The Behavioral Effects Of Early Intervention For Children From Low-Income Households

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This paper seeks to evaluate the effects of an early childhood intervention program through the lens of modern human capital theory. Data from a child health clinic validate the assumptions of human capital theory. This paper concludes that Penfield Children Center's new intervention program significantly improves behavior and noncognitive human capital. Past intervention programs are considered and compared with the costs of Penfield Clinic's treatment, revealing among other things that Penfield Clinic offers the least expensive option in its peer group. Finally, recommendations for future cost-benefit studies of the program are offered with several potential cost-savings channels.

1 Introduction

The field of early childhood intervention combines the work of economists, psychologists, sociologists, and policymakers to address the developmental delays and challenges that manifest as a young child ages. This interdisciplinary field draws its roots in the 1960s from the Head Start preschool program, which quickly spread to classrooms, academic research labs, and communities across the United States. The advent of the Individuals with Disabilities Education Act (IDEA) in 1990 proliferated funding for developmental delay-focused programs and increased the academic research of non-educational interventions. Now, policymakers at the state and federal levels consider the results of numerous early childhood studies when considering what programs to fund.

Early interventions vary widely in approach, ranging from early preschool and education services, to nutritional programs, to behavioral therapy and parent counseling. The reasons for early intervention vary as well, from a desire to augment the skills of a country's future labor force, to the hope that programs focused on low-income communities may one day close achievement and income gaps. Endorsed by entrepreneurs and magnates like Bill Gates and Warren Buffett, early interventions have gained acceptance in the business community as investments that present potential net benefits to society. While the field of early intervention has drawn much excitement and funding as a whole, not all programs have enjoyed equal attention or support, including the work of early childhood behavioral therapy (ECBT) interventions.

This paper seeks to test the economic theory of human capital formation and evaluate a new and promising ECBT intervention program. Section 2 of this paper provides necessary background information on the terms and institutions relevant to early interventions. Section 3 reviews the economic literature of human capital formation theory and examines past early intervention programs and their economic evaluations. Section 4 considers the implications of recent human capital theory and the existence of market failure in the ECBT market, with three testable hypotheses. Section 5 summarizes the data studied in this paper, while Section 6 highlights the estimation results of testing the hypotheses. Section 7 offers a discussion that extends human capital theory and evaluates the merits of an ECBT program. Section 8 acknowledges the limitations of this paper, and Section 9 makes concluding remarks.

2 Background Information

This paper discusses on the early results of an ongoing ECBT program at a non-profit child and infant health clinic called Penfield Children's Center[1], located in Milwaukee, Wisconsin. Milwaukee is an urban Midwestern city with roughly 1.3 million people living in its metropolitan statistical area (MSA). With a median household income of $49,774 in 2010 and a population that is 65% white, 19% black, and 11% Latino, Milwaukee's MSA is comparable to MSA's like Chicago, Cleveland, Detroit, and St. Louis.[2]

2.1 Penfield Children's Center's Intervention in Context

Penfield's services include early education, special care nursery services for children with disabilities, family services, and a behavior clinic. The Parent and Child Therapy program offered by Penfield Children's Center is an in-home, eight-week, referral-based therapy intervention that focuses on the relationship between parent and child (Fox & Holtz 2009). In the first four weeks of treatment, clinicians focus on coaching parent-child interactions, educating parents on child developmental milestones, and providing direct therapy services to the child. In the second half of treatment, clinicians work with parents to develop and achieve household-specific treatment goals (e.g. "establishing bedtime routines for children with sleeping problems"; Fox & Mattek 2012). The PCT program was designed to entail eight weekly 90 minute visits, but additional sessions are often scheduled to meet treatment goals. Families may attend less than eight sessions because of work or school conflicts, or simply because they skipped or forgot sessions. Penfield Children's Center has funded its Behavior Clinic services with private philanthropic donations for several years, but as of February 6, 2013, Medicaid and the State of Wisconsin will officially reimburse Penfield's treatment for low-income households.

For the purposes of this paper, early childhood is defined as the formative period of birth to five years of age. Early intervention programs vary greatly in focus and scope, but for the purposes of this study they can be placed into two broad categories: Educational Interventions and Family Support Interventions. Educational Intervention programs focus on extending intensive tutoring and preschool services to children with socioeconomic disadvantages or developmental delays. Family Support Interventions encompass a broader array of interventions,

[1] http://penfieldchildren.org/. For brevity, this paper will make use of the titles Penfield Children's Center and Penfield interchangeably.
[2] Data are from the 2010 census.

including counseling and education services for mothers, mentoring for young children, parent-child behavioral therapy (Penfield's PCT service), and pediatric healthcare.

Finally, this paper makes frequent use of two human capital terms that warrant early definition. Noncognitive capabilities or skills refer to stocks of human capital determined by attitude, motivation, and behavior. Cognitive capabilities or skills refer to academic and intellectual stocks of human capital that are determined by past schooling and innate intelligence.

