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Social Competence of Preschool Children Born Very Preterm

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Abstract

Background—Relatively little is known about the early social development of children born very preterm despite clear suggestions of later interpersonal difficulties.

Aims—To compare the social competence of very preterm (VPT) and full term (FT) born children at age 4 and identify infant, social and family factors associated with later risk.

Study design—Prospective longitudinal study.

Subjects—A regionally representative cohort of 103 VPT (32 weeks gestation) children and a comparison group of 105 FT children (36-41 weeks gestation) born between 1998 and 2000.

Outcome measures—At corrected age 4 years, a range of parent report, observational and laboratory measures assessed children's emotional and behavioral adjustment, emotional regulation, social interactive behavior and theory of mind understanding. Extensive perinatal, social background and family functioning data were also available from birth to age 4.

Results—Compared to their FT peers, VPT born children had poorer emotional and behavioural adjustment, were less effective in regulating their emotions, had lower levels of positive peer play and had less synchronous interactions with their parents. Within the VPT group, predictors of poor social competence included family socioeconomic disadvantage, extreme prematurity, severity of cerebral white matter abnormalities and early childhood exposure to high levels of maternal anxiety and negative parenting.

Conclusions—VPT pre-schoolers are characterized by a range of subtle social difficulties likely to adversely affect their ability to establish and maintain positive relationships with others. These difficulties need to be monitored alongside other potential neurodevelopmental concerns and parents supported to actively nurture child social competence.

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Keywords

very preterm; low birth weight; social competence; behavior; emotion regulation; early childhood

An important aspect of child development that has been largely neglected by follow-up studies of children born very preterm (VPT) is social competence or the development of skills and abilities essential for the formation of positive relationships with others. This is somewhat surprising given that school aged children born VPT are often described by their peers as more withdrawn and passive [1], and by their parents as experiencing high rates of sibling conflict and peer victimization [2,3]. Longer term there is suggestion that these difficulties persist, with VPT young adults having greater difficulty establishing and maintaining social relationships than their full term peers. For example, they are less likely to have a romantic partner, more often live alone and without children, and are at increased risk for psychiatric hospitalization [4-9].

Despite a growing awareness of the social impacts of prematurity, few studies have systematically examined the early social development of children born VPT across key domains of social competence shown to be important for children's longer term adaptive functioning [10,11]. These domains span behavioral and emotional adjustment, emotional regulation, a child's interactive behavior with others and social cognitive processing. The adjustment domain, which has been most well studied, includes both externalizing and internalizing behavior. Externalizing behavior problems are characterized by poor behavioural control including conduct problems, hyperactivity/inattention and inhibitory control problems. Internalizing behavior problems are characterized by extreme behavioural control and span emotional symptoms, social withdrawal and anxiety. Emotional regulation refers to a child's capacity to modulate their emotions in response to people and situations using a range of cognitive, physiological and behavioral processes/strategies allowing for empathic and socially appropriate behavior [12,13]. The third domain, social interactive behavior relates to the skills and ability that are involved in forming and maintaining relationships with others, which in turn foster popularity and social acceptance [14]. Finally, emerging social cognitive processes such as being able to see the world from another's perspective also play an important role in helping a child to understand and function in their social world. One important cognitive process used to facilitate the perception of both others and self is that of theory of mind, being the ability to impute mental states to self and others [15]. Impairments in social cognitive processing have been linked with aggression, social anxiety and low popularity with peers [11].

To date, follow-up studies of the social development of preschool children born VPT have focused predominantly on children's early emotional and behavioral adjustment, with occasionally a few additional peer items or subscales added. Results from these studies suggest that difficulties emerge early and typically consist of inattention/hyperactivity and emotional problems [16-18]. For example, Spittle et al. (2009) found that by age 2, 9% of VPT children and 3% of FT children were in the clinical range for externalizing problems, 9% and 6% for internalizing problems, and 16% and 6%, respectively for global social competence difficulties (compliance, attention, imitation/play, mastery motivation, empathy,

prosocial peer relations) on the parent reported Infant Toddler Social and Emotional Assessment [17]. Similarly, using the Strengths and Difficulties Questionnaire, Delobel-Ayoub et al. (2006) showed that by age 3, VPT children were at increased risk of hyperactivity/inattention, emotional and peer problems[19]. These studies like many others in the field are somewhat limited by their narrow conceptual focus and reliance on single informant measures. To address this research gap, we use a multi-informant/cross-contextual approach to assess the early social competence of a cohort of children born VPT across key domains of social functioning found to be important in mainstream child development research.

