

# Temperamental predictors of externalizing problems among boys and girls: a longitudinal study in a high-risk sample from ages 3 months to 15 years

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**Abstract** In a high-risk community sample, we examined the role of regulative temperament and emotionality as well as the extent of gender specificity in the development of externalizing problems. 151 boys and 157 girls born at differing degrees of obstetric and psychosocial risk were followed from birth into adolescence. In infancy and childhood, NYLS-derived temperamental characteristics were assessed by a highly structured parent interview and standardized behavioral observations. At age 15 years, externalizing problems were measured by the Child Behavior Checklist. As revealed by multiple linear regression and logistic regression, low regulative abilities predicted adolescent behavioral and attentional problems over and above obstetric and psychosocial risks. Gender specificity was found in the strength of the association rather than in the kind with a stronger long-term prediction from infant and toddler temperament in girls. Compared to regulative abilities, temperament factors describing aspects of mood and fear/withdrawal versus approach tendencies played a minor role in the development of externalizing problems. Findings are discussed in terms of gender-

specific risk factors and possible differential developmental trajectories to subtypes of disruptive behavior.

**Keywords** Temperament · Externalizing problems · Development · Gender · Risk

## Introduction

A variety of studies has shown that the development of externalizing behavior problems is associated with certain temperamental styles. Thomas and Chess [52–54] whose pioneering New York Longitudinal Study (NYLS) had a great influence on temperament research defined the difficult child factor as comprising five of the nine temperamental dimensions proposed in their model: withdrawal, slow adaptability, prevailing negative mood, high intensity of response and dysrhythmicity, and emphasized its significance as a risk factor for later psychopathology. Other researchers have confirmed that difficultness is concurrently associated with or can predict child externalizing as well as internalizing problems [18, 19, 24, 33, 37, 43, 50].

However, the difficult child concept has also been questioned due to the use of varying definitions and a lack of specificity for later emotional and behavioral problems [23, 36]. It has been argued that the concept comprises several basic dimensions containing features of both regulative temperament factors and emotionality/neuroticism which may be differentially related to externalizing or internalizing problems, respectively [16, 35]. Emotionality/neuroticism or negative emotionality encompasses distinct lower-order traits such as fear, anxiety, sadness, irritability or anger/frustration [35, 51]. Anger/frustration and irritability or irritable distress appear to be more strongly related to conduct problems, whereas fear, anxiety, and sadness are

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predominantly associated with internalizing problems. In contrast, low levels of fear are associated with conduct problems [16, 35, 36].

Furthermore, not all replication studies on the NYLS dimensions could confirm the same factor structure [33, 40, 41, 50]. In our prospective longitudinal study of at-risk children, a principal component analysis (PCA) of NYLS-derived temperament dimensions resulted in a two-factorial structure [40]. The first factor resembles aspects of difficulty (with strong loadings of mood and approach/withdrawal), whereas the second factor labeled self-control/behavioral control contains traits such as attention/persistence, distractibility/soothability, and negative loadings of activity and intensity. As a result, our control factor shows similarities with conscientiousness or constraint (for review see [36, 51]) and shares features of attentional control with the concept of effortful control described by Rothbart et al. [46]. The higher-order trait of conscientiousness/constraint or effortful control refers to self-regulative processes and executive functioning. Low levels of children's regulatory abilities have been consistently linked to aggression, conduct problems, and attention problems [8, 17, 36–39, 51, 56].

Increasingly, additive or interactive contributions of regulatory abilities and irritable distress are thought to characterize the temperamental vulnerability to externalizing problems [16, 35, 36, 51]. However, others found only weak additive effects of anger/frustration to the impact of effortful control on early externalizing problems [38].

Since the children in their study group were 3 years, Olson et al. hypothesized that the relation between anger and effortful control would become stronger in later years “due to increasing levels of adverse social experiences” ([38], p. 40). On the other hand, it has been argued that, by the age of 3 years, temperament already substantially reflects the influence of the social milieu [21]. In a recent study, we have shown that children's regulatory abilities from the age of 2 years on are inversely related to the degree of psychosocial adversity present at birth [40].

Environmental factors, especially high levels of cumulative family adversity and ecological risks, exert not only a negative impact on the emergence of emotional self-regulation [44], but also constitute risk factors for the development of externalizing problems [21, 29, 38]. To account for environmental effects in models of temperament and psychopathology, most researchers controlled for the socioeconomic status (SES). However, although SES is associated with a range of biological and psychosocial risk factors, family adversity as a cumulative risk index was found to have a developmental impact independent of material conditions or social status [10, 27, 49]. Moreover, family adversity better characterizes the proximal familial

risks, and although more frequently present in low SES samples, it can be found at any SES level [49]. Olson et al. [38] described for the first time independent contributions of effortful control and psychosocial adversity to concurrently measured externalizing problems. However, they confined the social risk to parenting behavior and marital discord. To extend these findings we used a more comprehensive psychosocial risk index adapted from the Family Adversity Index of Rutter and Quinton [48], and additionally a measure of perinatal insults to study the prediction of adolescent externalizing behavior.

