method

Sample

This study is part of the TRacking Adolescents' Individual Lives Survey (TRAILS), a new prospective cohort study of Dutch preadolescents who will be measured biennially until they are at least 25 years old. The key objective of TRAILS is to chart and explain the development of mental health and social development from preadolescence into adulthood. The TRAILS target sample involved pre-adolescent boys and girls living in five municipalities in the North of the Netherlands, including both urban and rural areas.

The present study involves the first assessment wave of TRAILS, which ran from March 2001 to July 2002 (De Winter et al., 2005; Oldehinkel et al., 2004). Of all children approached for enrollment in the study (i.e., children selected by the municipalities and attending a school that was willing to participate; $N = 3,145$ children from 122 schools, with 90.4% of the schools responding), 6.7% were excluded because of incapability or language problems. Of the remaining 2,935 children, 76.0% were enrolled in the study, yielding a sample size of 2,230. Both the child and the parent consented to participate. The mean age of the children was 11.09 years ($SD = 0.55$); 50.8% were girls; 10.3% were children who had at least one parent born in a non-Western country; and 32.6% of children had parents with a low educational level (i.e., a lower track of secondary education was the highest level attained). We did not find any nonresponse bias in our study for the estimation of the prevalence rates of psychopathology, including antisocial behavior. Boys, children from lower social strata, and children with worse school performance were somewhat more likely to belong to the nonresponse group (De Winter et al., 2005).

Measures

Well-trained interviewers visited one of the parents (preferably the mother, 95.6%) at their homes to conduct an interview covering a wide range of topics, including the child's developmental history and somatic health, parental psychopathology, and care utilization. The parent was also asked to fill out a questionnaire. Children filled out questionnaires at school (in the classroom), under the supervision of one or more TRAILS assistants. In addition, intelligence and a number of biological and neurocognitive parameters were assessed individually (also

at school). Teachers were asked to fill out a brief questionnaire for all children in their class who were participating in TRAILS. Measures that were used in the present study are described more extensively in the following sections.

Antisocial behavior. Antisocial behavior was assessed by the Child Behavior Checklist (CBCL), one of the most commonly-used questionnaires in current child and adolescent psychiatric research (Achenbach, 1991b; Verhulst & Achenbach, 1995). It contains a list of 112 behavioral and emotional problems, which parents can rate as 0 = not true, 1 = somewhat or sometimes true, or 2 = very or often true in the past six months. In addition to the CBCL, we administered the self-report version of this questionnaire, the Youth Self-Report (Achenbach, 1991a). Test-retest reliabilities of the CBCL and YSR have been found to be good. Consistent with other reports (e.g., Achenbach, McConaughy, & Howell, 1987; Jensen, Traylor, Xenakis, & Davis, 1988; Verhulst & Van der Ende, 1992), the agreement between parent-reported and child-reported problems was only moderate ($r = .31$ for antisocial behavior). We feel that both informants perceive different aspects of problem behavior and differences between informants are meaningful. Antisocial behavior that is rated as present by both parent and child is assumed to be more severe (more generalized) than problems rated by only one informant. Based on this assumption, we used the mean of the parent and child scores as a measure of antisocial behavior in this study. An additional advantage of using the mean score is that it reduces the bias associated with mono-informant information (Angold & Costello, 1996; Sourander, Helstelä, & Helenius, 1999). The outcome variable deviated not much from normality (skewness = 1.07, kurtosis = 1.47).

Perceived parenting. The Egena Minnen Beträffande Uppfostran (My Memories of Upbringing) for Children [EMBU-C] (Markus, Lindhout, Boer, Hoogendijk, & Arrindell, 2003) has been developed to assess the perception of actual parental rearing by children and early adolescents. The original EMBU-C contained 81 items. Markus et al. (2003) have developed a shorter version. We used that version and dropped the Favoring Subject factor prior to administration, because it was a weak scale (an internal consistency below .60). Children could rate the EMBU-C as 1 = no, never, 2 = yes, sometimes, 3 = yes, often, 4 = yes, almost always. Each item was asked for both the father and the mother. The EMBU-C contains the factors Emotional Warmth, Rejection, and Overprotection. The main concepts of Emotional Warmth are giving special attention, praising for approved behavior, unconditional love, and being supportive and affectionately demonstrative. An example of an item is: "Do your parents make it obvious that they love you?" The Rejection factor is characterized by hostility, punishment (physical or not, abusive or not), derogation, and blaming of subject. An example of an item is: "Do your parents sometimes punish you even though you haven't done anything wrong?" The dimension Overprotection is characterized by fearfulness and anxiety for the child's safety, guilt engendering, and intrusiveness. An example of an item is: "Are your parents concerned about what you do after school hours?"

