Author(s): Schmid, G; Schreier, A; Meyer, R; Wolke, D
Article Title: A prospective study on the persistence of infant crying, sleeping and feeding problems and preschool behaviour

Year of publication: 2010
Link to published version:
http://dx.doi.org/ 10.1111/j.1651-2227.2009.01572.x
Publisher statement: The definitive version is available at www.blackwell-synergy.com

A Prospective Study on Persistence of Infant Crying, Sleeping, and Feeding Problems and Preschool Behaviour

Gabriele Schmid[1], Andrea Schreier[2], Renate Meyer[2], Dieter Wolke[2]

1. Department of Psychology, University of Basel, Basel, Switzerland
2. Department of Psychology and Health Sciences Research Institute, Warwick Medical School, University of Warwick, UK

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

Competing interests: none.

Correspondence:
Prof. Dieter Wolke
The University of Warwick
Department of Psychology and Health Sciences Research Institute, Warwick Medical School
UK-Coventry CV4 7AL
Phone: 0044 24 7652 3537
Fax: 0044 24 7652 4225
D.Wolke@warwick.ac.uk
And cc: gabriele.schmid@unibas.ch

Abstract:

Aim: To determine the persistence of regulatory problems (RP), i.e., excessive crying (> 3 months of age), feeding, and sleeping difficulties, from infancy to preschool age, and to evaluate whether RP at 5 months are predictive of preschool adaptive behaviour and social skills.

Method: A prospective population study of newborns admitted to neonatal care. RP at 5, 20, and 56 months of age were obtained via parent interviews and neurological examination, and preschool adaptive behaviour and social skills by parent ratings. Logistic and linear regression analyses were conducted, controlled for psychosocial and neurological factors.

Results: More than half of the sample had RP at least at one measurement point. In about 8% of infants RP persisted across the preschool years. Multiple RP and feeding problems increased the odds of eating problems at 20 and 56 months. Persistent RP and feeding problems were predictive of deficits in preschool adaptive behaviour and social skills. In addition, sex differences were found.

Conclusions: Multiple RP and feeding problems had the highest stability. Persistent RP were predictive of adverse social and adaptive behaviour. Understanding of the aetiology may help to prevent persistent RP.

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

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).

In summary, variable findings concerning the persistence of infant RP are partly explained by different definitions of RP, study design, or population. There is a lack of studies considering the stability and outcome of single versus multiple RP. The aims of this study were firstly, to determine the persistence of single and multiple infant RP during early childhood and preschool age. Secondly, we evaluated whether persistent and / or single / multiple infant RP are predictive of preschool adaptive behaviour and social skills, controlled for psychosocial and neurological factors. Finally, we investigated sex differences in prevalence and predictive models.

METHODS

Subjects

The sample consisted of infants born at risk in a geographically defined area in Southern Bavaria (Germany) during a 15-month period in 1985-1986 who were admitted to one of 16 children hospitals within 10 days after birth (n = 7505 out of N = 70 600 life births, 10.6% of all life births). At that time all newborns who were born preterm or experienced birth or neonatal complications or caesarean section were admitted to a children's hospital neonatal unit. Parents were approached within 48 hours of the infant's hospital admission and asked to give written informed consent to participate (20). Ethical approval was obtained from the University of Munich Children's Hospital.

This report includes all children who participated at all four measurement points, i.e., neonatal, 5, 20, and 56 months of age (n = 4427, 66.0% of n = 6705 eligible survivors). The sample description and the results of the dropout analyses are shown in the Appendix, Table A1.

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

Measures

Regulatory Problems (5, 20, and 56 Months)

As part of a neurodevelopmental assessment, a standardized interview concerning crying, feeding, and sleeping problems at 5 months was conducted with the parents by paediatricians (see Table 1). The definitions of crying, feeding, and sleeping problems have been derived from literature (21-23). The variable “Regulatory problems (RP) at 5 months” consisted of eight mutually exclusive categories, namely (I) single crying, (II) single feeding, (III) single sleeping, (IV) crying and feeding, (V) crying and sleeping, (VI) feeding and sleeping, (VII) crying, feeding, and sleeping problems, and (VIII) no regulatory problems at 5 months.

