Birth weight as destiny? The changing influence of childhood health and social environment on cognitive ability

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Through numerous studies, scholars have come to view normal birth weight as an essential component of a child's academic success. However, much of the literature views this positive influence in a time-free space, where health impacts a child's academic performance throughout their lifetime. This approach overlooks varying levels of parental investment in early childhood and the growing saliences of neighborhood and school environments. Using panel data from Fragile Families Child Well Being, I chart the influence of birth weight, parental investment, and school SES overtime on cognitive ability. The results show that while birth weight is a significant factor in determining a child's cognitive ability early in life, by age nine the academic gains from health are minor. This work reveals an interesting interplay among school effects, parental investment, and health and their capacity to influence cognitive ability.

Introduction:

There is overwhelming support in the literature of the negative effects of low birth weight in the short and long term. The consensus in the literature is that birth weight is a significant predictor of education, employment, and health outcomes. Conley and Bennett find the children with lower birth weight are less likely to graduate on time (2001). A study using Norwegian twin data found that the twin with a higher birth weight is more likely to have a higher IQ, greater educational attainment, and higher wages (Black, Devereux, and Salvanes, 2005).

The field boasts a positive association between health and education. Many of these studies, however, rely solely on birth weight to explain outcome differences and overlook other influential experiences that shape children's learning ability after birth. Recent literature demonstrates that parents invest different amounts of time in their children from an early age that either exacerbates or compensates for the deficiencies of low birth weight (Hisn 2012). In addition, neighborhoods and school environments are known to significantly affect a child's educational outcomes. Moreover, children's sustained exposure to impoverished neighborhoods creates a cumulative disadvantaged effect on their performance outcomes (Sharkey and Elwert, 2011; Wodtke, 2013).

This study looks to reconcile how early childhood health, environmental effects, and parental investments contribute to child development. I look to combine these studies and investigate the temporal effect of health and the rising salience of environmental factors. I begin this assessment by examining the effect of birth weight on cognitive ability before children are school age. In the short run, normal birth weight children have an advantage and have higher cognitive scores at year three, even in the presences of high parental investment. Once children are school aged and interact with their school environment and neighborhood, their cognitive ability begins to mirror their surroundings and their neonatal health becomes less significant. Thus, children may receive an initial increase in cognitive ability from improved neonatal health, but school effects and early childhood parental investment, as seen through children's local environment, gain in salience and become significant factors in determining a child's cognitive ability by years five and nine.

Literature Review:

A large body of literature exists on the lingering effects that early adolescent health has on educational outcomes, cognitive ability, and adult earnings. While there are various explanations offered for how childhood health influences educational success, numerous studies focus on a child's birth weight and use this metric to explain differences in high school graduation, wage earnings, or performances on a IQ test. For example, a highly cited study from Conley and Bennett (2000), using the panel study of income dynamics data of children born between 1968 and 1992, finds that low birth weight reduces the probability of on-time graduation by 74% for siblings when at least one sibling is of normal birth weight. This is such a large difference that it is questionable that birth weight alone could produce this difference. Another study using Norwegian twin data of children born between 1967 and 1981, finds that a 10% higher birth weight is equivalent to a quarter year of education in the labor market (Black, Devereux, and Salvanes 2007).

Cross-section studies such as Black et. al (2007) and Conley and Bennett (2000) are limited, in that they are unable to account for anything that happens between birth and graduation or some other outcome. These sibling and twin fixed effects models assume that children receive the same upbringing financially and emotionally. While many may receive the same financial benefits of living in the same household and attending the same schools, many studies suggest that parental investment among siblings differ and reinforce the birth weight differences (Hsin 2012; Datar, Kilburn, Loughran 2010). These works argue that parents invest more time in their heavier birth weight children, because during a child's adolescence years parents may find it more difficult to invest developmental time with the low birth weight child due to cognitive delays. These early differences, especially in twins can shape parents' expectations for their children that can alter a child's life trajectory. Further, Hsin (2012) found these differences in parental time investment differed greatly depending on the level of education of the mother. More educated mothers spent more time with their lower birth weight children while less educated mothers spent more time with their heavier birth weight children. This may contribute to the growing divide in cognitive ability between low birth weight children with low socioeconomic status and low birth weight children with high social economic status.

A key limitation is that few studies chart the year-to-year changes in cognitive ability; however, some studies are able to capture these changes. Boardman et. al (2002) uses NLSY79 and looks at cognitive scores from age 6 to age 14 and finds no affect of moderately low birth weight (1,500-2,499 grams) by age 14. They find the social context as measured by a HOME index score in the NLSY to be significantly more influential on children's development than birth outcomes. Due to data limitations, this study lacks a clear mechanism as to what drives this improvement. This index score does not distinguish between neighborhoods, schools, parental involvement, parental discipline, home resources, family structure, or a host of other social factors.