2.2 The Window of Early Childhood

As the tools of neuroscience and developmental psychology improve, a growing body of developmental literature and data demonstrate that early childhood is a crucial window of human development that is sensitive to positive and negative environmental stimuli (Shonkoff & Phillips 2000; Knudsen & Heckman 2006). During this time the architecture of the human brain is "wired," vocabulary explodes from cries into thousands of words, and the ability to regulate emotions is developed (Center on the Developing Child 2007). Figure 1 demonstrates this unique and rapid development, showing that the total number of synapses (i.e. connections between brain cells) peaks in the human brain during early childhood and decreases over the course of adult life (Huttenlocher 1999).[3]

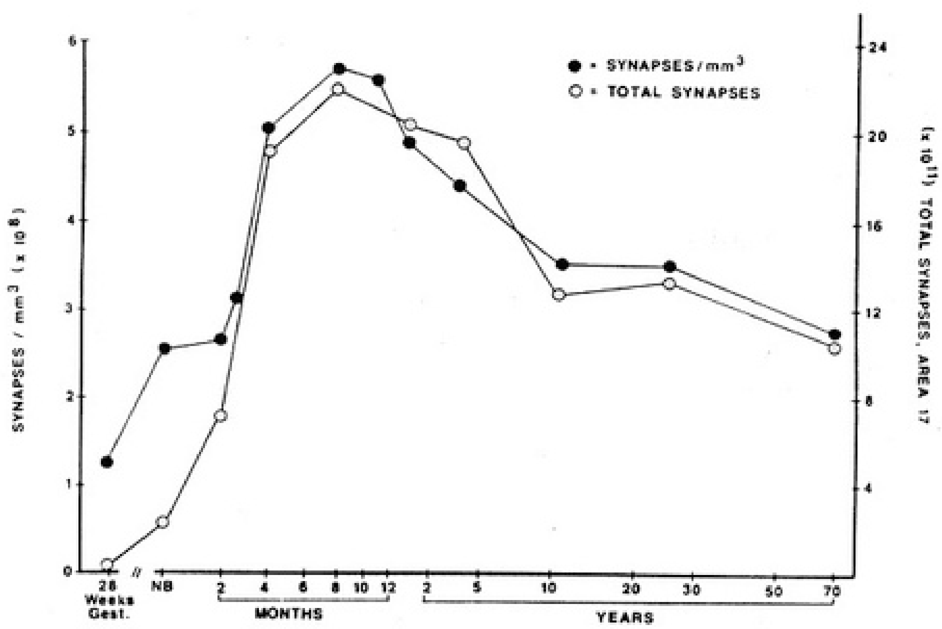

Figure 1. Synapse density (●) and total number of synapses (○) with respect to age.

[3] Figure source: Peter R. Huttenlocher/Elsevier Ltd.

The brain develops an initial endowment of synapses in this window of early childhood and prunes those connections as it matures into adulthood. Thus, this period of prolific synaptogenesis holds the potential for outside stimulus or intervention to increase the early endowment of synapses in a child's brain and offer a greater number of connections to prune from (Huttenlocher 1999).

The flip-side of this developmental opportunity is the lifelong deficiencies that may form in negative or understimulating childhood environments. Developmental gaps can form quickly, with children of high-income households acquiring twice the vocabulary of low-income children by age three (Center on the Developing Child, 2007). Cognitive capabilities crystallize first, as recent studies show IQ scores to stabilize around 10 years of age (Heckman 2007). Noncognitive capabilities settle later in adolescence: the prefrontal cortex, which controls decision-making and strategic thinking, starts to lose malleability around age 20 (Heckman 2007) and lifelong behavior patterns emerge (Loeber 1991). The stabilization of human behavior marks the end of an opportunity for flexible and proactive change, and the beginning of corrective responses to delinquency and academic underachievement. Thus interventions in young, low-income children can be seen as more productive than adolescent and adult remediation, and present the potential to close socioeconomic gaps.

While the window of developmental opportunity may close quickly, the disorders that begin in early childhood can last into adulthood. McLeod & Kaiser (2004) showed that behavioral problems at age six decrease the likelihood of high school graduation and college enrollment by 31% and 19%, respectively. Behavioral problems wield economic consequences well into adulthood, as Capsi et al (1998) examined predictors of unemployment at age 21, and found early behavioral problems at ages seven and nine to increase the likelihood of future unemployment by 17.7%, and length of unemployment by 2.6 months. Aggression and antisocial behavior during childhood are significantly associated with delinquency and incarceration (Zigler & Taussig 1992; Nagin & Tremblay 1999), dropping out of school (Robst 2010), and low wages (Osborne-Groves 2005). Despite the significance of early behavior on adult economic outcomes and the window of opportunity that early childhood presents, imperfect information still surrounds the effects of ECBT on behavior and Noncognitive skill.

3 Literature Review

3.1 Human Capital Formation Theory

Early childhood interventions invoke economic theory of human capital formation because at their core, interventions are investments in a child's future skills. In 1964, Gary Becker wrote the seminal book, Human Capital, and opened a line of economic literature that sought to explain an individual's earnings with human capital. Literature in the Becker tradition can be characterized by two major assumptions: (1) that the development of a child can be modeled as a single time period before adulthood; and (2) Cognitive capabilities develop additional stocks of human capital. Two particular models in this tradition capture the limitations that face assumptions (1) and (2). First, Becker and Tomes's (1979) model considers how parents maximize their utility from investments in children subject to their income and the anticipated future income of their children. The authors acknowledge the effects of race, culture, and fortune on a child's future income, but treat all children in a household as identical and as passive recipients of parents' investments rather than participants in the formation of their own capital. Their model stressed credit constraints and family income as the key influences on a child's development. Most importantly, Becker and Tomes (1979) make a major assumption of traditional human capital formation theory and treat childhood as a single time period in their model. The single time period assumption implicitly treats the impact of investments in a four year old as identical to investments in a thirteen year old. In light of the recent developments in neuroscience and developmental psychology discussed previously, this assumption seems untenable and outdated.