We looked further for gender-differences, since previous results from our longitudinal sample support gender-specific temperamental trajectories in the developmental course [28, 40]. Also, environmental factors such as family dysfunction or poor parenting practices may differentially affect girls' behavior problems relative to boys [22, 31, 55]. Since verbal abilities are known to modulate the development of externalizing behavior problems, we also controlled for the influence of language development.

To summarize, the aim of the present study was to examine in a high-risk community sample followed over 15 years the cumulative contribution of child temperament factors together with obstetric and psychosocial risks present at birth to adolescent externalizing problems. Secondly, we were interested in gender differences in the developmental trajectories.

## Subjects and methods

### Participants

Participants in this investigation are from the Mannheim Study of Risk Children, an ongoing prospective longitudinal study of the long-term outcome of early risk factors followed from birth to adolescence [29]. The initial sample consisted of a cohort of 362 infants born between 1986 and 1988, who were recruited from two obstetric and six children's hospitals from the Rhine–Neckar region of Germany. Depending on pregnancy and birth history and on family background, children were assigned to one of nine groups of a two-factorial design, with factor I representing the degree of obstetric risk (perinatal complications) and factor II representing the degree of psychosocial risk (family adversity). Each factor was scaled as no risk, moderate risk or high risk. All groups were of roughly equal size, with a slight oversampling in the high-risk combinations and with sex evenly distributed in all subgroups. To control for confounding effects of family environment and infant medical status, only firstborn children with single births and German-speaking parents were enrolled in the study. Additionally, children with

severe physical handicaps, obvious genetic defects, or metabolic diseases were excluded. The participation rate at the time of recruitment was 64.5%, with a slightly lower rate in families from psychosocially disadvantaged backgrounds. The participants were primarily Caucasians. Assessments were conducted at the ages of 3 months at and 2, 4.5, 8, 11, and 15 years. Additional details on this sample have been reported previously [29, 30]. Participants with severe handicaps (IQ <70 or neurological disorder,  $N = 19$ ) were excluded from the original sample. The prevailing investigation included 308 participants (151 male, 157 female) for whom complete longitudinal data were available. The study was approved by the ethics committee of the University of Heidelberg and the parents of all participants gave their written informed consent.

#### Measures of infant risk characteristics

From a large number of pre-/peri- and postnatal complications assessed in detail some particularly reliable items were selected to define the obstetric risk [13]. No risk: born full-term, normal birth weight, and no medical complications ( $n = 107$ , 46.7% males). Moderate risk: preterm birth or preterm labor or edema–proteinuria–hypertension–gestosis of the mother but no severe complications ( $n = 107$ , 56.1% males). High risk: very low birth weight, or clear case of asphyxia with special care treatment, or severe complications during the first 7 days of life ( $n = 94$ , 43.6% males) (for precise definition see Appendix A).

The definition of psychosocial risk was based on the Family Adversity Index of Rutter and Quinton [48] adapted to the specific situation of young families. Eleven risk factors were defined as follows: low education level of parents, crowded living conditions, psychiatric disorders of the parents according to DSM-III-R, delinquency or institutional care in the parents history, troubled relationship between the parents, early parenthood, one-parent family, complete rejection of pregnancy, lack of social integration and support, severe chronic difficulties, and lack of coping skills. No psychosocial risk was defined as no risk factors present ( $n = 108$ , 46.3% males), moderate risk as one or two risk factors ( $n = 95$ , 52.6% males) and high risk as three or more risk factors present ( $n = 105$ , 48.6% males) (for precise definition see Appendix B).

#### Assessment of verbal abilities

Verbal abilities were measured at 4.5 years using four subtests (Grammatical closure, Auditory association, Auditory closure, and Auditory reception) of the German version of the Illinois Test of Psycholinguistic Abilities [26].

A composite verbal intelligence score was formed as the mean of the respective scales.

#### Assessment of childhood temperament

Temperamental characteristics were measured in two ways at each assessment from the age of 3 months until the age of 11 years: within the frame of a standardized parent interview and during structured direct observations in four standardized settings on two different days in both familiar (home visit, psychological assessment) and unfamiliar surroundings (neurological examination, EEG recording). This procedure provides two advantages: the assessment is neither based on parental information alone nor on a one-time observation. Both distortion by parental characteristics and lack of generality are critical issues in the discussion of temperament measures [4, 42, 47].

All ratings were made by trained judges on 5-point rating scales of nine temperamental dimensions adapted from the NYLS [52]. The dimensions consisted of (1) activity, ranging from being inactive and slow to being overactive and restless, (2) rhythmicity, referring to the regularity in biological functions (at the age of 11 years also including regularity of habits), (3) approach/withdrawal (4) adaptability (at the age of 11 years also including aspects of manageability), (5) threshold of responsiveness, ranging from being oversensitive to insensitive or “thick-skinned”, (6) intensity of reaction, ranging from apathetic to irritable/boisterous, (7) the prevailing mood on a continuum between positive and negative mood, (8) distractibility/soothability (not assessed at 11 years), and (9) attention span/persistence. At the ages of 3 months and 2 years the interrater reliability was measured in a preliminary study of 30 children each. Satisfactory interrater agreement was obtained between two raters (3 m: mean kappa = 0.68, range 0.51–0.84; 2 years: mean kappa = 0.82, range 0.52–1.00). Due to organizational demands as a part of a wide-ranging longitudinal investigation at the later assessments, no reliability studies of the temperamental measures could be done. To avoid distortions resulting from parental judgment or one-time observations in an unfamiliar surrounding, a mean score was formed out of all five ratings (parent interview and behavioral observations) for each dimension except for rhythmicity, which solely is based on parental judgment.

