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Sensory profiles obtained from parental reports correlate with independent assessments of development in very preterm children at 2 years of age

Abbey L. Eeles [a,b,c,*], Peter J. Anderson [a,b], Nisha C. Brown [a,c], Katherine J. Lee [a,b], Roslyn N. Boyd [d], Alicia J. Spittle [a,b,c], Lex W. Doyle [a,b,c]

[a] Victorian Infant Brain Study, Murdoch Childrens Research Institute, Melbourne, Victoria, Australia
[b] University of Melbourne, Melbourne, Victoria, Australia
[c] The Royal Women's Hospital, Melbourne, Victoria, Australia
[d] Queensland Cerebral Palsy and Rehabilitation Research Centre, School of Medicine, The University of Queensland, Brisbane, Australia

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ABSTRACT

Background: Very preterm (VPT) children have different sensory profiles than term-born controls, but how the sensory profiles in VPT children relate to development has not been reported.
Aim: The aim of this study was to examine the relationship between VPT infant sensory profiles and concurrent developmental outcomes at 2 years' corrected age.
Study design: Cohort study.
Subjects: 243 children <30 weeks' gestation.
Outcome measures: Primary caregivers completed the Infant/Toddler Sensory Profile Questionnaire to obtain information on sensory processing at 2 years of age. Independent observers assessed the child's neurodevelopment with either the Mental Developmental Index (MDI) and Psychomotor Developmental Index (PDI) of the Bayley Scales of Infant Development version 2 (Bayley 2) or the Cognition, Language and Motor Composites of the Bayley Scales of Infant and Toddler Development version 3 (Bayley 3).
Results: A stronger Low Registration pattern correlated with lower MDI and PDI scores and a stronger Sensation Avoiding pattern correlated with a lower PDI score. A stronger Low Registration pattern correlated with a lower Language Composite score. More frequent visual and oral sensory processing behaviours were associated with higher performance on the MDI and PDI, with more frequent auditory sensory processing behaviours also associated with higher PDI scores. More frequent auditory, touch and oral sensory processing behaviours were associated with improved outcomes on the Language Composite and more frequent auditory, touch and vestibular processing behaviours correlated with improved outcomes on the Cognition Composite. A secondary analysis using a computed MDI score derived from the Bayley 3 scores did not substantially alter any conclusions.
Conclusion(s): Different sensory profile patterns obtained from parental reports of VPT children are associated with various aspects of neurodevelopment at 2 years of age, obtained from independent assessment.

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1. Introduction

The organisation of sensation for use is often referred to as 'sensory processing', and dysfunctions in this area have been hypothesised to be a cause of developmental and learning difficulties in some children [1–10]. It is well established that very preterm (VPT) children (defined as children <32 weeks' gestational age) are at high risk for developmental and learning problems [11–15], and more recently we have demonstrated that these children have different sensory processing patterns compared to those of term born peers [16]. It is not surprising that VPT children have different sensory processing patterns compared with term-born infants given that they enter the neonatal intensive unit at a time of rapid brain development and when their sensory systems are exposed to stimuli which are in conflict with the infant's sensory needs [17]. The altered sensory patterns of VPT children may be associated with the developmental problems observed in these children, but to date this relationship has not been explored. Thus the aim of this study was to examine the relationship between sensory profiles and developmental outcomes at 2 years' corrected age in VPT children.

* Corresponding author at: The Royal Women's Hospital, Newborn Research, Level 7, Locked Bag 300, Parkville, Victoria 3052, Australia. Tel.: +61 401 888 697; fax: +61 3 8345 3789.
E-mail address: abbey.eeles@thewomens.org.au (A.L. Eeles).

2. Methods

2.1. Participants

Study participants were derived from two cohorts of VPT infants recruited from the Neonatal Intensive Care Units at The Royal Women's and The Royal Children's Hospital, Melbourne, Australia. Cohort 1 comprised 207 infants born <30 weeks' gestational age between July 2001 and December 2003 as described previously [18]. The second cohort of VPT infants comprised 120 infants born <30 weeks' gestational between January 2005 and January 2007 who were enrolled in a randomised controlled trial of a home-based preventative care programme over the first year of life, the results of which at two and four years of age have been reported elsewhere [19,20]. There was little evidence for differences in sensory profiles in children in the intervention and control groups at 2 years' corrected age, therefore the data for both groups were pooled in the second cohort for the analysis presented here.

Children were excluded from both cohorts if they were born with a major anomaly associated with a poor neurodevelopmental outcome or if their family did not speak any English. This research was approved by the Royal Women's Hospital's Human Research Ethics Committee, and parents gave written informed consent for their child to participate.

2.2. Outcome measures

The Infant/Toddler Sensory Profile Questionnaire [21] was completed by the primary caregiver to evaluate sensory processing at 2 years' corrected age, and standardised scores were obtained for the Low Registration, Sensation Seeking, Sensory Sensitivity and Sensation Avoiding quadrants, and the Auditory, Visual, Tactile, Vestibular and Oral sensory processing sections, as described previously [16]. Lower standardised scores for each category represent more of a particular profile or sensation.

