

A Longitudinal Investigation of the Development of Fullterm, Preterm and 'At-Risk' Infants from Birth to Four Years using a Parent Report Measure

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Abstract

Children born preterm, with low birth weight, or via a complicated birth, are more likely to display developmental delays than their fullterm counterparts. While research has consistently reported delays in the development of preterm and 'at-risk' infants, the nature of these delays has not been clearly documented. In this study, the parent-completed Ages and Stages Questionnaire (Squires, Potter & Bricker, 1995) was used to examine the development of fullterm, low risk preterm, and 'at-risk' infants from 4 to 48 months of age. Children were assessed on five developmental dimensions (communication, gross motor, fine motor, problem-solving, and personal-social) at 11 points within the 48-month period. Results show significant differences between preterm and 'at-risk' groups, and the fullterm group on all dimensions, however these differences were not consistent across age. We also investigated gender differences within and between the groups across the five dimensions. This research highlights specific areas of developmental delay in preterm and 'at-risk' infants that may require early intervention. The research also demonstrates the suitability of using parental reports for monitoring early development.

Introduction

Children born preterm, with low birth weight, or via a complicated birth are more likely to display developmental delays than their fullterm counterparts. Traditionally, research into the consequences of preterm or complicated birth has focused on the cognitive development of these infants and the potential for early intervention to improve cognitive outcomes. However it has been suggested that focusing only on the cognitive development of these infants is short sighted and reduces the potential of early intervention programs (Shonkoff & Hauser-Cram, 1987). It is now recognized that development in a number of areas can impact on the later achievements of these infants (e.g., motor and social development). For example, Losse, Henderson, Elliman, and Hall (1991) found that a group of 16 children who were diagnosed as clumsy were still having motor coordination difficulties six years after the original diagnosis (the children were in their teenage years at follow-up). At this follow-up the

children were assessed on a number of dimensions and were found to have significantly lower verbal IQ and significantly more behavioural problems than their age, gender and class matched controls. Similarly, Skinner and Piek (2001) found that children with Developmental Coordination Disorder (DCD) had significantly lower levels of global self worth than their age and sex matched peers both at 8 to 10, and 12 to 14 years of age. Skinner and Piek also found that the 12 to 14 year old children with DCD had significantly lower global self worth than the 8 to 10 year old children with DCD. These studies illustrate the ongoing and additive impact of early delays.

In many cases motor skill deficits in children are not diagnosed until a child enters formal schooling. In an effort to identify fine and gross motor skill deficits in younger children, Goyen and Lui (2002) examined 58 high-risk infants (born less than 29 weeks duration or less than 1000 grams) none of whom showed any disability at a 12 months corrected age assessment. The progress of these infants was assessed at 18 months corrected age and again at three and five years chronological age using the Peabody Developmental Motor Scales, which assesses both fine and gross motor skills. Goyen and Lui reported that over half of the children displayed mild to significant motor deficits at 18 months and that this deficit was relatively stable at five years of age. The pattern of development was quite different for gross motor deficits. Goyen and Lui found that at 18 months of age, only 13.8% of children were classified as having mild to significant deficits. By five years of age this proportion had increased to 81.1% of the children (with 43% having significant gross motor deficits). The results highlighted the need to follow-up infants at risk, as delays may not manifest in the first year or two of life. This paper also suggests that when age is corrected (as it was at 12 and 18 months), it may 'mask' any potential problems.

Research has now begun to make links between developmental dimensions in infants. Van Beek, Hopkins, Hoeksma, and Samson (1994) found that level of postural control differed between fullterm and preterm infants. For example, preterm infants were delayed in their ability to hold their head upright without support. The authors also found that this

delayed postural control impacted on the looking behaviour of infants during face-to-face interactions with their mothers. Wijnroks and Kalverboer (1997) found that insecure attachment relationships between mothers and infants were also related to delayed postural control in preterm infants (as cited in Wijnroks & van Veldhoven, 2003). In a further study, Wijnroks and van Veldhoven (2003) investigated the link between postural control, attention and problem solving in low risk preterm infants (< 37 week gestational age). Poor postural control (transient dystonia) at six months of age (as indicated by hyperextension or extension of elbows) was predictive of performance on a problem solving task and an attention task at both 18 and 24 months of age. The authors also report that this transient dystonia, in agreement with other research, is no longer related to motor status by two years of age. This demonstrates that while this particular motor delay is overcome by two years of age, it may have already had a significant impact on another area of development. This highlights the need to investigate multiple developmental dimensions in conjunction with one another.