Second, the Ben-Porath (1967) model assumes that Cognitive capabilities are the only type of capital used in the production of additional stocks of human capital. In other words, no matter what the investment in capital is (e.g. schooling, job training, therapy, etc.), Ben-Porath (1967) suggests that Cognitive capability is the sole mediator of that investment's productivity. The assumption that cognitive capabilities are the only relevant factor in the capital production function is restrictive, and ignores the impact of Noncognitive capabilities such as attitude, motivation, and behavior. The work of modern capital formation theory assigns equal importance between Cognitive and Noncognitive skills, and describes capital production as a function of both (Carneiro & Heckman 2003; Heckman & Stixrud 2006; Cunha 2006).[4]

Carneiro and Heckman (2003) challenge the assumptions of traditional Becker-era capital production models and serve as a turning point in the capital formation literature. The authors directly contradict Becker and Tomes (1979), asserting that “at most 8% of American youth are credit constrained.” Examining systematic education gaps between socioeconomic and racial groups, the authors find that “family environments at early ages, not parental income in adolescent years” best explain differences in educational attainment. Under this framework, parents and social planners interested in developing the human capital of the next generation should focus more on the environment and investments of early childhood than the credit or tuition constraints that might block the path to more schooling.

Following Carneiro and Heckman (2003), Cunha (2006) advances a modern, multistage model of child capital formation. His model describes capital as a function of Cognitive and Noncognitive capabilities, as well as parents’ human capital. Thus, the model suggests that the productivity of investments in children is mediated by both cognitive and Noncognitive capabilities. Allowing for cross-productivity effects between cognitive and Noncognitive skills provides an intuitive improvement over the Ben-Porath model – it stands to reason that investments in a child with extraordinary Cognitive abilities and poor Noncognitive abilities that can’t sit still in a classroom are less productive than investments in a child with average Cognitive and normal Noncognitive abilities. Section 4 presents the Cunha model, and the discussion section of this paper offers theoretical extensions of the Cunha model to shed light on the challenges many intervention programs face.

3.2 Past Studies of Early Intervention Programs

Educational Interventions and Family Support Interventions both draw upon the broad thesis developed by capital formation theory and neuroscience: earlier investments in human capital are more efficient and leverage greater gains over time. Educational Interventions are some of the first and best-studied child investment programs. Seminal studies like the High/Scope Perry Preschool Program and the Carolina Abecedarian Project attracted national attention in the 1960s and 70s (respectively) when they were conducted. Few programs up to that point – even through

[4] Previous to Carneiro and Heckman (2003), only Marxist economists’ work invoked Noncognitive capabilities when describing human capital (Cunha 2006).

today – had incorporated randomly assigned control groups, and the results of these studies flowed into long-term cost-benefit analyses (Nores & Belfield 2005; Barnett & Masse 2007). In the High/Scope Perry Preschool Program, a cohort of 123 three and four year old black children was randomly enrolled into either treatment or control groups (Nores & Belfield 2005). Treatment group participants attended preschool from October to March for two years and received a weekly home visit from teachers during that time. A 40-year follow-up did not find treatment to significantly increase IQ score, but did show that treatment significantly explained improvements in employment and income as well as reductions in incarceration in adulthood compared to the control group (Nores & Belfield 2005). This finding supports the cross-productivity feature of the Cunha (2006) model and offers an example of Cognitive investments facilitating Noncognitive skills.

Unlike High/Scope, the Abecedarian program did demonstrate significant and permanent increases in adult IQ score (Heckman 2007); however, this program involved a much more intensive set of interventions than the High/Scope program that began when participants were four months old (Cunha 2006). At $76,400, the yearly per-child cost of the Abecedarian program dwarfed the High/Scope intervention's $18,500 yearly price tag.[5] The cost of even the High/Scope program is staggering when compared to the $4,175 average nation-wide cost[6] of traditional preschool programs in 2010, but Nores & Belfield (2005) justify the expense, finding that for every dollar spent on High/Scope the program repaid $12.90 to the general public.[7] The results of long-term cost-benefit studies like Nores and Belfield's (2005) make a compelling argument for households or social planners to spend more in early years and recoup the investment later. Costs vary widely by program in the world of early intervention, and the discussion section of this paper offers a side-by-side comparison of the costs and results of several programs including Penfield's PCT intervention.

Studies of High/Scope, Abecedarian and other educational programs fuel the growing consensus that early interventions offer positive returns to society (Barnett & Masse 2007; Aos 2004). However, this literature also reveals a bias for Cognitive capabilities as both the means and the outcome of childhood investments. In light of the cross-productivity effect of the Cunha

[5] Both in 2010$.
[6] Source: http://nieer.org/sites/nieer/files/2011yearbook_executive_summary.pdf
[7] Benefits were evaluated with a 3% discount rate.

capital production model, a bias for Cognitive interventions seems suboptimal to an approach that emphasizes both educational and behavioral interventions.

While the bias of policymakers and economists remains with cognitive investments and capital, several successful programs have focused on Family Support Interventions. The Yale Child Welfare Research Program selected 17 young, first-time mothers and provided them with comprehensive educational and social service support in the home. Treatment effects were measured in terms of academic achievement, IQ, and teachers' ratings of the child's agreeableness in class – once again, demonstrating a bias for measuring cognitive outcomes even when treatment does not involve schooling (Zigler & Taussig 1992). Seitz (1985) conducted a ten-year follow-up study using a matched-pairs control group and found no lasting cognitive effects for the experimental group but did find significant improvements in ratings by teachers, suggesting that Noncognitive skills were significantly improved.