Another study that takes advantage of panel data is Case, Fertig, and Paxson's (2005) British cohort study from 1958 that found that children born with low birth weight score lower on school exams during year 7, 11, and 16. However, another study using the same data found a strong influence of parental social class based on the father's occupation and they concluded that social class seemed to have a greater effect than birth weight (Jefferis, Power and Hertzman 2002).

A major limitation of previous panel studies is that they often follow relatively old cohorts. The use of older cohorts does not allow us to assess improved medical techniques of low birth weight children. A low birth weight child born in 1950 may not be exposed to the same risk as a low birth weight child born in 2000. Medical technology and techniques have improved greatly in pre and post natal care, thus reducing mental delays disabilities associated with very low birth weight (Peters et al. 2009, Costello 2007). One study looked at low birth weight children who receive seven interventions at the hospital and four home visits and compared them with low birth weight children who did not receive any interventions and normal birth weight children (Achenbach et. al 1993). The study found that at age 3 the low birth weight children with and without interventions scored significantly lower than normal birth weight children, but by age 9 low birth weight children with interventions were not significantly inferior to normal birth weight children, while low birth weight children without interventions scored significantly lower on cognitive test than the other two comparison groups.

A more recent study looks at the births in Florida from 1992 to 2000 and combines information on births of twins, singletons, and siblings with school data and test scores in grades three through eight (Fugilio and Guryan 2014). This is one of the first studies that look at the impact of schools. They conclude that by third grade children with a higher birth weight has a cognitive advantage throughout their academic experience regardless of schooling. The effect is magnified in twins as compared to siblings. The study finds that there may be different parental investment as evident by different school choices for some twins, but due to data limitations is unable to investigate this further. In addition, according to a study by Tang (2006) Florida births from 1996 to 2000 found that multiple births have nearly 50% greater chance of being born with a birth defect. This may also account for the exceedingly higher twin fixed effects in the Fugilio and Guryan study as compared to sibling fixed effects.[1]

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[1] Most studies do not make mention of how they categorized births with sever mental delays. Low birth weight is associated with birth defects such as down syndrome and developmental delays (Suresh et. al 2001, Mili et. al 1991). In this study, I look at all children with no major developmental delay as diagnosed by a doctor.

Socioeconomics status is known to mitigate the effects of low birth weight in the development of children. Conley and Bennett show on-time graduation declines by 34% in children with low birth weight, but increases by 6% for every one unit increase in income to needs ratio (2001). A Taiwanese study found that college educated parents could buffer the negative effects of moderately low birth weight (1500-2499 grams) children, but the negative effects in very low birth weight children persisted despite parents education (Lin, Liu, Chou 2007). The effects of neighborhoods also greatly influence cognitive development for low birth weight children. A study with only low birth weight children finds that children have higher IQ's, as measured by Wechsler Preschool and Primary Scale of Intelligence, when they live in more affluent neighborhoods, while controlling for maternal education, race, and income (Duncan, Brooks-Gunn, Klevanov 1994).

Theoretical Framework

Current prospective of the effect low birth weight on cognitive development is viewed as a 'biological destiny' and does not offer much hope for lower birth weight individuals. I view parental involvement and schools as an essential component to child development. While low birth weight has significant negative effects in early childhood, I theorize that environmental factors gain in saliency over time. I expect birth weight to significantly impact a child's cognitive ability at age 3, and decrease slightly in significance by age 5, depending on parental involvement. However, by age 9 when the child is more aware of their surroundings and has been in school at least four years, I do not expect birth weight to have much explanatory power on cognitive ability. Thus, I hypothesize that the effect of birth weight is temporal. Birth weight competes with sociological factor in adolescence and wanes as children engage in their environment.

This study contributes to the literature primarily in three ways. First, this is one of the few studies to explore the effect of schooling on cognitive ability. Once a child is school age they spend a significant portion of time outside the house around non-family members. Therefore, it is reasonable expect schools to have a strong impact on children's cognitive development. Children are greatly influenced by their teachers as well as their peers. This study shows that regardless of birth weight endowments, schools have a profound effect to positively influence cognitive ability.

Secondly, this study looks at how the time parents invest in children can mitigate the effects of low birth weight. More specifically, this study looks at age appropriate developmental activities that are known to aid in school readiness (Gunn-Brooks and Markman 2005, see appendix B for complete list). Despite parents' best efforts, there is no denying the short term impact of low birth weight on cognitive ability. Thus, regardless of increased parental investment before age three, lower birth weight children still exhibit negative effects of low birth weight. Numerous studies show developmental delays are most pronounced before age three. However, increased parental involvement prior to age three, has significant long-term impacts on cognitive development. The increase parental investment is not as apparent by age three, but by age five increased parental investment positively affects cognitive development.