Both at 20 and 56 months of age sleeping and eating problems were assessed via standardized interviews with the parents and neurological examinations by paediatricians who had review and training meetings 2 monthly; the inter-rater reliability exceeded 90% (Table 1).

The assessments at 5 and 20 months were carried out corrected for prematurity and the 56 months assessment at chronological age.

(Please Insert Table 1 in the Supplementary Material online)

Adaptive Behaviour and Social Skills (56 Months)

The parents were asked 8 items by paediatricians concerning *adaptive behaviour and social skills,* namely separation from mother or other reference persons, comprehension and observance of game rules, acceptance in peer group, friends, role play, comprehension of emotional expressions, getting dressed, and toilet training. The response range was from 1 (does not apply) to 4 (applies strongly). The grand total was computed and could range from 1 (deficits in adaptive behaviour and social skills) to 4 (high adaptive behaviour and social skills) (Mean 3.63 (± 0.40)). The standardized Cronbach’s Alpha was 0.71. The validity of the assessment has been described elsewhere (24).

Control variables (confounders)

Based on previous research findings (e.g.,(11, 16, 18)) the following variables were used as control variables in the analyses (20): *gestational age* (25), *neonatal neurological problems (intensity of neonatal treatment index = INTI score)*, the *socioeconomic status* (*SES*), *parent-infant relationship index* (*PIRI*), and *family adversity index (FAI)*, *head circumference* (*HC*), and *breastfeeding* (see Appendix, Table A2 for details).

(Please Insert Table A2 in the Supplementary Material online)

Statistical Analyses

Statistical analyses were conducted with SPSS version 11.0. The assumption of normal distribution was assured for all continuous outcome variables (26). Binary logistic regression analyses were conducted to investigate differences between participants and dropouts (Appendix, Table A1), and, additionally, between girls and boys in terms of the prevalence and persistence of regulatory problems (RP) (Appendix, Table A3).

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

Hierarchical binary logistic regression analyses were conducted to examine the effect of RP at 5 months on sleeping / eating problems (0=no; 1=yes) at 20 and 56 months. In the first step, the variable RP at 5 months consisting of the reference group (no RP) and seven mutually exclusive categories (see Table 2 and Measures section for details), and additionally, infant's sex and the control variables were entered; and in a second step, in addition, the interaction terms between the categories of the variable RP at 5 months × infant's sex. If the second step did not account for a significant improvement of the regression model ($\Delta\chi^2$, degrees of freedom (*df)*, significance level $p > .05$), the adjusted odds ratios (OR) and 95% confidence intervals (95% CI) of the first step are reported (Table 2). If the second step significantly accounted for an improvement of the model ($\Delta\chi^2$, *df*, $p < .05$), a separate model was tested consisting of the main effects (categories of the variable RP and infant's sex), the control variables, and the significant interaction terms (27); the adjusted ORs (95% CI) of this final model are reported (Table 2). The goodness of fit of the final 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 × 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.

More than half of the children had at least at one measurement point single or combined RP, and girls had less often RP at any measurement point compared to boys (very small effect; see Appendix, Table A3). In 59.8% of those with RP at least at one assessment point the problems were transient, i.e., they occurred only at 5, 20, or 56 months. However, in 29.2% of the children with RP ever, they occurred at two assessment points, and in 7.7% the RP were persistent (i.e., at all three measurement points) (Table A3). ***(Please Insert Table A3 in the Supplementary Material online).***

Single crying, single feeding, and combined crying, feeding, and/or sleeping problems at 5 months of age were predictive of eating problems at 20 months (see Table 2). In infants who suffered from crying, feeding, and sleeping problems at 5 months the odds of having eating problems at 20 months were 7.22 times increased (large effect). Eating problems at 56 months were predicted by combined crying and feeding (small effect), feeding and sleeping (small effect), and crying, feeding, and sleeping problems (medium effect) at 5 months (Table 2). In addition, significant interaction terms were found between single crying problems × sex (medium effect) and single feeding problems × sex (small effect), i.e., only in girls, single crying (OR 2.44; 95% CI (1.44; 4.14); $|d|$=0.49, small effect) and single feeding problems (OR 2.10; 95% CI (1.47; 3.01); $|d|$=0.41, small effect) increased the odds of eating problems at 56 months, but not in boys (single crying: OR 0.78; 95% CI (0.45; 1.36); $|d|$=0.14, very small effect / single feeding: OR 1.18; 95% CI (0.82; 1.72); $|d|$=0.11, very small effect).

