1   **A Prospective Study on Persistence of Infant Crying, Sleeping, and Feeding Problems**

2   **and Preschool Behaviour**

3

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10   ***Running head:*** Persistence of Crying, Sleeping, and Feeding Problems

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24   **Abstract:**

25   Aim: To determine the persistence of regulatory problems (RP), i.e., excessive crying (> 3

26   months of age), feeding, and sleeping difficulties, from infancy to preschool age, and to

27   evaluate whether RP at 5 months are predictive of preschool adaptive behaviour and social

28   skills.

29   Method: A prospective population study of newborns admitted to neonatal care. RP at 5, 20,

30   and 56 months of age were obtained via parent interviews and neurological examination, and

31   preschool adaptive behaviour and social skills by parent ratings. Logistic and linear

32   regression analyses were conducted, controlled for psychosocial and neurological factors.

33   Results: More than half of the sample had RP at least at one measurement point. In about

34   8% of infants RP persisted across the preschool years. Multiple RP and feeding problems

35   increased the odds of eating problems at 20 and 56 months. Persistent RP and feeding

36   problems were predictive of deficits in preschool adaptive behaviour and social skills. In

37   addition, sex differences were found.

38   **Conclusions: Multiple RP and feeding problems had the highest stability. Persistent**

39   **RP were predictive of adverse social and adaptive behaviour. Understanding of the**

40   **aetiology may help to prevent persistent RP.**

41

42

43   **Keywords:** Behaviour problems; Infant crying, Infant feeding; Persistence; Sleeping

44   problems;

45

INTRODUCTION

Behaviours assumed to be enduring characteristics of an infant or child such as activity level or regulation of distress are often considered as dimensional temperament traits (1). Infants who are on the extremes of these temperament traits, e.g., highly irritable and fussy, have been characterized as being temperamentally difficult (2). Within clinical classification systems for infants such as by the Zero to Three organization (DC 0-3R) these extremes have been subsumed under the concept of regulatory problems (RP) (3). Infants with RP have difficulties with self-regulation and exhibit fussiness, irritability, poor self-calming, intolerance to change, and hyperalert state of arousal (4). The main symptoms of infant RP have been proposed to include excessive crying (> 3 months of age), feeding, and sleeping difficulties (5). Due to the lack of a standardized definition of RP and different assessment methods the prevalence rates of RP vary widely between 2-46% (6-9). Infant RP are associated with high parental burden and are a frequent reason for seeking help from health services (10).

Persistent excessive crying after three months of life has been reported to be predictive of later eating and sleeping disturbances (9), hyperactivity, discipline problems, and lower cognition (11, 12). Findings concerning the persistence of sleeping problems are mixed (13). Severe and persistent sleeping problems have been shown to be precursors of behaviour problems during toddlerhood and attention-deficit/hyperactivity disorder at preschool age (13, 14). There is consensus that feeding problems are moderately stable during the preschool years and associated with behaviour problems and hyperactivity during the first years of life (15), but sample sizes have been small. Studies of clinical populations suggest that multiple RP are more persistent than single, and the consequences may be more adverse (12) but persistence and consequences may be explained by other factors such as family adversity (16). Finally, differences between boys and girls have been reported regarding self-regulatory abilities of newborns (17), RP during infancy (18), and behaviour problems in early childhood and at preschool age (19).

73   In summary, variable findings concerning the persistence of infant RP are partly

74   explained by different definitions of RP, study design, or population. There is a lack of studies

75   considering the stability and outcome of single versus multiple RP. The aims of this study

76   were firstly, to determine the persistence of single and multiple infant RP during early

77   childhood and preschool age. Secondly, we evaluated whether persistent and / or single /

78   multiple infant RP are predictive of preschool adaptive behaviour and social skills, controlled

79   for psychosocial and neurological factors. Finally, we investigated sex differences in

80   prevalence and predictive models.

