The Relationship Between Birth Weight and Executive Function Development in Children Born Appropriate for Gestational Age

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Introduction

Research has demonstrated that variations in both prenatal and early postnatal experience have a profound impact on brain and cognitive development (Greenough et al., 1987). For example, studies examining neurodevelopmental outcomes in infants, preschoolers, and adolescents born low birth weight (<2500 grams) have suggested that cognitive and brain developmental processes may be altered, even among those infants born without significant medical complications (Aarnoudse-Moens et al., 2009; Martinussen et al., 2009).

However, effects of early experience may not be limited to infants born at the extremes of birth weight (Bohnert & Breslau, 2008). Recent studies have suggested that the relationship between fetal growth rate and neurodevelopment during childhood extends across the normal range of birth weights (Qiu et al., 2012). Additionally, interest has also increased in monitoring neurodevelopmental outcomes of children born moderate to late preterm (32-36 weeks gestation), who are often similar in birth weight to full-term infants (Wang et al., 2004).

The purpose of this project was to investigate whether normal variation in birth weight was associated with performance on executive function tasks at four years of age in a low-risk sample of children who were born at birth weights appropriate for their gestational age.

Question

Is normal variation in birth weight in children born between 30-42 weeks gestation related to later executive function development?

Participants

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

	Full-Term Children (n=52)	Moderate to Late Preterm Children (n=52)
Age at Test	*M* = 57.0 months Range = 53-59 months	*M* = 56.7 months Range = 50-59 months
Gender	26 f, 26 m	26 f, 26 m
Gestational Age	*M* = 39.4 weeks Range = 37.0-42.1 weeks	*M* = 35.0 weeks Range = 31.7-36.7 weeks
Birth Weight	*M* = 3542 grams Range = 2605-4761 grams	*M* = 2406 grams Range = 1300-3671 grams

Demographics: Children were predominantly Caucasian and lived in two-parent families, with most households having at least one parent who had completed a college or graduate level degree. Median household income for the sample was between $76,000-$100,000.

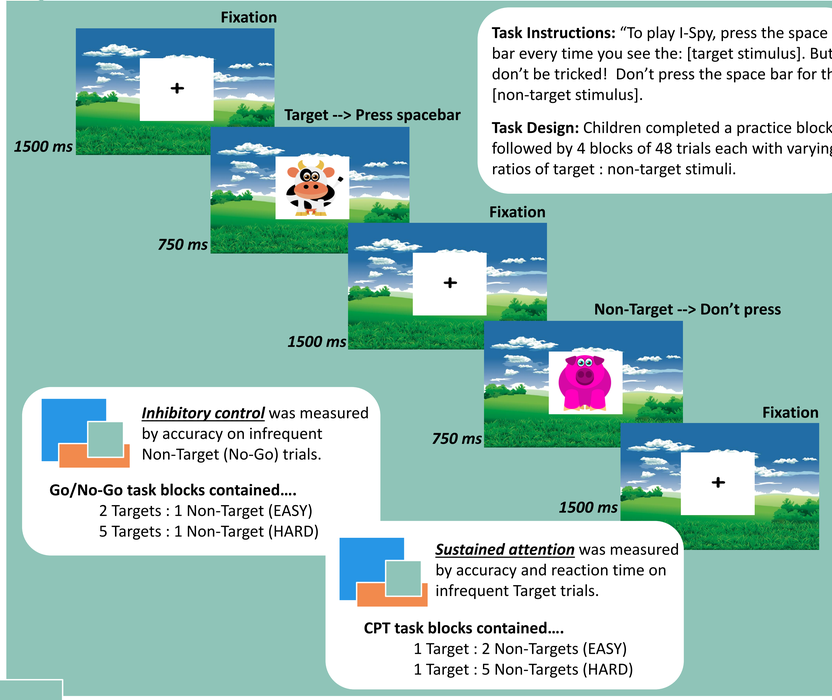
Methods

Day/Night Stroop Task

Task Instructions: Children were instructed to say "day" for the moon and stars and "night" for the sun.