Single and combined sleeping problems at 5 months increased the odds of sleeping problems at 20 months (small to medium effects). Sleeping problems at 56 months were only predicted by single crying problems at 5 months (small effect) (Table 2).

(Insert Table 2 about here)

Associations between the Occurrence and Persistence of Infant Regulatory Problems and Preschool Adaptive Behaviour and Social Skills

Single feeding problems at 5 months were associated with problems in adaptive behaviour and social skills as rated by the parents (β = -0.05; 95% CI (-0.08; -0.02)) controlled for confounders. Furthermore, there was an interaction effect (step 2: ΔF = 2.1; *df* = 7; *p* = .04; final model: *F* = 32.5; *df* = 17; *p* < .001) indicating that only in boys, combined crying and feeding problems were predictive of problems in adaptive behaviour and social skills (β = -0.08; 95% CI (-0.13; -0.04)), but not in girls (β = 0.03; 95% CI (-0.02; 0.07)). All effect sizes were very small.

Moreover, both transient and persistent RP were related to preschool problems in adaptive behaviour and social skills (final model: *F* = 60.4; *df* = 12; *p* < .001), namely, for RP at one measurement point (i.e., at 5, 20, or 56 months) β = -0.07 (95% CI (-0.10; -0.03), very small effect), for RP at two measurement points β = -0.12 (95% CI (-0.15; -0.09), small effect), and for RP at all three measurement points β = -0.20 (95% CI (-0.23; -0.17), small effect).

DISCUSSION

More than half of the children in this sample of infants born at risk suffered from RP at some time during early childhood and the preschool years. For over half of those with RP ever the RP were transient, and for almost one third of those with RP they were intermittent. However, for about 7-8% of those with RP ever the RP were highly persistent from infancy to preschool age. Wake et al. reported that cry-fuss/sleeping problems were persistent in about 6% of children from 2 to 24 months (13). Our results extend these findings to a period from 5 to 56 months of age. In our study, overall persistence was generally high for infant feeding and eating problems as reported previously (15), while sleeping problems showed short (5 to 20 months) but no long term stability (5 to 56 months) (13). Even when controlled for confounders the effect sizes remained small to medium.. Previous research could show that among RP sleeping problems are most strongly related to parenting practices (18) and 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

disorder (35). As we did not assess genetic profiles of the participants we could not replicate these findings but further research on the role of genes in terms of the aetiology of RP and associated adverse outcome may be indicated.

There are several limitations of our study. Firstly, the data were collected in 1985-86. In the last two decades the standard of care has changed. Secondly, as our sample consisted of children who were referred to special neonatal care units after birth, the results might not be generalizable to all infants requiring normal postnatal care. Thirdly, RP were not assessed with structured diaries. However, this is not realistic in a general population sample due to the often observed high subject loss in diary studies (36). Nevertheless, there are a number of strengths. Firstly, this is one of the rare longitudinal studies concerned with multiple RP and adverse outcome in childhood that allowed for control of neurological and psychosocial risk factors that had been meticulously measured. Secondly, the dropout rate was low: two third of the eligible survivors participated at all four measurement points. Nevertheless, those who dropped out were socially disadvantaged which may have affected reported prevalences of RP.

CONCLUSIONS

Transient RP are frequent while persistent multiple RP are found in up to 8% of children with RP. Persistent RP and feeding difficulties predicted subsequent deficits in social skills. Even when controlled for confounding factors the effect sizes remained small to medium. Infant RP cause substantial expense in primary health delivery, are associated with high parental burden, can have severe developmental consequences including abuse and shaken baby syndrome (10), and behavioural consequences for the infants as shown here and elsewhere (12). Further research should focus on the aetiology of persistent infant RP and early prevention to reduce parent and infant burden.

