



# Hot and Cool Executive Function Abilities in Preschoolers Born Moderate-to-Late Preterm

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## Introduction

Do children born moderate-to-late preterm (32 – 36 weeks gestation) show differences in the development of hot and cool executive function at preschool age?

Moderate-to-late preterm children are at higher risk than their full term peers for exhibiting attention and behavior regulation problems.

- At school age, children born moderate-to-late preterm have more cognitive and emotional regulation difficulties, a slightly lower IQ, and increased rates of attention and behavioral problems (L. van Baar et al., 2009).
- Moderate-to-late preterm birth also has a negative impact on academic achievement.
- Poor academic achievement and attention regulation skills in this population may be related to atypical executive function development.

Children born moderate-to-late preterm may be at risk for executive dysfunction.

- Executive function refers to cognitive processes that are associated with regulation and control, including working memory, inhibitory control, and cognitive flexibility (set-shifting).
- Very preterm children (<28 weeks gestation) show significant executive dysfunction as compared with their normal birth weight counterparts (Anderson et al., 2004).
- Recent studies indicate that moderate-to-late preterm children also exhibit discrepant EF development (Brumbaugh et al., 2014).

Prior studies of executive function (EF) development in preterm children have primarily assessed EF in affectively neutral contexts (cool EF), while disruptions in motivational or emotionally significant contexts (hot EF) have not been investigated.

- The current study examines the development of both hot and cool EF in low-risk, healthy children born moderate-to-late preterm in comparison to full term peers at preschool age.

## Participants

All children were screened for significant prenatal or birth complications, developmental or neurological disorders, and vision or hearing impairments

	Full Term Children (n = 46)	Moderate-to-Late Preterm Children (n = 45)
Age at Test	M = 4.75 years Range = 4.55 – 4.94 years	M = 4.64 years Range = 4.48 – 4.97 years
Sex	21 f, 25 m	22 f, 23 m
Gestational Age	M = 39.6 weeks Range = 37.7 – 42.0 weeks	M = 35.6 weeks Range = 32.9 – 35.6 weeks
Birth Weight	M = 3768 grams Range = 2873 – 5050 grams	M = 2696 grams Range = 1300 – 3710 grams
IQ	M = 114.8 Range = 88 – 138	M = 115.8 Range = 74 – 138

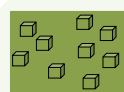
Demographics: Children were predominantly Caucasian (92%), and lived in two-parent families (95%), with most households having at least one parent who had completed a college or graduate level degree (81%). Median household income for the sample was between \$51,000-\$100,000.

## Acknowledgments

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## Methods

### Cool Executive Function



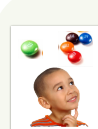
**Spatial Working Memory:** Children recalled and tapped sequences of locations that increased in length in both forward and reverse order. Highest span length for forward and backward trials was recorded and IQ was adjusted for analysis.

#### Inhibitory Control:

Children played a computer game where they pressed the space bar for a frequent target and were required to inhibit responding when a rare non-target appeared. Accuracy and reaction time for correct trials were recorded.



### Hot Executive Function



**Delayed Choice:** Children made repeated choices between receiving a small, immediate reward (eating a candy or using a sticker), or a larger reward that was put aside in an envelope for later consumption or use. Percentage of delayed choices was recorded.

#### Maudsley Index of Delay Aversion (MIDA):

Children played a computer game where they made decisions to earn 1 point following a 2 second delay, or 2 points following a 30 second delay. Percentage of delayed choices was recorded.



**WPPSI:** Children completed the WPPSI-III vocabulary and matrix reasoning subtests to estimate full-scale IQ. The symbol search and coding subtests were used as a measure of processing speed quotient. Analyses were run with and without controlling for individual differences in estimated IQ.

**BRIEF-P:** Parents completed the Behavior Rating Inventory of Executive Function–Preschool Version questionnaire as a measure of parental perception of children's behavior and attention in everyday contexts.

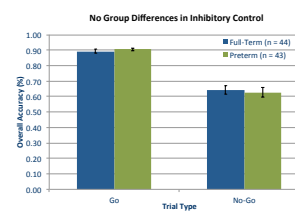
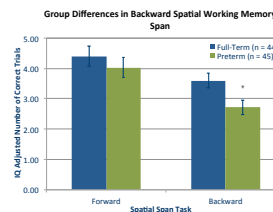
## Results: Cool Executive Function

PT children had shorter backward spatial working memory spans than FT children.

- **Span length?** PT children had shorter average span lengths than FT children on backwards, but not forwards, trials.

No group differences existed between PT and FT children on the inhibitory control task.

- **Accuracy?** There were no significant group differences in accuracy between PT and FT children on either Go or No-Go trials.



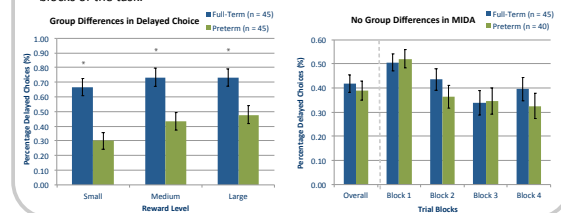
## Results: Hot Executive Function

PT children were less likely to select delayed rewards on the delayed choice task.

- **Reward level effects?** FT children delayed more frequently compared to PT children at all levels of reward.

No group differences existed between PT and FT children on the MIDA task.

- **Overall?** There was no group difference in overall percentage of delayed choices.
- **Data Blocks?** There was no group difference in percentage of delayed choices across the blocks of the task.



## Results: Parental Report of Executive Function

- Parents of PT children reported a non-significant increase in self-control problems ( $p < .07$ ).
- Report of working memory difficulties predicted poorer performance on the cool spatial working memory task in the FT and PT groups.
- Report of inhibitory control problems predicted performance on the hot delayed choice task in FT, but not PT, children.

## Conclusions

Moderate-to-late preterm children display differences in both hot and cool EF development at preschool age.

Like very preterm children, children born moderate-to-late preterm also show atypical EF development.

- Developmental differences in EF for moderate-to-late PT children are more subtle (in comparison to effects observed in very PT samples), are not present on all EF tasks, and are not universally reflected in parental report.
- Because this study was not longitudinal in nature, it is unclear whether these deficits persist beyond the preschool age range, a time of rapid EF development in children.

To our knowledge, this is the first study to report differences in hot EF development following preterm birth.

- Differences in hot EF development are of particular interest given its relation to real world outcomes in typically developing children (e.g. relationship between delay of gratification task performance and college academic achievement).
- Further characterization of hot EF in PT children will be necessary to understand whether hot EF difficulties may account for increased rates of behavioral, emotional, and school problems in this population.

Our results argue for increased monitoring of long-term neurodevelopmental outcomes, including both hot and cool EF, in children born at 32-36 weeks gestation.