81

82   **METHODS**

83   **Subjects**

84   The sample consisted of infants born at risk in a geographically defined area in Southern

85   Bavaria (Germany) during a 15-month period in 1985-1986 who were admitted to one of 16

86   children hospitals within 10 days after birth ($n = 7505$ out of $N = 70\ 600$ life births, 10.6% of

87   all life births). At that time all newborns who were born preterm or experienced birth or

88   neonatal complications or caesarean section were admitted to a children's hospital neonatal

89   unit. Parents were approached within 48 hours of the infant's hospital admission and asked

90   to give written informed consent to participate (20). Ethical approval was obtained from the

91   University of Munich Children's Hospital.

92   This report includes all children who participated at all four measurement points, i.e.,

93   neonatal, 5, 20, and 56 months of age ($n = 4427$, 66.0% of $n = 6705$ eligible survivors). The

94   sample description and the results of the dropout analyses are shown in the Appendix, Table

95   A1.

96   *(Please Insert Appendix, Table A1 in the Supplementary Material online).*

97

98   **Measures**

99   *Regulatory Problems (5, 20, and 56 Months)*

100   As part of a neurodevelopmental assessment, a standardized interview concerning crying,

101   feeding, and sleeping problems at 5 months was conducted with the parents by

102   paediatricians (see Table 1). The definitions of crying, feeding, and sleeping problems have

103   been derived from literature (21-23). The variable "Regulatory problems (RP) at 5 months"

104   consisted of eight mutually exclusive categories, namely (I) single crying, (II) single feeding,

105   (III) single sleeping, (IV) crying and feeding, (V) crying and sleeping, (VI) feeding and

106   sleeping, (VII) crying, feeding, and sleeping problems, and (VIII) no regulatory problems at 5

107   months.

108   Both at 20 and 56 months of age sleeping and eating problems were assessed via

109   standardized interviews with the parents and neurological examinations by paediatricians

110   who had review and training meetings 2 monthly; the inter-rater reliability exceeded 90%

111   (Table 1).

112   The assessments at 5 and 20 months were carried out corrected for prematurity and the

113   56 months assessment at chronological age.

114   *(Please Insert Table 1 in the Supplementary Material online)*

115

116   *Adaptive Behaviour and Social Skills (56 Months)*

117   The parents were asked 8 items by paediatricians concerning *adaptive behaviour and social*

118   *skills,* namely separation from mother or other reference persons, comprehension and

119   observance of game rules, acceptance in peer group, friends, role play, comprehension of

120   emotional expressions, getting dressed, and toilet training. The response range was from 1

121   (does not apply) to 4 (applies strongly). The grand total was computed and could range from

122   1 (deficits in adaptive behaviour and social skills) to 4 (high adaptive behaviour and social

123   skills) (Mean 3.63 (± 0.40)). The standardized Cronbach's Alpha was 0.71. The validity of the

124   assessment has been described elsewhere (24).

125

126   *Control variables (confounders)*

127   Based on previous research findings (e.g.,(11, 16, 18)) the following variables were used as

128   control variables in the analyses (20): *gestational age* (25), *neonatal neurological problems*

129   *(intensity of neonatal treatment index = INTI score)*, the *socioeconomic status* (*SES*), *parent-*

130   *infant relationship index* (*PIRI*), and *family adversity index (FAI)*, *head circumference* (*HC*),

131   and *breastfeeding* (see Appendix, Table A2 for details).

132   **(Please Insert Table A2 in the Supplementary Material online)**

133

134   **Statistical Analyses**

135   Statistical analyses were conducted with SPSS version 11.0. The assumption of normal

136   distribution was assured for all continuous outcome variables (26). Binary logistic regression

137   analyses were conducted to investigate differences between participants and dropouts

138   (Appendix, Table A1), and, additionally, between girls and boys in terms of the prevalence

139   and persistence of regulatory problems (RP) (Appendix, Table A3).