Very few studies have investigated developmental differences between male and female infants. Thomas and French (1985) conducted a meta-analysis of 64 studies that reported gender differences in motor performance. The analysis revealed gender differences in performance on a number of motor tasks, however the role of gender was not consistent throughout childhood. For example, boys outperformed girls on the tasks of running (dash) and grip strength until puberty where the differences reduced. On tasks such as balance and tapping there were no gender differences until the age of 11 or 12 at which point the boys have the advantage. The authors suggest that these gender differences are related to social factors such as opportunity and encouragement. In a more recent study, Piek, Gasson, Barrett, and Case (2002) found gender differences in the limb coordination of fullterm infants. There were significant differences between boys and girls with girls having tighter synchrony between the joints of both arms. There was also a trend for boys to have more synchrony in their legs. The authors report that these findings support the idea that girls are more proficient at fine motor skills and more proficient in gross motor skills (Touwen, 1976). All these studies support the idea that gender differences in the performance of children on motor skills have both biological and social origins. However, these studies have not investigated gender differences within pre-term and at-risk infant groups.

The previous studies have shown some links between developmental dimensions but none have studied them longitudinally and together across three infant groups.

The aim of this study is to investigate children classified as low risk fullterm, low risk preterm, and 'at-risk' across five developmental dimensions (communication, gross motor, fine motor, personal-social, problem-solving) from 4 to 48 months of age. It is expected that the 'at-risk' infants will differ from the fullterm and preterm groups on the five developmental dimensions assessed, however it is likely that this delay will differ between dimensions across age. It is also predicted that there will be gender differences within the three infant groups.

Method

Participants

Three groups of infants participated in this study as part of an ongoing longitudinal study of infant motor development. Group one (Low Risk Fullterm) included 22 male and 21 female infants born 38-42 weeks gestation and who had an apgar score of eight or above at five minutes after birth. Group two (Low Risk Preterm) included 10 male and 7 female infants born 33-37 weeks gestation, with normal birth weight, and who had an apgar score of eight or above at five minutes after birth. Group three (At-Risk) comprised 11 males and 6 females. Infants in this group met at least one of the following criteria: born at less than 33 weeks gestation, had a birth weight less than 1500 grams, were small or large for gestational age, had an apgar score of seven or less at five minutes after birth, or experienced a serious birth complication (e.g., were ventilated at birth, or mother suffered from pre-eclampsia).

Apparatus

The Ages and Stages Questionnaire (ASQ) is a series of parent-report questionnaires that were developed out of a need to monitor children who are at risk of developmental problems (Squire et al., 1995). The questionnaire series assesses children at 11 ages (4, 6, 8, 12, 16, 18, 20, 24, 30, 36 and 48 months) across five developmental dimensions (communication, gross motor, fine motor, personal-social, and problem-solving). The validity of the questionnaire series has been established by comparing the parent-rated identification of delay with those delays detected by professionally administered tests such as the McCarthy Scales of Children's Abilities and the Bayley Scales of Infant Development (correlations ranged from .76 to .91). Inter-rater reliability between parents and professionals was greater than .9. Test-retest reliability over a three-week period was also over .9 (Squire et al., 1995).

Procedure

Parents whose infants are involved in a longitudinal motor development study at Curtin University participated in this study (see Piek, 1996; Piek & Gasson, 1999; Piek et al., 2002). From approximately two to four weeks of age, infants attended motion analysis sessions at the university at two weekly intervals where spontaneous movements, crawling and walking were recorded. Infants attended approximately 20 sessions. As the infants approached four months chronological age, parents were asked to begin completing the ASQ. It was explained to parents that these questionnaires would be given every few months until their child was four years of age. After the university sessions were completed, the questionnaires were posted to the infant's home and parents were asked to complete the questionnaire as close as possible to the chronological age indicated on the questionnaire (e.g., 18 months). This research was conducted in accordance with the NH&MRC ethical guidelines.

Results

Information regarding the three infant groups can be found in Table 1.

Table 1: Sample Characteristics

Group	Gestational Age (weeks)	Birth Weight (grams)	N
Low Risk Fullterm			
Male	39.71	3596	22
Female	39.78	3499	21
Total	39.45	3548	43
Low Risk Preterm			
Male	36.06	2775	10
Female	36.57	2735	7
Total	36.32	2755	17
At-risk Infants			
Male	33.82	2135	11
Female	32.78	1685	6
Total	33.30	1910	17

Separate ANOVA's were conducted at each of the 11 ages (4 months to 4 years) to investigate sex differences within each infant group across each of the five developmental dimensions (communication, gross motor, fine motor, problem solving, personal/social). No significant sex main effects or sex by group interactions were found and data has been pooled for subsequent analysis.