Principal components analysis (PCA) with three factors (Emotional Warmth, Rejection, and Overprotection) as criterion, followed by VARIMAX rotation, mainly confirmed the results of Markus et al. (2003). With the exception of five items of the Rejection scale, all items loaded on the right scale.

Five Rejection items (the items 8, 24, 35, 71, and 76 in the article of Markus et al.) had loadings lower than .30 or had a loading that differed less than .10 with the second highest loading. The loadings of these items were also relatively low, on average .36, in the study of Markus et al. (2003). We decided to exclude these items from further analyses. The three factors explained 34.0% and 32.5% of the variance in the ratings on fathers and mothers.

The scale for Emotional Warmth contained 18 items with an internal consistency of .91 for both fathers and mothers. The scale for Rejection contained 12 items with an internal consistency of .84 for fathers and .83 for mothers. The scale for Overprotection contained 12 items with an internal consistency of .70 for fathers and .71 for mothers. The answers for both parents were highly correlated ($r_s = .79$ for Emotional Warmth, .67 for Rejection, and .81 for Overprotection), so we felt it was justified to combine them. The test-retest stability of a shortened version of the EMBU-C (10-item scales) over a 2-month period has been found to be satisfactory, $r_s = .78$ or higher (Muris, Meesters, & Van Brakel, 2003). Markus et al. (2003) have reported on the validity of the EMBU-C.

Temperament. Temperament was assessed by the parent and the child version of the Early Adolescent Temperament Questionnaire-Revised [EATQ-R] (Ellis, 2002; Putnam, Ellis, & Rothbart, 2001). We used the parent version, because its factor structure was superior to that of the child version in our sample (Oldehinkel et al., 2004). The EATQ-R is a 62-item questionnaire based on the temperament model developed by Rothbart and colleagues (Putnam et al., 2001). Effortful Control is the capacity to voluntarily regulate behavior and attention (11 items, $\alpha = .86$). Frustration is the negative affect related to goal blocking or an interruption of ongoing tasks (5 items, $\alpha = .74$). To the best of our knowledge, no test-retest data of the EATQ-R are currently available.

Sex and SES. The sample consisted of 50.8% girls and 49.2% boys. The TRAILS database contains various variables for SES: income level, educational level of both the father and the mother, and occupational level of each parent, using the International Standard Classification for Occupations (Ganzeboom & Treiman, 1996). SES has been measured as the average of

the five items (standardized). The SES scale captures 61.2% of the variance in the five items and has an internal consistency of .84. Missing values (e.g., when there is only one parent in the family) did not affect the association of this scale with other variables.

Familial vulnerability to externalizing psychopathology. Parental psychopathology with respect to depression, anxiety, substance abuse, antisocial behavior, and psychoses was measured by means of the Brief TRAILS Family History Interview, administered at the parent interview. Each syndrome was introduced by a vignette describing its main symptoms and followed by a series of questions to assess lifetime occurrence, professional treatment, and medication use. The scores for substance abuse and antisocial behavior were used to construct a Familial Vulnerability index for Externalizing Disorder. For each syndrome, parents were assigned to any of the categories 0 = (probably) not, 1 = (probably) yes, and 2 = yes and treatment/medication (substance abuse) or picked up by police (antisocial behavior). The Brief TRAILS Family History Interview yielded lifetime rates that were by-and-large comparable to those found in studies that employed CIDI-interviews, with the exception of fathers' rates for substance abuse, which were relatively low (Ormel et al., 2005; Veenstra et al., 2005).