140   **(Please Insert Table A1 and A3 in the Supplementary Material online)**

141   Hierarchical binary logistic regression analyses were conducted to examine the effect of

142   RP at 5 months on sleeping / eating problems (0=no; 1=yes) at 20 and 56 months. In the first

143   step, the variable RP at 5 months consisting of the reference group (no RP) and seven

144   mutually exclusive categories (see Table 2 and Measures section for details), and

145   additionally, infant's sex and the control variables were entered; and in a second step, in

146   addition, the interaction terms between the categories of the variable RP at 5 months $\times$

147   infant's sex. If the second step did not account for a significant improvement of the

148   regression model ($\Delta\chi^2$, degrees of freedom (*df*), significance level $p > .05$), the adjusted odds

149   ratios (OR) and 95% confidence intervals (95% CI) of the first step are reported (Table 2). If

150   the second step significantly accounted for an improvement of the model ($\Delta\chi^2$, *df*, $p < .05$), a

151   separate model was tested consisting of the main effects (categories of the variable RP and

152   infant's sex), the control variables, and the significant interaction terms (27); the adjusted

153   ORs (95% CI) of this final model are reported (Table 2). The goodness of fit of the final

154   models was evaluated using the Omnibus Test of model coefficients (χ^2, *df*, and *p*; fit is good

155 if $p < .05$) (26). The odds ratios (ORs) were converted to Cohen's d, i.e., $d = \ln(OR)/1.81$

156 (26). The effect is small, if $|d|$ is 7 0.2 and < 0.5, medium if $|d|$ 7 0.5 and < 0.8, and large if $|d|$

157 7 0.8 (28) (Table 2).

158   Furthermore, hierarchical linear regression analyses were conducted to evaluate whether

159 RP at 5 months and/or persistent RP were predictive of adaptive behaviour and social skills

160 as rated by parents at 56 months. Again, in the first step, RP at 5 months or the persistence

161 of RP, i.e., RP at only one (5, 20, or 56 months), two, or all three measurement points

162 (dummy coded), infant's sex, and the control variables were entered, and in the second step,

163 additionally, the interaction terms between (persistence of) RP $\times$ infant's sex. The adjusted

164 standardized beta weights (β), the 95% confidence intervals (95% CI of β), the significance of

165 each step, the fit of the final models (ΔF or F, df, and p), and the effect sizes of the

166 standardized beta weights, i.e., small effect if $|\beta|$ 7 0.10, medium if $|\beta|$ 7 0.30, and large if $|\beta|$

167 7 0.50 (28), are reported.

168

169 **RESULTS**

170 **Prevalence and Persistence of Regulatory Problems**

171 At 5 months of age 4.9% suffered from a single crying, 10.7% from a single feeding, and

172 9.4% from a single sleeping problem. In 4.4% two combined problems occurred, namely

173 crying and feeding problems in 1.4%, crying and sleeping in 1.5%, and feeding and sleeping

174 problems in 1.5%. Less than one per cent (0.6%) had all three problems. In summary, 30%

175 of the sample suffered from at least one regulatory problem at 5 months. At 20 months,

176 17.8% had sleeping problems, and 8.9% eating problems. At 56 months, sleeping problems

177 occurred in 15.5%, and eating problems in 16.2%.

178   Girls suffered less often from single sleeping problems (girls 7.8% vs. boys 10.6%; OR

179 0.71; 95% CI (0.58; 0.88); $|d|$=0.19, very small effect), combined feeding and sleeping

180 problems at 5 months (girls 0.9%; vs. boys 2.0%; OR 0.47; 95% CI (0.28; 0.81); $|d|$=0.42,

181 small effect), or sleeping problems at 56 months (girls 14.2% vs. boys 16.6%; OR 0.84; 95%

182 CI (0.71; 0.99); $|d|$=0.10, very small effect) compared to boys.

7

183   More than half of the children had at least at one measurement point single or combined

184   RP, and girls had less often RP at any measurement point compared to boys (very small

185   effect; see Appendix, Table A3). In 59.8% of those with RP at least at one assessment point

186   the problems were transient, i.e., they occurred only at 5, 20, or 56 months. However, in