While many Family Support Interventions have been university-based (Lally & Mangione 1988; Seitz 1985), private-sector institutions have also entered the field of early childhood intervention. Parent-Child Interaction Therapy (PCIT) International is a for-profit corporation that, like Penfield's PCT program, focuses on improving the relationship between a parent and child through parent coaching and child therapy. PCIT-certified treatment professionals offer clinic-based services that have been shown to significantly reduce behavior problems in young children (Goldfine 2008). The success of PCIT treatment reinforces the early studies of Penfield's program, suggesting that parent-child interventions deserve closer evaluation by policymakers and economists. However, PCIT does not target and accommodate low-income households with in-home treatment the way Penfield does. Thus, an open question remains in the literature as to whether in-home parent-child programs present a viable investment option for policymakers and social planners, something this paper will seek to address.

4 Economic Theory

4.1 Cunha Model of Human Capital Production

The Cunha model of human capital production breaks from previous single time period childhood models of human capital theory by allowing for multiple stages in child development before adulthood. It is important to understand the multi-stage model developed in Cunha (2006), as it informs the testable hypotheses and estimation of this paper. The model also illustrates the potential for an equity-efficiency tradeoff in childhood investments, which is described in the discussion section of this paper.

To begin, the Cunha model recursively defines stocks of child human capital in time period t as a function of parent(s)' human capital and resources (h), the level of human capital in the previous time period (θ_{t-1}), and investments in the child's human capital in the previous time period (I_{t-1}) for $t = 1, 2, \ldots T$:

$$\theta_t = f_{t-\mathbf{1}}(h, \theta_{t-1}, I_{t-1}). \tag{1}$$

Thus, at any given time period, stocks of a child's human capital can be described as a function of all past investments. The function f_t is assumed to be increasing in θ_t and I_t, and concave in I_t. Cunha (2006) relaxes the assumption made in the Ben-Porath (1967) model that cognitive capabilities are the only mediator in capital production, and offers a variant of the model:

$$\theta_t^k = g_{t-\mathbf{1}}\left(\boldsymbol{h}^C, \boldsymbol{h}^N, \quad \theta_{t-\mathbf{1}}^C, \quad \theta_{t-\mathbf{1}}^N, I_{t-\mathbf{1}}^k\right), \tag{2}$$

where the total stock of capital in capability k (θ_t^k) is described by previous investments in capability k $(I_{t-\mathbf{1}}^k)$, levels of Cognitive and Noncognitive capital from the previous time period ($\theta_{t-\mathbf{1}}^C$ and $\theta_{t-\mathbf{1}}^N$), and parent(s)' Cognitive and Noncognitive capital (h^C,h^N). This variant motivates the first hypothesis tested in this paper: parent(s)' human capital, household resources, and child Cognitive abilities will significantly impact the level of Noncognitive capital that children entering Penfield Children's Center for service will possess at intake.

The Cunha model of capital formation also presents an interesting interpretation of the change in human capital over time. Taking the derivative of the Cunha model with respect to time, the parent's capital term drops out and change in capital over a period (df_t/d_t) relates to the quantity of investments and initial levels of capital in that time period (θ, I). Taken in the context of Penfield's PCT treatment program, I hypothesize from this extension of the Cunha model that ECBT treatment will have a significant effect on the change in behavior and Noncognitive capital within a single time period, and that the more treatment (i.e. investment) a child receives the greater the change in Noncognitive capital will be.

4.2 Imperfect Information

The Cunha model provides an intuitive theoretical framework to explain child capital formation, but it does nothing to suggest what specific interventions or programs are the most efficient investments. The bias for Cognitive capabilities and interventions in past literature has deprived Family Support Interventions of the same amount of funding and study that Educational Interventions have received. Thus, imperfect information in Family Support Interventions like Penfield's PCT program is pervasive, and early childhood interventions are characterized by market failure. Though past literature suggests that Family Support Interventions wield significant impacts on child behavior, and that behavioral problems are linked with economic outcomes, more work must be done studying this field to provide a more complete picture of intervention effects and curb further potential market failure.

The true cost of imperfect information in the Family Support Intervention market comes from the underutilization of this potentially powerful service. This paper evaluates the effects Penfield's PCT program not only to test economic theory, but also in an attempt to offer a more complete picture of the intervention choices at policymakers' disposal.

In the interest of providing more complete information to the Family Support Intervention market, this paper also seeks to examine whether certain household characteristics increase the likelihood of dropping out of Penfield's PCT treatment. Understanding the profiles of households at greater risk of dropping out will allow Penfield to anticipate a family's needs and allocate greater resources at intake, to make sure that family completes treatment. Here, I hypothesize that greater socioeconomic status and older mothers will both decrease the likelihood of dropping out.

4.3 Hypotheses

The testable hypotheses for this paper can be summarized as

> *Hypothesis 1: Noncognitive capital at treatment intake is a function of parent(s)' human capital, household resources, and Cognitive ability*
>
> *Hypothesis 2: Change in Noncognitive capital will increase with session attendance*
>
> *Hypothesis 3: Household socioeconomic status and mother's age will decrease the likelihood of dropping out*

5 Data and Variable Overview

The data for this study come from Penfield Children's Center's ongoing Shaw Study. Since the program began in April 2012, 194 children have gone through intake procedure. Of this 194, 81 children have completed treatment, 69 have dropped out, and 44 completed treatment but did not have the results of treatment coded in the dataset at the time of estimation.[8] The effect of treatment is evaluated using the 81 children to complete the program, while systematic effects on dropout likelihood and pre-scores are evaluated using all 194 children. Two-stage least squares procedures in this study also incorporate historical climate data[9] and per capita personal income[10] as instrumenting variables.