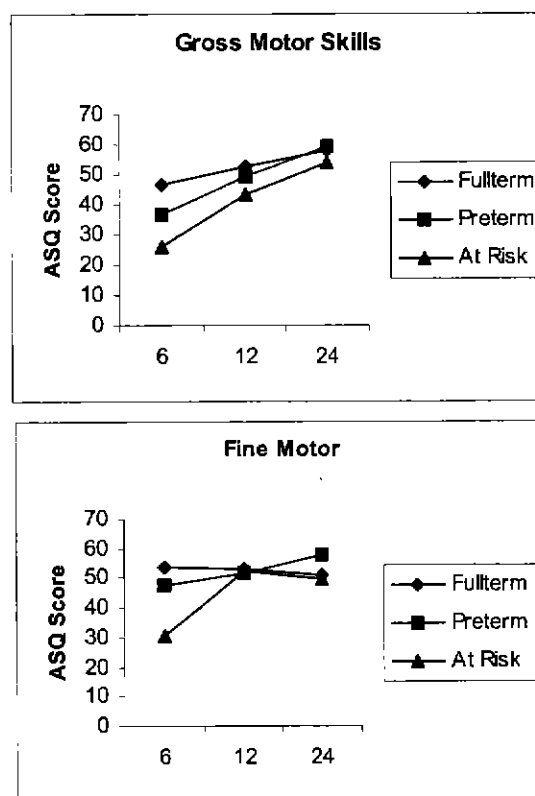
Independent repeated measures ANOVA's were performed to investigate group differences at 6, 12, and 24 months chronological age across the five developmental dimensions. All ages were not included as all age data had not been collected from many

children, and as the missing data varied for each child this would have resulted in very few cell numbers for some ages (particularly the older ages where data are still being collected). A Bonferroni correction was applied for multiple comparisons and all analyses were tested at alpha .01. Results can be seen in Table 2.

Table 2: P values for repeated measures ANOVA's comparing group and age.

Dimension	Group Effects	Age Effects	Age x Group Interactions
Communication	ns	ns	ns
Gross Motor	.006	.000	.003
Fine Motor	.000	.001	.001
Problem Solving	ns	.006	.002
Personal / Social	.002	.000	ns

The results indicate significant group differences, age effects and interactions that differ across dimensions. Figure 1 illustrates the results for Gross Motor Skills, Fine Motor Skills, Problem Solving and Personal/Social Skills at 6, 12 and 24 months of age.



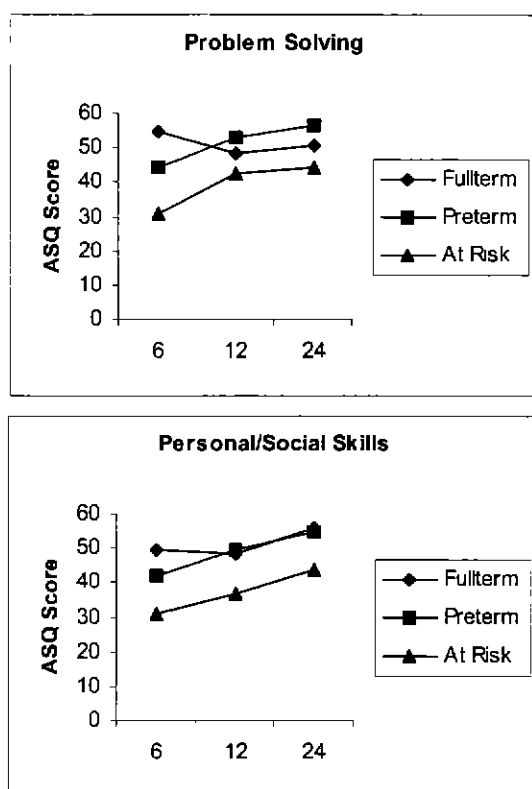


Figure 1: Gross Motor and Personal/Social Skills

Of particular interest is the lack of group by age interaction on the personal/social dimension $F(2,31) = 1.139$, $p = .333$ which demonstrates that there are group differences that are not disappearing with age. For the other three dimensions (gross motor, fine motor and problem solving) there are significant age by group interactions that indicate that the differences between the groups at 6 months of age have disappeared by 24 months of age. At 6 months of age there is a significant difference between the groups on all four dimensions: gross motor $F(2,59) = 11.424$, $p = .000$, fine motor $F(2, 59) = 10.547$, $p = .000$, problem solving $F(2,59) = 10.591$, $p = .000$, and personal/social $F(2,59) = 13.329$, $p = .000$. At 12 months of age there is a significant difference between the groups on personal/social skills $F(2,52) = 4.389$, $p = .018$ but no significant differences between the groups on gross motor skills, fine motor skills or problem solving. Again at 24 months of age there is a significant difference between the groups for personal/social skills $F(2,48) = 4.137$, $p = .023$ but no significant differences between the groups on gross motor skills, fine motor skills or problem solving.

