ABSTACT

Background: Although both Very Preterm (VP) and Small for Gestational Age (SGA) births are suggested to increase the likelihood of childhood emotional problems, there has been a lack of research comparing these effects.

Aims: To investigate levels of emotional problems in children aged between 6-13 years and contrast the impact of being born either Very Premature (irrespective of birth weight) or Small for Gestational Age.

Study Design: Prospective Longitudinal Cohort Study.

Subjects: 654 Bavarian children (born 1985-1986) who were followed from birth to age 12/13 years.

Outcome Measures: Emotional problems at ages 6;3 and 8;5 years were measured via the Child Behavior Check List (CBCL). Emotional problems were measured at age 12/13 years via the Strengths and Difficulties Questionnaire (SDQ). Trajectories of emotional problems were derived between 6;3-13 years.

Results: Two distinctive patterns of age 6-13 year emotional problems were found: 1) A low and stable level of problems in 76% of children; 2) A high and stable level of problems in 24% of children. The high and stable pattern of emotional problems was significantly associated with a VP but not an SGA birth. Consistent additional determinants included male child gender and lower family socioeconomic status.

Conclusions: The disparity between VP rather than SGA birth as a predictor of age 6-13 year old emotional problems is considered in terms of fetal and/or glucocorticoid programming. The stability of emotional problems between 6-13 years reinforces the need for early childhood interventions aimed at children born very preterm.

Keywords: emotional disorder; prematurity; small for gestational age

A comparison of prematurity and small for gestational age as risk factors for age 6-13 year emotional problems

INTRODUCTION

Emotional problems that are evident in adolescence and early adulthood may often be traced back to emotional problems experienced before puberty[1]. For example, generalized anxiety symptoms are noted to rapidly escalate shortly before pubertal onset[2] and pre-adolescent anxiety has been identified as an important precursor of adolescent depression. Such findings reaffirm the need for longitudinal investigations and suggest that risk factors for prepubescent emotional problems may have longer lasting consequences than previously thought[3].

The etiology underlying childhood emotional problems is understood to be complex and multi-factorial[4]. Risk factors for the development of emotional problems in children have been identified from multiple sources: *biological* factors including genes and hormones, *psychosocial* factors such as stressful life events, and the *social/demographic* background of an individual and/or their family (echoing the bio-psychosocial model)[5]. However, while the exploration of interactions between these different levels has seen increasing popularity[6] (e.g. Gene-Environmental Interaction[7]), there are still a substantial number of more fundamental questions that are still waiting to be adequately addressed[8].

The *perinatal* risk factors of prematurity and Small for Gestational Age birth (SGA; indicating Intrauterine Growth Restriction, IUGR) have both been linked with the development of future emotional problems. This relationship has been reported in infants[9], pre-pubescent children[10], adolescents[11], and adults[12]. However, when contrasting preterm versus SGA births, there remains considerable debate surrounding the risk-specific underlying mechanisms involved[12]. For SGA/IUGR[13] the underlying mechanism has been proposed to concern fetal malnourishment and brain growth, whereas for premature infants the underlying mechanism has been argued to concern aberrant brain-development with superimposed insult[14]. Even presuming different mechanisms are at-play however, a comparison of prematurity versus SGA as risk factors for emotional problems is complicated by their co-morbidity - be this in terms of commonality in direct risk effects or commonality as joint predictors of low birth weight[13].

This longitudinal investigation studied Very Preterm (VP, irrespective of birth weight) and SGA births and compared how each was related to the development of prepubescent emotional problems. First, we identified distinctive patterns of emotional problems within a mixed-risk sample of Bavarian children aged 6-13 years of age. Second, we then examined the impact of VP and SGA births within independent but otherwise identical statistical analyses so as to avoid confounding their (hypothesized) overlapping but independent mechanisms of effect.

METHOD

Participants

Participants were drawn from the prospective Bavarian Longitudinal Study (BLS) which is an on-going investigation that follows a geographically defined sample of Very Preterm (<32 weeks gestation) and/or Very Low Birth Weight (VLBW; <1500g birth weight) infants born in south Bavaria between January 1985 and December 1986 (with mothers giving informed consent for family participation within 10 days of child-birth). Exact details of the design of the BLS may be found elsewhere[15] and so are only briefly outlined here. 682 VP or VLBW children were admitted to one of 16 children hospitals within the first 10 days of life. Of this sample, 448 survivors met the inclusion criteria (alive, German speakers) for subsequent follow-up with assessment points at 6;3, 8;5, and 12/13 years. This sample of perinatally at-risk children was complemented with the additional sampling of 333 children who were born healthy and fullterm within the same hospitals and the same 1985/6 time frame. This paper studies those 654 VP/VLBW and fullterm children who consented to participate in the BLS at the age 12/13 year assessment point (84% of the potential n=781).