A second important and related issue concerns the risk factors and life course processes that place some but not all VPT children at increased risk of poor social competence. Few studies have examined the relative net contributions of a wide range of factors spanning not only early medical risk exposures but also social background and family functioning factors. Spittle et al. (2009) found that female gender, low birth weight, cerebral white matter abnormalities on term MRI and postnatal corticosteroid exposure were significant perinatal predictors of poor social competence in VPT children at age 2 [17]. With respect to family factors, in a second study from this cohort, parental warmth and parent-child synchrony were also linked with better parent reported child social emotional competence. In contrast, parental negative affect was associated with increased child anxiety and withdrawal [20]. Insensitive parenting behavior and parental mental health problems have also been shown to place VPT children at increased risks of emotional and behavioral dysregulation [21,22]. Such studies, although small in number, suggest that modifiable family factors such as parenting behavior, caregiver mental health and the quality of the parent-child relationship have a clear role, alongside perinatal risk factors, in shaping the social outcomes of children born VPT. Developing a better understanding of the individual and family factors that foster these children's adaptive social development during the socially important preschool years is needed to improve the identification of those at risk, as well as to assist monitoring and intervention efforts to better address the social needs of VPT children alongside other developmental concerns.

The aims of this study were:

1. To describe the early social competence of VPT and FT born children at corrected age 4 years using a multi-method approach. Key aspects of social competence examined included children's behavioral adjustment, emotional regulation, the quality of early peer and parent social interactions, and the development of theory of mind. We hypothesized that compared to their FT peers, children born VPT would be characterized by behavioral adjustment problems especially inattention, more emotional dysregulation, lower quality parent and peer interactions, and less well-developed theory of mind.
2. To identify infant clinical characteristics and socio-familial factors that place preschool children born VPT at increased risk of poorer social competence. We hypothesized that male gender, extreme prematurity, cerebral white matter abnormalities at term, family social risk, maternal mental health difficulties, and

negative/intrusive parenting would be associated with lower levels of child social competence.

Methods

Participants

The sample consisted of two groups. The first group was a regional cohort of 110 children born VPT (< 32 weeks gestation; range = 23-33 weeks) who were consecutively admitted to a level III Neonatal Intensive Care Unit (NICU) at Christchurch Women's Hospital (New Zealand) from November 1998 to December 2000. Those with congenital abnormalities or born into non-English speaking families were excluded. In total, 92% of eligible infants were recruited. At age 4, excluding deaths ($n=3$), 98% ($n=105$) of these children were followed up. Two further children were excluded due to blindness ($n=1$) and incomplete data ($n=1$). This group included infants born extremely preterm (<28 weeks gestation; $n=43$) and very preterm (< 32 weeks gestation; $n=60$).

The second study group consisted of a comparison sample of 113 FT born children (>37 weeks completed gestation; range = 36-41 weeks) recruited at age 2 years. These children were identified from hospital birth records for the same period ($n=7,200$ total births) by alternately selecting the previous or next child of the same gender in the hospital delivery schedule. Of 177 eligible families, 62% agreed to participate. Reasons for non-participation included: untraced (47%); moved overseas (12.5%); refused (12.5%); and agreed to participate but could not be assessed within the four week assessment window due to illness or family circumstances (28%). No significant differences were found between recruited and non-recruited FT children on measures of birth weight, gestational age, gender, family SES (Elly & Irving, 2003), single motherhood or M ori ethnicity. At age 4 years, 96% ($n=108$) of all FT children were followed up. Reasons for sample loss included unable to be traced ($n=3$) and refused ($n=2$). Data was excluded from a further three children due to incomplete data. Table I provides a descriptive profile of the neonatal characteristics and family circumstances of both study groups.

Procedure

All study children completed a neurodevelopmental assessment at corrected age 4 years that included a range of social competence measures, an assessment of child intelligence (IQ) using a short-form of the Wechsler Preschool and Primary Scales of Intelligence - Revised (WPPSI-R [23]), and measures of family social context and functioning. All procedures were approved by the Regional Ethics Committee and informed written consent obtained from all parents/guardians. Key measures included in this analysis are described below.