The dependent variable for the first two hypotheses is Noncognitive capability. Heckman and Stixrud (2006) acknowledge the difficulty in proxying for Noncognitive capability and used smoking behavior and ratings of teachers as proxies in their work. This paper uses the Early Childhood Behavior Screen (ECBS) to measure behavior and Noncognitive capability. The ECBS is a 20 question, parent-reported behavior inventory designed specifically for low-income children in early childhood (Holtz 2012).[11] Unique among child behavior inventories, the ECBS is segmented into Challenging and Prosocial factors that measure behavior problems and strengths, respectively. Scores for the two factors are determined by measuring levels of cooperation, temperament, and behavior of a child, making the ECBS a strong proxy for Noncognitive skill. Table 1 presents the variables used in this paper with definitions.

Table 1. Variables for all models with definitions.

Variable	*Symbol*	*Definition*
Age	AGE	Child's age at time of treatment, in years
Gender	DGENDER	0 if child is male; 1 if child is female
Black	DBLACK	0 if child is not black; 1 if he/she is
Latino	DLATINO	0 if child is not Hispanic; 1 if he/she is
Mother's Age	MAGE	Mother's age at intake, in years
Number of Children	NUMCHILD	Number of children living in the household
Significant Other	DSIG	0 if child lives with a single parent; 1 if a second parent figure lives in the household
Public Assistance	PUBASSIST	0 if household is not on public assistance; 1 if it is
Mother Has a Job	PRICAREJOB	0 if primary caregiver is unemployed; 1 if not

[8] These 44 are included in testing Hypothesis 1, but could not be used in testing Hypotheses 2 and 3.

[9] www.weather-warehouse.com.

[10] www.bea.gov.

[11] Table A.1 presents these questions is in Appendix A.

Child Diagnosed with Developmental Delay	DEVELDELAY	0 if child is not diagnosed with a developmental delay; 1 if the child has a known delay entering treatment
Mother's GAF Score	MGAF	Continuous (0-100) clinical rating scale of adult social, occupational, and psychological functioning
PCRS Score	PCRS	Rating of a child's perspective on relationships with their parent(s)
Tantrums	DTANT	0 if child does not have significant tantrum problems; 1 if child does
Slosson Mental Age	SLOS	Quantitative measure of child cognitive ability
Prosocial Score	PRESCORE1	Child's Prosocial ECBS score (0-30) at intake
Challenging Score	PRESCORE2	Child's Challenging ECBS score (0-30) at intake
Change in Prosocial Score	CHGSCORE1	Change in Prosocial ECBS score after treatment
Change in Challenging Score	CHGSCORE2	Change in Challenging ECBS score after treatment
Dropout	DROPOUT	0 if child did not drop out of treatment; 1 if child attended less than 3 sessions (i.e. dropped out)
LnAttendance	LNATTEND	Natural log of the number of sessions a child attends; 0 for children in control group

The summary statistics in Table 2 offer several interesting insights into the data used to estimate Hypotheses 1 and 3. The limitations section of this paper will address concerns these insights pose, but several observations are worth pointing out immediately. Black children represent half of the overall sample (53%) and over half of all children that dropped out of the program (68%). 95% of black mothers were the only parent present in their household. Finally, white mothers exhibited the highest average age and lowest average number of kids.

Table 3 offers a similar set of summary statistics for the data used when evaluating the effects of Penfield's treatment. Black, Latino, and white children are more evenly distributed in this smaller dataset and show similar average values across demographic controls. Racial change in score averages aggregate both treatment and control observations. Latino children post the highest changes in average Prosocial and Challenging scores. The average change in Prosocial score for Black children is lower than the control group average change. This is the most troubling result of these summary statistics, and calls into question whether Penfield's PCT treatment is successful in treating all races equally.

Table 2. Means and (standard deviations) for variables used in testing the Cunha model.

	All	Black	Latino	Mixed Race	White
Age	3.45	3.53	3.34	3.44	3.33
	(1.08)	(1.06)	(0.95)	(1.23)	(1.26)
Female*	64	32	15	9	8
	0.33	*0.31*	*0.36*	*0.38*	*0.32*
Mother's Age	28.46	27.16	28.16	28.41	34.4
	(6.59)	(6.07)	(6.29)	(5.87)	(6.97)
Number of Children	2.42	2.63	2.57	2.13	1.64
	(1.58)	(1.72)	(1.48)	(1.26)	(1.15)
Significant Other*	39	5	16	5	13
	0.20	*0.05*	*0.38*	*0.21*	*0.52*
Mother Has Job*	85	42	18	11	14
	0.44	*0.41*	*0.43*	*0.46*	*0.56*
Public Assistance*	171	97	38	21	15
	0.88	*0.94*	*0.90*	*0.88*	*0.60*
Mother-Child PCRS Score	53.58	49.90	55.23	56.46	63.2
	(14.46)	(14.21)	(11.73)	(15.91)	(13.38)
Mother's GAF Score	54.87	54.66	55.38	56.58	53.24
	(8.27)	(7.57)	(9.05)	(10.48)	(7.46)
Child's Slosson Mental Age	3.32	3.37	3.04	3.22	3.65
	(1.37)	(1.40)	(1.10)	(1.36)	(1.61)
ECBS Challenging Score	22.96	23.62	22.73	21.41	22.16
	(4.18)	(4.26)	(4.25)	(3.45)	(4.01)
ECBS Prosocial Score	22.37	22.49	22.07	22.04	22.72
	(2.86)	(2.56)	(2.78)	(4.01)	(2.96)
Dropout*	66	49	7	7	3
	0.34	*0.48*	*0.17*	*0.29*	*0.12*
N	194	103	42	24	25

* Indicates a dummy variable. Dummy variables are reported with counts and *relative percents*.