Analysis

Sex differences were examined by means of *t*-tests; associations between variables by means of Pearson correlations. Main and interaction effects of sex, SES, parenting, and temperament on antisocial behavior, adjusted for familial externalizing psychopathology, were tested by multiple linear regression analyses. To ensure sufficient power for the interaction effects, we wanted to keep the number of interactions fairly small and hence performed separate analyses for SES, Emotional Warmth, Overprotection, and Rejection. Subsequently, interactions that were significant in the separate analyses were included in a model encompassing all variables.

A *p*-value smaller than .05 was considered statistically significant. Because we performed many statistical tests, the results may suffer from capitalization on chance: one would expect some 5% of the associations examined to be significant

Table 1

Sex differences in antisocial behavior, environment, temperament, and familial vulnerability to externalizing psychopathology

Variable	Girls			Boys			Difference		
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>T</i>	<i>df</i>	<i>p</i>
Antisocial Behavior ^a	0.22	0.15	1128	0.29	0.18	1094	-9.95	2220	<.01
<i>Environment</i>									
SES	-0.03	0.78	1115	-0.07	0.82	1073	1.39	2186	.16
Overprotection	1.84	0.37	1123	1.88	0.39	1083	-2.81	2204	<.01
Rejection	1.45	0.29	1123	1.51	0.33	1083	-5.01	2154	<.01
Emotional Warmth	3.26	0.49	1124	3.16	0.51	1083	4.81	2205	<.01
<i>Temperament</i>									
Effortful Control	3.35	0.65	1013	3.10	0.69	972	8.16	1983	<.01
Frustration	2.74	0.64	1012	2.84	0.68	971	-3.35	1981	<.01
<i>Other</i>									
Fam. Ext. Psych.	0.14	0.42	1107	0.14	0.42	1058	0.11	2163	.91

^a Mean of standardized and transformed parent and self-report scores.

merely on the basis of chance. Hence, a statistically significant result in this context does not have the same weight as a significant result in an experimental design.

To provide an impression of the effect size and facilitate the interpretation of the interaction effects, we wrote out multiple equations, alternating the values of the predictor variables (1 standard deviation below and above the mean for the parenting and temperament variables, 0 and 1 for girls and boys) while holding other variables to their sample means. The resulting predicted antisocial behavior scores were plotted in a series of graphs.

We employed corrected-item-mean (CIM) imputation to handle missing data at the item level (Huisman, 2000). At the scale level we did multiple imputation using the MICE method of multivariate imputation (Allison, 2002; Royston, 2004; Van Buuren, Boshuizen, & Knook, 1999). These procedures assume the data are missing at random. See Table 1 for the amount of missing data. As a result of the imputations we could use all 2,230 cases in our analyses.

Results

Descriptives

Table 1 contains means and standard deviation of antisocial behavior, parenting, temperament, SES, and familial externalizing psychopathology, separately for boys and girls. Because SES was based on a standardized score, the mean is close to 0. Familial externalizing psychopathology was highly skewed to the right, with a mean of 0.14 and a maximum of 4.32. All other means represent mean item scores (range Antisocial Behavior 0–2, parenting variables 1–4, temperament variables 1–5).

Except for SES and familial externalizing psychopathology, all variables showed significant sex differences. Girls perceived less Overprotection and Rejection, and more Emotional Warmth than boys. Furthermore, they scored higher on Effortful Control and lower on Frustration and antisocial behavior.

Correlations between the variables are presented in Table 2, above the diagonal for girls, below the diagonal for boys. All parenting and temperament variables were moderately associated with antisocial behavior and with each other. Familial externalizing psychopathology was positively associated with antisocial behavior and negatively associated with Effortful Control and SES but not related to perceived parenting

behaviors. The correlation between Overprotection and Emotional Warmth was higher for boys (.25) than for girls (.13). Rejection and SES were significantly related for girls, but not for boys.

Testing the hypotheses

Direct effects. Table 3 shows the results of the analyses with respect to the interaction of temperament (Effortful Control and Frustration) and environment (Overprotection, Rejection, Emotional Warmth, and SES). In order to control for possible confounding effects of genetic risk which may affect both temperament and antisocial behavior, we controlled for familial vulnerability to externalizing psychopathology (as a proxy for genetic risk) in the regression. Our environment hypotheses stated that Rejection and Overprotection will be positively associated with antisocial behavior and that Emotional Warmth and SES will be negatively associated with antisocial behavior. We see from Table 3 that, as predicted, Overprotection and Rejection are significantly positively associated and Emotional Warmth and SES significantly negatively associated with antisocial behavior. Our temperament hypotheses stated that Effortful Control will be negatively and Frustration positively associated with antisocial behavior. These hypotheses are also supported by our results. Our sex hypothesis stated that being a boy will be more positively related to antisocial behavior than being a girl. Our results are in line with this hypothesis.