PCA procedures revealed a two-factor solution at each assessment (for details see [40]). In both genders until the age of 8 years, the first factor resembled in its bipolar spectrum the easy–difficult trait. It was primarily defined by loadings of distractibility/soothability, mood, approach/withdrawal, and adaptability and explained 38% of variance at the age of 3 months (37% at 2 years, 42% at

4.5 years, and 34% at 8 years). The second temperament factor, self-control comprised attention/persistence, distractability/soothability, and negative loadings of activity and intensity. It explained 18% of variance at the age of 3 months (24% at 2 years, 25% at 4.5 years, and 26% at 8 years).

At the age 11 years, a markedly different two-factorial structure was found with slightly different factor loadings in both genders. In the boys, approach/extraversion (explaining 28% of the variance) was defined by loadings of activity, approach, positive mood, and intensity on one pole of its bipolar spectrum. In the girls, this factor comprised additionally a negative loading from rhythmicity/regularity (explaining 29% of the variance). The boys' behavioral control comprised primarily adaptability/manageability, attention/persistence, positive mood, and rhythmicity/regularity as well as a negative loading of activity, albeit in a weaker manner (explaining 28% of the variance). The female behavioral control additionally comprised a negative loading from threshold whereas activity did not weigh with this factor at all (explaining 31% of the variance).

#### Assessment of adolescent behavior problems

The German version of the Child Behavior Checklist (CBCL/4–18) [1] was used to measure behavior problems as reported by parents at age 15. The CBCL is a widely used child behavior problem checklist which has been translated into more than 40 languages. A considerable body of reliability and validity of the instrument has been published [cf. 45] and also confirmed for the German translation [12]. The CBCL describes 118 problem behaviors which are likely to occur in children and adolescents 4–18 years. Eight gender- and age-specific behavior syndrome scales were formed. Second-order factor analyses yielded two broadband dimensions of externalizing and internalizing behavior problems. A total problem score is also available. The externalizing problem scale is composed of items from the subscales of aggressive and delinquent behavior. These subscales, the attention problem scale, and the externalizing score were used for the present analyses.

#### Statistical analyses

Descriptive analyses were used to summarize demographic and clinical characteristics of the sample. Chi-square analyses were performed on categorical variables and *t* tests on continuous variables (see Table 1).

Next, using multiple linear regression techniques, we examined whether the temperament factors at different ages made unique contributions to adolescent externalizing

problems after accounting for contributions of obstetric and psychosocial risk factors, verbal abilities, and earlier measures of temperament. Psychosocial and obstetric risks and verbal IQ were entered in the first step. In the second step, child temperament (self-control and easy–difficult) at age 3 months was entered. In the third through the sixth step, both temperament factors of every following assessment were entered successively.

Finally, we examined whether early risk factors and childhood temperament at different ages would predict membership in the at-risk group for adolescent externalizing problems using logistic regression analyses. Adolescents with externalizing scores in the borderline and clinical range (*T* score  $\geq 60$ ) [1] were assigned to the at-risk group (31 males, 33 females). From the remaining sample, participants with a CBCL total problems *T* score  $\geq 60$  and/or internalizing *T* score  $\geq 60$  were excluded, resulting in a control group of 99 males and 106 females. All analyses were conducted separately for boys and girls due to the differing temperament structure which emerged in preadolescence.

#### Results

##### Prediction of adolescent behavior from infant and childhood temperamental traits

In both genders, psychosocial adversity exhibited a marked effect on the externalizing score at the age of 15. The obstetric risk as well as the verbal IQ exhibited no significant influence on adolescent outcome. Boys' poor self-control at age 8 years and poor behavioral control at age 11 made significant contributions to externalizing problems in adolescence after entering psychosocial and obstetric risk factor and the verbal IQ, whereas the earlier temperament measures showed no significant effect (see Table 2). In girls, a different pattern was found. As early as from the age of 2 years on, poor self-control contributed significantly to externalizing problems at age 15 in contrast to the later measures of self-control and behavioral control. Further, female difficultness at age 8 years and approach/extraversion at age 11 years accounted for an additional portion of adolescent externalizing problems (see Table 3).