Finally, the contribution of parents and schools on child development is not consistent overtime. This study is able to capture how these endowments influence development over time. The findings show that birth weight is a significant factor of cognitive ability, but parental involvement in early childhood can significantly reduce the negative effects in low birth weight children. However, the prominence of school quality grows in salience and plays a vital role in influencing cognitive ability. This study is one of the few works that looks at how parental investment in early childhood combined with neighborhood and school effects minimize the negative effects of low birth weight. This study offers a more complete picture of early childhood cognitive development.

Data, Measures, and Methods

The data come from the Fragile Families and Child Well Being Study (FFCW). This is a longitudinal study of a nationally representative sample of individuals living in large US cities. The study follows nearly 5000 children born in the United States between 1998 and 2000. This study over samples unmarried families with nearly 75% of families unmarried at the time of the child's birth. There is also an oversampling of black with 52% of the respondent identifying as black. This is a unique data set in that it includes school and neighborhood characteristics as well as parental endowments. A drawback of this study is that it does not include families with more than one child. It indicates if the child has a sibling, but does not offer information on multiple children with the same parents.

My dependent variable of interest is the Peabody Picture Vocabulary test (PPVT). It is a widely used test that measures vocabulary. The drawback is that it only measures vocabulary, but it is the only test given in each wave.[2] The test generally takes 20 to 30 minutes. Individuals as young as two and half years can take this test since there is no reading required. There are four pictures on a page and the child is asked to use a word to describe one of the pictures on the page. The test is either free response or multiple-choice depending on the age of the child. I used the PPVT standardized test scores. At year three

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[2] Other dependent variables I can use include the Woodcock-Johnson 22 (writing) in year 5 and Woodcock-Johnson 9 (reading) and Woodcock-Johnson 10 (mathematics) in year 9. The problem with these variables is that I only have one wave, and thus the structure of the data is not a panel. The PPVT is an untimed test and is intended to test verbal intelligence.

the scores range from a minimum of 40 to a maximum of 137 with a mean of 85.81. In year five, the scores range from 40 to 139 with a mean of 92.89 and in year nine, the scores range from 37 to 159 with a mean of 92.72. For my analysis, I centered the PPVT score on its mean. I kept all available data, and thus I have missing PPVT scores. For example, many children only have one or two waves of data for their test scores, so I have unbalanced panel data. Ancillary analyses indicated that there is not a significant difference in my outcome between the balanced panel data of only 520 cases and the unbalanced panel data with 2,704 cases.

My primary independent variables are birth weight, neighborhood poverty levels, and parental investment. Birth weight is a continuous variable from 470 grams to 5,585 grams. This information is collected from hospital records. However, many medical professionals and researchers place a high emphasis on a birth weight threshold. They define low birth weight as children under 2500 grams. Numerous studies of the short and long term effects of low birth weight on educational outcomes are well documented, thus I provide additional checks using this dichotomous variable. The drawback of using birth weight as a dichotomous variable is the low number of children born measuring less than 2500 grams. To offer greater context, there are only 444 children defined as low birth weight out of a total of 4607 respondents.

I eliminated all children who were medically diagnosed as having a developmental delay. This is only restricted to individuals who were diagnosed by a medical doctor as having mental retardation or down syndrome. This reduced the sample by 162 and of these, 40 were defined as having low birth weight (less than 2500 grams), which is nearly 25%. Prior research shows that low birth weight is associated with birth defects and children with severe mental birth defects typically have lower cognitive scores. I eliminated these respondents, because my study does not test if children diagnosed with severe mental disabilities perform better or worse than children not diagnosed with a mental disability.[3]

Neighborhood poverty is measured by the percentage of individuals living in poverty in their census tract using 2000 census data. This is a time invariant variable that is taken at the time of the child's birth, so if the child moves to a less impoverished neighborhood after birth this is not captured by this variable. This variable has a minimum of 0% in poverty to a maximum of 92.67% in poverty and the average percent of poverty in a track is 15%, which matches up with the US average. Extreme poverty is defined as over 40% of people in a census tract living in poverty. Only 8% of my sample lives in extreme poverty.

Parental investment is measured by the amount of activities the mother reports performing with her child in each wave. Research shows that parental investment is most crucial from birth to three years old. In this study, I only collect parental investment at year one and year three. The activities change year-to-year to capture age appropriate activities and asked how often parents participate in these activities on a weekly basis. In year one activities include singing songs, reading stories, playing peekaboo, or showing affection (for a complete list see appendix A). In year three many of the activities overlap but also include playing imaginary games with the child and having the child help with simple chores. I create an index by summing the total number of days per week a parent

[3] I eliminated children diagnosed by a doctor with either metal retardation or down syndrome.

engages in these activities with the child in year one and year three. This creates a parental investment index from 0 to 126.

I include school poverty levels as measured by the number of students in a school who qualify for free lunch. This is done in a separate analysis, since children are not in school during year five and year nine. This information is available on a yearly basis beginning in the 2005– 2006 school year until the 2008– 2009 school year. In year five, I use the percent that receive free lunch in the 2005-2006 year and for year 9, I take the average percent of students who receive free lunch from the years 2006 until 2009. Schools with low poverty have less than 25% of their students eligible for free lunch and high poverty schools have 76% or more eligible for free lunch.