Interaction effects. Our *protective environment hypotheses* stated that the environment protective factors (Emotional Warmth and SES) will help reduce the more antisocial behavior where the preadolescent is temperamentally more at risk (low Effortful Control and high Frustration). From Table 3, we see that there are significant interactions of Emotional Warmth with Frustration and SES with Effortful Control and Frustration, consistent with the hypothesis. Observe though, that in the simultaneous model, the interaction of Emotional Warmth and Frustration on antisocial behavior is only significant at the .10 level. To ease the interpretation of the results from the simultaneous model, predicted antisocial behavior scores for each combination of SES and temperament factor were plotted in a series of graphs, see Figure 1. Low and high Effortful Control and Frustration denote, respectively, one standard deviation below and above the mean. The interactions of Effortful Control and Frustration with SES are illustrated by

Table 2

Correlations between antisocial behavior, environment, temperament, and familial vulnerability for girls and boys (correlations above and below the diagonal, respectively)

	<i>Antisocial Behavior</i>	<i>Overprotection</i>	<i>Rejection</i>	<i>Emotional Warmth</i>	<i>SES</i>	<i>Effortful Control</i>	<i>Frustration</i>	<i>Familial Vulnerability</i>
Antisocial Behavior	–	.25	.44	–.23	–.12	–.37	.46	.13
Overprotection	.20	–	.46	.13*	–.10	–.03	.07	.08
Rejection	.40	.41	–	–.33	–.10*	–.16	.18	–.01
Emotional Warmth	–.24	.25*	–.31	–	.17	.18	–.11	–.01
SES	–.17	–.07	.00*	.13	–	.16	–.06	–.21
Effortful Control	–.37	–.07	–.16	.15	.15	–	–.39	–.14
Frustration	.49	.09	.16	–.09	–.06	–.41	–	.07
Familial Vulnerability	.10	.02	.00	–.04	–.21	–.10	.06	–

Bold: $p < .01$; * Significant sex difference.

Table 3

Main effects and interactions (standardized coefficients) of sex, temperament, environment, and their interactions on antisocial behavior: separately and simultaneously for overprotection, rejection, emotional warmth, and SES

Variable	Model 1: Overprotection (R ² = .34)		Model 2: Rejection (R ² = .41)		Model 3: Em. Warmth (R ² = .34)		Model 4: SES (R ² = .33)		Simultaneous Model (R ² = .43)	
	B	SE ^a	B	SE ^a	B	SE ^a	B	SE ^a	B	SE ^a
<i>Main Effects</i>										
Sex (1 = boys)	.27	(.04)**	.24	(.03)**	.26	(.04)**	.28	(.04)**	.22	(.03)**
Overprotection	.17	(.02)**	–	–	–	–	–	–	.07	(.02)**
Rejection	–	–	.31	(.02)**	–	–	–	–	.25	(.02)**
Emotional Warmth	–	–	–	–	–.15	(.02)**	–	–	–.06	(.03)*
SES	–	–	–	–	–	–	–.09	(.02)**	–.03	(.02)
Effortful Control	–.20	(.02)**	–.17	(.02)**	–.18	(.02)**	–.20	(.02)**	–.15	(.02)**
Frustration	.37	(.02)**	.35	(.02)**	.38	(.02)**	.38	(.02)**	.34	(.02)**
Familial Vulnerability	.06	(.02)**	.08	(.02)**	.07	(.02)**	.05	(.02)*	.06	(.02)**
<i>Temperament-by-environment</i>										
Overprotection × Effortful Control	–.02	(.02)	–	–	–	–	–	–	–	–
Overprotection × Frustration	.04	(.02)*	–	–	–	–	–	–	.01	(.02)
Rejection × Effortful Control	–	–	.01	(.02)	–	–	–	–	–	–
Rejection × Frustration	–	–	.07	(.02)**	–	–	–	–	.04	(.02)~
Em. Warmth × Effortful Control	–	–	–	–	.01	(.02)	–	–	–	–
Em. Warmth × Frustration	–	–	–	–	–.08	(.02)**	–	–	–.04	(.02)~
SES × Effortful Control	–	–	–	–	–	–	.06	(.02)**	.05	(.02)**
SES × Frustration	–	–	–	–	–	–	–.08	(.02)**	–.06	(.02)**
<i>Sex Interactions</i>										
Sex × Emotional Warmth	–	–	–	–	–	–	–	–	–.04	(.04)
Sex × SES	–	–	–	–	–	–	–	–	–.07	(.03)*