Measures

<u>Gestational age (weeks) and gestational age-appropriateness of birth weight.</u> The number of weeks gestation at which a child was born was determined from: 1) maternal records of last menstrual period, 2) serial ultrasounds during pregnancy, 3) Dubowitz examination. Maternal records and ultrasound were the primary methods of determining gestational age while Dubowitz examination was only used if these initial estimates differed by more than 2 weeks[15]. A VP birth was defined as any birth prior to 32 weeks gestation. SGA was defined as a birth weight less than 10 percent of all

Bavarian children who were born at the same gestational age and within the BLS recruitment period. 54.6% of the 654 children were born at low birth weight (<2.5 kg; n=357). Here we concentrate upon solely those preterms (<37 weeks gestation) born Very Premature (VP; <32 weeks) as these were the only preterms that the BLS studied continuously up to age 12/13 years (non-VP preterms were dropped from the study after the age 8 assessment point).

41.7% of children were born VP (n=257), 28.9% were born SGA (n=178), and 12.2% were born both (n=75). Due to the design of the BLS the percentages of children born VP and/or SGA are much larger than would be expected from a normative sample, although the overlap between VP and SGA births is at the lower end of the range of overlaps reported elsewhere (approximately 11-18%[16]). Table 1 presents the exact overlap.

[Insert Table 1 here]

Outcome measures (6;3 years, 8;5 years, 12/13 years). At 6;3 and 8;5 years, children's behavior was rated by parents on the Child Behavior Check List (CBCL[17]). Emotional problems were assessed via the '*Internalizing Problems*' scale that is composed of the three subscales: 'Withdrawn', 'Somatic Complaints', and 'Anxious/Depressed' behaviors.

At 12/13 years, the parents of participating children were again asked to rate their BLS child's behavior, but this time with the Strengths and Difficulties Questionnaire (SDQ)[18]. Closely matching the CBCL[19] children's emotional problems were assessed via the '*Emotional Symptoms*' subscale that takes the mean of five items that have scores ranging from 1-3 ('Certainly true' - 'Not true'). The five items comprising the 'Emotional Symptoms' subscale were reverse coded prior to analysis so that the directionality of the SDQ matched that of the CBCL.

The term '*Emotional Problems*' was used to refer to that aspect of children's' behavior that is commonly measured by both the CBCL *'Internalizing Problems'* scale and the SDQ *'Emotional Symptoms'* subscale. Our use of this term is consistent with past research carried out with both the CBCL[20] and the SDQ[21].

Other predictor variables (potential confounders from prenatal period to age 6;3 years). Seven potential confounders were included in the analyses as additional predictors of prepubescent emotional problems. Socio-Economic Status (SES) was coded as a thee-category variable (low,

middle, high) computed from a weighted composite that reflected the occupation of the head of the family and the highest level of education held by either parent[22]. Pre-pregnancy complications (e.g. previous still birth, diabetes) were recorded on an eight item scale based on the medical histories of the mother as kept by obstetric units. Whether or not the family lived in an urban or rural area ('Urban' defined as >50,000 inhabitants). The four other predictor variables were background characteristics: child gender; nationality of primary caregiver (German, non-German); mother age (years); and the number of children born from that pregnancy.

These confounders were deliberately limited to events that occurred either before or during pregnancy and were assessed via standard parental interview when families first enrolled in the study[23]. Other potentially confounding (but later occurring) measures (such as those during the neonatal period) were not included in the analyses due to the possibility that their role may be to mediate the impacts of VP and SGA on the development of emotional problems between 6-13 years[24]. Though the seven potential confounders may remain present *after* birth, that they were also present before ensures that there can be no reverse-causality between these and either VP/SGA birth or childhood emotional problems. For example, we can be sure that neither a VP/SGA birth or high emotional problems may have led parents to give up work in pregnancy – thus lowering their SES.

Data Analysis

In order to differentiate the impacts of VP from SGA births on age 6-13 year emotional problems, two Latent Class Growth Analyses (LCGA) were specified using Version 3.13 of the MPLUS software. Linear growth in emotional problems was estimated with latent variables representing the CBCL scale 'Internalizing Problems' at 6;3 and 8;5 years, and the SDQ subscale 'Emotional Symptoms' at 12/13 years. The three CBCL subscales and five SDQ items that contributed to these three latent variables (see Table 4) were all z-scored *a priori* to avoid any distortion of truly changing patterns of emotional problems over-time (bearing in mind that latent growth estimated from latent variables relies upon the Means And Covariance Structure [MACS] of the data)[21]. A pattern of linear growth was tested after preliminary exploration of an additional (more complex) quadratic effect returned an insignificant quadratic term (mean=-0.004, p=0.663).

As part of the LCGA, statistical estimations were made of the number of distinctive *classes* evident within the linear growth of age 6-13 year emotional problems (see Figure 2) and assessments were

made of how strongly these classes were related to either a VP or SGA birth (see Table 5). The 12% of children who were born both VP *and* SGA were retained in these analyses as their exclusion would have jeopardized the identification of any overlapping risk effects. Figure 1 illustrates the LCGA that was carried out.