Alternative Explanations

I control for a number of characteristics that are known to influence cognitive ability. I have five different racial and ethnic groups. They are non-Hispanic white, non-Hispanic black, Hispanic, biracial black (includes black Hispanic, black and white, and black and other), and biracial non-black (includes white Hispanic, white and other, and other). Non-Hispanic white is the reference category. I control for gender, because boys typically develop at a slower rate than girls during elementary years; this is coded as 1=male and 0 = female.

I also include many family level variable, such as household income, marital status, and various characteristics of the biological mother. Since this is a fragile family's data set where most of the couples are not married at the time of the birth, I measure if the biological mother and father are married by year three. I coded this as 1=married and 0 =

variable name	N	Mean	SD	Median	Min	Max	SE
PPVT	7801.00	0.53	15.61	0.28	-52.89	66.28	0.18
Low Birth Weight	13821.00	0.10	0.30	0.00	0.00	1.00	0.00
Birth Weight	10011.00	3227.38	609.31	3265.00	470.00	5584.95	6.09
Parental Investment	8883.00	103.41	15.14	105.00	40.00	126.00	0.16
Neighborhood Poverty	13698.00	19.01	13.92	16.60	0.00	100.00	0.12
School Poverty	5864.00	54.88	27.66	59.57	0.00	99.54	0.36
Controls							
Log Income	10610.00	9.97	1.86	10.28	-4.61	13.82	0.02
Family status (married=1)	11412.00	0.32	0.46	0.00	0.00	1.00	0.00
Gender (male=1)	14199.00	0.52	0.50	1.00	0.00	1.00	0.00
Race and Ethnicity							
Non-Hispanic white	14178.00	0.16	0.37	0.00	0.00	1.00	0.00
Non-Hispanic black	14142.00	0.44	0.50	0.00	0.00	1.00	0.00
Hispanic	14169.00	0.23	0.42	0.00	0.00	1.00	0.00
Other	14145.00	0.08	0.28	0.00	0.00	1.00	0.00
Biracial black	14085.00	0.08	0.28	0.00	0.00	1.00	0.00
Mother Characteristics							
Mother's PPVT	8148.00	89.56	12.31	89.00	40.00	160.00	0.14
Mother's Age	14190.00	25.31	6.07	24.00	14.00	47.00	0.05
Mother's Education	14184.00	1.22	1.04	1.00	0.00	3.00	0.01

Table 1: Description of the data

not married. I restrict this to only married individuals, because prior research shows that cohabiting couples in the United States are more similar to single parent households. I have mother's education, which is a discrete variable from 0-3; less than high school (0), high school/GED (1), some college(2), or college degree (3). This variable increases in each wave if the mother obtains more education since the last wave. Lastly, I have the mother's PPVT score to capture the mother's cognitive ability passed to her child.

The data set is unique because I am able to capture the child's cognitive ability at year three and the poverty level of their neighborhood as well as the poverty level in their schools. Most data sets use income as a proxy, but this is not ideal given that income and neighborhoods mismatch greatly across race and ethnicity. Prior literature says that blacks with similar incomes to whites are more likely to live in poor neighborhoods and attend high poverty schools (Parisi, et. Al 2011). I included a table below that describes my date is set in more detail.

Methods

To evaluate the effect of birth weight, parental investment, and neighborhood affects over time, I use panel data and a random estimator. The panel data provides information on individual behavior and I am able to follow that same person over three waves. I interacted the main variables of interest with time. First I pooled all the data in each wave, then I ran a Breusch-Pagan Lagrange Multiplier to choose between a random effect or an OLS model. Next, I incorporated Hausman tests to assess whether I should use a fixed effects or a random effect. I use a random effects estimator since I do not have constant variance and standard errors are clustered at the individual level. I run four separate analyses to determine the effect of each main variable of interest and then I run a full model containing all the main effects and controls, using longitudinal data.

$$y_{it} = \beta_0 + \beta_1 w_i \cdot year + \beta_2 n_i \cdot year + \beta_3 p_i \cdot year + \mathbf{x'}_{it} + u_{it} + \epsilon_{it}$$

The outcome, *y* is measured by the Peabody picture vocabulary test (PPVT) scores at years 3, 5, and 9. **x'** in the model represents a vector of the child's characteristics, such as race, gender, and family controls. In addition, *u* denotes a random disturbance term of the mean 0, and $\boldsymbol{\varepsilon}_{it}$ is a vector of normally distributed random error terms. Therefore, equation 1 argues that cognitive ability *y* in child *i* at time *t* is a linear function of the child's birth weight *i* neighborhood n_i, and parental investment *p*.

I run a separate analysis to see the effect of schools using the same framework. I have to run a separate analysis because children are only in school during year five and year nine. The inclusion of schools characteristics is extremely valuable since children spend roughly seven hours per day in school.