Stroop performance was measured by number of correct trials out of 16. This task assesses **inhibitory control** and **working memory**.

Combined Inhibitory Control and Sustained Attention Task



Task Instructions: "To play I-Spy, press the space bar every time you see the: [target stimulus]. But don't be tricked! Don't press the space bar for the: [non-target stimulus].

Task Design: Children completed a practice block, followed by 4 blocks of 48 trials each with varying ratios of target : non-target stimuli.

Inhibitory control was measured by accuracy on infrequent Non-Target (No-Go) trials.

Go/No-Go task blocks contained....
2 Targets : 1 Non-Target (EASY)
5 Targets : 1 Non-Target (HARD)

Sustained attention was measured by accuracy and reaction time on infrequent Target trials.

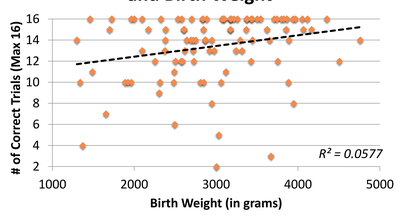
CPT task blocks contained....
1 Target : 2 Non-Targets (EASY)
1 Target : 5 Non-Targets (HARD)

Day/Night Stroop Results

- **Birth weight predicted performance on the Day/Night Stroop** (r=.240, p=.016)

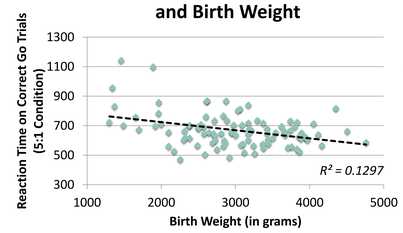
Is this relationship driven by gestational age?
Yes. After adjusting for gestational age, birth weight did not uniquely predict Stroop performance.

Day/Night Stroop Performance and Birth Weight



Inhibitory Control Results

Go Trial Reaction Time and Birth Weight



- **Birth weight did not predict accuracy on No-Go trials**
- **Birth weight predicted reaction time on Go trials in both easy** (r=-.322, p<.001) **and hard** (r=-.360, p<.001) **blocks**

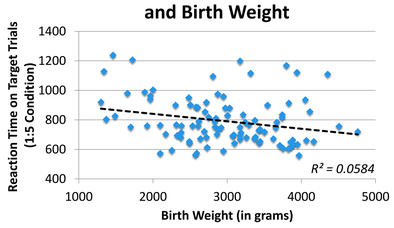
Is this relationship driven by gestational age?
No. After adjusting for gestational age, birth weight continued to predict reaction times (r's=-.289, p's<.001).

Sustained Attention Results

- **Birth weight did not predict accuracy on Target trials**
- **Birth weight predicted reaction time on Target trials in both easy** (r=-.170, p=.091) **and hard** (r=-.242, p=.015) **blocks**

Is this relationship driven by gestational age?
Partially. After adjusting for gestational age, birth weight only trended toward predicting reaction times.

CPT Target Reaction Time and Birth Weight



Discussion

We found a relationship between birth weight and later executive function development in preschoolers born moderate to late preterm and full-term at birth weights appropriate for their gestational ages.

- Higher birth weight was correlated with better Day/Night Stroop performance and faster reaction times on Go trials (Go/No-Go task) and Target trials (CPT).
- Variation in birth weight uniquely predicted task reaction times even after statistically adjusting for gestational age, suggesting an influence on processing speed.

These results indicate that **even children born moderate to late preterm and/or full-term within the normal range for birth weight are not a uniform group.**

- Outside of the normal birth weight range, growth restriction (Morsing et al., 2011), poor postnatal weight gain in low birth weight preterm infants (Ramel et al., 2012), and being large for gestational age (Langworthy et al., 2011) are associated with poorer neurodevelopmental outcome.

•Future studies should investigate the impacts and mechanisms of normative variation in birth weight and/or growth on long-term neurodevelopment.

Conclusion

Prenatal influences that manifest in birth weight differences within the normal range may have long-term impacts on neurodevelopment.

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