Discussion

Results did not support the expectation that there would be gender differences within each of the three infant groups. This was an unexpected result, especially in

the motor skill dimensions where previous research has repeatedly found gender differences in the gross and fine motor skills of infants and children (Piek et al., 2002; Thomas & French, 1985). In relation to this study it needs to be noted that while the current sample has equal numbers of male and female infants in the fullterm group, there were nearly twice as many boys in both the preterm and at-risk groups. These gender differences will be reinvestigated as the longitudinal sample ages and more preterm and at-risk girls reach 48 months of age.

Unlike other studies that correct for gestational age these results revealed significant differences between the three infant groups on three of the five developmental dimensions (gross motor, fine motor, personal/social). This is in line with research that shows preterm and at-risk infants being vulnerable to delay. For example, Goyen and Lui (2002) who found motor delay in high-risk infants at five years of age. This study supports that the early group differences in personal/social skills continue until at least four years of age. The results also show that the early group differences on gross and fine motor skills persist to at least 24 months of age.

Results also showed significant age effects on four dimensions (gross motor, fine motor, problem solving, personal/social). This indicates that the groups are showing improved performance on the dimensions as they age. This illustrates a potential problem with the ASQ. A test such as this needs to be standardized for age so that useful comparisons about a child's performance can be made at different ages.

However, the results also revealed significant group by age interactions for three dimensions (gross motor, fine motor, problem solving). This illustrates that the age and group effects are different across the developmental dimensions, indicating different patterns of development and delay. For example, the results show significant group differences at six months of age for gross motor, fine motor, problem solving and personal/social skills, with fullterm infants performing better than the preterm infants and in turn the at-risk infants. At 12 and 24 months of age there is no longer a significant group difference on gross motor, fine motor or problem solving skills. This supports previous research that indicates that by two years of age children with motor delays have 'caught up' to their peers (Wijnroks & van Veldhoven, 2003). However, the differences between the groups still exist for personal/social skills. This illustrates that on other developmental dimensions (in this case personal/social skills) children with delays have not 'caught up'. This indirectly supports earlier research that has found links between early motor delay and later personal/social difficulties. Van Beek and colleagues (1994) linked

early delays in postural control with different looking behaviours during interactions between infants and their mothers. Similarly Wijnroks and Kalverboer (1997) and later Wijnroks and van Veldhoven (2003) have linked early postural delay with later development of insecure attachments and poorer performance on attention and problem solving tasks. Therefore, even though preterm and at-risk infants with motor delay appear to 'catch up' to their peers by two years of age it is likely that these delays will have affected other aspects of development (e.g., personal/social skills).

One criticism of studies such as this has been related to the use of parent-report measures of child development. Hieser and colleagues (2000) investigated the consistency with which parent-report questionnaire data were able to detect developmental delay by comparing it with professionally diagnosed developmental delay. In this study each of 108 very low birth weight infants (less than 1500 grams) were matched with two control infants (matched on sex, hospital, and single vs. multiple birth). Parents completed the Revised Prescreening Developmental Questionnaire at 12 months corrected age while professionals assessed the infants using the Griffiths Developmental Scale. Heiser and colleagues reported a correlation of -.67 between the parent and professional reports, with the parent reports identifying delay in 22 very low birth weight and 32 control infants that was not substantiated by the professional report. This suggests that parents are hyper vigilant when assessing their own children as opposed to being over optimistic and possibly missing any developmental problems. However, the parents of very low birth weight children were two times more likely than parents of fullterm infants to identify a developmental delay that was not supported by professional assessment. Overall, this means that parent-report questionnaires are a useful and essential method of long-term follow-up in preterm and at-risk infants who in earlier assessments, have not shown any developmental delay.

In conclusion, the current results support the idea that while gross motor skill deficits in preterm and at-risk infants resolve with age we are seeing persistent ongoing difficulties in these infants in other areas e.g., personal/social skills. Other research has already linked early developmental delay with later achievement (e.g., Losse et al., 1991; Skinner & Piek, 2001). It is essential that children at risk of developmental delay are monitored during childhood and appropriate interventions be applied where necessary.

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