187   29.2% of the children with RP ever, they occurred at two assessment points, and in 7.7% the

188   RP were persistent (i.e., at all three measurement points) (Table A3). **(Please Insert Table**

189   **A3 in the Supplementary Material online).**

190   Single crying, single feeding, and combined crying, feeding, and/or sleeping problems at

191   5 months of age were predictive of eating problems at 20 months (see Table 2). In infants

192   who suffered from crying, feeding, and sleeping problems at 5 months the odds of having

193   eating problems at 20 months were 7.22 times increased (large effect). Eating problems at

194   56 months were predicted by combined crying and feeding (small effect), feeding and

195   sleeping (small effect), and crying, feeding, and sleeping problems (medium effect) at 5

196   months (Table 2). In addition, significant interaction terms were found between single crying

197   problems $\times$ sex (medium effect) and single feeding problems $\times$ sex (small effect), i.e., only in

198   girls, single crying (OR 2.44; 95% CI (1.44; 4.14); $|d|$=0.49, small effect) and single feeding

199   problems (OR 2.10; 95% CI (1.47; 3.01); $|d|$=0.41, small effect) increased the odds of eating

200   problems at 56 months, but not in boys (single crying: OR 0.78; 95% CI (0.45; 1.36);

201     $|d|$=0.14, very small effect / single feeding: OR 1.18; 95% CI (0.82; 1.72); $|d|$=0.11, very small

202   effect).

203   Single and combined sleeping problems at 5 months increased the odds of sleeping

204   problems at 20 months (small to medium effects). Sleeping problems at 56 months were only

205   predicted by single crying problems at 5 months (small effect) (Table 2).

206   *(Insert Table 2 about here)*

207

208   **Associations between the Occurrence and Persistence of Infant Regulatory Problems**

209   **and Preschool Adaptive Behaviour and Social Skills**

210 Single feeding problems at 5 months were associated with problems in adaptive behaviour

211 and social skills as rated by the parents (β = -0.05; 95% CI (-0.08; -0.02)) controlled for

212 confounders. Furthermore, there was an interaction effect (step 2: ΔF = 2.1; df = 7; p = .04;

213 final model: F = 32.5; df = 17; p < .001) indicating that only in boys, combined crying and

214 feeding problems were predictive of problems in adaptive behaviour and social skills (β = -

215 0.08; 95% CI (-0.13; -0.04)), but not in girls (β = 0.03; 95% CI (-0.02; 0.07)). All effect sizes

216 were very small.

217   Moreover, both transient and persistent RP were related to preschool problems in

218 adaptive behaviour and social skills (final model: F = 60.4; df = 12; p < .001), namely, for RP

219 at one measurement point (i.e., at 5, 20, or 56 months) β = -0.07 (95% CI (-0.10; -0.03), very

220 small effect), for RP at two measurement points β = -0.12 (95% CI (-0.15; -0.09), small

221 effect), and for RP at all three measurement points β = -0.20 (95% CI (-0.23; -0.17), small

222 effect).

223

224 **DISCUSSION**

225 More than half of the children in this sample of infants born at risk suffered from RP at some

226 time during early childhood and the preschool years. For over half of those with RP ever the

227 RP were transient, and for almost one third of those with RP they were intermittent. However,

228 for about 7-8% of those with RP ever the RP were highly persistent from infancy to preschool

229 age. Wake et al. reported that cry-fuss/sleeping problems were persistent in about 6% of

230 children from 2 to 24 months (13). Our results extend these findings to a period from 5 to 56

231 months of age. In our study, overall persistence was generally high for infant feeding and

232 eating problems as reported previously (15), while sleeping problems showed short (5 to 20

233 months) but no long term stability (5 to 56 months) (13). Even when controlled for

234 confounders the effect sizes remained small to medium.. Previous research could show that

235 among RP sleeping problems are most strongly related to parenting practices (18) and

236 amenable to early intervention and treatment (29).