Results

My results are presented in Tables 2 and 3. In Table 2, I present four different models to estimate the effect of birth weight, parental investment, and neighborhood effects on cognitive ability. This table shows my result with birth weight in model one, the parental investment in model two, neighborhood effects in model three, and the full model in the last column. In each model I interacted time with the main variables of interest. These results provide information on the my main variables work independent of one another and how they work in conjunction to provide a more complete depiction of cognitive development.

The first column in the table looks solely at birth weight and analyzes its effect overtime. Birth weight is a continuous variable and in year three, every one thousand grams increases a child's cognitive score by three points. Lower birth weight has a significant and negative association with low test scores. This is consistent with the literature that finds a strong negative association with low birth weight in the short term. The interaction effect shows that relative to year three, most the gains from increased birth weight have disappeared by year five as indicated by a negative association of birth weight with cognitive ability. In year nine, higher birth weight children show an improvement relative to year five, but they still perform worse relative to year three; however, in year nine, birth weight is not significant relative to year three. This implies that low birth weight students do not do as well on the PPVT in year nine as in year five, but also in year nine low birth weight is not significant, relative to year three.

In the second column, I examine how parental investment in early childhood can mitigate the effects of low birth weight. This model shows that despite high parental investment, the negative effects of birth weight are apparent and higher birth weight is associated with higher cognitive ability. In year five, the effects of parental investment are apparent and a 100 unit increase in parental investment, increases cognitive scores by nearly 7 points relative to year three. Parental effects are short-lived and once a child has been in school for some years, the returns to early parental investment are no longer significant. By year nine children spend a large portion of their day under the guidance of individuals who are not their parents.

The third column shows how the environment has the ability to influence one's cognitive development. The variable neighborhood measures the percent of individuals in poverty in the respondent's census tract at birth. Surprisingly neighborhoods are insignificant in year three, but by nine they are highly significant relative to year three and has a large negative affect. For every 10% increase in poverty in a neighborhood one's cognitive score drops by over 11 points relative to year three. The long-term negative effects of living in poverty can be highly detrimental to one's development.

	Dependent variable:			
	PPVT score			
	(Birth Weight)	(Parental Investment)	(Neighborhood)	(Full)
Birth Weight	2.926***			2.806***
	(0.594)			(0.680)
Birth Weight:factor(year)5	−2.670***			−2.418***
	(0.687)			(0.774)
Birth Weight:factor(year)9	−1.018			−1.378
	(0.761)			(0.860)
Parental Investment		0.054**		0.024
		(0.022)		(0.026)
Parental Investment:factor(year)5		0.039		0.070**
		(0.025)		(0.030)
Parental Investment:factor(year)9		−0.012		0.016
		(0.028)		(0.034)
Neighborhood Poverty			−0.004	0.020
			(0.021)	(0.029)
Neighborhood Poverty:factor(year)5			−0.038*	−0.057*
			(0.023)	(0.031)
Neighborhood Poverty:factor(year)9			−0.072***	−0.104***
			(0.026)	(0.035)
Race/Ethnicity				
Black	−7.098***	−7.237***	−6.790***	−6.732***
	(0.861)	(0.810)	(0.760)	(1.045)
Hispanic	−7.854***	−6.697***	−7.123***	−6.776***
	(0.997)	(0.944)	(0.873)	(1.167)
Biracial Black	−4.190***	−4.079***	−3.520***	−4.295***
	(1.163)	(1.126)	(1.015)	(1.353)
Other	−1.668	−1.311	−0.640	−1.671
	(1.186)	(1.120)	(1.015)	(1.358)
Gender (male)	−1.131**	−0.837	−1.158**	−0.840
	(0.521)	(0.597)	(0.527)	(0.607)
Constant	−35.249***	−35.994***	−26.276***	−42.592***
	(3.527)	(3.773)	(2.615)	(5.120)
Observations	4,212	4,577	5,693	3,159
R^2	0.161	0.162	0.161	0.162
Adjusted R^2	0.160	0.162	0.160	0.161
F Statistic	53.624*** (df = 15; 4196)	58.961*** (df = 15; 4561)	72.372*** (df = 15; 5677)	28.936*** (df = 21; 3137)

Note: *p<0.1; **p<0.05; ***p<0.01

I also control for Mother's PPVT, Mother's education, Mother's age at birth, family income logged, and family status

