Moderate to Late Preterm Infants Demonstrate Verbal Working Memory and Verbal Inhibitory Control Deficits at Preschool Age

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Background

Children born at very preterm have deficits in executive function.[1] The impact of moderate to late preterm birth on executive function remains incompletely defined. Over 10% of births in the United States occur at 32-36 weeks gestation.[2] With a significant proportion of brain growth occurring after 34 weeks gestation[3] and neonatal disease processes affecting the developing brain, moderate to late preterm birth has the potential to impact cognitive outcomes.

Hypothesis

Moderate to late preterm children (32-36 weeks) demonstrate deficits in executive function compared with full term (37-42 weeks) peers at 4½ years of age.

Methods

Recruitment was by telephone from a database of families. Children with neurologic or cyanotic heart disease were excluded. Full term children admitted to an intensive care unit were also excluded.

Children completed a battery of executive function tasks and a measure of verbal intelligence quotient (IQ).

Sample Characteristics	Preterm (n=52)	Full Term (n=52)
Chronologic age (months), mean (SD)	57.02 (1.72)	56.67 (2.05)
Male, n (%)	26 (50.0)	26 (50.0)
Caucasian, n (%)	49 (94.2)	43 (82.7)
Birth History		
Gestational age (weeks), mean (SD)	34.95 (1.63)*	39.41 (1.29)
Birth weight, grams (SD)	2406.21 (522.98)*	3542.35 (458.50)
Apgar at 5 minutes, mean (SD)	8.81 (0.50)	8.94 (0.25)
Household Characteristics		
Married, n (%)	48 (92.3)	49 (94.2)
Bachelor's degree or higher, n (%)	42 (80.8)*	49 (94.2)
Annual Income ≤ $50,000, n (%)	2 (3.8)	3 (5.8)

*p<0.05

References

[1]Aarnoudse-Moens CS, Weisglas-Kuperus N, van Goudoever JB, Oosterlaan J. Meta-analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children. *Pediatrics* 2009;124(2):717-28.

[2]Martin JA, Hamilton BE, Sutton PD, Ventura SJ, Menacker F, Kirmeyer S, et al. Births: Final data for 2006. *National vital statistics reports*. USDoHHS, editor. Hyattsville, Maryland; 2009.

[3]Huppi PS, Warfield S, Kikinis R, Barnes PD, Zientara G P, Jolesz FA, et al. Quantitative magnetic resonance imaging of brain development in premature and mature newborns. *Ann Neurol* 1998;43(2):224-35.

[4]Nosarti C, Giouroukou E, Healy E, Rifkin L, Walshe M, Reichenberg A, et al. Grey and white matter distribution in very preterm adolescents mediates neurodevelopmental outcome. *Brain* 2008;131(1);205-217.

[5]Lee ES, Yeatman JD, Luna B, Feldman HM. Specific language and reading skills in school-aged children and adolescents are associated with prematurity after controlling for IQ. *Neuropsychologia* 2010. [Epub ahead of print].

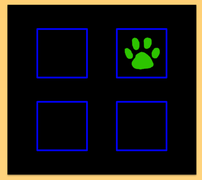
Acknowledgments

This research was supported by Seed and Travel Grants from the Center for NeuroBehavioral Development (Jane E. Brumbaugh), Ruth L. Kirschstein National Research Service Awards from the NIH (T32 DA022616-05 – Jane E. Brumbaugh, T32 HD007151-05 – Amanda S. Hodel), and a University of Minnesota Graduate School Fellowship Award (Amanda S. Hodel). The authors thank the families and the members of the Kathleen M. Thomas' Cognitive Developmental Neuroimaging Lab.

Short Term Memory Tasks

For verbal memory, children repeated a sequence of numbers after Count von Count with a maximum length of 5 digits (3 trials per load, 15 trials).

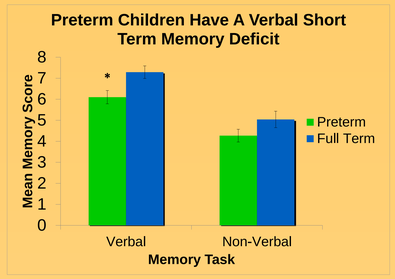
Verbal Memory Task: Computerized Digit Span

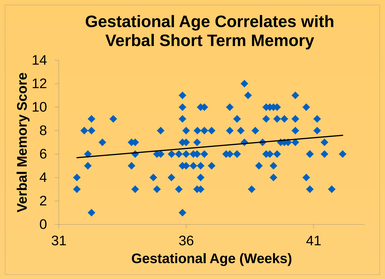


For spatial memory, children recalled a sequence of locations where paw prints appeared with a maximum length of 6 locations (3 trials per load, up to 18 trials).

Non-Verbal Memory Task: Computerized Spatial Span

Short Term Memory Results



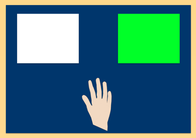


- Preterm children scored lower on the verbal short term memory task (p<0.01).
- There was no group difference on the non-verbal short term memory task.
- Gestational age correlated with verbal short term memory (r=0.23, p=0.02).
- The group difference in verbal short term memory was reduced to a trend with PPVT as a covariate.

Inhibitory Control Tasks

For the verbal task, children were instructed to say "day" for the moon and stars and "night" for the sun (16 trials).

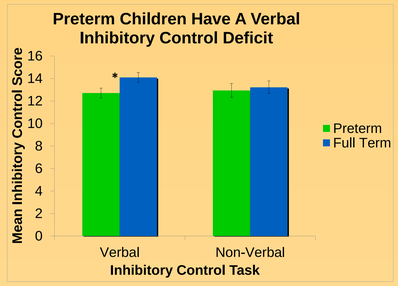
Verbal Inhibitory Control Task: Day-Night

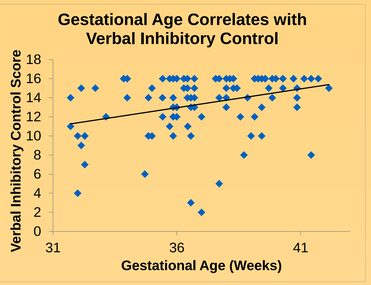


For the non-verbal task, children were instructed to point to green in response to the word "snow" and to white in response to the word "grass" (16 trials).

Non-Verbal Inhibitory Control Task: Grass-Snow

Inhibitory Control Results





- Preterm children scored lower on a verbal inhibitory control task (p=0.03).
- There was no group difference on the non-verbal inhibitory control task.
- Gestational age correlated with verbal inhibitory control (r=0.29, p<0.01).
- The group difference in verbal inhibitory control was reduced to a trend with PPVT as a covariate.

Verbal Intelligence Results

- Children completed the Peabody Picture Vocabulary Test-4 (PPVT).
- The mean PPVT score was 118.17 (10.04) for the preterm group and 123.12 (12.96) for the full term group.
- The correlation between gestational age and verbal IQ approached significance (r=0.19, p=0.06).

Conclusion

Children born moderate to late preterm demonstrated verbal short term memory and verbal inhibitory control deficits at 4½ years of age compared to their full term peers.

Discussion

- Whether group differences reflected a delay in development or a permanent deficit in moderate to late preterm children was unknown as the study was not longitudinal. However, adolescents born very preterm demonstrate executive function deficits.[4]
- Discrepant language development in children born preterm may explain in part the group performance differences on verbal executive function tasks.[5]
- Children were raised in well-educated, two-parent households with a high socioeconomic status. The group differences for children raised in less enriched environments may be greater.
- Executive dysfunction has the potential to impact success in the classroom setting and may not be picked up on routine kindergarten screening.