237   Parents who have infants with multiple RP are most likely to consult community or

238   paediatric services (10). This study confirms that those infants with multiple regulatory

239   disturbances are indeed at the highest risk for persistent RP, particularly eating problems,

240   and early treatment may well be indicated to prevent longer term problems (9) and parental

241   distress (10). Additionally, persistent RP made a small but significant contribution to the

242   prediction of preschool deficits in adaptive behaviour and social skills.

243   Furthermore, we found that single feeding problems at 5 months were precursors of

244   deficits in adaptive behaviour and social skills at 56 months (very small effect), even when

245   controlled for neurological and psychosocial factors (e.g., family adversity). As infant feeding

246   problems are highly stable, they may affect social and behaviour development (15).

247   However, parent ratings of preschool adaptive behaviour and social skills may be biased in

248   ex-feeding problem children due to difficult interaction patterns that persist (30) and/or due to

249   a perception of continued vulnerability (31).

250   Finally, a single crying problem was the only predictor of sleeping problems at 56

251   months. This is in line with some previous studies showing associations between excessive

252   infant crying and subsequent childhood sleeping problems (e.g., (9)) but not others (32).

253   Our results revealed some sex differences: Sleeping problems were more prevalent in

254   boys than in girls which has been reported by others (18). Only in girls, single crying and

255   single feeding problems at 5 months increased the odds of eating problems at 56 months

256   (small effects). It appears that in boys single crying and single feeding problems are more

257   transient. However, only in boys, combined crying and feeding problems were predictive of

258   deficits in adaptive behaviour and social skills at 56 months (very small effect), indicating that

259   multiple RP might be a risk factor for subsequent adverse behavioural outcome in boys but

260   not in girls. A recent study found that only in boys, the presence of a certain allele in

261   polymorphisms of the dopamine receptor gene was associated with the occurrence of

262   multiple RP (33). In addition, this allele seems to be involved in the occurrence and

263   persistence of attention-deficit/hyperactivity disorder in boys, but not in girls (34). Preschool

264   deficits in social skills might be a precursor or correlate of attention-deficit/hyperactivity

265 disorder (35). As we did not assess genetic profiles of the participants we could not replicate

266 these findings but further research on the role of genes in terms of the aetiology of RP and

267 associated adverse outcome may be indicated.

268   There are several limitations of our study. Firstly, the data were collected in 1985-86. In

269 the last two decades the standard of care has changed. Secondly, as our sample consisted

270 of children who were referred to special neonatal care units after birth, the results might not

271 be generalizable to all infants requiring normal postnatal care. Thirdly, RP were not assessed

272 with structured diaries. However, this is not realistic in a general population sample due to

273 the often observed high subject loss in diary studies (36). Nevertheless, there are a number

274 of strengths. Firstly, this is one of the rare longitudinal studies concerned with multiple RP

275 and adverse outcome in childhood that allowed for control of neurological and psychosocial

276 risk factors that had been meticulously measured. Secondly, the dropout rate was low: two

277 third of the eligible survivors participated at all four measurement points. Nevertheless, those

278 who dropped out were socially disadvantaged which may have affected reported prevalences

279 of RP.

280

281 **CONCLUSIONS**

282 Transient RP are frequent while persistent multiple RP are found in up to 8% of children with

283 RP. Persistent RP and feeding difficulties predicted subsequent deficits in social skills. Even

284 when controlled for confounding factors the effect sizes remained small to medium. Infant RP

285 cause substantial expense in primary health delivery, are associated with high parental

286 burden, can have severe developmental consequences including abuse and shaken baby

287 syndrome (10), and behavioural consequences for the infants as shown here and elsewhere

288 (12). Further research should focus on the aetiology of persistent infant RP and early

289 prevention to reduce parent and infant burden.