	Dependent variable:	
	PPVT score	
	(School Poverty)	(Full)
School Poverty	−0.059***	−0.033**
	(0.012)	(0.016)
School Poverty:factor(year)9	−0.036***	−0.060***
	(0.013)	(0.019)
Birth Weight		0.00003
		(0.001)
Birth Weight:factor(year)9		0.001
		(0.001)
Parental Investment		0.072***
		(0.027)
Parental Investment :factor(year)9		−0.080**
		(0.033)
Controls		
Gender (male)	−1.143**	−0.950
	(0.528)	(0.704)
Income	0.103	0.160
	(0.124)	(0.179)
married	2.451***	2.263***
	(0.596)	(0.777)
as.factor(year)9	1.053	6.770
	(0.821)	(4.885)
Race/Ethnicity		
child_raceBB	−5.306***	−4.679***
	(0.904)	(1.240)
child_raceHH	−6.132***	−5.684***
	(1.037)	(1.359)
child_mixedB	−1.144	−0.960
	(1.190)	(1.564)
child_mixedO	0.251	−0.494
	(1.199)	(1.608)
Mother's Characteristics		
Education	1.776***	1.384***
	(0.316)	(0.421)
Age at birth	0.081	0.105
	(0.050)	(0.070)
PPVT	0.260***	0.290***
	(0.025)	(0.036)
Constant	−19.582***	−32.419***
	(3.126)	(5.962)
Observations	2,885	1,642
R^2	0.224	0.204
Adjusted R^2	0.222	0.202
F Statistic	63.568*** (df = 13; 2871)	24.542*** (df = 17; 1624)
Note:		*p<0.1; **p<0.05; ***p<0.01

The last column shows the full model with both parental investment and the neighborhood effects. This model shows that despite parental investment and low poverty neighborhoods, birth weight is still a significant factor in year three in determining one's cognitive ability. The effective birth weight is fairly consistent in both models (model 1 and model4), but the inclusion of birth weight in the full model significantly increases the magnitude of the effect of parental investment as well as neighborhood poverty in years 5 and 9. As expected from previous literature, boys typically do develop at a slower rate than girls, and minorities have lower test scores than whites.

Table 3 includes the effects of school poverty on child development and is highly significant to a child's development. Since children are only in school during years five and nine, I restricted my data to these two waves. In this regression, school poverty levels are significant and increasing magnitude in year nine relative to year five. The inclusion of schools greatly reduces the black-white achievement gap. Controlling for schools reduces the minority achievement gap in both blacks and Hispanics by nearly 2 point. This is notable because one would expect neighborhoods poverty to have a similar effect as school poverty, but this is not the case; neighborhood poverty only reduces the black-white achievement gap by half a point. Even more surprising, is the inclusion of schools renders the effect of birth weight insignificant in year five and year nine, while parental invest is highly significant in year five as well as school poverty.

These model illustrate the significance of neighborhood and schools effects that seem to compound over time. Sustained exposure to poverty in neighborhoods and schools can severely reduce cognitive ability. It is important to note the standard deviations in table 2 for school poverty. A child attending a school with 62% poverty will score a full standard deviation less on their PPVT test. The effects of school poverty are compounded by year nine. Continued attendance in a high poverty school decreases a student's score by 5.76 points below the mean. Underrepresented minorities comprise most of the students in high poverty schools, so these students are double penalized --- one for their race and two by highly segregated schools along class and racial lines. A recent study of the urban Institute shows that only 6% of whites are likely to attend high poverty schools, well over 40% of black students attend high poverty schools. In addition only 10% of blacks attend low poverty schools, meaning that 90% of black students attend moderate to high poverty schools.

Discussion and Conclusion

This article examines how different parental investments and school and neighborhood effects to offer a more complete picture of the negative consequences of low birth weight. In contrast to prior studies, this study is able to look at how school and neighborhoods influences cognitive development as well as early childhood parental investment. Parents who invest a greater amount of time with their children up to year three are able to mitigate the negative consequences of low birth weight. High poverty neighborhoods have a significant impact on cognitive ability and the negative effects of high poverty neighborhoods grow in salience over time.

This article maintains the short-term effects of lower birth weight on cognitive the development especially in year three. Despite increased parental involvement, cognitive development in lower birth weight children is still significantly less than cognitive scores and higher birth weight children. In year five the returns of parental investment is apparent and children who receive greater endowments from their parents show an increase and cognitive development. The inclusion of school especially in year nine has the ability to greatly reduce or exacerbate the playing field. Attending a high poverty school has can decrease PPVT scores up to 6.0 points

This article makes two important contributions. First this study is one of the few that is able to look at parental investment as well as school and neighborhood effects. Second, I am able to chart the changes that take place and identify when the effects of low birth weight declines and when parental involvement and neighborhoods factors gain in importance. This can have policy implication on how the federal government directs its resources to reduce inequality. In the early years, especially prior to year three, birth weight and health is extremely important to child development. This highlights the need to continue to promote health and nutrition during the neonatal stages as well as in infancy and toddler year. This paper finds that parental involvement can minimize some of the risk associate with lower birth weight. Thus, the federal government may look to invest in parental class or promote the benefits of parental involvement in young children. Then when a child transitions to school, there needs to be a greater focus on reducing poverty rates in schools. The importance of schools and neighborhoods raise in salience and high poverty areas have the ability to drastically hinder cognitive development.