Table 3. Means and (standard deviations) for variables used in evaluating treatment effects.

	All				
	Treatment	Control	Black	Latino	White
Age	3.50 (0.99)	3.55 (0 .95)	3.54 (1.14)	3.36 (0.88)	3.62 (0.89)
Female*	19 *0.35*	6 *0.22*	8 *0.30*	8 *0.32*	9 *0.31*
Mother's Age	30.59 (7.58)	28.96 (6.36)	28.37 (7.49)	30.32 (7.13)	31.37 (6.90)
Number of Children	2.14 (1.65)	2.07 (1.20)	2.22 (1.80)	2.44 (1.41)	1.75 (1.24)
Mother Has Job*	22 *0.41*	8 *0.29*	8 *0.29*	10 *0.40*	18 *0.38*
Developmental Delay*	24 *0.44*	11 *0.41*	9 *0.33*	11 *0.44*	25 *0.51*
Tantrums*	34 *0.63*	22 *0.81*	19 *0.70*	20 *0.80*	36 *0.73*
Intake Challenging ECBS Score	21.75 (4.18)	23.55 (3.25)	23.44 (3.34)	21.92 (3.87)	21.72 (4.47)
Intake Prosocial ECBS Score	22.90 (2.62)	21.44 (3.38)	22.33 (2.52)	22.40 (2.73)	22.51 (3.56)
Change in Challenging ECBS Score	5.37 (3.93)	1.51 (2.83)	2.33 (4.02)	5.88 (3.68)	4.17 (3.70)
Change in Prosocial ECBS Score	2.18 (3.07)	0.40 (1.94)	.07 (2.20)	2.88 (3.19)	1.89 (2.52)
N	54	27	27	25	29

* Indicates a dummy variable. Dummy variables are reported with counts and *relative percents*.

6 Estimation

6.1 Estimating Human Capital

This study begins the estimation process by testing human capital formation theory using the Penfield Shaw Study dataset. To test the Cunha model, I use the Prosocial and Challenging ECBS subscores measured upon child intake. To explain the variance in initial ECBS scores, I control with a vector of demographic variables, $\mathbf{d}_i$. Household resources are captured in a socioeconomic vector, $\mathbf{S}_i$. Parent's human capital and relationship with child are proxied by GAF and PCRS scores, respectively, while Cognitive effects on Noncognitive human capital are tested using Slosson Mental Age. The final equation used in the first test of this paper can now be presented as:

$$ECBS_{Pro/Chal} = \beta_0 + \beta_1 PCRS_i + \beta_2 MGAF_i + \beta_3\, SLOS_i + \Sigma\beta_i \mathbf{S}_i + \Sigma\beta_i \mathbf{d}_i + e_i \quad (3)$$

Equation 3 is estimated in linear functional form, and unlike the models to be estimated in Section 6.2, the parameters do not vary between the Prosocial and Challenging estimations. A Koencker-Bassett test of the data reveals pervasive heteroscedasticity in the Prosocial estimation (t = -3.64) but no heteroscedasticity in the Challenging estimation (t = -0.79). To correct for any systematic relationships between variables and the error terms, results are presented with robust OLS regression estimates. Estimation results for Prosocial and Challenging subscores are presented in Table 4.

Column 1 of Table 4 presents the results for estimating the Challenging subscore. Equation 3 explains 31.9% of the variance in intake Challenging score with several statistically significant relationships. Recall that the Challenging subscore is a 0-30 numeric measure of challenging behavior, where a score of 30 indicates an extremely challenging behavior and a low level of socioemotional health – thus, variables with a negative coefficient decrease challenging behavior. Mother's GAF score presents the most significant explanatory power, decreasing intake Challenging score by a quarter of a point for every additional GAF point. In other words, as the mother's psychological and emotional capital increases, the negative behaviors of her child decreases. Challenging behavior also decreases with mother's age, suggesting that either the circumstances often linked with early pregnancy or the skills and income a mother accrues ceteris paribus by having children at an older age increase a child's socioemotional health and human capital. The age of a child significantly reduces challenging behavior, reinforcing the crux of human capital theory that additional time periods allow for further human capital accrual. Requiring public assistance significantly increased challenging behavior, supporting the idea that parents' income increases a child's human capital. The dummy variable for black children also demonstrated significant and negative effects on child socioemotional health. While Cunha's model of human capital theory (and indeed, this paper) makes no argument regarding systematic racial differences in human capital accrual, it is possible that historic associations between household income and race in the Milwaukee area lend a significant and negative interpretation to this demographic control.

Column 2 of Table 4 presents Equation 3's estimation of Prosocial ECBS subscore. Equation 3 explains less of the variance (17.3%) in the Prosocial measure of behavior than in the Challenging measure, but shows that mother's GAF score remains significant and robust in explaining the level of a child's human capital. In addition to GAF score, the child's Slosson Mental Age score presents a significant and positive effect on positive behavior and socioemotional health. This result supports the theoretical argument that Cognitive and Noncognitive skills facilitate one another (Heckman & Stixrud 2006).

Table 4. Robust OLS Estimates for Challenging and Prosocial subscores at intake.