297   **List of abbreviations**

298

299   β: standardized regression weight (beta)

300   χ^2: chi-square statistic

301    $\Delta\chi^2$: change of chi-square statistic

302   CI: confidence interval

303   d: effect size according to Cohen

304   df: degrees of freedom

305   F: F statistic (regression mean square divided by the residual mean square)

306   ΔF: change of F statistic

307   FAI: family adversity index

308   HC: head circumference

309   INTI: intensity of neonatal treatment index

310   ln: logarithm

311   OR: odds ratio

312   p: significance level p

313   PIRI: parent-infant relationship index

314   RP: regulatory problems

315   SES: socioeconomic status

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Table 1 Definition of Crying, Feeding, and Sleeping Problems at 5, 20, and 56 Months of Age and Assessment Mode

Regulatory problems	Definition	Assessment Mode
5 months of age		
Crying problems:	1. Cry duration: 7 2 hours per day. **AND/OR**	PI
	2. Cry amount: above average. **AND/OR**	PI
	3. Infant is usually difficult to soothe. **AND/OR**	PI
	4. Infant is constantly irritable.	PI
Feeding problems:	1. Infant does not eat and drink well. **AND/OR**	PI
	2. Formerly and currently problems with vomiting. **AND/OR**	PI
	3. Disordered oral-motor functioning, i.e., problems with sucking / swallowing, disordered mouth / tongue movement.	PI
Sleeping problems:	1. Infant wakes up 7 2 times per night. **AND/OR**	PI
	2. Infant wakes up for 7 15 minutes at night.	PI
20 months of age		
Eating problems:	1. Occurrence of eating problems. **AND/OR**	PI
	2. Problems with chewing, swallowing, or not accepting solid food. **AND/OR**	NE
	3. Oral-motor dysfunction, i.e., uncoordinated movements, not harmonic.	NE
Sleeping problems:	Occurrence of sleeping problems.	PI
56 months of age		
Eating problems:	1. Eating problems / problems with food intake. **AND/OR**	PI
	2. Neurological / behavioral dysfunction (motor problems, loss of appetite, refusal to eat, or other problems).	NE
Sleeping problems:[a]	1. Sleeps through during less than three nights per week.	PI
	2. Needs more than 30 minutes to fall asleep.	PI
	3. Only falls asleep when parents are around.	PI
	4. Regularly sleeps in the parental bed.	PI

Note. PI = Standardized parental interview; NE = Neurological examination by paediatrician.

[a] sleeping problems at 56 months of age were diagnosed if 7 2 of the 4 criteria were fulfilled.

Table 2 Adjusted Odds Ratios (95% Confidence Intervals) and Effect Sizes (|*d*|) of Regulatory Problems at 20 / 56 Months Predicted by Regulatory Problems (RP) at 5 Months

			Outcome at 20 months		Outcome at 56 months	
			Eating problems	Sleeping problems	Eating problems	Sleeping problems
RP at 5 months of age	***n***		OR (95% CI); |*d*|	OR (95% CI); |*d*|	OR (95% CI); |*d*|	OR (95% CI); |*d*|
No problems	3071		Reference	Reference	Reference	Reference
Single crying	217	adjusted[a]	**1.74 (1.08; 2.80); 0.31**	1.33 (0.90; 1.95); 0.16	0.77 (0.44; 1.34); 0.14	**1.76 (1.23; 2.52); 0.31**
Single feeding	472		**2.90 (2.16; 3.89); 0.59**	1.02 (0.77; 1.36); 0.01	1.20 (0.83; 1.73); 0.10	0.98 (0.73; 1.32); 0.01
Single sleeping	414		1.12 (0.71; 1.77); 0.06	**2.08 (1.60; 2.70); 0.40**	1.03 (0.74; 1.43); 0.02	1.13 (0.84; 1.53); 0.07
Crying and feeding	62		**5.08 (2.66; 9.71); 0.90**	1.92 (0.99; 3.73); 0.36	**2.11 (1.13; 3.92); 0.41**	1.15 (0.53; 2.47); 0.08
Crying and sleeping	66		**3.42 (1.75; 6.68); 0.68**	**3.18 (1.84; 5.48); 0.64**	1.17 (0.59; 2.29); 0.09	1.40 (0.75; 2.64); 0.19
Feeding and sleeping	66		**3.01 (1.48; 6.12); 0.61**	**2.80 (1.61; 4.86); 0.57**	**1.84 (1.00; 3.38); 0.34**	1.54 (0.83; 2.86); 0.24
Crying, feeding, & sleeping	26		**7.22 (2.97; 17.52); 1.09**	**2.81 (1.20; 6.61); 0.57**	**3.56 (1.55; 8.19); 0.70**	1.21 (0.41; 3.60); 0.11
Significant interaction terms:						
Single crying × sex			- -	- -	**3.18 (1.49; 6.81); 0.64**	- -
Single feeding × sex			- -	- -	**1.73 (1.04; 2.88); 0.30**	- -
Model fit indices:						
Step 1:[b] $\Delta\chi^2$; *df (p)*			150; 16 (< .001)	105.9; 16 (< .001)	112.3; 16 (< .001)	52.3; 16 (< .001)
Step 2:[c] $\Delta\chi^2$; *df (p)*			3.7; 7 (.81)	7.3; 7 (.40)	18.3; 7 (.01)	5.7; 7 (.57)
Final model:[d] χ^2; *df (p)*			150; 16 (< .001)	105.9; 16 (< .001)	125.0; 18 (< .001)	52.3; 16 (< .001)