[Insert Figure 1 here]

The growth modeling of emotional problems across the CBCL and SDQ (Figure 1) was only made possible due to the specification of emotional problems with latent variables. Normally, growth modeling across different measures is invalid due to: 1) An inability to ensure the same concept is measured across instruments; 2) Inconsistent measurement scales. However, here the equivalance of the CBCL with the SDQ[19, 25-26] ensured that the same underlying concept was being assessed over-time while the operationalization of emotional problems with *latent* variables provided a CBCL/SDQ consistent measurement scale[27].

RESULTS

Descriptive Statistics

Of the 781 potential participants at age 12/13 years, 654 (84%) consented to participate. The 127 dropouts were either: 1) children (or families) who had previously withdrawn from the study; 2) not contactable at this time point; 3) past participants who now actively declined to participate. Non-participants were significantly more likely to have been born Very Premature, born Small for Gestational Age (SGA), have been born to a younger mother, as part of a multiple birth, and/or had parents of lower socio-economic status. However, there were no significant differences between the two groups in the extent of past emotional problems (at ages 6;3 or 8;5 years). Table 2 provides full details of the differences between the participants and dropouts while Table 3 presents the simple bivariate correlations between the measures subsequently analyzed.

[Insert Table 2 here]

[Insert Table 3 here]

Emotional Problems at 6;3, 8;5 and 12/13 years

Table 4 reveals the composition of the three latent variables (lamda loadings, standard errors, 95% confidence interval) that were estimated to represent children's emotional problems at 6;3, 8;5, and 12/13 years of age from the initial single-class latent growth model. This initial model was found to fit the data well (CFI: 0.95; RMSEA: 0.048; SRMR: 0.042). Common across the CBCL and SDQ, the latent variables reflecting 'Emotional Problems' were most strongly associated with levels of underlying anxiety/depression and were least reflective of underlying somatic complaints.

[Insert Table 4 here]

Trajectory Classes

The initial series of Latent Class Growth Analyses (LCGA) suggested two distinct underlying patterns within age 6-13 year emotional problems. A two-class solution returned a significantly more accurate representation of the data than did a single class alternative (Lo-Mendell-Rubin adjusted likelihood ratio test, LMR: p=0.004; Vuong-Lo-Mendell-Rubin likelihood ratio test, VLMR: p=0.003). There was also no significant improvement in model fit by going on to estimate three-classes (LMR: p=0.26; VLMR: p=0.25). Further, results suggested that the two-class model was actually *better* able to represent emotional problems rather than the less parsimonious three-class alternative (entropy value of 0.75 rather than 0.71).

Figure 2 illustrates the two distinctive patterns of 6-13 year emotional problems that were identified from the initial series of LCGA. 76% of the children were found to display consistently low levels of emotional problems whereas 24% exhibited a pattern of emotional problems that was consistently high. Post-hoc t-tests showed that the emotional problems exhibited by the two groups of children were also significantly different at all three time points (at 6;3 years: $t(652)=31.07$, $p<0.001$; at 8;5 years: $t(652)=29.9$, $p<0.001$; at 12/13 years: $t(652)=18.48$, $p<0.001$).

[Insert Figure 2 here]

Predicting Trajectory Class Membership

Table 5 contrasts the extent to which either a Very Premature or SGA birth could successfully discriminate between a child's membership of the 'consistently high' rather the 'consistently low'

groupings of age 6-13 year emotional problems. Children who exhibited a consistently high level of emotional problems were more likely to have been born Very Premature *but not SGA*. In addition, two other predictors of the consistently higher level of emotional problems were identified: male child gender and lower family SES. Post-hoc analysis showed that of the n=264 children born Very Premature, n=85 (32%) demonstrated the 'consistently high' pattern of emotional problems compared to 29% of the n=178 children born SGA (n=51) and 18% of the n=317 children born full-term (n=56).

[Insert Table 5 here]

Considering the Positive Predictive Value (PPV) of the combination of Very Premature birth, male gender and lower SES, there were n=52 individuals who demonstrated this combination in our sample of n=654. Of these n=52 children, n=28 were found to demonstrate the consistently high level of emotional problems, thus the PPV of these measures is 58%.

DISCUSSION

Distinctive trends in emotional problems between the ages of 6-13 years

We identified two distinctive patterns of emotional problems in children aged between 6-13 years. While 76% of children demonstrated consistently low levels of emotional problems across this preadolescent period, the remaining 24% exhibited problems that were significantly greater in magnitude. This pattern of results is broadly consistent with past studies that have also investigated childhood emotional problems over this same period. In particular, our identified patterns of emotional problems are very similar to those reported by Proctor and colleagues[28]. Further, this is despite the study of Proctor and colleagues investigating an American rather than German sample and despite different risks being considered (placement in foster care). However, Proctor and colleagues reported similar patterns of emotional problems to those reported here: 67% of their sample of children aged 6-14 years demonstrated low levels of internalizing behavior (i.e. stable adjustment/fewer emotional problems), while 25% were found to exhibit a consistently greater level. The similarity between the results presented here and those of Proctor and colleagues validates our identified pattern of preadolescent emotional problems. This validity comes from the Proctor study identifying longitudinal emotional problems based on a greater number of time points than here (five rather than three) and

from sole use of the CBCL rather than a combination of the CBCL and the SDQ. Nonetheless, the similarity between both these studies' identified pattern of emotional problems (high vs. low) is remarkable given the differences between the samples, the likely different etiologies at-play, and the populations under investigation – a consistency referred to as 'Equifinality'[29].

