



# Effects of Prematurity and Neonatal Risk Factors on Cognitive Development in Preschool Age Children

Samantha J. Sherman<sup>1</sup>, Amanda S. Hodel<sup>1</sup>, Jane E. Brumbaugh<sup>2</sup>, & Kathleen M. Thomas<sup>1</sup>

<sup>1</sup>Institute of Child Development, University of Minnesota; <sup>2</sup>Department of Pediatrics, University of Iowa Hospitals and Clinics



## Introduction

Critical brain development and maturation happens both prenatally and postnatally. Almost 10% of babies in the United States are born moderate-to-late preterm (32-36 weeks gestation). For moderate-to-late preterm (PT) infants, brain development occurs earlier in the postnatal world than biologically expected, which could have long-term impacts on cognitive development. Other neonatal risk factors, such as maternal health issues and low 1 minute Apgar scores at birth could also be associated with long-term cognitive development impairments.

Few studies have investigated whether gestational age and neonatal risk factors impact cognitive development in early childhood. We hypothesized that PT birth, along with maternal health risk and/or low 1 minute Apgar scores would be associated with worse performance on both hot and cold executive functioning (EF) tasks at preschool age.



## Questions

Does a history of PT birth impact cognitive development at preschool age?  
Are other neonatal risk factors (maternal risk, low Apgar scores) associated with altered cognitive development?

## Participants

Variables	Preterm Infants n = 74	Full Term Infants n = 76
Age at Test	M = 4.70 years Range = 4.43 – 4.99 yrs	M = 4.76 years Range = 4.53 – 4.98 yrs
Gender	36 f, 38 m	37 f, 39 m
Gestational Age	M = 35.21 weeks Range = 31.29 – 36.86 weeks	M = 39.74 weeks Range = 37.71 – 42 weeks
Birth Weight	M = 2569.65 grams Range = 1300 – 3710 g	M = 3705.28 grams Range = 2755 – 5050 g
1 minute Apgar < 7	9 out of 72 (12.5%)	6 out of 72 (8.3%)
Higher Maternal Risk	20 out of 74 (27.0%)	8 out of 75 (10.6%)

**Demographics:** Children were predominantly Caucasian (93% in both groups), with most households having a mother who had completed a college or graduate degree (89.2% in PTs; 90.8% in FTs).

## Methods

### Cold EF Tasks:

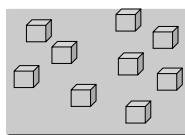
#### Digit Span task:

Children are told to repeat a sequence of numbers verbatim. Each number is read at a rate of 1 digit/second. Forward and backward spans were measured.



#### Corsi Block task:

Children are told to repeat a sequence of tapped blocks with their index finger. Cubes are touched at a rate of 1 cube/second. Forward and backward spans were measured.



### Hot EF Task:

#### Delayed Choice task:

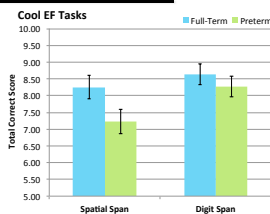
Children are given repeated opportunities to choose a small reward (stickers or M&Ms) now, or wait to receive a larger reward later.

### Neonatal Risk Factors:

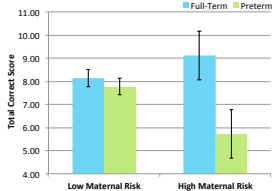
- **Maternal risk variable** included presence of one or more of the following: pregnancy induced hypertension, preeclampsia, or gestational diabetes
- **Neonatal risk variable** included infants who received an Apgar score < 7 on a 1-10 point scale 1 minute after birth

## Results: Cold EF Tasks

• **Gestational Age:** PTs perform worse than FTs on the Corsi block task; there was a linear relationship between gestational age and Corsi block task performance.

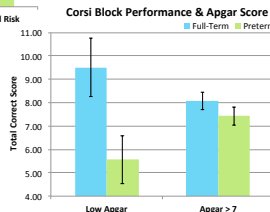


### Corsi Block Performance & Medical Risk



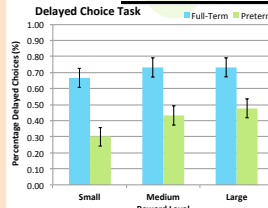
• **Maternal Risk:** presence of maternal risk factors and being PT is associated with poorer performance.

• **Apgar Scores:** having a low 1-minute Apgar score and being preterm is associated with poorer performance.



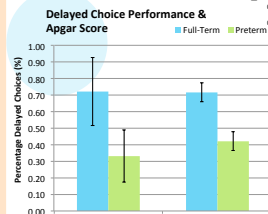
**Overall, PTs perform worse than FTs on measures of spatial working memory. Risk factors are predictive of performance in the PT group.**

## Results: Hot EF Tasks



• **Gestational Age:** PTs are less likely to delay than FTs across all reward levels; there was a linear relationship between gestational age and delayed choice performance.

• **Maternal Risk:** presence of maternal risk factors is associated with poorer performance in both PT and FT children.



• **Apgar Scores:** No effect of Apgar scores on performance.

**Overall, PTs perform worse than FTs on a measure of hot EF. Maternal risk factors are associated with worse performance in both groups.**

## Discussion

We found evidence that moderate-to-late preterm birth has long-term impacts on both cold and hot executive function development at preschool age.

- On both tasks, gestational age was a linear predictor of performance, suggesting that there is not a specific cutoff point at which PT children are spared from altered brain development.
- In PT children, additional risk factors (maternal risk factors and low Apgar scores) were associated with poorer outcomes.
- On the hot EF task, maternal risk predicted worse performance in both PT and FT children.

**Future studies** should investigate interventional efforts appropriate for moderate-to-late PT children who are at higher risk for atypical cognitive development. These efforts may be particularly valuable for monitoring cognitive development during early childhood when the brain is at highest plasticity.

## Conclusion

By preschool age, PT children show long-term impacts in executive function development, with poorer outcomes in those at higher neonatal risk.

## Acknowledgments

This research was supported by the University of Minnesota Center for Neurobehavioral Development, Ruth L. Kirschstein National Research Service Awards (T32 DA022615-05 – Brumbaugh; T32 HD007151-05 – Hodel), the Benjamin Walker Hanson Neonatology Fund (Brumbaugh), and a University of Minnesota Graduate School Fellowship Award (Hodel). The authors thank the members of the Cognitive Development & Neuroimaging Lab, especially Alyssa Morris, Shelby Rentmeester, Sara Van Den Heuvel, and Anika Willgen, as well as all the families who kindly participated in this research.