Note. ORs (95% CIs) in bold are significant at the *p* < .05 level; ORs (95% CIs) of the final models are presented.

[a] Adjusted for control variables, i.e., gestational age, INTI score, SES, PIRI, FAI, HC, and breastfeeding.

[b] Step 1: Predictors: categories of RP at 5 months and control variables.

[c] Step 2: Step 1 and additionally, the interaction terms between the categories of RP at 5 months and sex.

[d] Final model: equivalent to step 1 if step 2 was not significant at the *p* < .05 level; otherwise, final model consisted of step 1 and significant interactions terms of step 2.

Table A1 Sample Description and Results of Dropout Analyses

Characteristic	Participants		Dropouts		Differences participants / dropouts
	n	% or Mean ± SD	*n*	% or Mean ± SD	OR (95% CI); |*d*| [a]
Infant's gender:	4427		2278		
Male	2397	54.1	1217	53.4	1
Female	2030	45.9	1061	46.6	0.97 (0.88; 1.08); 0.02
Gestational age (weeks):	4427	37.2 ± 3.2	2278	37.5 ± 3.0	**0.96 (0.95; 0.98); 0.02**
Mother's age at birth (years):	4419	28.5 ± 5.1	2275	27.5 ± 5.6	**1.03 (1.02; 1.04); 0.02**
Father's age at birth (years):	4266	31.8 ± 6.4	1733	31.0 ± 6.9	**1.02 (1.01; 1.03); 0.01**
Socioeconomic status:	4421		1898		
Lower class	1788	40.4	1011	53.3	**1**
Middle class	1755	39.7	562	29.6	**1.77 (1.65; 2.00); 0.32**
Upper class	878	19.9	325	17.1	**1.53 (1.32; 1.77); 0.23**
Family status:	4297		1771		
Living together	4113	95.7	1615	91.2	**1**
Living apart	184	4.3	156	8.8	**0.46 (0.37; 0.58); 0.43**
Place of residence:	4422		2268		
City	1232	27.9	775	34.2	**1**
Countryside	3190	72.1	1493	65.8	**1.34 (1.21; 1.50); 0.16**
Nationality:	4414		2258		
German	4159	94.2	1911	84.6	**1**
Non-German	255	5.8	347	15.4	**0.34 (0.29; 0.40); 0.60**
Caesarean section:	3931		1950		
No	2679	68.2	1383	70.9	**1**
Yes	1252	31.8	567	29.1	**1.07 (1.01; 1.13); 0.04**

[a] Odds ratios (OR) and 95% confidence intervals (95% CI) in bold are significant at the $p < .05$ level.

