Executive Function in Children of Diabetic Pregnancies

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Introduction

Previous research from our group suggests that maternal diabetes during pregnancy may impact infant memory functions (Nelson et al., 2000), potentially due to the effects of prenatal iron deficiency on development of the hippocampus and prefrontal brain regions (Rao & Georgieff, 2007). Similar cognitive impacts have been reported for children born high birth weight, or large for gestational age (LGA), a correlate of diabetic pregnancy and fetal iron deficiency (Sorensen et al., 1998). Finally, studies of chronic iron deficiency in infancy suggest that cognitive functions are impaired years after the iron deficiency is resolved (Lozoff et al., 2006). The current study examined executive function in a longitudinal sample of children of diabetic pregnancies. We hypothesized that prenatal iron deficiency would be associated with impaired executive function in later childhood.

Methods

Participants

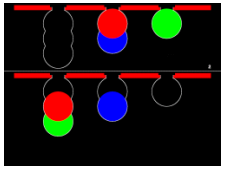
Group	N	Gender	Mean Age	Low Ferritin
Control	37	21 M; 17 F	9.60	7 Low
CDP	27	17 M; 10 F	9.50	6 Low
Total	64	38 M; 27 F	9.56	13 Low

Ferritin

- 39 ferritin scores
  - 13 Low (<76µL)
  - 26 Normal (>76µL)
- Collected at birth from cord blood samples

Tasks

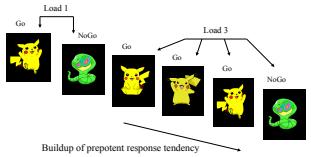
Stockings of Cambridge



- Children required to move colored balls to match pre-specified pattern
- Participants told to plan moves to solve problems in as few moves as possible
- Problem difficulty and number of problems

Go/NoGo

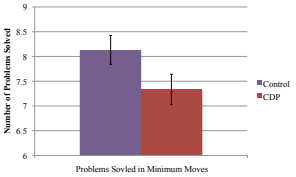
- Children instructed to press button whenever yellow Pikachu character, but not when green Arbok character was on the screen
- Inhibitory control load varied by increasing number of Go trials prior to NoGo trial

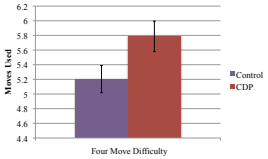


Stockings of Cambridge

Problems Solved in Minimum Moves

- CDP trend toward lower overall planning proficiency (t=1.93, p = 0.06)
- CDP show fewer problems solved in the minimum number of moves (CDP = 7.33 problems, Controls = 8.16 problems)



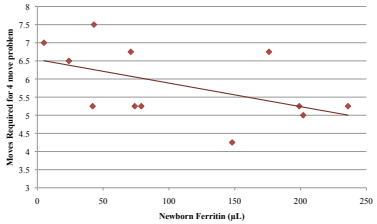


Four Move Problem Accuracy

- CDP show require more moves than Controls to solve four move difficulty problems (t = -2.10, p < 0.05; CDP = 5.78 moves, Controls = 5.20 moves)

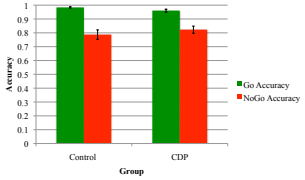
Newborn Ferritin and Planning Accuracy

- Within CDP group, Newborn Ferritin is significantly correlated with four move problem accuracy (r = -.57, p = 0.05)



Go/NoGo Results

- No significant differences between groups in inhibitory control task
- No significant differences across inhibitory load between groups



Birth Weight Results

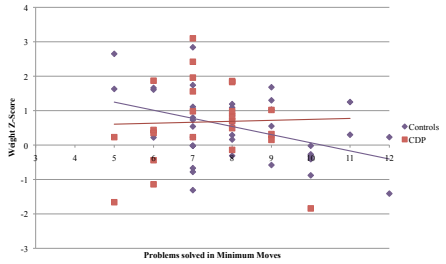
- Birth weight Z-score significantly predictive of the number of problems solved in the minimum number of moves

Table 1.
Does Birthweight Z-score predict Stockings of Cambridge Performance?
Problems solved in minimum number of moves

	B	*SE B*	*β*	R^2	ΔR^2
Step 1					
Constant	-3.91	8.01			
Age	.09	.07	.17		
Gender	-.19	.42	-.06		
WASI IQ	.02	.01	.17	.06	.06
Step 2					
Constant	-4.43	7.63			
Age	.09	.07	.18		
Gender	-.32	.41	-.10		
WASI IQ	.02	.01	.21		
Problems solved in min. moves	-.49	.19	-.33	.17*	.10*
Total R^2				.17*	.10*

Note. * $p < .05$

- Correlation between birth weight Z-score and Problems solved in minimum moves in Controls (r = -.42, p < 0.01) but not in CDP group (r = .03, p = 0.90)
- Controls with higher birth weight showed fewer problems solved in the minimum number of moves



Conclusions

Current findings indicate that children of diabetic pregnancy show poorer planning proficiency than typically developing children. Children with evidence of perinatal iron deficiency (low ferritin) required more moves to solve more difficult problems. These findings indicate that low ferritin at birth, though previously linked to memory deficits in younger children, may also impact planning processes later in childhood. However, the CDP group did not show poorer inhibitory control, indicating that lower level cognitive processes may be less affected by this early risk factor.
Additionally, being large for gestational age was also related to poorer performance on difficult problems. It is possible that early risk factors such as low ferritin or high birth weight impact the development of brain structures such as the prefrontal cortex, that are thought to support with executive functions such as planning.

Acknowledgements:
This work was supported by a grant from the NIH to Charles A. Nelson (R01 NS34458). Special thanks to the Center for Neurobehavioral Development (CNBD), Neely Miller and members of the CDN Lab.