Both aggressive and delinquent problems are included in the externalizing score with the respective syndrome subscales being substantially correlated ( $R = 0.691$ ,  $P < 0.01$ ). Since aggressive and delinquent scores tap somewhat different aspects of disruptive behavior, we examined whether these subscales are differentially predicted by child temperament. In both genders, the respective contributions of psychosocial risk and child temperament to aggressive

**Table 1** Study variables, mean  $\pm$  SD for male and female groups

	Male ( <i>N</i> = 151)	Female ( <i>N</i> = 157)	Gender difference
Psychosocial risk			
Non	<i>N</i> = 50	<i>N</i> = 58	NS
Moderate	<i>N</i> = 50	<i>N</i> = 45	
High	<i>N</i> = 51	<i>N</i> = 54	
Obstetric risk			
Non	<i>N</i> = 50	<i>N</i> = 57	NS
Moderate	<i>N</i> = 60	<i>N</i> = 47	
High	<i>N</i> = 41	<i>N</i> = 53	
Verbal IQ at 4.5 years	100 $\pm$ 12	104 $\pm$ 11	<i>P</i> < 0.05
Standardized temperament factor scores			
Easy–difficult			
3 months	0.02 $\pm$ 0.98	−0.02 $\pm$ 1.05	NS
2 years	−0.06 $\pm$ 1.09	0.12 $\pm$ 0.90	NS
4.5 years	−0.14 $\pm$ 1.01	0.12 $\pm$ 0.96	<i>P</i> < 0.05
8 years	−0.15 $\pm$ 1.03	0.11 $\pm$ 0.97	<i>P</i> < 0.05
Approach/extraversion			
11 years	−0.02 $\pm$ 0.99	0.02 $\pm$ 1.01	— <sup>a</sup>
Self-control			
3 months	0.03 $\pm$ 1.04	−0.03 $\pm$ 1.02	NS
2 years	−0.18 $\pm$ 1.14	0.15 $\pm$ 0.86	<i>P</i> < 0.01
4.5 years	−0.19 $\pm$ 1.03	0.18 $\pm$ 0.93	<i>P</i> < 0.01
8 years	−0.17 $\pm$ 1.09	0.14 $\pm$ 0.92	<i>P</i> < 0.001
Behavioral control			
11 years	0.01 $\pm$ 1.03	0.03 $\pm$ 0.99	— <sup>a</sup>
CBCL raw scores			
Total externalizing	7.3 $\pm$ 8.0	6.0 $\pm$ 6.5	NS
Aggressive	5.5 $\pm$ 6.0	4.5 $\pm$ 4.7	NS
Delinquent	1.8 $\pm$ 2.3	1.5 $\pm$ 2.5	NS
Attention problems	2.8 $\pm$ 3.1	2.0 $\pm$ 2.4	<i>P</i> < 0.01
Subjects in the at-risk group	<i>N</i> = 31	<i>N</i> = 33	NS

<sup>a</sup> At age 11 years, the PCA of the temperamental dimensions was conducted separately for boys and girls

behavior did not markedly differ from the prediction of the broadband externalizing score (data not shown). Interestingly, adolescent boys' easiness at age 8 years made an additional significant contribution to the delinquent problems ( $\beta = 0.209$ ,  $t = 2.287$ ,  $P < 0.05$ ). In girls, difficulty at age 8 years did not significantly influence adolescent delinquent problems as it did with externalizing and aggressive behavior.

Attention problems were also positively correlated with the total externalizing score ( $R = 0.656$ ,  $P < 0.01$ ) as well as with the aggressive ( $R = 0.646$ ,  $P < 0.01$ ), and delinquent score ( $R = 0.534$ ,  $P < 0.01$ ). As it can be expected from the magnitude of these correlations, the prediction of adolescent attention problems showed some similarities to the prediction of externalizing behavior. However, in the girls—but not in the boys—the obstetric risk made an additional significant contribution to adolescent attention problems (see Table 4). In the boys, infant easiness

additionally contributed to later attention problems. However, this step did not significantly increase the explained variance of the model (see Table 5).

#### Prediction of at-risk groups for externalizing problems

So far, we have analyzed associations between temperament and disruptive problems through the whole range of externalizing problem behavior. Beyond that, we were interested in whether childhood temperament could predict severe externalizing problems in adolescence (CBCL externalizing scores in the borderline range or clinical range). In stepwise logistic regression analyses, we examined the contribution of childhood temperament over and above early risk factors (see Table 6). Boys in the at-risk group for externalizing problems were more likely to have experienced a greater degree of psychosocial adversity whereas the obstetric risk load diminished the probability

**Table 2** Stepwise multiple linear regression on CBCL Total externalizing problems at age 15 years in boys

Predictor variable	$R^2$	$\Delta R^2$	$\Delta F$	$\Delta P$	Beta	$T$	$P$
Control variables	0.061	0.061	3.183	<0.05			
Obstetric risk					−0.122	−1.505	NS
Psychosocial risk					0.218	2.66	<0.01
Verbal IQ at 4.5 years					−0.021	−0.257	NS
Temperament at 3 months	0.073	0.011	0.883	NS			
Easy–difficult					0.102	1.230	NS
Self-control					0.047	0.575	NS
Temperament at 2 years	0.085	0.012	0.927	NS			
Easy–difficult					0.064	0.760	NS
Self-control					−0.102	−1.183	NS
Temperament at 4.5 years	0.103	0.019	1.465	NS			
Easy–difficult					−0.082	−0.895	NS
Self-control					−0.137	−1.390	NS
Temperament at 8 years	0.171	0.068	5.664	<0.01			
Easy–difficult					0.114	1.259	NS
Self-control					−0.306	−3.169	<0.01
Temperament at 11 years	0.226	0.055	4.821	<0.01			
Approach/extraversion					0.102	1.046	NS
Behavioral control					−0.298	−2.956	<0.01