Social Competence Measures (4 Years)

Externalizing and Internalizing Behavior—Parents completed the 25-item Strengths and Difficulties Questionnaire (SDQ[24]) which provides a measure of the extent of child hyperactivity/inattention, conduct and emotional disorder symptoms. The SDQ is internally consistent and has high test-retest reliability [25] and discriminant validity [26]. This short scale was supplemented with items from the Behavioral Rating Inventory of Executive

Function – Preschool version (BRIEF-P) inhibitory control subscale [27]. A composite behavior problems score was also computed by converting scores to a common metric (Mean of 100 and SD of 15) and summing children's scores across all measures (Cronbach alpha .92) since factor analysis of these four subscales supported a single common factor, accounting for 62.2% of sample variance (66.9% VPT; 53.9% FT).

Emotional Regulation—Three measures of emotional regulation were administered. The first consisted of a 10-item emotion regulation scale from an age-adapted scale based on the Emotional Regulation Checklist (ERC; see Clark et al., 2008[21]). This was used to assess appropriate affect and emotional self-awareness. The ERC correlates positively with observations of children's regulatory abilities [28,21]. Second, parents also completed the 9-item self-regulation subscale of the Infant-Toddler Symptom Checklist (ITSC[29]). Although designed for younger children, the 25-30 month version has been shown to be a useful screening measure for older children [30] and was used due to a dearth of other suitable parent report measures. Third, observational ratings of children's emotional regulation skills during 2.5-4 hours of developmental testing were obtained from two independent examiners, with rater discrepancies resolved by consensus. This customized rating scale was adapted from the emotional regulation subscale of the Bayley Scales of Infant Development (BSID-II[31]) previously used at age 2. This provided a global measure of observed testing behavior across our 2 and 4 year evaluations. The emotional regulation subscale assessed task persistence, frustration tolerance, attention, activity level, and adaptation to change. Example items include co-operates with adult requests and cries, frowns, whines or complains. Factor analysis of these three scales showed they formed a single factor, accounting for 61.4% of the total sample variance (59.0% VPT; 61.3% FT). Therefore an overall composite score was computed by summing children's scores across measures (Cronbach alpha .82).

Social Interactive Behavior with Peers and Parents—The quality of children's peer interaction behavior was assessed using all three parent-report subscales of the Penn Interactive Peer Play Scale (PIPPS[32]), including play interaction (affiliative play, positive affect), play disconnection (withdrawn and avoidant behaviour) and play disruption (peer aggression and antisocial behaviour). The PIPPS has been shown to be internally consistent [32], and to correlate highly with other measures of social behavior with peers [33]. The quality of children's interactions with their parents was assessed using a global dyadic observational rating of parent-child interactional synchrony. Ratings were done from recording of a 10-minute structured parent-child interaction by three independent raters who were unaware of children's group status or perinatal history. Parent-child synchrony assessed the degree of turn taking, reciprocity, responsiveness, and shared affect between each child and their primary caregiver. Inter-rater reliability was assessed across 20% of all recordings with the intra-class correlation of .82 for intrusiveness and .84 for negative affect. Similar to the measures described above, a composite measure of overall social interaction quality was computed by summing scores across all measures (Cronbach's alpha .83). This approach was supported by factor analysis.

Theory of Mind (Social Cognition)—Three well-established false belief tasks were administered to assess children's developing theory of mind or ability to take the perspective of others. These included the 'Sally-Ann' unexpected location task [15], the 'Smarties' unexpected contents task [15] and the linguistically undemanding 'Fishing Story' [34]. All tasks required children to correctly infer the perspective of another person. The number of tasks (0-3) passed by answering all questions correctly was summed to create an overall theory of mind score.

Infant Clinical and Socio-familial Predictors

In order to identify infant neonatal, social background and family functioning predictors of social competence at age 4, a wide range of measures were selected from the larger study database based on previous research and theory. Key measures included in this analysis are described below.

Infant Clinical Characteristics—Eight measures of infant clinical status following birth were included: 1) gender; 2) extreme prematurity (< 28 weeks gestational age), 3) twin birth; 4) number days on ventilation, 5) chronic lung disease, 6) patent ductus arteriosus and 7) maternal antenatal steroids. In addition, at the time of their expected date of delivery (term), all VPT infants underwent MR imaging using a 1.5 T GE Scanner (GE Medical Systems, Milwaukee, WI). Details of this scanning protocol have been reported previously [35]. Based on the severity of qualitatively defined cerebral white matter abnormalities, VPT children were classified into one of four groups: no white matter abnormalities (score <7), mild (7-9), moderate (10-12) and severe (>12).

