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Attention problems in relation to gestational age at birth and smallness for gestational age ☆

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ABSTRACT

Background: While it is well established that very preterm birth (gestational age at birth <32 weeks) is related to increased attention problems, there is still considerable uncertainty of the effects of moderate or late preterm birth or smallness for gestational age (SGA) on attention regulation.
Aims: To investigate the impact of gestational age at birth and SGA, birth on child attention problems.
Study design: Prospective longitudinal cohort study.
Subjects: A total of 1435 children sampled from the Bavarian Longitudinal Study (BLS).
Outcome measures: Main outcome variables were parent-reported attention problems and examiner-reported attention skills at 6 and 8 years. Predictors were linked to attention outcomes using hierarchical regression analyses.
Results: Gestational age at birth ranged from 25 weeks to 41 weeks. We found a quadratic effect of gestational age on attention problems ($\beta_{6\ years} = 0.161$, 95% CI = 0.085; 0.236; $\beta_{8\ years} = 0.211$, 95% CI = 0.135; 0.287), and attention skills at 6 and 8 years ($\beta_{6\ years} = -0.178$, 95% CI = −0.252; −0.104; $\beta_{8\ years} = -0.169$, 95% CI = −0.243; −0.094). Elective caesarean birth did not predict child attention. In adjusted models, SGA was an additional risk factor for attention problems ($\beta = 0.080$, 95% CI = 0.026; 0.134), and attention skills ($\beta = -0.091$, 95% CI = −0.143; −0.039) at 6 years but not at 8 years after adjusting for child sex and family SES.
Conclusion: Adverse effects on attention are disproportionately higher at early gestations. In contrast, the impact of SGA status was found to be similar at all gestational ages but disappeared by 8 years.

1. Introduction

Attention skills are a fundamental prerequisite of learning and attention problems predict lower academic success [1,2]. Attention skills have been regularly reported to be impaired in children and adolescents who were born very preterm (gestational age at birth <32 weeks) [3–6]. In contrast, findings are inconsistent for children born moderately or late preterm (gestational age at birth between 32 and 36 weeks) [3,7–10].

Up to a third of preterm births are iatrogenic because of concerns about maternal or foetal health [11]. Elective caesarean birth is common in iatrogenic births, and this mode of delivery has been associated with adverse outcomes in the neonatal period [12–15] and beyond [8,16]. Talge and her colleagues [8] reported a significant association between elective caesarean birth and attention problems in children born late preterm (34–36 weeks).

Foetal growth restriction (FGR), commonly associated with a variety of pregnancy complications (i.e., preeclampsia), is a common reason for elective caesarean birth [8]. Smallness for gestational age (SGA: i.e., a birth weight below 10th percentile) has been used as a proxy for FGR [17]. SGA has been reported to significantly predict attention related problems in some studies [6,10,18] but not in others [8,19,20]. Thus, while the link between very preterm birth and childhood attention problems is well established, the impacts of moderate/late preterm birth, SGA and elective caesarean birth are still uncertain.

The objective of this study was to investigate the impact of gestational age at birth, and SGA on child attention at 6 and 8 years across the full gestation spectrum. Firstly, we examined the impact of gestational age on child attention. We hypothesized that gestational age at birth is associated with child attention at school age (6 and 8 years) independent of whether reported by parents or examiner. We also hypothesized that the relation of attention with gestational age at birth would be non-linear because attention difficulties are disproportionally higher after very preterm birth than previously reported after later preterm birth. Secondly, we examined whether SGA additionally predicts attention outcomes while controlling for potential confounders such as prenatal complications, elective caesarean birth, head circumference in infancy and family socio-economic status (hereafter family SES).

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2. Materials and methods

2.1. Study sample

Details of the design of the Bavarian Longitudinal Study have been described previously [21]. Ethical approval of this study was granted by the Ethical Review Board of the Rheinische Friedrich Wilhelms University, Medical Faculty on 18 August 2009 (reference # 159/09). Informed consent was provided by the parents within 48 h of their child's birth. Subjects were children born alive in a geographically defined area of Southern Bavaria (Germany) between February 1985 and March 1986 and who required admission to children's hospitals within the first 10 days after birth (N = 7505; 10.6% of all live births). Healthy infants who were born in the same obstetric hospitals, cared for on normal postnatal wards were recruited as controls (N = 916), resulting in a total study sample of 8421 newborns. Of the 8421 participants, 1513 children were selected for follow-up at 6 and 8 years of age according to the following criteria: 1. either very preterm (<32 week gestation) or very low birth weight (<1500 g birth weight); 2. a subsample of children born at ≥32 week gestation randomly selected within the stratification factors gender, family SES (low, medium and high) and degree of neonatal risk (none, low, moderate, high and very high) [22].

Of the eligible children, 1475 participated in the follow-up at both 6 and 8 years. Children who did not attend the assessments either at 6 years or at 8 years (N = 38) did not differ from children who attended assessments at both time points (N = 1475) in terms of gestational age, prenatal complications, mode of delivery, SGA status and head circumference but were more often of low family SES (χ^2 (1) = 21.315, p < 0.001). Furthermore, we excluded an additional 40 children who were born post-term (42 or more completed weeks of gestation) because post term birth has different causes and is associated with an increased risk of developmental abnormalities [23]. Table 1 shows the characteristics of the final sample with gestational age at birth ranging from 25 weeks to 41 weeks (N = 1435).