Risk factors for stable and high levels of emotional problems between 6-13 years

Children were more likely to demonstrate consistently high levels of age 6-13 emotional problems if they had been born Very Preterm, male, or if they had parents of lower socioeconomic status. While this SES finding is consistent with previous research, there is less consensus between past research and our findings concerning prematurity, birth weight, and child gender[30]. Ongoing debate surrounds the impacts of prematurity, SGA, and low birth weight on the development of emotional problems due to their frequent co-occurrence as part of the multi-factorial etiology for emotional problems with child gender differences being known to vary by child age[31]. However, before a broader discussion of risk factors can begin and considering the multi-factorial etiology of emotional problems in more detail, the fact that we studied a high-risk group rather than a normative sample means that it is quite possible that we identified a set of predictors that are particular to high perinatal risk children only.

Limiting our consideration of past research to that which has investigated only prematurity, SGA and low birth weight as risk factors for emotional problems, our results both concur [32-33] and yet also diverge[34-35] from past studies. Further, this disparity of findings is evident despite all (four) of these investigations assessing emotional problems using only the CBCL. Considering all four of these studies[32-35] together, they suggest prematurity to be a risk factor for *early* emotional problems (pre-pubescent) but low birth weight to be a risk factor for *later* problems (from puberty onwards). For example, near-term preterms (34-36 weeks) were found to be at an increased risk for age 6 emotional problems[32] and significantly greater levels of emotional problems were reported in 7-9 year olds who were born at 32-36 weeks gestation[33]. By contrast, greater levels of anxiety/depression were reported in *adolescent* children who were born below 2000g[34] and even 2500g[35].

Examining reasons for the diverging perinatal etiology between prematurity and low birthweight for subsequent emotional problems, theories of fetal brain development such as the *"fetal programming hypothesis"* suggest that in uterine events such as prematurity or poor growth go on to affect the development of organs, in particular the brain. However once children are born, so the body's organs

and systems are altered by additional adversities (such as socioeconomic adversities, as shown here) and developmental changes (such as puberty)[36]. Thus, we conclude that it is quite possible that Very Preterm and SGA births may have *different* effects on *pre*-adolescent emotional problems because of *different* underling mechanisms post-birth (including neurological such as glucocorticoid programming of the hypothalamic-pituitary-adrenal axis[37]) although additional studies are needed to test this hypothesis. One particular avenue for future research in this area would be to build upon previous research that has shown Very Preterm births to be associated with limited cortical folding while lowered birthweight is related to reduced brain volume[13]. Considering building upon the VP effects and lack of SGA effects found here, past research has found premature births to be associated with an increase in subsequent internalizing behavioural problems due to neurological damage such as Cerebellar Hemorrhagic Injury (CHI)[38].

That VP and fostering[28] have been linked with higher pre-adolescent emotional problems whereas less certain evidence has been found for SGA[32-35] suggests that different mechanisms may be at work explaining why different risks are (or are not) likely to lead to increased emotional problems (see Figure 3). Indeed, although the analyses reported here aimed to reveal important differences between the emotional sequalae of VP versus SGA births, there yet remain a number of important causal mechanisms remaining to be determined with evident implications for clinicians. One likely causal mechanism differentiating outcomes for VP and SGA births is likely to involve mother-infant interactions and attachment. Not only does research continue to demonstrate that mother-child (in this case infant) interactions are significant drivers of long-term mental health outcomes in children[39], but VP and SGA children also likely to experience different mother-child interactions and attachment representations as well[40-41]. These potential mediating factors need to be investigated in future[42]. As a result, we posit two particular questions for future researchers. First, what proportion of the variance in pre-adolescent emotional problems that is commonly attributed to pre-birth measures is in fact due to intermittent perinatal risks? Second, how do perinatal risks vary in the malleability of their own mechanisms-of-effect (mediators) that lead to emotional problems?

[Insert Figure 3 here]

Considering past research that has investigated child gender differences for emotional problems, our finding that *prepubescent boys* were at significantly greater risk for emotional problems is also not

unprecedented. This is particularly evident in studies that have investigated childhood depression – that aspect of emotional problems that our results demonstrated as most strongly associated with other internalizing disorders[43].