Table A2 Overview and Description of Control Variables

Measure (point in time)	Definition	Score / categories
Gestational age (at birth)	• Determined from maternal dates of last menstrual period and serial ultrasounds during pregnancy • When estimates from these two methods differed by more than two weeks, examination result by Dubowitz & Dubowitz (1979) was used.	Measured in weeks
Intensity of neonatal treatment index (INTI score, neonatal)	• Neurological problems, assessment of (1) care level, (2) respiratory support, (3) feeding dependency, (4) mobility, (5) muscle tone, and (6) neurological excitability (each scored daily on a 4-point rating scale: 0 = normal/good state; 3 = worst state) (daily ratings during the first 10 days or until a stable clinical state was reached)	Mean of daily ratings, ranging from 0.0 to 18.0 (higher scores indicate more problems)
Socioeconomic status (SES, neonatal)	• Standard interview with the parents • Weighted composite score of maternal and paternal highest educational qualification and occupation of the head of the family	Three categories: (1) Lower SES (40.4% of the sample) (2) Middle SES (39.6%) (3) Upper SES (19.8%)
Parent-infant relationship index (PIRI, neonatal / 5 months)	• Standard interview with the parents and study nurses' observations • Eight items covering attachment-related parental concerns and feelings, and current or anticipated relationship problems • Seven neonatal items (e.g., mother shows little pleasure when interacting with the infant, the probability of subsequent parent-infant care problems is rated high), and one item at 5 months (mother had difficulties in establishing a relationship to the infant).	Sum score, ranging from 0 to 8 (higher scores indicate more problems)
Family adversity index (FAI, neonatal / 5 months)	• Standard interview with the parents • Eight adverse family factors covering characteristics of the parents and the family environment (e.g., parental psychopathology, mother < 20 years, single mother/father) • Assessed neonatally and at 5 months	Sum score, ranging from 0 to 8 (higher scores indicate higher family adversity)
Head circumference (HC, 5 months)	• Using a standard tape for HC measurement (two measurements conducted by research nurses)	in cm, adjusted for boys / girls: Boys: > 42.4 and > 42.4 cm

		(74.7%)
		Girls: > 41.4 and > 41.4 cm
		(72.0%)
Breastfeeding (5 months)	• Mother was asked of current and/or past breastfeeding	Two categories:
		(1) never breastfed / already
		stopped (2) still partly / fully
		(13.0%)

Table A3 Prevalence and Persistence of Regulatory Problems (RP) at Measurement Points and Sex Differences

	All (n = 4427)		Boys (n = 2397)		Girls (n = 2030)		Girls vs. Boys
	n	%	*n*	%	*n*	%	OR (95% CI); |*d*|
Never regulatory problems:	1813	41.0	917	38.3	896	44.1	**1.27 (1.12-1.43); 0.13**
7 1 measurement point: [a]	2519	56.9	1423	59.4	1096	54.0	**0.79 (0.69-0.89); 0.13**
		% of all		% of boys		% of girls	OR (95% CI); |*d*|
	n [b]	with RP [c]	*n* [b]	with RP [c]	*n* [b]	with RP [c]	of RP
at one measurement point: [c]	1507	59.8	842	59.2	665	60.7	1.07 (0.90; 1.26); 0.04
at two measurement points: [c]	735	29.2	432	30.4	303	27.6	0.87 (0.73; 1.04); 0.08
at three measurement points: [c]	195	7.7	102	7.2	93	8.5	1.20 (0.90; 1.61); 0.10

Note. Odds ratios (OR), 95% confidence intervals (95% CI) in bold are significant at the $p < .05$ level.

[a] less than $n = 2519$ (of whole sample), $n = 1423$ (boys), or $n = 1096$ (girls) with regulatory problems at least at one measurement point are reported; due to missing data the exact number of measurement points could not be determined for some children.

[b] children with regulatory problems at least at one measurement point ($n = 2519$ of whole sample, $n = 1423$ boys, or $n = 1096$ girls).

[c] measurement points, i.e., at 5, 20, and/or 56 months of age.

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