Family Characteristics—Seven family measures were identified. These included 1) child ethnicity, 2) maternal age, 3) maternal education, 4) family SES, 5) maternal anxiety, 6) maternal depression, and 7) observed negative parenting behavior. Family SES was assessed using the Elly-Irving Socio-Economic Index [36] which classified families from 1 (professional/managerial) to 6 (semi-skilled/unskilled/unemployed). Maternal anxiety was assessed at ages 2 and 4 years using the anxiety subscale of the Hospital Anxiety and Depression Scale [37]. Maternal scores across the two assessments were averaged given their high inter-correlation ($r=.54$, $p<.0001$) to form a composite measure of the extent of maternal anxiety during the preschool years. Finally, based on a structured parent child interaction procedure involving three problem-solving tasks, a measure reflecting the extent to which observed parenting behavior was characterized by high levels of negative affect and parental intrusiveness was created by summing blinded observational ratings of parents negative affect (extent of parental disapproval, negativity and anger) and intrusiveness (extent parental behavior was excessively controlling, poorly timed and intrusive). Inter-observer reliability for each of these observational measures was excellent with intra-class correlation coefficients of 0.84 for negative affect and .83 for intrusiveness. Principal component analysis confirmed these scales loaded (>0.73) on a single common factor.

Statistical analysis

Data analysis involved three steps. First, to minimize the likelihood of Type 1 errors due to multiple testing, between-group differences on all social competence outcomes were

examined using analysis of covariance (ANCOVA) for continuous variables. Chi-squared analysis was used for the three theory of mind dichotomous variables. Cohen's *d* provided an estimate of effect size for all continuous outcomes. Then for each social competence domain, principal component analysis was used to assess the extent to which psychometrically robust composite measures could be created. These analyses were run both for the total sample and each group separately. If appropriate, composite measures were then computed for each domain by rescaling all individual scores to a common metric (mean of 100 and standard deviation of 10).

Second, the extent to which VPT children were at increased risk of significant social difficulties in each domain relative to their FT peers was examined. Based on the score distributions of the full-term group, a clinically significant impairment was defined using a worst 10% cut-point [16,3]. This was done for all outcomes except social cognitive outcomes due to insufficient variability in children's scores across both groups. These measures had also failed to differentiate the two groups.

Third, linear regression modeling was undertaken to identify specific infant clinical, social background, family functioning and child risk factors correlated with later social competence at age 4 years. This analysis was confined to the VPT group. An overall social competence problems score was used as the dependent variable to capture all social domains on which VPT showed difficulties or delays relative to their FT peers. This composite was computed by summing children's total scores across the following domains: emotional and behavioral adjustment; emotional regulation; and social interactive behavior. Children's overall theory of mind score was not included due to the limited variability of measures in this domain that suggested possible floor effects. This approach was also supported by Principal Component Analysis.

Regression models were fitted in three steps using both backward and forward variable elimination to identify the best fitting and most parsimonious model. First, the overall social competence problem score was regressed on a wide range of infant clinical and social background factors assessed around birth. A core model was identified containing those variables that made a significant net contribution ($p < .10$) to child social competence problems at age 4. Second, this core model was then extended, by individually adding and removing measures of family rearing context from birth to age 4 years. Finally child intelligence quotient (IQ) (WPPSI-R short form) assessed at age 4 was added to examine the extent to which social competence problems might be explained by concurrent child cognitive ability.

Results

Social Competence of Children Born Very Preterm and Full-Term

Table II describes the early social competence of VPT and FT born children across a range of domains assessed at corrected age 4 years.

Behavioral adjustment—Compared to their FT peers, VPT children were characterized by higher mean levels of hyperactivity/inattention ($p = .01$) and emotional ($p = .008$) but not

conduct problems ($p=.09$) on the parent report SDQ. They were also rated on the BRIEF-P as having poorer inhibitory control ($p=.03$).

Emotional regulation—Both parents ($p=.01$) and “blinded” examiners ($p=.01$) rated VPT children as showing higher mean levels of emotional dysregulation when assessed using the adapted ERC and a qualitative observational rating scheme. Parents also rated their VPT child as having more self-regulatory difficulties at home ($p<.001$) on the ITSEA.

Social interactive behavior—On the PIPPS, parents rated VPT children as being less likely to experience positive play interactions with peers ($p=.04$) suggesting early difficulties in establishing and maintaining friendships, although the effect size was small ($d=-.28$). No significant between group differences were found for play disruption ($p=.57$) or play disconnection ($p=.54$), suggesting similar levels of avoidant and aggressive peer play behavior in both groups. Observations of VPT children's interactions with their parents during a structured play procedure showed their interactions to be less synchronous or in-tune ($p=.02$).