**Table 3** Stepwise multiple linear regression on CBCL Total externalizing problems at age 15 years in girls

Predictor variable	$R^2$	$\Delta R^2$	$\Delta F$	$\Delta P$	Beta	$T$	$P$
Control variables	0.041	0.041	2.175	<0.10			
Obstetric risk					0.013	0.169	NS
Psychosocial risk					0.197	2.432	<0.05
Verbal IQ at 4.5 years					−0.022	−0.286	NS
Temperament at 3 months	0.052	0.011	0.840	NS			
Easy–difficult					0.085	1.048	NS
Self-control					−0.064	−0.779	NS
Temperament at 2 years	0.115	0.063	5.259	<0.01			
Easy–difficult					0.105	1.281	NS
Self-control					−0.214	−2.559	<0.05
Temperament at 4.5 years	0.171	0.056	4.992	<0.01			
Easy–difficult					0.051	0.617	NS
Self-control					−0.258	−2.961	<0.01
Temperament at 8 years	0.200	0.030	2.664	<0.10			
Easy–difficult					−0.184	−2.141	<0.05
Self-control					−0.118	−1.195	NS
Temperament at 11 years	0.244	0.044	4.152	<0.05			
Approach/extraversion					0.179	1.746	<0.10
Behavioral control					−0.192	−2.082	<0.05

of adolescent externalizing behavior. A poor self-control or behavioral control at ages 8 or 11 years, respectively, further increased the odds ratio for externalizing problems at age 15 years. Thus, the predictors were the same as for the continuous externalizing score except for the

additional contribution of the obstetric risk. In the girls, the same variables (psychosocial adversity and early poor self-control) that predicted higher adolescent externalizing scores also increased the odds ratio for being in the at-risk group.



**Table 4** Stepwise multiple linear regression of CBCL attention problems at age 15 years in girls

Predictor variable	$R^2$	$\Delta R^2$	$\Delta F$	$\Delta P$	Beta	$T$	$P$
Control variables	0.083	0.83	4.604	<0.01			
Obstetric risk					0.181	2.325	<0.05
Psychosocial risk					0.232	2.930	<0.01
Verbal IQ at 4.5 years					0.011	0.139	NS
Temperament at 3 months	0.084	0.001	0.063	NS			
Easy–difficult					0.019	0.243	NS
Self-control					−0.021	−0.260	NS
Temperament at 2 years	0.143	0.059	5.122	<0.01			
Easy–difficult					−0.020	−0.252	NS
Self-control					−0.259	−3.151	<0.01
Temperament at 4.5 years	0.187	0.043	3.895	<0.05			
Easy–difficult					0.028	0.348	NS
Self-control					−0.233	−2.694	<0.01
Temperament at 8 years	0.239	0.052	4.920	<0.01			
Easy–difficult					−0.248	−2.968	<0.01
Self-control					−0.143	−1.480	NS
Temperament at 11 years	0.291	0.053	5.266	<0.01			
Approach/extraversion					0.018	0.178	NS
Behavioral control					−0.285	−3.200	<0.01

**Table 5** Stepwise multiple linear regression of CBCL attention problems at age 15 years in boys

Predictor variable	$R^2$	$\Delta R^2$	$\Delta F$	$\Delta P$	Beta	$T$	$P$
Control variables	0.065	0.065	3.405	<0.05			
Obstetric risk					0.015	0.188	NS
Psychosocial risk					0.205	2.514	<0.05
Verbal IQ at 4.5 years					−0.116	−1.405	NS
Temperament at 3 months	0.086	0.021	1.663	NS			
Easy–difficult					0.147	1.794	<0.10
Self-control					−0.009	−0.115	NS
Temperament at 2 years	0.104	0.018	1.436	NS			
Easy–difficult					0.061	0.725	NS
Self-control					−0.135	−1.581	NS
Temperament at 4.5 years	0.112	0.007	0.588	NS			
Easy–difficult					0.001	0.013	NS
Self-control					−0.107	−1.083	NS
Temperament at 8 years	0.187	0.075	6.381	<0.01			
Easy–difficult					−0.016	−0.182	NS
Self-control					−0.341	−3.558	<0.01
Temperament at 11 years	0.232	0.045	3.948	<0.05			
Approach/extraversion					0.115	1.183	NS
Behavioral control					−0.260	−2.586	<0.05

## Discussion

In the present study, we examined the contribution of childhood temperament to adolescent externalizing and attention problems. Previous research in our longitudinal

sample had revealed two higher-order temperamental traits (easy–difficult and self-control) with increasing stability from infancy to middle childhood, and a somewhat altered two-factorial structure (approach/extraversion and behavioral control) in preadolescence [40].