2.2. Measures

Gestational age was determined from a combination of maternal reports of the last menstrual period and serial ultrasound foetal biometry during pregnancy. Prenatal data were coded from the standard Bavarian perinatal survey [24] assessed prospectively and included 14 items (e.g., preeclampsia) (Table 1). Higher scores on this scale indicate more complications with a range from 0 (best condition) to 14 (most risky condition) [25].

Mode of delivery was coded in the Bavarian perinatal survey [24] as elective caesarean birth, emergency caesarean birth or vaginal birth. For the purposes of the current study we reclassified mode of delivery as elective caesarean birth versus delivery following labour (vaginal birth or emergency caesarean birth). Children with birth weight less than the gender specific 10th percentile for gestational age according to a perinatal survey of all Bavarian newborns [24] were classified as small for gestational age (SGA); 376 children were SGA and 1059 children were born with a birth weight appropriate for their gestational age (AGA). Fig. 1 shows the frequency of children who were born small across the whole gestation spectrum. SGA was most frequent between 32 weeks and 37 weeks with a range from 35% to 50% of total births at each week.

The primary outcome of this study was the level of attention of the children reported by parents and examiners separately at the ages of 6 and 8 years. Mothers rated their children's attention problems using

Table 1
Description of the total sample and for appropriate for gestational age (AGA) and small for gestational age (SGA) children separately.

Variables		Total (N = 1435)	AGA (N = 1059)	SGA (N = 376)	p-Values[a]
Gestational age in weeks	*Mean* (*SD*)	36.27 (4.11)	36.66 (4.15)	35.19 (3.78)	<0.001
Birth weight in grammes	*Mean* (*SD*)	2582.14 (970.42)	2853.58 (914.68)	1817.64 (668.32)	<0.001
Prenatal complications	*Mean* (*SD*)	1.26 (1.21)	1.18 (1.17)	1.48 (1.29)	<0.001
Preeclampsia	*N* (%)	38 (2.7)	10 (0.9)	28 (7.5)	<0.001
Anaemia	*N* (%)	9 (0.6)	3 (0.3)	6 (1.6)	<0.01
Urinary tract infection	*N* (%)	27 (1.9)	21 (2.0)	6 (1.6)	*Ns*
Bleeding before 28 weeks	*N* (%)	106 (7.4)	75 (7.1)	31 (8.2)	*Ns*
Bleeding after 28 weeks	*N* (%)	57 (4.0)	40 (3.8)	17 (4.5)	*Ns*
Pathologic CTG	*N* (%)	63 (4.4)	31 (2.9)	32 (8.5)	<0.001
Preterm labour	*N* (%)	401 (27.9)	24 (2.3)	127 (33.8)	<0.001
Multiples	*N* (%)	132 (9.2)	95 (9.0)	37 (9.9)	*Ns*
Nicotine addiction	*N* (%)	194 (13.5)	136 (12.8)	58 (15.4)	*Ns*
First booking after 12 weeks	*N* (%)	224 (15.6)	173 (16.3)	51 (13.6)	*Ns*
No regular check-ups	*N* (%)	25 (1.7)	16 (1.5)	9 (2.4)	*Ns*
Infectious disease	*N* (%)	197 (13.7)	142 (13.4)	55 (14.6)	*Ns*
Severe illness or accident	*N* (%)	263 (18.3)	188 (17.8)	75 (19.9)	*Ns*
(Oligo)-hydramnion	*N* (%)	74 (5.2)	46 (4.3)	26 (6.9)	*Ns*
Mode of delivery[b]					<0.001
Vaginal birth	*N* (%)	732 (51.0)	596 (56.3)	136 (36.2)	
Emergency caesarean birth	*N* (%)	124 (8.6)	88 (8.3)	36 (9.6)	
Elective caesarean birth	*N* (%)	313 (21.8)	178 (16.8)	135 (35.9)	
Head circumference[c] in cm	*Mean* (*SD*)	42.55 (1.45)	42.78 (1.36)	41.88 (1.52)	<0.001
Female	*N* (%)	699 (48.7)	515 (48.6)	184 (48.9)	*Ns*
Family SES					<0.05
SES — high	*N* (%)	423 (30.1)	331 (31.3)	92 (24.5)	
SES — middle	*N* (%)	543 (37.8)	397 (37.5)	146 (38.8)	
SES — low	*N* (%)	467 (32.5)	330 (31.2)	137 (36.4)	
Outcome variables					
Parent-reported attention problems at 6 years	*Mean* (*SD*)	3.49 (2.79)	3.30 (2.75)	4.02 (2.84)	<0.001
Parent-reported attention problems at 8 years	*Mean* (*SD*)	2.34 (2.41)	2.21 (2.35)	2.70 (2.56)	<0.001
Examiner-reported attention skills at 6 years	*Mean* (*SD*)	5.90 (1.58)	6.03 (1.56)	5.54 (1.57)	<0.001
Examiner-reported attention skills at 8 years	*Mean* (*SD*)	6.65 (1.28)	6.75 (1.26)	6.37 (1.31)	<0.001

[a] Variables were compared between AGA and SGA groups using One-Way ANOVA for continuous variables and χ^2 test for categorical variables.
[b] Missing data: n = 142 (9.9%) did not have elective caesarean birth but not clear whether delivery vas via vaginal birth or emergency caesarean, n = 124 (8.6%) did not have mode of delivery information.
[c] Head circumference was measured at 5 months (corrected for prematurity).