ACKNOWLEDGEMENTS

The Bavarian Longitudinal Study was supported by grants PKE24, JUG14 (01EP9504 and 01ER0801) from the German Ministry of Education and Science (BMBF). This specific work is part of the National Centre of Competence in Research (NCCR) Swiss Etiological Study of Adjustment and Mental Health (sesam). The Swiss National Science Foundation (SNF) (project no. 51A240-104890), the University of Basel, the F. Hoffmann-La Roche Corp. and the Freie Akademische Gesellschaft provide core support for the NCCR sesam.

List of abbreviations

β: standardized regression weight (beta)

χ^2: chi-square statistic

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

CI: confidence interval

d: effect size according to Cohen

df: degrees of freedom

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

ΔF: change of F statistic

FAI: family adversity index

HC: head circumference

INTI: intensity of neonatal treatment index

ln: logarithm

OR: odds ratio

p: significance level *p*

PIRI: parent-infant relationship index

RP: regulatory problems

SES: socioeconomic status

316 **References**

317 1. Thomas A, Chess S. Temperament and development. New York: Bruner/Mazel;
318 1977.
319 2. Barr RG. Crying in the first year of life: good news in the midst of distress. Child Care
320 Health Dev 1998;24:425-439.
321 3. Zero to Three. Diagnostic classification: 0-3. Diagnostic classification of mental health
322 and developmental disorders of infancy and early childhood: Revised edition (DC:0-3R).
323 Washington, DC: Zero to Three Press; 2005.
324 4. DeGangi GA, DiPietro JA, Greenspan SI, Porges SW. Psychophysiological
325 characteristics of the regulatory disordered infant. Infant Behav Dev 1991;14:37-50.
326 5. von Hofacker N, Lehmkuhl U, Resch F, Papousek M, Barth R, Jacubeit T. Leitlinien
327 zur Diagnostik und Therapie von psychischen Störungen im Säuglings-, Kindes- und
328 Jugendalter. Köln: Deutscher Ärzte Verlag; 2007.
329 6. Hiscock H, Wake M. Infant sleep problems and postnatal depression: A community-
330 based study. Pediatrics 2001;107:1317-1322.
331 7. Wolke D. Frequent problems in the infancy and toddler years: excessive crying,
332 sleeping, and feeding difficulties. In: Bergmann KE, Bergmann RL, editors. Health promotion
333 and disease prevention in the family. Berlin: Walter de Gruyter; 2003. p. 44-88.
334 8. Wolke D, Meyer R, Ohrt B, Riegel K. Co-morbidity of crying and feeding problems
335 with sleeping problems in infancy: Concurrent and predictive associations. Early Dev
336 Parenting 1995;4:191-207.
337 9. von Kries R, Kalies H, Papousek M. Excessive crying beyond 3 months may herald
338 features of multiple regulatory problems. Arch Pediatr Adolesc Med 2006;160:508-511.
339 10. St James-Roberts I. Infant crying and sleeping: Helping parents to prevent and
340 manage problems. Prim Care 2008;35:547.
341 11. Rao MR, Brenner RA, Schistermann EF, Vik T, Mills JL. Long term cognitive
342 development in children with prolonged crying. Arch Dis Child 2004;89:989-992.

12. Wolke D, Rizzo P, Woods S. Persistent infant crying and hyperactivity problems in middle childhood. Pediatrics 2002;109:1054-1060.

13. Wake M, Morton-Allen E, Poulakis Z, Hiscock H, Gallagher S, Oberklaid F. Prevalence, stability, and outcomes of cry-fuss and sleep problems in the first 2 years of life: Prospective community-based study. Pediatrics 2006;117:836-842.

14. Thunström M. Severe sleep problems in infancy associated with subsequent development of attention deficit/hyperactivity disorder at 5.5 years of age. Acta Paediatr 2002;91:584-592.

15. Dahl M, Sundelin C. Feeding problems in an affluent society. Follow-up at four years of age in children with early refusal to eat. Acta Paediatr 1992;81:575-579.

16. Becker K, Holtmann M, Laucht M, Schmidt MH. Are regulatory problems in infancy precursors of later hyperkinetic symptoms? Acta Paediatr 2004;93:1463-1469.

17. Lundqvist C, Sabel K-G. Brief Report: The Brazelton Neonatal Behavioral Assessment Scale detects differences among newborn infants of optimal health. J Pediatr Psychol 2000;25:577-582.