**Table 6** Predictors of membership in an at-risk group for externalizing behavior at age 15 years

Predictor variable	Boys (at-risk $N = 31$ , controls $N = 100$ )				Girls (at-risk $N = 33$ , controls $N = 107$ )			
	Nagelkerkes $R^2$	$P$	OR	95% CI	Nagelkerkes $R^2$	$P$	OR	95% CI
Control variables	0.100	<0.05			0.074	<0.10		
Obstetric risk			0.57*	0.31–0.99			1.06	0.65–1.71
Psychosocial risk			1.72*	1.00–2.95			1.88*	1.15–3.08
Verbal IQ at 4.5 years			0.97	0.85–1.11			0.99	0.86–1.14
Temperament at 3 months	0.108	NS			0.136	<0.05		
Easy–difficult			1.21	0.75–1.96			1.25	0.85–1.85
Self-control			1.09	0.75–1.96			0.60*	0.38–0.94
Temperament at 2 years	0.119	NS			0.261	<0.01		
Easy–difficult			1.16	0.76–1.77			1.29	0.75–2.23
Self-control			0.86	0.59–1.2			0.41**	0.24–0.71
Temperament at 4.5 years	0.175	<0.10			0.329	<0.05		
Easy–difficult			0.70	0.43–1.14			1.02	0.60–1.72
Self-control			0.60	0.34–1.06			0.46**	0.26–0.82
Temperament at 8 years	0.259	<0.05			0.356	NS		
Easy–difficult			1.27	0.76–2.12			0.63	0.38–1.06
Self-control			0.49**	0.29–0.84			0.77	0.43–1.41
Temperament at 11 years	0.330	<0.05			0.367	NS		
Approach/extraversion			1.326	0.70–2.26			1.34	0.70–2.59
Behavioral control			0.44*	0.23–0.83			0.84	0.47–1.51

OR odds ratio, CI confidence interval

\*  $P < 0.05$ , \*\*  $P < 0.01$

#### Psychosocial and obstetric risk factors and verbal abilities

In line with many previous reports, psychosocial adversity was strongly related to adolescent externalizing and attention problems [10, 21–23, 29, 38]. Further, a higher psychosocial risk load differentiated youths at-risk for severe externalizing problems from undisturbed controls. As reported previously [29], the effect of psychosocial adversity clearly outweighed the influence of obstetric risk. Only in girls did the prediction of attention problems by obstetric complications reach statistical significance. Perinatal risks associated with low birth weight are known risk factors for later attention problems [3, 6, 29, 32]. Recent research suggests that the pathways from low birth weight to inattention may be sex-specific [32]. In contrast to our results, Martel et al. [29] found a slightly stronger relation between low birth weight and attention problems in boys compared to girls. However, their findings describe the effects of low birth weight in 6-year-old children. When our study members were 8 years, we also observed no gender  $\times$  obstetric risk interactions. Thus, it cannot be ruled out that the impact of perinatal complications on attention problems may vary between the genders in the developmental course. Our findings are in agreement with

Hack et al. [20] describing that parents of 20-year-old very low birth weight women—but not men—report higher scores of attention problems in the Young Adult Behavior Checklist (YABC).

The verbal abilities did not contribute to the development of adolescent externalizing behavior problems. This conflicting result may be explained by the fact that we did not differentiate between early- and adolescent-onset externalizing problems, since only the early onset type is characterized by deficient verbal abilities [34]. Further, it has been questioned whether neurodevelopmental impairments in infancy and early childhood contribute from the outset to the early onset type or whether they develop as a consequence of psychosocial adversity [2]. Thus, further studies should investigate the impact of neurodevelopmental variables such as verbal abilities on different types of externalizing behavior.

#### Regulative temperament and behavioral problems in adolescence

Self-control and behavioral control describe regulatory abilities including dimensions such as attention span/persistence, motor activity, distractibility/soothability, or manageability. In our sample, a poor self-control or



behavioral control was strongly associated with externalizing and attention problems in adolescence. These findings are in line with earlier results that have consistently linked regulative temperament factors [8, 37–39] or activity level [7, 18] with the development of externalizing and attention problems. Despite differences in type of measurement (temperament was assessed as a composite score of parent interview and expert rating in standardized behavioral observations whereas the behavioral outcome was solely based on a parent questionnaire) childhood temperament contributed significantly to adolescent disruptive behavior. Further, our results support the findings of Olson et al. [38] that variations in regulative temperament factors in preschool age are associated with externalizing behavior after controlling for psychosocial adversity. These associations also held when additionally controlling for obstetric risks. Moreover, we could extend their findings to a longitudinal perspective by predicting adolescent externalizing and attentional problems from preschool temperament. These relations also applied to the aggressive and delinquent subscales. Individual differences in early regulative temperament also differentiated between adolescents with externalizing problems in the clinical range and borderline clinical range (at-risk group) and undisturbed controls, thus underlining the clinical significance of children's self-control/behavioral control abilities.

#### Contributions of the easy–difficult temperament

In contrast to the findings concerning regulative temperament, associations between easy–difficult temperament and adolescent behavior problems were less clear. Variation of this temperament trait in infancy and early childhood did not contribute to later externalizing and attention problems. At the early assessments, our easy–difficult factor was primarily defined by approach, mood, and distractability/soothability [40]. Thus, at the negative pole this factor appears more closely related to fearful distress than to irritable distress. Moreover, irritability was stronger (negatively) associated with self-control than with the easy–difficult factor. The lack of association between early difficultness and externalizing problems in our study may be partly due to the fact that, from these facets of emotionality, fearful distress seems to be less strongly related to externalizing problems [16, 35].