Social cognition—No significant differences were found between VPT and FT children's performance on each of the three theory of mind tasks (Sally-Ann task, $p=.26$; Smarties, $p=.13$; Fishing Story, $p=.68$).

Composite scores for each social competence domain shown in Table II revealed a generally similar pattern of findings. VPT children had higher mean levels of behavioral and emotional adjustment problems ($p=.004$; $d=.40$), were less emotionally regulated at home and during their research visit ($p<.001$; $d=.55$), and were subject to more interpersonal difficulties with peers and parents ($p=.002$, $d=.45$). These associations, as were those found for individual outcomes, remained largely unchanged following covariate adjustment for between group differences in family socio-economic status (with the exception of inhibitory control problems).

Examination of the proportions of children in each group exhibiting more severe problems in each domain (i.e., scoring above the 90th percentile of the control group) showed that VPT children were almost twice as likely to have emotional and behavioral adjustment problems by age 4. They also had double the risk for emotional dysregulation and interpersonal relationship problems than their FT peers. Mean social cognition scores for the two groups were similar ($p=.17$; $d=-.18$). Consistent with the above results, findings remained unchanged when analyses were repeated to take account of SES (with the exception of severe emotional and behavioral problems). The same was true when twin births were excluded.

Predictors of Early Social Competence Difficulties in Children Born Very Preterm

Table IV assesses the extent to which specific infant clinical characteristics and socio-environmental risk factors may explain variations in the social development of children born VPT. For each of the three models fitted, the table shows the regression coefficients, standard errors, and tests of significance for all variables included in each of the final models. Model 1 showed that lower family socioeconomic status (SES) ($p=.002$), male sex

($p=.005$), being born extremely preterm (<28 weeks; $p=.08$) and increasing severity of cerebral white matter abnormalities on term MRI ($p=.03$) placed VPT children at increased risk of poorer social competence at age 4 years. When the model was extended to include measures of family functioning and parenting (Model 2) results showed that higher maternal anxiety ($p<.0001$) and parenting characterized by high levels of intrusiveness and negative affect ($p=.007$) predicted poorer social competence at age 4 years. Finally, the addition of child IQ to the model showed that IQ made a significant net contribution to social competence, with decreasing IQ scores being associated with poorer social competence ($p=.001$). The results of this analysis suggest that child IQ mediated the effects of family SES and cerebral white matter abnormalities on later social competence. This final fitted model explained 48% of the variance in social competence suggesting moderately good prediction. Taken together, these findings suggest that both infant clinical factors and family rearing environment influence the social development of children born VPT.

Discussion

Drawing on prospective, longitudinal data we examined the early social competence of a regional cohort of children born VPT, and identified neonatal, social and family predictors of later risk. This analysis extends previous research by adopting a broader conceptual framework of social competence beyond largely emotional and behavioral adjustment. Key findings are discussed below.

Findings suggest that prior to school entry, VPT children are already beginning to exhibit early signs of social challenges that are likely to impact their longer term social functioning at home and school. Consistent with other preschool and school aged studies [3,38,18,17,39], children born VPT had higher mean levels of emotional and behavioral adjustment problems including inhibitory control difficulties, hyperactivity/inattention, and emotional symptoms. Elevated mean levels of emotional dysregulation were also evident, with both parents and examiners reporting higher levels of emotional and behavioral dysregulation characterized by mood swings, disruptive outbursts, fussiness/upset and difficulties regulating excitement. These difficulties appeared to be manifesting in relationship difficulties with peers and parents, with VPT children tending to experience lower levels of positive play with peers and their interactions with parents being less synchronous and harmonious. Although, it is important to acknowledge that lower levels of parent-child synchrony likely reflect not only characteristics of the child, but also the parent, such as maternal mental health.

Examination of the risks of more severe difficulties in each domain defined on the basis of a worst 10% cut-point, showed that VPT children were twice as likely as their FT peers to exhibit serious emotional and behavioral adjustment problems (19.4% v. 10.5%; $p=.05$), emotional dysregulation (28.2% v. 11.4%; $p<.01$), and social interactional difficulties with others (23.8% v. 10.7%; $p=.01$) by age 4 years. While attenuated somewhat, these differences were not fully explained by between group differences in family socio-economic status. It should be noted, however, that between group differences were modest with effect sizes in the small to moderate range.