^a Tests were two-tailed. ***p* < .01; **p* < .05; ~ *p* < .10.

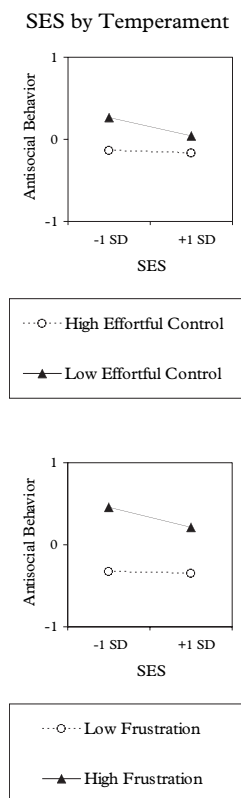


Figure 1. Graphical presentation of the interaction of SES and Temperament in relation to Antisocial Behavior.

steeper lines for high Frustration compared to low Frustration and low Effortful Control compared to high Effortful Control. Simple slope analyses (Aiken & West, 1991) revealed that SES was significantly related to antisocial behavior at one standard deviation below the mean of Effortful Control ($b = -.08$, $t(2226) = -2.38$, $p = .02$), but not at one standard deviation above the mean of Effortful Control ($b = .02$, $t(2226) = 0.62$, $p = .54$). Furthermore, it was significantly related to antisocial behavior at one standard deviation above the mean of Frustration ($b = -.09$, $t(2226) = -2.79$, $p < .01$), but not at one standard deviation below the mean of Frustration ($b = .03$, $t(2226) = 0.92$, $p = .36$).

With regard to sex, we see in the last model in Table 3 an interaction effect with SES, which indicates that SES relates negatively to antisocial behavior for boys ($b = -.10$, $t(2226) = -3.99$, $p < .01$) and not for girls ($b = -.03$, $t(2226) = -1.23$, $p = .22$). This is in line with our expectation. Against our prediction, we find no extra protective effect of emotional warmth for boys.

Our protective temperament hypotheses stated that the temperamental protective factors (high Effortful Control and low Frustration) will help reduce antisocial behavior the more the environment (Overprotection, Rejection) puts the child at risk. From Table 3, we see that there is a significant interaction effect of Overprotection as well as Rejection with Frustration. The protective temperament hypotheses with Effortful Control were disconfirmed. Observe though, that in the simultaneous model, only the interaction between Rejection and Frustration remains (marginally) significant. Simple slope analyses (Aiken & West, 1991) revealed that Rejection was indeed a somewhat

weaker predictor of antisocial behavior at one standard deviation below the mean of Frustration ($b = .21$, $t(2226) = 6.71$, $p < .01$) than at one standard deviation above the mean of Frustration ($b = .29$, $t(2226) = 9.42$, $p < .01$).

Discussion

The results support our *environment hypotheses* and reaffirm similar findings in other studies. All parenting characteristics examined in our study (emotional warmth, overprotection, and rejection) appeared to be related to antisocial behavior. Because they were adjusted for familial externalizing psychopathology, the associations are unlikely to be spurious on account of genetic risk. Consistent with previous studies, we found that rejection was positively linked and that emotional warmth was negatively linked to antisocial behavior (Bugental & Goodnow, 1998; Carlo et al., 1998; Dekovic et al., 2003). These results are also in line with Farrington (1997) who argued that children who are exposed to poor parenting practices may be more likely to offend because they do not build up internal inhibitions against socially-disapproved behavior. Results in the literature with respect to overprotection have been more equivocal. Various studies identified lack of care as the predominant risk factor (e.g., Enns, Cox, & Clara, 2002), some found, in addition to a lack of parental care, overprotection to be related to antisocial behavior (Rey & Plapp, 1990; Reti et al., 2002). The reasoning behind our hypothesis about a positive association of antisocial behavior with overprotection, is that autonomy is valued highly among children and antisocial behavior might be an act of protest against too much parental interference (related to this are discussions about the impact of a maturity gap: Moffitt, 1993).