Limitations and Strengths

This research has a number of limitations as well as strengths. Considering limitations, first our results are based exclusively on parent/caregiver reports of their children's emotional problems and generalizations should concentrate on other samples of high perinatal risk as the etiology of emotional problems may differ between normal BWT and low BWT/premature children. Second, our estimation of emotional problems between 6-13 years relies on only 3 measurement points over a 7 year period. It is quite possible that there may be additional patterns of changing emotional problems that could be revealed with more detailed measurement over-time; at the very least a greater number of measurement points would have permitted free-estimation of changing emotional problems. Third, the Positive Predictive Value of all three of the significant factors positively predicting a stable and high pattern of emotional problems between 6-13 years (male gender, lowest SES, VP birth) is modest at best and applicable only within VP samples. Further work is necessary to build upon this study of perinatal risks so as to more accurately capture the broader multi-factorial etiology of emotional problems that has been demonstrated in past research[4]. Fourth, our results provide only a starting point for differentiating the effects of Very Preterm from SGA births. For example, the potential for non-linear effects might be explored as might broader interactions between perinatal risks and other levels of risk (e.g. GxE[7]). What remains certainly necessary is experimental research which replicates or supports these findings as it is inherently difficult to completely isolate the influences of birth weight, gestational age, and IUGR in non-experimental studies such as this one.

These limitations aside, the strength of this research lies in its identification of groups of children who showed similar developmental patterns – groups who could be reliably distinguished from one another by perinatal risks and social factors. Our results are therefore of particular use to clinicians working with high-perinatal-risk samples as we identified child typologies based on discrete patterns of developmental change.

In conclusion, our study confirms the patterns of preadolescent period emotional problems that have been identified in previous research but goes on to identify that differences in preadolescent

emotional problems are explained by VP rather than SGA births, male sex, and parents from low SES backgrounds. Our findings suggest that the assessment of significant emotional problems in children as young as age 6 years (i.e. screening) could serve as a reliable indicator of future emotional problems for the next 6-7 years – particularly if these children were born at perinatal risk. Implementing such clinical practice would also be consistent with the recommendations that have been made by prior research[10].

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Table 1. Overlap between Very Premature and Small [birth weight] for Gestational Age births (n=616, 38 cases missing)

		AGA/SGA births (n):		
		AGA	SGA *(percentages SGA)*	Gestational Age Totals:
Premature births (n):	VP <32 weeks *(Percentages VP)*	182 *(29.5%)*	75 *(12.2%)* [a]	257 *(41.7% VP)*
	Premature non-VP 32-36 weeks	16	57 *(9.3%)*	73
	Fullterm Birth >36 weeks	240	46 *(7.5%)*	286
AGA/SGA Totals:		438	178 *(28.9% SGA)*	616

Abbreviations: AGA: Average [birth weight] for Gestational Age; SGA: Small [birth weight] for Gestational Age;

[a] 12.2% of the same of n=616 children sampled were born both VP and SGA (n=75)

Table 2. Sample description and comparison of age 12/13 participants

Measure	Participants		Dropouts		Statistical comparison	
	n	% or Mean ± SD	n	% or Mean ± SD	Statistic	p
PREDICTORS:						
Prematurity of birth	654		127		X^2=25.24; df=1	<.001
Very Premature birth (<32 weeks)	264	40.4%	82	64.6%		
Birth >31 weeks gestation	390	59.6%	45	35.4%		
Small (birth weight) for Gestational Age:	616		123		X^2=6.64; df=1	.010
Small for Gestational Age (SGA; <10%)	178	28.9%	50	40.7%		
Appropriate for Gestational Age (AGA; 10-90%)	438	71.1%	73	59.3%		
Child gender:	654		127		X^2=0.81; df=1	.369
Male	332	50.8%	70	55.1%		
Female	322	49.2%	57	44.9%		
Primary caregiver nationality:	653		127		(Fishers‘)	.064
German	647	99.1%	123	96.9%		
Non-German	6	0.9%	4	3.1%		
Mother age at birth (years):	652	28.7 ± 5.0	127	27.3 ± 4.9	t(777)= -2.83	.005
Number of children born from pregnancy:	654	1.2 ± 0.5	127	1.4 ± 1.0	t(136)= 2.33	.022
Parental Socio-Economic Status (at birth):	653		124		X^2=18.29; df=2	<.001
Low SES	218	33.4%	62	50.0%		
Middle SES	268	41.0%	49	39.5%		
High SES	167	25.6%	13	10.5%		
Place of residence:	654		126		X^2=0.17; df=1	.683
Rural	443	67.7%	83	65.9%		
Urban	211	32.3%	43	34.1%		
Number of pre-pregnancy complications (0-8)	652	1.3 ± 0.8	127	1.2 ± 0.8	t(777)= -0.99	.324
OUTCOMES:						
‘Internalizing Behavior' CBCL subscales:						
At age 6;3 years: ‘Withdrawn'	628	2.6 ± 2.2	72	2.5 ± 2.3	t(698)= -0.51	.612
‘Somatic Complaints’	628	0.8 ± 1.2	72	0.7 ± 1.3	t(698)= -0.40	.689
‘Anxious/Depressed’	628	4.1 ± 3.4	72	4.0 ± 3.3	t(698)= -0.39	.696
At age 8;5 years: ‘Withdrawn'	613	2.4 ± 2.0	60	2.3 ± 2.0	t(671)= -0.05	.958
‘Somatic Complaints’	613	0.9 ± 1.3	60	1.2 ± 0.2	t(671)= -0.66	.511
‘Anxious/Depressed’	613	4.0 ± 3.1	60	3.3 ± 0.4	t(671)= -0.15	.877
‘Emotional Symptoms' SDQ items at age 12/13 years:						
‘Often complains of headaches, stomach aches or sickness'	643	2.6 ± 0.6	-	-		-
‘Many worries, often seems worried'	648	2.5 ± 0.7	-	-		-
‘Often unhappy, down-hearted or tearful'	650	2.7 ± 0.5	-	-		-
‘Nervous or clingy in new situations, easily loses confidence'	650	2.2 ± 0.7	-	-		-
‘Many fears, easily scared'	649	2.6 ± 0.6	-	-		-