Only in girls did being more difficult at age 8 years predict adolescent externalizing, aggressive and—somewhat stronger—attentional problems but not delinquent problems, whereas in boys, being more easy at age 8 years solely contributed to delinquent problems. Thus, the pattern of associations between temperament and aspects of disruptive behavior in both genders appear to be mirror images. This might be partly explained by the fact that

boys were more difficult during childhood than girls [40]. That is, difficultness may be additionally required for the development of female externalizing behavior. It has already been suggested that reinforcement for sex-appropriate behavior might suppress externalizing behavior in girls so that a higher cumulative risk load is needed to precipitate externalizing problems [22, 31]. In contrast to our results, Leve et al. [29] found increases in girls externalizing behavior when fear/shyness was low. However, the subjective experience of low self-competency (which may be regarded as a component of withdrawn or fearful behavior), e.g. an elevated sensitivity to peer rejection [23] or perceiving oneself as less cognitive competent [14], is known as risk factor for disruptive behavior in girls. Also, conduct-disordered girls show a higher comorbidity with internalizing problems compared to boys [23]. In conclusion, variations in the easy–difficult trait play a minor role in the development of externalizing behavior, although aspects of fearful distress/withdrawal additionally might take effect in females due to a higher threshold for the development of externalizing problems.

Surprisingly, the boys' easiness contributed solely to adolescent delinquent problems and the girls' difficultness contributed to all behavioral problems except for the delinquent score. Some researchers assume a second pathway to conduct problems (the callous-unemotional type) starting with a low standing on dispositional fear or withdrawal motivation which is unrelated to effortful control/constraint but is characterized by instrumental antisocial behavior [16, 36]. If we assume that the delinquent problem score taps this instrumental antisocial behavior, the association with easiness might partly reflect the callous-unemotional type. However, this supposition remains speculative since the CBCL does not reliably differentiate between reactive and instrumental antisocial behavior.

#### The role of approach/extraversion

We have previously shown that the temperamental trait of approach/extraversion emerged in preadolescence, with antecedents from childhood easiness as well as from poor self-control, the latter association being stronger in girls [40]. Compared to males, the female approach/extraversion factor comprised moderate negative loadings of attention span/persistence and regularity, and was longitudinally associated with Cloninger's novelty seeking [9]. Thus, it was not surprising that approach/extraversion was associated with increased externalizing problems in girls. Approach tendencies and exploratory behavior have been linked to the development of externalizing problems, although it remains controversial whether these behaviors act as a risk factor in combination with low control or with low fearful inhibition [36]. However, relative to the regulative temperament, the

contribution of approach/extraversion to adolescent externalizing problems was weaker, and did not emerge in the boys. Further, approach/extraversion did not predict the membership in the at-risk group.

### Gender issues

Although the majority of studies have been carried out in boys, there is growing evidence that the developmental trajectories of adolescent externalizing and attention problems share many features in both genders [5, 8, 22, 23, 37–39]. In our study, the gender differences concerning the contribution of temperament factors to externalizing and attentional problems were more in the strengths rather than in the nature of the effects. In both genders the regulative temperament was associated with adolescent problem behavior. While in girls early temperamental characteristics were the strongest predictors (with a significant contribution of low self-control as early as at 3 months to the adolescent at-risk group membership), in boys these temperamental traits appeared to be more significant in middle childhood and preadolescence. These results are in agreement with findings that the stability of early disruptive traits in girls is at least as stable as in boys [23]. However, they seem to contradict the widely accepted knowledge that toddler temperament is predictive of adolescent externalizing problems in males (e.g. [8, 37]). These unexpected findings might be partly explained by the nature of our study population. Our sample comprises a well-defined high-risk population which is completely gender-balanced throughout its two-factorial matrix accounting for obstetric and psychosocial risks. Using the psychosocial risk index, we controlled not only for economic disadvantage, but also for more proximal familial risks which are related to behavioral problems independent of social class or family income [10, 27, 49]. In addition, temperament is known to be susceptible to environmental influences, with psychosocial adversities exerting a negative impact on regulative temperament [44]. In our sample, children with a higher psychosocial risk load displayed lower levels of self-control [40]. Thus, by controlling for psychosocial adversity one would expect the association between self-control and later psychopathology to become weaker.

One possible explanation for the greater independent contribution of early self-control in females is that different parenting attitudes toward boys and girls with poor regulative abilities might in turn influence the development of externalizing problems. Gender-specific parental reactions such as higher stress levels in disruptive girls' families [15] or protective effects of parental warmth on externalizing problems only in boys [25] have already been reported. It has also been suggested that in girls a higher cumulative risk load (e.g. variations in temperament additionally to environmental risks) is needed to precipitate externalizing

problems [22]. Second, our psychosocial risk index might be confounded by genetic factors since it includes items such as a history of psychiatric disorder or delinquency in the parents. It might well be that underlying genetic factors differ between the sexes. For instance, although the heritability of attention deficit hyperactivity disorder and oppositional defiant disorder was the same in boys and girls, the genes involved seem to be partly different [11].