Nonetheless, the early onset of these social difficulties raises the possibility that for the VPT child, social problems may potentially exacerbate with time due to their direct impacts on future social relationships with others but also because of constrained opportunities for learning new adaptive social skills. There is some support for this speculation given that VPT children have increased risks for a range of social difficulties during middle-late childhood and adolescence, including poor social skills [40], greater levels of peer rejection [41,42] and lower social competence [43], as well as increased risks of psychiatric disorders such as anxiety disorders and attention-deficit/hyperactivity disorder[44-46].

In contrast to the above findings, similar proportions of VPT and FT children failed each of the theory of mind tasks, with children in both groups performing at below chance levels. About half of all children failed the Sally-Ann task, three quarters failed the Fishing Story, and around 90% failed the Smarties task at age 4 years. The absence of any detectable differences in VPT and FT children's performance across these social cognition tasks may reflect the age at testing and a floor effect in children's task performance. Such results add to existing concerns about the reliability and validity of theory of mind tasks [47], and suggest the need for further investigation of the psychometric utility of traditional false belief tasks with high-risk samples, especially those who may be subject to cognitive impairment. Further evaluation of the social cognitive processing abilities of VPT children at older ages will be important in clarifying whether these abilities are indeed intact, or whether the current findings simply reflect measurement timing.

Examination of infant clinical and socio-familial predictors of social competence amongst children born VPT supported the importance of both biological exposures and the childrearing environment in shaping VPT children's social competence during the preschool years. Results suggest that VPT children born extremely preterm, subject to cerebral white matter abnormalities during the neonatal period and whose family backgrounds were characterized by socioeconomic disadvantage, may be most vulnerable to later social problems. Boys also appeared to be more vulnerable to social difficulties than girls. These risks were further compounded by the childrearing context, with children reared in family environments characterized by high levels of maternal anxiety and negative, intrusive parenting being more likely to have lower levels of social competence. Conversely, we found that female VPT children from higher SES families who were less immature at birth and were not subject to cerebral white matter abnormalities were the least likely to have social difficulties, especially if being raised in an affectively supportive and sensitive home environment.

These results are consistent with Delobel-Ayoub et al. (2006) who found a link between gestational age at birth and behavioral outcome at age 3, with a greater percentage of children born between 24-28 weeks gestation displaying clinically significant behavioral difficulties, spanning hyperactivity, conduct problems, emotional symptoms, and peer problems compared to later born VPT children [19]. More recently, a national cohort of over 1 million school children aged from 6 to 19 years [48], found that as gestational age decreased there were stepwise increases in the odds of ADHD treatment (2.1 for 23-28 weeks' gestation compared to 1.1 for 37-38 weeks gestation relative to 39-41 weeks gestation).

While little effort has been made to examine the role of gender in the social outcomes of preschool samples of children born VPT [19,17], our findings suggest associations between male gender and poor social outcomes in the form of emotional regulatory difficulties, as well as more interpersonal problems. Such gender-based differences may arise from a range of processes that could include, socialization effects with females encouraged to channel problem behaviors into more accepted, sex-stereotyped forms (i.e., shy, withdrawn), differing biological, physical, verbal, socio-emotional and self-regulatory capabilities [49], and/or increased susceptibility to clinical risk for VPT males [50], including recent evidence of differential brain growth compared to VPT females [51].

The link between cerebral white matter abnormalities on term MRI and later impaired social functioning is consistent with previous studies showing associations between the severity of white matter abnormalities and later cognitive, executive functioning and language risk [52-54]. However, the link with social competence appears to be less direct, but rather mediated by child cognitive ability. These findings suggest that VPT children with more severe white matter abnormalities are at increased risk of cognitive delay, which then in turn places them at risk for a range of social competence difficulties.

Associations found in the present study between maternal anxiety and social competence are of some concern given that mothers of VPT infants are at increased risk of anxiety, depressive mood and fatigue during the neonatal period and beyond [55,56]. Children whose mothers are characterized by higher levels of maternal anxiety may be exposed to more stressful home environments, and could be at increased risk for emotional regulatory problems due to genetic predisposition [57] as well as possible on-going disturbances in the quality of mother-child relations [55]. Follow-up support of parents is clearly important as well as the development of interventions to foster attachment and positive mother-child relations.