Our *temperament hypotheses* that effortful control will be negatively and frustration positively associated with antisocial behavior were also supported. Again, spurious associations due to familial vulnerability are unlikely. Consistent with earlier studies, we found effortful control to be negatively associated with antisocial behavior. Children with low effortful control, that is with a limited ability to regulate attention and behavior, are less likely to consider the possible consequences of their actions, especially consequences that are likely to be long-delayed. The inability to restrain undesirable, hedonic urges by considering their consequences may result in antisocial behavior. Frustration reflects the tendency to experience negative feelings if things do not run according to plan. It was positively associated with antisocial behavior. If the efforts to reach a goal do not succeed, the situation involves loss, and the irritation and anger associated with blocked goals renders highly-frustrated children prone to externalizing (Caspi et al., 1995; Kochanska et al., 2000; Rothbart & Putnam, 2002). We found that boys were more at risk of developing antisocial behavior than girls. This replicates previous findings and is consistent with our *sex hypothesis*.

The hypotheses on *temperament-by-environment interactions* were based on the idea of risk-buffering which can also be found in a variety of other studies, even though not much yet in studies on preadolescents and with other environments than parental control (Bates et al., 1998; Belsky et al., 1998; Kochanska, 1995, 1997; Sanson et al., 2004; Stice & Gonzales, 1998; Wills et al., 2001). We predicted that environmental factors that protect against the risk of antisocial behavior (emotional warmth, SES) are assumed to be more

helpful for children who are temperamentally (or because they are boys) more at risk of committing antisocial behavior. Conversely, temperamental factors that protect against the risk of antisocial behavior (effortful control and low frustration) are assumed to work better for children who are environmentally more at risk (because of overprotection and rejection). Seemingly, SES has extra protective effects for preadolescents who are temperamentally at risk of committing antisocial behavior. This is in line with other research showing that relations of parenting to self-regulation have been found to be stronger in more disadvantaged, i.e. low SES, populations (Raver, 2004).

It turned out that SES is almost exclusively protective for preadolescents who are at risk either because of a difficult temperament (low effortful control or high frustration) or because of sex (being a boy means a higher risk of antisocial behavior). This makes it extra important to consider interaction effects when studying the impact of SES on antisocial behavior. Lynam et al. (2000) found a similar interaction between temperament (high impulsivity) and environment (neighborhood). A poor neighborhood, defined by the census-SES, had only an effect on juvenile offending for impulsive boys and not for non-impulsive boys.

Maybe the mechanisms linked to SES, as identified by Pinderhughes et al. (2000), can help us explain such temperament by environment effects. They found that higher SES is associated with less attribution of hostile intent when the child misbehaves and with more alternative discipline strategies than physical punishment. When parents are better able to distinguish hostile intent from temperamental sources (lack of effortful control and being easily frustrated) of antisocial behavior and when they have a wider repertoire of discipline strategies to deal with them, they are more likely to buffer the effects of non-hostile temperamental problems.

We have no ready explanation as to why the interactions with emotional warmth are weaker (with frustration) or absent (with effortful control). We can only speculate that parental emotional warmth bleeds into overprotection for children who are at risk of committing antisocial behavior. In Table 2, we can see that emotional warmth correlates .25 with overprotection for boys and .13 for girls. This suggests that emotional warmth does indeed bleed into overprotection and that it does so more for boys than for girls. The extra protective effect of emotional warmth may thus be counteracted by its closeness to overprotection exactly for those preadolescents who are most at risk of antisocial behavior.