Abbreviations: CBCL: Child Behavior Check List; SDQ: Strengths and Difficulties Questionnaire

Table 3. Pearson Correlations between the measures used in this paper. Measures drawn from the perinatal period and at 6;3, 8;5 and 12/13 years

Measures	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Very Premature?	1																			
2. SGA?	.005	1																		
3. Female child gender?	**-.081***	-.002	1																	
4. PCG Nationality (German)?	-.019	-.046	-.034	1																
5. Mother age	.031	-.064	.036	.017	1															
6. No, of children born from pregnancy	**.212*** **	.019	.071	.036	**.079***	1														
7. Parental SES	.030	**.085***	-.021	.031	-.280	.047	1													
8. Rural family home?	**.088***	.053	.025	.036	-.050	.061	**.182*** **	1												
9. No. pre-pregnancy birth complications	**.118****	**.105****	-.010	.049	**.423*** **	**.104****	**-.110****	.000	1											
10. Age 6 Emotional Problems: Withdrawn	.057	.020	-.080*	.010	-.080*	-.004	.075	.010	.040	1										
11. Age 6 Emotional Problems: Somatic Complaints	.003	-.006	.015	.043	.056	-.053	.014	-.018	**.090***	**.235*** **	1									
12. Age 6 Emotional Problems: Anxious/Depressed	**.081***	.071	-.007	.040	-.060	.045	**.108****	.023	**.093***	**.629*** **	**.325*** **	1								
13. Age 8 Emotional Problems: Withdrawn	**.084***	.038	-.063	.009	**-.116****	-.036	**.116****	.051	.019	**.572*** **	**.164*** **	**.414*** **	1							
14. Age 8 Emotional Problems: Somatic Complaints	-.024	.064	-.005	-.008	.024	-.056	.018	-.000	.068	**.151*** **	**.356*** **	**.142*** **	**.224*** **	1						
15. Age 8 Emotional Problems: Anxious/Depressed	.085*	**.095***	-.037	.057	-.064	-.052	.100*	.019	**.090***	**.393*** **	**.196*** **	**.553*** **	**.551*** **	**.251*** **	1					
16. Age 12/13 Emotional Problems: "Often complains..."	.009	.057	**-.108****	.049	.0183	-.030	-.080*	.017	.012	-.051	-.080*	-.116**	-.095*	-.231***	-.162***	1				
17. Age 12/13 Emotional Problems: "Many worries..."	**-.108****	**-.089***	-.046	.044	-.015	.021	-.049	-.027	-.052	**-.169*** **	-.071	**-.280*** **	**-.092***	**-.170*** **	**-.310*** **	**.250*** **	1			
18. Age 12/13 Emotional Problems: "Often unhappy..."	-.028	-.080*	-.045	.067	**.103****	.036	-.072	.035	.020	**-.111****	-.050	**-.211*** **	**-.13****	**-.10****	**-.240*** **	**.308*** **	**.421*** **	1		
19. Age 12/13 Emotional Problems: "Nervous..."	**-.219*** **	**-.157*** **	-.024	.006	0.056	.023	-.067	-.047	.029	**-.243*** **	**-.159*** **	**-.314*** **	**-.317*** **	**-.130****	**-.335*** **	**.164*** **	**.331*** **	**.340*** **	1	
20. Age 12/13 Emotional Problems: "Many fears..."	**.213*** **	**-.085***	-.038	.009	.009	-.010	-.010	-.028	.010	**-.200*** **	-.072	**-.272*** **	**-.183*** **	**-.126****	**-.296*** **	**.183*** **	**.448*** **	**.404*** **	**.514*** **	1

Abbreviations: SGA: Small (birth weight) for Gestational Age; PCG: Primary Care Giver; SES: Socio-Economic Status; * *p<0.05; ** p<0.01; ***p<0.001*

Table 4. The composition of the 'Emotional Problems' latent variable at 6;3, 8;5 and 12/13 years: Standardized factor loadings