In addition to maternal anxiety, findings also confirm the importance of parenting in fostering the social skills of children born VPT alongside other aspects of behavioral development as shown in younger preterm cohorts [21,22]. For example, using the same parent-child interaction paradigm, Treyvaud et al's (2010) examination of 177 VPT and 69 term comparison children at age 2 years revealed significant associations between increased risk for dysregulation and overall parental mental health. Given concerns that children born VPT may be especially susceptible to the adverse effects of negative parenting behavior due to increased neurological vulnerability [58], these findings have important clinical implications pertaining to key areas of intervention that may reduce the likelihood of compromised development across a number of developmental domains prior to school entry.

Examination of the role of child IQ alongside infant clinical and familial predictors of social competence outcomes revealed significant relationships with behavioral, emotional and interpersonal social development during early childhood. These findings suggest that the effects of WMI abnormalities and family SES are mediated by child IQ, while the influences of family contextual factors that remain significant are having a direct influence on social outcomes. Nonetheless findings do suggest that cognitive functioning is important in explaining the elevated risks of impaired social competence in children born VPT.

While our study had a number of methodological strengths, including the prospective longitudinal design and broad conceptual framework, some caveats should be considered. First, study findings concerning behavioral adjustment and maternal anxiety were based solely on parent report and therefore may be subject to negative-reporting bias. Second, a lack of reliable standardized measures of social competence suitable for use with preschool-aged children resulted in a limited selection of measures to tap different aspects of child social competence. Additionally, it is noted that the VPT sample consisted of a high number of twins (VPT 33%; FT 3.8%). This may have led to within family clustering in the data, as the ratio of parents-to-children in the VPT group would have been lower than that of the FT group. This may have contributed to stronger correlations in the VPT sample. Finally, it will be important to examine the on-going relationships between clinical presentation at birth, environmental and family factors and the social competence of VPT children beyond the preschool period. Longitudinal research of this nature may further enhance abilities to identify those VPT children who are at increased risk of social difficulties.

Nevertheless, our findings do suggest that the adverse developmental outcomes associated with VPT birth are not limited to physical, sensory, neurological and cognitive impairment. A significant proportion of these children (19-30%) may also be at elevated risk for poor behavioral adjustment, emotional dysregulation, and interpersonal difficulties, with both early neonatal/biological risk and family rearing environment contributing to later social competence. Awareness of these potential difficulties and the parental and family factors that may exacerbate problems will be important in intervention efforts aimed at supporting VPT children in the transition to school as well as their longer-term social and educational opportunities. Also important will be understanding relations between early emerging social difficulties and longer term mental health risks.

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Table I

Clinical and Socio-Familial Characteristics of Children in the Study.

Measure	Very Preterm (n=103)	Full Term (n=105)	χ^2/t	p
<u>Infant Clinical Characteristics (birth)</u>				
Mean (SD) gestational age	27.84 (2.35)	39.47 (1.18)	-45.20	<.001
Mean (SD) birth weight	1,058.14 (312.82)	3,571.87 (414.05)	-49.33	<.001
% Male	50.5	54.3	0.30	.58
% Twin	33.0	3.8	29.69	<.001
% Intrauterine growth restriction [†]	7.8	1.0	5.83	.01
% Proven sepsis	28.3	-	-	-
% Chronic lung disease	35.0	-	-	-
% Patent ductus arteriosus	44.7	-	-	-
% Mod./sev. white matter abnormalities	18.4	-	-	-
<u>Social Background and Family functioning (birth-4 years)</u>				
% New Zealand European ethnicity (birth)	86.4	84.8	9.38	.15
Mean (SD) maternal age (birth) [‡]	30.69 (5.30)	31.03 (4.52)	-0.49	.62
% Mother left school <16 years (birth)	40.4	18.8	11.20	.001
% Un/semi-skilled family socio-economic status (2 years)	30.1	11.4	11.05	.001
Mean (SD) maternal anxiety (2-4 years)	5.15 (2.85)	4.46 (2.75)	1.77	.07
Mean (SD) observed parental negative affect and intrusiveness (4 years) [*]	104.88 (16.42)	99.95 (8.06)	2.68	.008

[†]IUGR = birth weight >2 SD below the mean for gestational age.

^{*}Based on 99 VPT children due to 2 incomplete data and 2 technical difficulties, and 99 FT children due to 4 incomplete data and 2 technical difficulties.

Based on 102 VPT children due to incomplete data.

[‡]Based on 104 FT children due to incomplete data.

Table II

Social Competence of Children Born Very Preterm and Full Term at Age 4 Years.