Developmental outcome was also measured at 2 years' corrected age using the Bayley Scales of Infant Development version 2 (Bayley 2) in cohort 1 [22], and the Bayley Scales of Infant and Toddler Development version 3 (Bayley 3) in cohort 2. The Bayley 2 generates two scales, the Mental Developmental Index (MDI) which evaluates cognitive and language development and the Psychomotor Developmental Index (PDI) which evaluates gross and fine motor development. The Bayley 3 generates three composite scores: Cognitive, Language and Motor Composites [23]. All indices and composite scores are standardised to a mean of 100 and a SD of 15. The developmental assessments were completed by an accredited psychologist or occupational therapist who was blind to the Infant Toddler Sensory Profile results.

2.3. Data analysis

The Bayley 2 and Bayley 3 have different structures and are only moderately correlated [23]. Therefore the initial analyses were completed separately on each cohort. Linear regression was used to explore the influence of each sensory profile pattern and sensory processing section (z scores) on MDI and PDI performance in cohort 1, and cognitive, language and motor performance (composite scores) in cohort 2. Separate models were fitted for each predictor–outcome combination. Models were fitted using generalized estimating equations (GEEs) to account for the clustering of twins where possible, however due to convergence issues sandwich estimators of variance were used to account for clustering in some of the models (MDI and Low Registration, MDI and Sensation Seeking, MDI and visual sensory section, MDI and oral sensory section, cognition and Low Registration, language and all four sensory profile patterns, and language and auditory, touch, vestibular and oral sensory sections). The regression coefficient, 95% confidence intervals and p-values were reported for each sensory profile quadrant and sensory system section and its relationship with indices and composite scores from the relevant version of the Bayley Scales. A secondary

analysis was undertaken involving the conversion of the Bayley 3 Language and Cognition composite scores into an MDI score. This adjustment was completed in order to address the limitation of using different developmental assessment tools across cohorts and the inability to pool data. The algorithm described by Moore and colleagues [24] was used to compute this adjustment. The regression analyses were repeated, as described above, combining data from both cohorts using the MDI outcome from cohort 1 and the converted MDI score from cohort 2. No algorithm was available for the conversion of Bayley 3 motor composite scores into a PDI score and therefore motor performance across the two cohorts could not be merged. Given the large number of associations considered, the findings were interpreted by looking at overall patterns of results rather than focusing on individual p-values.

3. Results

At 2 years' corrected age, 143 of the 207 (69%) children from cohort 1 had some data from the Infant/Toddler Sensory Profile questionnaire and were assessed using the Bayley 2. From cohort 2 98 of the 120 (82%) children with data on the Infant/Toddler Sensory Profile questionnaire were assessed at 2 years' corrected age using the Bayley 3. The characteristics of participants with and without sensory profile data from both cohorts are summarized in Table 1. Those children with complete data at 2 years' corrected age in cohort 1 (n = 143) had higher social risk (p = 0.01) and shorter hospital stay (p = 0.03) compared with children who did not have available data. There was little difference between children with and without data in cohort 2.

For both cohorts, there was an overall pattern of weaker sensory profile patterns with improved cognitive and motor performance, but not all differences were statistically significant.

3.1. Cohort 1

There was strong evidence of an association between a weaker Low Registration pattern (higher score) and improved performance on the MDI and PDI scales (regression coefficient; 3.96 [95% CI 1.51 to 6.40], p = 0.002 and 3.31 [95% CI 1.13 to 5.49], p = 0.003, respectively) (Figs. 1 and 2). In addition, a weaker Sensation Avoiding pattern was associated with improved PDI performance (regression coefficient; 3.90 [95% CI 1.17 to 6.62], p = 0.005). A similar relationship was seen with Sensation Seeking and MDI scores (regression coefficient; 4.18 [95% CI − 0.18 to 8.54], p = 0.06) and Sensory Sensitivity patterns and PDI scores (regression coefficient; 3.12 [95% CI − 0.02 to 6.27], p = 0.05) although the evidence for these latter two relationships was weaker. Less of the behaviours (higher scores) on the sensory processing sections of auditory visual and oral sensory processing were associated with improved MDI and PDI performance. However there was little evidence that less frequent vestibular and touch processing behaviours were associated with improved performance either in the MDI or PDI on the Bayley 2.

3.2. Cohort 2

There was strong evidence of a relationship between a weaker Low Registration pattern (higher score) and improved performance on the Language Composite (regression coefficient; 4.32 [95% CI 1.99 to 6.65], p = <0.001) (Figs. 1 and 2). The evidence to support other associations was lacking, however there was a trend towards weaker Low Registration and Sensation Seeking patterns and improved cognitive performance on the Bayley 3. There was evidence that less frequent auditory, touch and oral sensory processing behaviours (higher scores) were associated with improved language performance in cohort 2 (regression coefficients; 5.11 [95% CI 1.86 to 8.36], p = 0.002; 3.61 [95% CI 0.1 to 7.12], p = 0.04 and 3.68 [95% CI 0.52 to 6.85], p = 0.02 respectively), with weaker evidence of a similar relationship between less vestibular and visual processing section behaviours and improved