Indicator of 'Emotional Problems'		Standardized Factor (lamda) Loadings	SE	95% CI
CBCL subscales:				
At age 6;3 years:	'Withdrawn'	0.68***	0.034	[0.61, 0.74]
	'Somatic Complaints'	0.35***	0.038	[0.27, 0.42]
	'Anxious/Depressed'	0.94***	0.038	[0.86, 1.01]
At age 8;5 years:	'Withdrawn'	0.63***	0.029	[0.57, 0.69]
	'Somatic Complaints'	0.32***	0.038	[0.24, 0.39]
	'Anxious/Depressed'	0.86***	0.036	[0.79, 0.93]
SDQ items at age 12/13 years:				
'Often complains of headaches, stomach aches or sickness'		0.34***	0.050	[0.24, 0.44]
'Many worries, often seems worried'		0.42***	0.042	[0.54, 0.70]
'Often unhappy, down-hearted or tearful'		0.59***	0.040	[0.51, 0.67]
'Nervous or clingy in new situations, easily loses confidence'		0.63***	0.037	[0.56, 0.71]
'Many fears, easily scared'		0.71***	0.035	[0.65, 0.78]

Abbreviations: CI: Confidence Interval; CBCL: Child Behavior Check List; SDQ: Strengths and Difficulties Questionnaire;

** p<0.05; **p<0.01; ***p<0.001*

Table 5. A comparison of Very Premature against SGA births in distinguishing 'stable high' vs. 'stable low' levels of emotional problems between 6-13 years of age

Predicting child membership of the latent class 'consistently *high'* rather than 'consistently *low'*	Latent Class Growth Analyses including the measure of **VP birth**			Latent Class Growth Analyses including the measure of **SGA birth**		
	B	OR (e^B)	95% CI	B	OR (e^B)	95% CI
1a) Very Premature born child	0.17*	1.19	[1.01, 1.36]	-	-	
1b) Small for Gestational Age?	-	-		0.09	1.09	[0.69,1.72]
2) Male child gender?	0.34*	1.40	[1.06, 1.86]	0.37*	1.45	[1.04, 1.95]
3) Primary caregiver has German nationality?	-0.14	0.87	[0.72, 1.04]	-0.15	0.86	[0.72,1.04]
4) Mother age at birth (years)	0.02	1.02	[0.71, 1.50]	0.04	1.04	[0.68,1.59]
5) Number of children born from pregnancy:	-0.03	0.97	[0.74, 1.28]	0.04	1.04	[0.80,1.34]
6) Family lives in a rural area?	0.23	1.26	[0.91, 1.73]	0.26	1.30	[0.96,1.76]
7) Lower family Socio-Economic Status at birth	0.47**	1.60	[1.18, 2.16]	0.46**	1.58	[1.14, 2.19]
8) Number of Pre-Pregnancy Complications	-0.03	0.97	[0.75, 1.26]	-0.01	0.99	[0.76,1.29]

Abbreviations: LCGA: Latent Class Growth Analysis; VP: Very Premature; SGA: Small for Gestational Age; OR: Odds-Ratio; CI: Confidence Interval;

** p<0.05; **p<0.01*

Figure 1. Distinct patterns of emotional problems between age 6-13 years: Differentiating the impacts of prematurity from Small (birth weight) for Gestational Age