With regard to the fact that we found no strong indications that favorable temperaments are extra protective when environmental risk is high, we also have no ready explanation (we only found interaction effects of overprotection and rejection with frustration, indicating that low frustration buffers the effect of environmental risk, but this effect is considerably weakened when the interactions with SES are added). Here too we can only speculate. It is possible that with regard to rejection, there is a confounding effect with negative aspects of temperament. In part, parents may reject the child because of the negative temperamental aspects (see correlations in Table 2). This confound may mask the risk-buffering effect of favorable temperament. For overprotection, we mentioned already that preadolescents might commit antisocial behavior as an act of protest against excessive parental interference. In this case high effortful control and low frustration would not have much mitigating influence. This interpretation is supported by the fact that at least in Dutch society, individual autonomy is

considered very important, especially by young generations. In older age groups and in cultures that value maintenance of affective bonds among family members more highly, parental over-interference is less likely to cause protest behavior (see also: Lui, 2003; Liu et al., 2005). Future research may profitable deal with these possibilities.

Strengths, limitations, and future directions

Our study has a number of notable strengths: It addresses an age group for which so far there have been few studies concerning temperament-by-environment interactions. In addition, the studies with these kinds of interactions for preadolescents had done so mainly for parental control. By contrast, we investigated overprotection, rejection, parental warmth and SES. To our knowledge, our study is the first to look at the temperament-by-environment interaction for preadolescents involving SES for preadolescents. It turned out that for SES there are indeed important interaction effects that should also be explicitly included in future studies. There are also a number of methodological strengths of our study. It included a large sample size, measurement of a number of potential confounders, the use of parent report to assess temperament and child report to assess parenting (instead of using a single informant for both sets of data), and measurement of antisocial behavior with reports from multiple informants.

Clearly, there are also limitations. First, the study was based on data at one time point from a single age group. The longitudinal nature of our survey, TRAILS, allows us to investigate prospective relations in the future. However, even before longitudinal data are available, it is worthwhile investigating temperament-by-environment interactions in order to check the robustness of direct environmental and temperamental factors in relation to interaction effects, and to get a better grip on the possible puzzles to be investigated with a longitudinal data set. For example, a variety of interesting puzzles came to the fore, such as the possible extension of emotional warmth into overprotection; or the possibility that antisocial behavior is not curbed by favorable temperament when it is protest behavior; or the possibility of gene-environment interactions. Of course, in addition to these puzzles, there are aspects of the association between temperament and environment that at present transcend our efforts but may come into reach in the future. For example, a child who starts with more frustration would likely experience more parental rejection and less warmth, which would act to retard effortful control development. These processes would continue in a transactional fashion, as temperament moderates the impact of the environment while also shaping the nature of parent-child interaction (Wills & Dishion, 2004; see for a discussion of gene-environment correlations: Rutter et al., 1998). Second, we relied on questionnaire measures. Studies investigating effects of parenting on social development using observations usually show larger effect sizes than studies centering on child or parent reports (Collins et al., 2000). Given the large sample size, we could not include observations of parenting practices but had to work with children's perceptions of actual parental rearing. However, the main effects on antisocial behavior were strong for all perceived parenting and temperament aspects. Thus, it seems that temperament and environment are strongly related to antisocial behavior. Third, predictors and outcome variable were based on information from only two informants (children and parents). This carries the risk of inflated associ-

ations, although it should be noted that our study is much less prone to this risk than the many studies that use data from a single informant. Finally, our measure of familial vulnerability to externalizing disorder was based on a proxy, the retrospective information from the mother. We hope that in the future, this information can be combined with information from both parents and with genetic information to be gathered in one of the following waves of TRAILS.

Future research may fruitfully investigate our speculative explanations of the fact that we did not find some temperament-by-environment interactions. Another important extension to our study would be to include feedback loops, because parenting is bi-directional and reciprocal. Parents have an impact on children but children also influence their parents (Bell, 1968; Gallagher, 2002; Kerr & Stattin, 2003; Maccoby, 2000). The longitudinal nature of our study will allow us to use such a bi-directional approach in the future. A third important extension would be to include other environmental factors, such as neighborhood context and peer influences, in the model (Beyers et al., 2003; Wills & Dishion, 2004). The search for temperament-by-environment interactions is an exciting and promising research area that will help to improve our understanding of pathways to adaptive and maladaptive development.

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