### Limitations and strengths

Since no reliability studies of the temperamental measures were performed after the assessment at age 2 years, a potential limitation of our later measurement cannot be ruled out. However, the assessment procedures adhered at each time-point to the same highly structured protocol including the training of the raters which produced satisfactory inter-rater agreement at ages 3 months and 2 years, respectively.

Further, limitations to the generalizability of our findings should be noted due to the character of our sample as a high-risk sample. About 88% of the participants had a history of perinatal insults and/or of psychosocial risks present at birth. Thus, the interpretation of our results with regard to other populations should be handled with caution.

Finally, the interpretation of our data with respect to the influence of the easy–difficult factor or of the approach/extraversion factor on adolescent externalizing problems shows some drawbacks. Strong approach tendencies and excitement-seeking behavior or low standing on fear are especially salient for subtyping externalizing behavior in the reactive–aggressive and the callous-unemotional types [16, 36]. However, the outcome measures in the present study did not reliably differentiate between these types. Thus, eventually differential contributions of easiness or approach/extraversion to a certain subtype of disruptive behavior should be regarded as preliminary and will have to be confirmed in future studies.

The strengths of the present study lie in the precise characterization of the sample and the well-defined risk conditions. The assessment of temperamental traits is based on a multi-informant procedure which combines expert ratings of behavioral observations (in familiar and unfamiliar surroundings) with parent reports. Thus, we could avoid distortions resulting from parental judgement or one-time observations as well as a broad method overlap between temperament assessment and outcome assessment.

### Conclusions

The present study provides further evidence that regulatory temperamental abilities contribute significantly and are clinically meaningful to adolescent externalizing and

attention problems over and above the influence of psychosocial adversity and obstetric risks. These associations are found in both genders. Gender specificity lies more in the strength of the association rather than the kind. The long-term prediction from infant and toddler temperament appeared to be stronger for girls after accounting for possible confounding risks. Future studies should aim at the (gender-specific) role of genetic variations and parenting styles in the development of externalizing problems.

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## Appendix A: Definition of obstetric risk groups<sup>1</sup>

ITEMS		
1	normal birth weight	2.500 - 4.200 g
2	normal gestational age	38 - 42 weeks
3	no signs of asphyxia	pH $\geq$ 7.20, lactic acid $\leq$ 3.5 mmol/l, and CTG-Fischer Score $\geq$ 8
4	no surgical delivery	except elective
5	EPH-gestosis	toxemia of pregnancy with edema, proteinuria, and hypertonia
6	preterm birth	gestational age < 37 weeks
7	preterm labour	tocolytic treatment or cerclage
8	very low birth weight	< 1.500 g
9	clear case of asphyxia	pH $\leq$ 7.10 or lactic acid $\geq$ 8.00 mmol/l or CTG-score $\leq$ 4 with special care treatment for $\geq$ 7 days
10	neonatal complications	seizures or respiratory therapy (mechanical ventilation) or sepsis
Risk groups		
<i>nonrisk</i>	: all of items 1 - 4 and none of 5 - 10	
<i>moderate risk</i>	: one out of items 5 - 7 and none of 8 - 10	
<i>high risk</i>	: one out of items 8 - 10	

<sup>1</sup> Appendix A has been previously published [28]

## Appendix B: Definition of psychosocial risk groups<sup>2</sup>

ITEMS		
1	<b>Low educational level of a parent</b>	parent without completed school education or without skilled job training
2	<b>Overcrowding</b>	more than 1.0 person a room or not more than a total of 50 m <sup>2</sup>
3	<b>Parental psychiatric disorder</b>	moderate or severe disorder according to DSM-III-R criteria (interviewer rating, kappa = .98)
4	<b>Parental broken home history or delinquency</b>	institutional care of a parent or more than two changes of caretakers or parental figures until the age of 18 or history of parental delinquency
5	<b>Marital discord</b>	low quality of partnership in two out of three areas (harmony, communication, emotional warmth) (interviewer rating, kappa = 1.00)
6	<b>Early parenthood</b>	age of a parent $\leq$ 18 years at child birth or relationship between parents lasting less than 6 months at time of conception
7	<b>One-parent family</b>	at child birth
8	<b>Unwanted pregnancy</b>	an abortion was seriously considered
9	<b>Poor social integration and support of parents</b>	lack of friends and lack of help in child care (interviewer rating, kappa = .71)
10	<b>Severe chronic difficulties</b>	affecting a parent lasting more than one year (interviewer rating, kappa = .93)
11	<b>Poor coping skills of a parent</b>	inadequate coping with stressful events of the last year (interviewer rating, kappa = .67)
Risk groups		
	<i>nonrisk</i>	: no item fulfilled
	<i>moderate risk</i>	: one or two items fulfilled
	<i>high risk</i>	: more than two items fulfilled

<sup>2</sup> Appendix B has been previously published [28]

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