The results I put forth disproportionally affect minority children. Black children in particular suffer from higher rates of low birth weight and black and Hispanic children are more likely to attend high poverty schools. These factors have the ability to compound over time and widen the inequality gap. There needs to be greater attention to provide assess at an early for disadvantaged groups if we are to level the playing field.

References:

Achenbach, Thomas M, Catherine T Howell et al. "Nine-year Outcome of the Vermont Intervention Program for Low Birth Weight Infants." Pediatrics 91.1 (1993): 45-55.

Black, Sandra E, Paul J Devereux, and Kjell Salvanes. "From the Cradle to the Labor Market? the Effect of Birth Weight on Adult Outcomes." The Quarterly Journal of Economics 122 (2007): 409-39.

Brooks-Gunn, Jeanne, and Lisa Markman. "The Contribution of Parenting to Ethnic and Racial Gaps in School Readiness." The future of children 15.1 (2005): 139-68.

Case, Anne, and Christina Paxson. "Causes and Consequences of Early-life Health." Demography 47.1 (2010): S65-85.

Case, Anne, Angela Fertig, and Christina Paxson. "The Lasting Impact of Childhood Health and Circumstance." Journal of health economics 24.2 (2005): 365-89.

Conley, Dalton, and Neil G Bennett. "Is Biology Destiny? Birth Weight and Life Chances." American Sociological Review 65.3 (2000): 458-67.

Conley, Dalton, and Neil G Bennett. "Birth Weight and Income: Interactions Across Generations." Journal of Health and Social Behavior (2001): 450-65.

Datar, Ashlesha, M Rebecca Kilburn, and David S Loughran. "Endowments and Parental Investments in Infancy and Early Childhood." Demography 47.1 (2010): 145-62.

Duncan, Greg J, Jeanne Brooks?Gunn, and Pamela Kato Klebanov. "Economic Deprivation and Early Childhood Development." Child development 65.2 (1994): 296-318.

Figlio, David N, Jonathan Guryan et al. "The Effects of Poor Neonatal Health on Children's Cognitive Development." American Economic Review 104(12).12 (2014): 3921-55.

Hsin, Amy. "Is Biology Destiny? Birth Weight and Differential Parental Treatment." Demography 49.4 (2012): 1385-405.

Jefferis, Barbara JMH, Chris Power, and Clyde Hertzman. "Birth Weight, Childhood Socioeconomic Environment, and Cognitive Development in the 1958 British Birth Cohort Study." Bmj 325.7359 (2002): 305.

Lin, Ming-Jen, Jin-Tan Liu, and Shin-Yi Chou. "As Low Birth Weight Babies Grow, Can Well-educated Parents Buffer This Adverse Factor? a Research Note." Demography 44.2 (2007): 335-43.

Mili, Fatima, Larry D Edmonds et al. “Prevalence of Birth Defects Among Low-birth-weight Infants: a Population Study.” American journal of diseases of children 145.11 (1991): 1313-18.

Peters, Kathrine Leigh, Rhonda Jean Rosychuk et al. “Improvement of Short-and Long-term Outcomes for Very Low Birth Weight Infants: Edmonton Nidcap Trial.” Pediatrics 124.4 (2009): 1009-20.

Suresh, Gautham K, Jeffrey D Horbar et al. “Major Birth Defects in Very Low Birth Weight Infants in the Vermont Oxford Network.” The Journal of pediatrics 139.3 (2001): 366-73.

Tang, Yiwei, Chang-Xing Ma et al. “The Risk of Birth Defects in Multiple Births: a Population-based Study.” Maternal and child health journal 10.1 (2006): 75-81.

Wilson-Costello, Deanne, Harriet Friedman et al. “Improved Neurodevelopmental Outcomes for Extremely Low Birth Weight Infants in 2000–2002.” Pediatrics 119.1 (2007): 37-45.

Appendix A

Year 1 - activities
1. Days/week mom play games like peek-a-boo or gotcha w/child?
2. Days/week mom play games like peek-a-boo or gotcha w/child?
3. Days/week mom read stories to child?"
4. Days/week mom tell stories to child?
5. Days/week mom play inside w/toys such as blocks or legos w/child?
6. Days/week mom hug or show physical affection to child?
7. Days/week mom put child to bed?
8. How many times since birth has child been to health car professional for well visit

Year 3 - activities
1. Days/week: sing songs or nursery rhymes with child?
2. Days/week: hug or show physical affection to child?
3. Days/week: tell child that you love him/her?"
4. Days/week: let child help you with simple chores?"
5. Days/week: play imaginary games with him/her?"
6. Days/week: read stories to child?
7. Days/week: tell stories to child?"
8. Days/week: play inside with toys with child?"
9. Days/week: tell child you appreciate something he/she did?"
10. Days/week: put child to bed?"