	Challenging		Prosocial	
	Coefficient	Standard Error	Coefficient	Standard Error
Age	-1.168^{**}	(0.407)	-0.0030	(0.252)
Female	-0.844	(0.570)	-0.0452	(0.380)
Black	1.762	(0.941)	0.742	(0.728)
Latino	0.538	(0.997)	0.00445	(0.736)
Mixed Race	-0.121	(1.021)	-0.106	(0.911)
Mother's Age	-0.121^{**}	(0.0406)	0.0116	(0.0296)
Significant Other	1.370	(0.812)	0.972	(0.505)
Number of Children	0.103	(0.153)	-0.154	(0.127)
On Public Assistance	1.760^{*}	(0.719)	-0.512	(0.593)
Mother Has a Job	0.757	(0.554)	-0.44	(0.390)
GAF Score	-0.243^{***}	(0.0348)	0.0687^{*}	(0.0338)
PCRS Score	0.0332	(0.0196)	0.0104	(0.0174)
Slosson Mental Age	0.361	(0.358)	0.427^{*}	(0.195)
Constant	37.65^{***}	(2.507)	16.77^{***}	(1.981)
N	194		194	
R^2	*0.319*		*0.173*	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6.2 Evaluating the Effects of Treatment

Encouraged by the results of the previous section, which validate the Cunha model's assumptions, I proceed to evaluate whether Penfield Children's Center's PCT program successfully changes Noncognitive capital over the course of treatment. Using the Early Childhood Behavioral Screen as the dependent measure of human capital offers a unique opportunity to test whether systematic demographic or socioeconomic characteristics affect a child's sensitivity to treatment of both positive and negative behaviors. Two final equations estimating change in Prosocial and Challenging subscores after treatment are advanced, expressed as:

Two Stage: $\Delta ECBS_k = \beta_0 + \beta_1 LnATTEND_i + \Sigma\beta_i\mathbf{S}_i + \Sigma\beta_i\mathbf{d}_i + \beta_i ECBCS_{k,0} + e_i$ (4.1)

and

$$\Delta ECBS_k = \beta_0 + \beta_1 LnATTEND_i + \Sigma\beta_i\mathbf{S}_i + \Sigma\beta_i\mathbf{d}_i + \beta_i ECBCS_{k,0} + e_i \quad (4.2)$$

Both equations use a nonlinear functional specification with respect to attendance because Cunha (2006) assumes that human capital is concave and increasing in previous investments. Taking the natural log of sessions attended also avoids the non-intuitive implication that behavior can be indefinitely improved with additional treatment sessions.

In addition, both equations use different subsets of the demographic and socioeconomic vectors when estimating changes in Prosocial and Challenging ECBS sores. By doing so, the models take advantage of the ECBS's segmentation and allow us to test whether good and bad behaviors are mediated by the same factors. The combinations of demographic and socioeconomic variables that maximize each model's descriptive power are advanced in this paper as the final models.[12]

Equation 4.1 estimates the change in ECBS score after treatment with a two-stage least squares procedure to correct for any endogeneity that may occur when including the intake score. Choosing appropriate instrumenting variables is an essential task, and in this case estimation of the two-stage procedure was somewhat limited by the variables in the Penfield dataset. To instrument for initial ECBS score and then estimate the change in score after treatment, we must ask: what variables will affect initial socioemotional health, but not a child's sensitivity to treatment? Ultimately, $ECBCS_0$ is instrumented with variables for the temperature in Milwaukee during the month of the child's birth, the per capita personal income for the metropolitan

[12] However, age, race, and gender control variables are included in both regardless of descriptive power.

statistical area of Milwaukee at the year of the child's birth, a dummy variable for clinical diagnosis of Oppositional Defiant Disorder, and the mother's GAF score. Following the Cunha model, I assume that the mother's level of Noncognitive human capital will not affect intertemporal changes in child Noncognitive human capital. Performing a Wu-Hausman test of endogeneity on Equation 2.1 yields inconclusive results for both the Challenging factor estimation (p=0.162) and the Prosocial factor estimation (p=0.135). OLS results are presented alongside the two-stage estimation because the existence of endogeneity is unclear, and because the dataset is limited in providing appropriate instrumenting variables.

Table 5 presents the results of estimating Equations 4.1 and 4.2 with the Challenging subscore of behavior. Across both estimations, the natural log of attendance is highly significant (p<0.001) and explains a decrease in Challenging score. These results show that Penfield's PCT program is significant and effective in reducing behavioral problems that may decrease Noncognitive skill. OLS estimation (shown in column 1) successfully described 53.6% of the variance in changes in treatment, while two-stage estimation (column 2) described 49.8% of the variation.

Table 5. Robust OLS and Two-Stage Least Squares estimation results for Challenging score.

	Robust OLS		Two-Stage	
	Coefficient	Standard Error	Coefficient	Standard Error
Age	0.651	(0.345)	0.412	(0.399)
Female	0.325	(0.762)	0.299	(0.734)
Black	-1.271	(0.920)	-1.171	(0.933)
Latino	2.268^{*}	(0.863)	2.084^{*}	(0.865)
Mixed Race	1.026	(1.271)	0.782	(1.163)
Mother's Age	-0.0674	(0.0446)	-0.0945^{*}	(0.0447)
Number of Children	-0.556^{*}	(0.263)	-0.475	(0.283)
Tantrums	-1.366	(0.698)	-1.236	(0.747)
Challenging Score at Intake	0.462^{***}	(0.0929)	0.240	(0.227)
LnAttendance	4.379^{***}	(0.752)	4.110^{***}	(0.789)
Constant	-7.477^{*}	(3.416)	-0.894	(6.700)
N	81		81	
R^2	*0.536*		*0.498*	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The Latino dummy variable maintains significance across both models as well, potentially suggesting greater sensitivity among Latino children to Penfield's treatment. One important systematic difference between Latino children's treatment and the treatment of all others is that Latino children had the option of receiving treatment in Spanish if English would have been a barrier to treatment. The use of Spanish in treatment should not intuitively convey additional sensitivity or effects on human capital, however, but should merely compensate for what would have been a systematic detriment to the treatment of Latinos had English been the only available language.