Outcome	Very Preterm (n=103)	Full Term (n=105)	F/X ²	P	Adj. p*	Effect Size (d)
<u>Emotional and Behavioral Adjustment</u>						
Mean (SD) parent-rated inhibitory control problems	25.59 (6.03)	23.94 (5.19)	4.47	.03	.07	.29
Mean (SD) parent-rated hyperactivity/inattention	3.82 (2.45)	2.99 (2.21)	6.55	.01	.02	.35
Mean (SD) parent-rated conduct problems	2.68 (2.08)	2.24 (1.67)	2.84	.09	.39	.23
Mean (SD) parent-rated emotional symptoms	2.03 (1.76)	1.44 (1.38)	7.24	.008	.02	.37
Mean (SD) Total adjustment problems score	103.52 (9.76)	100.05 (7.30)	8.48	.004	.02	.40
<u>Emotional Regulation[‡]</u>						
Mean (SD) parent-rated emotional regulation	25.12 (3.07)	26.12 (2.65)	6.23	.01	.04	-.34
Mean (SD) parent-rated self-regulation problems	4.62 (3.50)	3.03 (2.46)	14.12	<.001	.003	.52
Mean (SD) examiner-rated emotion regulation	15.22 (3.47)	16.45 (3.32)	6.74	.01	.02	-.36
Mean (SD) Total Emotional dysregulation score	104.79 (9.35)	100.03 (7.84)	15.54	<.001	.001	.55
<u>Social Interaction Behavior</u>						
Mean (SD) parent-rated peer play interaction	25.32 (2.83)	26.15 (3.09)	3.96	.04	.09	-.28
Mean (SD) parent-rated peer play disruption	27.12 (3.90)	26.82 (3.70)	0.32	.57	.83	.07
Mean (SD) parent-rated peer play disconnection	15.05 (2.96)	14.79 (3.07)	0.37	.54	.59	.08
Mean (SD) Parent-child interactional synchrony	9.61 (2.10)	10.28 (2.06)	4.92	.02	.06	-.32
Mean (SD) Total Interpersonal difficulties score [‡]	102.63 (5.74)	100.02 (5.76)	10.17	.002	.005	.45
<u>Social Cognition</u>						
% Passed Sally-Ann task	44.7	52.4	1.24	.26	.54	-
% Passed Smarties task	7.8	14.3	2.24	.13	.29	-
% Passed Fishing story	23.3	25.7	.16	.68	.88	-
Mean (SD) N. tasks passed	.76 (.84)	.92 (.89)	.004	.17	.43	-.18

* Adjusted for family SES.

[‡] Based on 99 VPT children due to 3 incomplete questionnaires and 1 missing booklet.[‡] Based on 101 VPT children due to 2 incomplete interview booklets.

Table III

Proportion of VPT and FT Children with Difficulties in each Domain.

Outcome	Very Preterm (n=103)	Full Term (n=105)	OR (95%CI)	P	Adj. p*
% Emotional and behavioral problems	19.4	10.5	2.05 (0.93-4.50)	.07	.11
% Poor emotional regulation	28.2	11.4	3.04 (1.45-6.37)	.02	.01
% Social interaction problems [†]	23.8	10.7	2.60 (1.20-5.65)	.002	.04

* Adjusted for family SES.

[†] Based on 101 VPT children due to incomplete data.

OR denotes odds ratio. CI denotes confidence interval.

Table IV
Final Fitted Regression Models for Predicting the Overall Social Competence of Preschool Children Born Very Preterm.

Measure	Model 1		Model 2		Model 3	
	B (SE)	p	B (SE)	p	B (SE)	p
<u>Infant Clinical and Social Background Factors (birth-term)</u>						
Family SES	3.76 (1.20)	.002	2.10 (1.16)	.07	0.75 (1.16)	.52
Male sex	11.19 (3.89)	.005	8.23 (3.70)	.03	6.12 (3.59)	.09
Extremely preterm (<28 weeks)	7.25 (4.06)	.08	6.57 (3.76)	.08	8.16 (3.58)	.03
Severity of Neonatal WMA	6.34 (2.93)	.03	4.12 (2.75)	.14	-1.87 (3.10)	.55
<u>Family Functioning and Parenting (discharge-4 years)</u>						
Maternal anxiety (2-4 years)	-	-	2.33 (0.64)	<.0001	2.29 (0.61)	<.0001
Parental negative affect and intrusiveness (4 years)	-	-	0.37 (0.13)	.007	0.36 (0.13)	.006
<u>Child Functioning (4 years)</u>						
WPPSI-R IQ Score	-	-	-	-	-0.54 (0.15)	.001