Appendix B - Table 1 Full Results

	Dependent variable:			
	PPVT score			
	(Birth Weight)	(Parental Investment)	(Neighborhood)	(Full)
Birth Weight	2.962***			2.798***
	(0.595)			(0.681)
Birth Weight:factor(year)5	−2.851***			−2.441**
	(0.839)			(0.958)
Birth Weight:factor(year)9	−1.469			−1.641
	(0.920)			(1.052)
Parental Investment		0.052**		0.019
		(0.022)		(0.026)
Parental Investment:factor(year)5		0.042		0.079**
		(0.031)		(0.037)
Parental Investment:factor(year)9		−0.020		0.011
		(0.034)		(0.041)
Neighborhood Poverty			−0.008	0.016
			(0.021)	(0.028)
Neighborhood Poverty:factor(year)5			−0.033	−0.053
			(0.028)	(0.039
Neighborhood Poverty:factor(year)9			−0.075**	−0.103**
			(0.031)	(0.043)
Race/Ethnicity				
Black	−7.027***	−7.201***	−6.674***	−6.818***
	(0.693)	(0.644)	(0.608)	(0.831)
Hispanic	−7.670***	−6.875***	−7.108***	−6.985***
	(0.806)	(0.749)	(0.699)	(0.928)
Biracial Black	−3.730***	−3.632***	−3.132***	−3.918***
	(0.938)	(0.892)	(0.813)	(1.075)
Other	−1.873**	−1.399	−0.672	−1.978*
	(0.949)	(0.882)	(0.807)	(1.068)
Gender (male)	−1.151***	−0.884**	−1.071***	−0.843*
	(0.420)	(0.402)	(0.359)	(0.484)
Mother's Characteristics				
Education	1.796***	1.399***	1.773***	1.021***
	(0.255)	(0.246)	(0.221)	(0.298)
Age at Birth	0.094**	0.109***	0.080**	0.123***
	(0.039)	(0.039)	(0.034)	(0.048)
PPVT	0.286***	0.324***	0.289***	0.326***
	(0.020)	(0.020)	(0.017)	(0.025)
Income	0.221*	0.264**	0.215**	0.216
	(0.127)	(0.126)	(0.107)	(0.155)
Family Status (married)	2.389***	1.935***	2.107***	1.784***
	(0.525)	(0.497)	(0.453)	(0.598)
Year 5	10.129***	−3.343	1.502**	2.040
	(2.738)	(3.250)	(0.708)	(5.085)
Year 9	4.970*	2.468	1.784**	6.453
	(3.019)	(3.579)	(0.759)	(5.716)
Constant	−35.881***	−36.001***	−26.564***	−41.742***
	(3.135)	(3.376)	(2.200)	(4.680)
Observations	4,216	4,581	5,697	3,163
R^2	0.227	0.239	0.232	0.231
Adjusted R^2	0.226	0.238	0.232	0.229
F Statistic	82.147*** (df = 15; 4200)	95.329*** (df = 15; 4565)	114.621*** (df = 15; 5681)	44.926*** (df = 21; 3141)
Note:				*p<0.1; **p<0.05; ***p<0.01

Appendix C – Using the dichotomous variable low birth weight

	Dependent variable:	
	PPVT	
	(1)	(2)
lowbir	−3.806***	−4.512***
	(1.011)	(1.169)
as.factor(year)5	0.543	−1.964
	(0.361)	(2.750)
as.factor(year)9	−0.005	1.717
	(0.394)	(3.037)
env_PerPovertyB		−0.007
		(0.024)
Pinvest		0.049**
		(0.022)
boy	−1.050**	−0.810
	(0.447)	(0.517)
child_raceBB	−7.210***	−6.811***
	(0.716)	(0.865)
child_raceHH	−7.511***	−6.575***
	(0.849)	(0.980)
child_mixedB	−3.909***	−3.880***
	(0.992)	(1.163)
child_mixedO	−0.960	−1.200
	(1.007)	(1.145)
loginc	0.079	0.127
	(0.101)	(0.125)
MotherEduc	1.855***	1.225***
	(0.263)	(0.309)
married	2.045***	1.660***
	(0.493)	(0.555)
MotherAge	0.097**	0.111**
	(0.042)	(0.050)
PPVT_Mstd	0.305***	0.327***
	(0.021)	(0.026)
lowbir:as.factor(year)5	3.489***	3.639***
	(1.171)	(1.335)
lowbir:as.factor(year)9	0.669	1.301
	(1.350)	(1.517)
as.factor(year)5:env_PerPovertyB		−0.043*
		(0.026)
as.factor(year)9:env_PerPovertyB		−0.059**
		(0.029)
as.factor(year)5:Pinvest		0.034
		(0.026)
as.factor(year)9:Pinvest		−0.005
		(0.028)
Constant	−26.479***	−34.109***
	(2.544)	(3.909)
Observations	5,675	4,339
R^2	0.165	0.166
Adjusted R^2	0.164	0.166
F Statistic	74.420*** (df = 15; 5659)	41.060*** (df = 21; 4317)
Note:		*p<0.1; **p<0.05; ***p<0.01