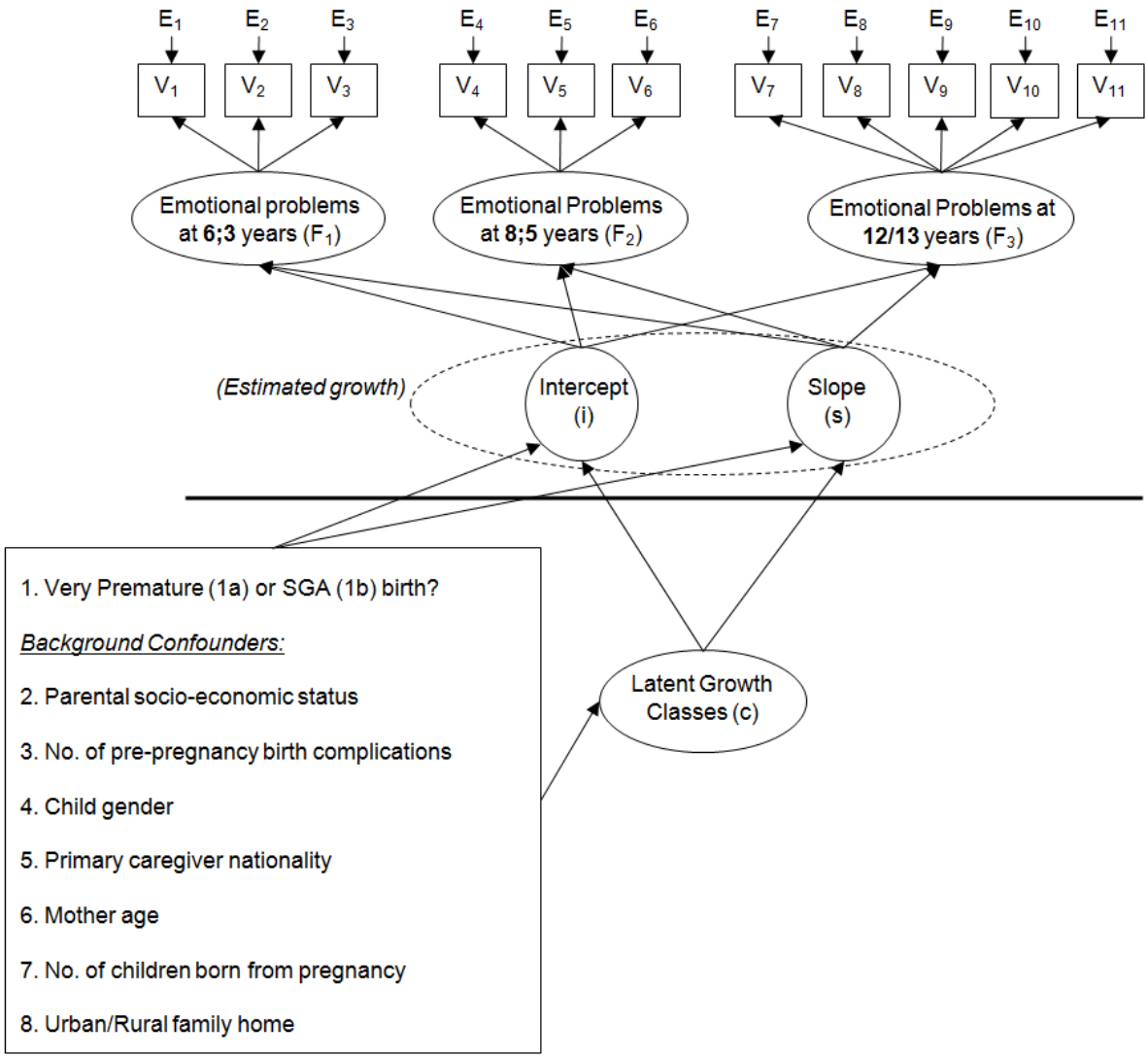

Figure 2. Distinctive patterns of emotional problems between 6-13 years of age

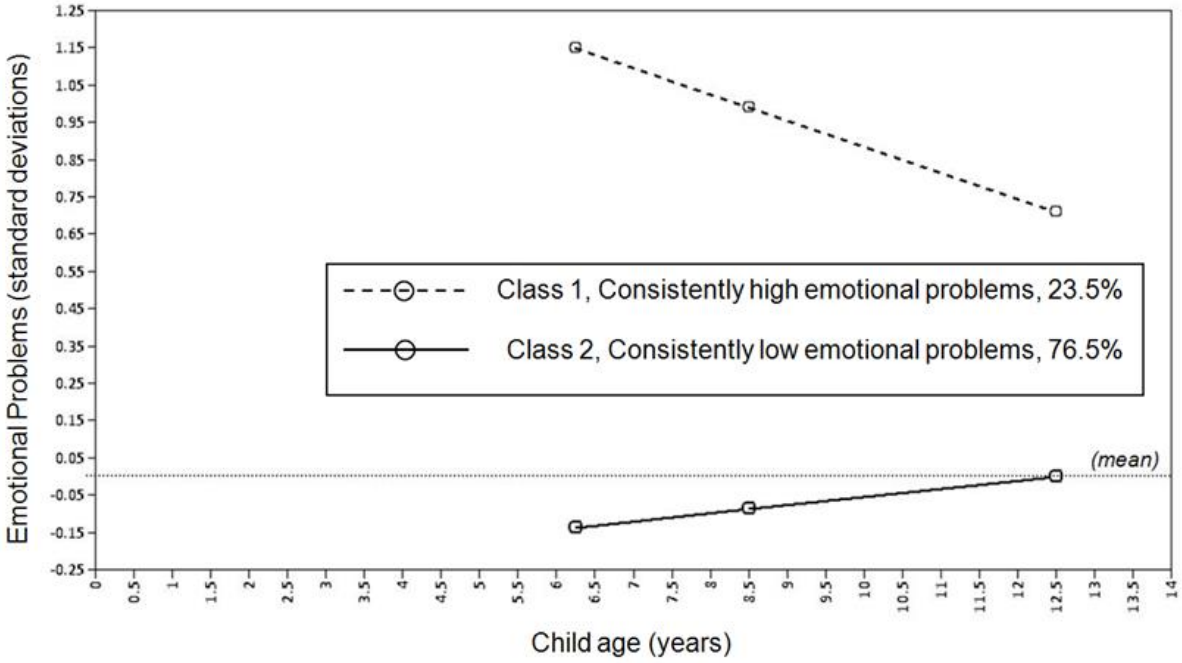

Figure 3. Potential mediating effects at-play distinguishing the impacts of pre-birth measures, VP and SGA births, and post-birth measures for childhood emotional problems