18. Thunström M. Severe sleep problems among infants in a normal population in Sweden: prevalence, severity, and correlates. Acta Paediatr 1999;88:1356-1363.

19. Kochanska G, Coy KC, Murray KT. The development of self-regulation in the first four years of life. Child Dev 2001;72:1091-1111.

20. Riegel K, Ohrt B, Wolke D, Österlund K. Die Entwicklung gefährdet geborener Kinder bis zum fünften Lebensjahr. Stuttgart: Ferdinand Enke Verlag; 1995.

21. Lindberg L, Bohlin G, Hagekull B. Early feeding problems in a normal population. Int J Eat Disord 1991;10:395-405.

22. St James-Roberts I, Halil T. Infant crying patterns in the first year: normal community and clinical findings. J Child Psychol Psychiatry 1991;32:951-968.

23. Messer D, Richards M. The development of sleeping difficulties. In: St James-Roberts I, Harris G, Messer D, editors. Infant crying, feeding, and sleeping: Development, problems, and treatment. London: Harvester Wheatsheaf; 1993. p. 194-210.

24. Schlack HG, Ohrt B, Largo RH, Michaelis R, Neuhäuser G. A developmental screening questionnaire for five-year-olds. In: Brambring M, Rauh H, Beelmann A, editors. Early childhood intervention: theory, evaluation, and practice. Berlin: De Gruyter; 1996. p. 118-127.

25. Dubowitz L, Dubowitz V. Clinical assessment of gestational age in the newborn infant. London: Cow & Gate; 1979.

26. Tabachnik BG, Fidell LS. Using multivariate statistics. Boston: Pearson Education; 2007.

27. Aiken LS, West SG. Multiple regression: Testing and interpreting interactions. London: Sage; 1991.

28. Cohen D. Statistical power analysis for the behavioral sciences. 2nd ed. Hillsdale: Lawrence Erlbaum Associates; 1988.

29. Ramchandani P, Wiggs L, Webb V, Stores G. A systematic review of treatments for settling problems and night waking in young children. BMJ 2000;320:209-213.

30. Hagekull B, Bohlin G, Rydell AM. Maternal sensitivity, infant temperament, and the development of early feeding problems. Infant Ment Health J 1997;18:92-106.

31. Forsyth BWC, Canny PF. Perceptions of vulnerability 3 1/2 years after problems of feeding and crying behavior in early infancy. Pediatrics 1991;88:757-763.

32. St James-Roberts I, Plewis I. Individual differences, daily fluctuations, and developmental changes in amounts of infant waking, fussing, crying, feeding, and sleeping. Child Dev 1996;67:2527-2540.

33. Becker K, El-Faddagh M, Schmidt MH, Laucht M. Dopaminerge Polymorphismen und frühkindliche Regulationsprobleme (Dopaminergic polymorphisms and regulatory problems in infancy). Z Kinder-Jugendpsychiatr Psychother 2007;35:145-151.

34. El-Faddagh M, Laucht M, Maras A, Vöhringer L, Schmidt MH. Association of dopamine D4 receptor (DRD4) gene with attention-deficit/hyperactivity disorder (ADHD) in a high risk community sample: a longitudinal study from birth to 11 years of age. J Neural Transm 2004;111:883-889.

399 35. Nijmeijer JS, Minderaa RB, Buitelaar JK, Mulligan A, Hartman CA, Hoekstra PJ.
400 Attention-deficit/hyperactivity disorder and social dysfunctioning. Clin Psychol Rev
401 2008;28:692-708.
402 36. St James-Roberts I, Sleep J, Morris S, Owen C, Gillham P. Use of a behavioural
403 programme in the first 3 months to prevent infant crying and sleeping problems. J Paediatr
404 Child Health 2001;37:289-297.
405

Please Insert Table 1 in the Supplementary Material online

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.

Please Insert Table A1 in the Supplementary Material online

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.

Please Insert Table A2 in the Supplementary Material online

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%)

Please Insert Table A3 in the Supplementary Material online

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**
	n [b]	**% of all with RP** [c]	***n*** [b]	**% of boys with RP** [c]	***n*** [b]	**% of girls with RP** [c]	**OR (95% CI); |*d*| 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.