Table 6 offers the results of estimating Equations 4.1 and 4.2 with the Prosocial subscore. Once again, the log form of the attendance variable retains its significance in explaining Prosocial improvements across both models. The significance of attendance on changes in both Challenging and Prosocial scores provides strong evidence that Penfield Children's Center's PCT treatment is effective at increasing behavioral strengths and decreasing behavioral problems.

OLS estimation describes 53.3% of the variation, while two-stage least squares estimation describes 47.5%. Age holds a significant and positive relationship with treatment improvement in the OLS models of both ECBS factors, suggesting that as young children age, treatment wields a greater effect on change in behavior. A lack of variance in child age (and limited sample size) precludes an analysis of potential nonlinear relationships between age and sensitivity to treatment. That said, I do not interpret the sign and significance of the age term to mean that change in score from treatment increases indefinitely with age – in other words, these results do not contradict economic and neurobiological theory that argues for the existence of an early window of development in which interventions are more effective.

Table 6. Robust OLS and Two-Stage Least Squares estimation results for Prosocial score.

	Robust OLS		Two-Stage	
	Coefficient	Standard Error	Coefficient	Standard Error
Age	0.589^{*}	(0.252)	0.360	(0.372)
Female	0.149	(0.549)	0.127	(0.541)
Black	-0.909	(0.688)	-1.046	(0.674)
Latino	1.170	(0.636)	1.110	(0.666)
Mixed Race	0.507	(0.842)	0.317	(0.777)
Developmental Delay	0.722	(0.521)	0.654	(0.509)
Mother Has a Job	1.348^{**}	(0.499)	1.438^{**}	(0.528)
Mother's Age	0.0550	(0.0296)	0.0473	(0.0305)
LnAttendance	1.962^{**}	(0.603)	1.520^{*}	(0.757)
Prosocial Score at Intake	-0.523^{***}	(0.0794)	-0.271	(0.231)
Constant	7.453^{***}	(1.915)	3.193	(4.032)
N	81		81	
R^2	*0.533*		*0.475*	

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Initial score at intake wields highly significant effects on the OLS models of both ECBS subscores, but in opposite directions. For the Challenging ECBS factor, a child coming in with a higher score (worse behavior and socioemotional health) will observe greater marginal improvements to human capital than a child that is already better behaved. In contrast, a child with a higher Prosocial score improves less than a child with a lower score. These results support Heckman's (2007) argument that interventions focusing on the most distressed and disadvantaged households are the most productive.

Existing economic literature does not differentiate the functional specification of human capital formation by demographics. Despite that fact, interacting the demographic variables for age, race, and gender with the LnAttendance variable to test for systematic differences in treatment sensitivity seems like a natural extension of this section's estimation procedure. Because of the sample size of the dataset, however, including these interacted terms alongside LnAttendance does violence to the model and introduces issues of collinearity, wiping away the statistical significance of any attendance term. Thus, this study proceeds with the linear-log functional specifications in Tables 5 and 6, and offers no interaction variables.

6.3 Predicting the Likelihood of Dropping Out

As we consider the efficient allocation of intervention resources across a population, the ability for families to complete treatment must be considered. Searching for systematic effects on the likelihood of leaving an intervention program can help intervention identify and offer additional resources to at-risk families, or start to ask how programs can be better suited to certain groups.

"Dropping out" is defined by the Penfield Children's Center as failing to attend at least three treatment sessions after intake. Thus, a dummy variable for families who failed to attend three sessions is the dependent measure of this logit estimation, while demographic and socioeconomic vectors seek to explain dropout and identify at risk groups. The equation for this estimation can be viewed as:

$$\text{DROPOUT} = \beta_0 + \Sigma\beta_i\mathbf{S}_i + \Sigma\beta_i\mathbf{d}_i + e_{i.} \tag{5}$$

Column 1 of Table 7 presents the estimation results of Equation 5, while column 2 presents the results of a marginal effects analysis in which the percent change in likelihood of dropping is given for a change in one variable at a time. The logit estimation of Equation 5 explains 18.0% of the variation in the dropout variable. Results from the marginal effects analysis show that the presence of a significant other in the home decreases the likelihood of dropping out of treatment by 28.2%. This result makes intuitive sense, because the presence of a second parent effectively doubles the household's endowment of leisure and creates the opportunity to spread parenting duties across two individuals. This coefficient may capture some of the explanatory power of the black dummy variable, however, given that 63% of single mothers in this study were black.

Having an additional child in the home increases the likelihood of dropout by 5%, while the likelihood of dropout decreases by nearly 2% for every year of mother's age. These results fit with a priori expectations and are not surprising. Nevertheless, they are useful in informing Penfield Clinic about profiles of future patients to watch out for and provide greater attention.

Table 7. Logit results and marginal effects of variables on the likelihood of dropping out.

	Logit		Marginal Effects	
	Coefficient	Standard Error	dy/dx	Standard Error
Age	-0.205	(0.165)	-0.205	(0.165)
Female	0.305	(0.371)	0.305	(0.371)
Black	0.701	(0.749)	0.701	(0.749)
Latino	-0.586	(0.848)	-0.586	(0.848)
Mixed Race	0.110	(0.857)	0.110	(0.857)
Mother's Age	-0.0784*	(0.0353)	-0.0784*	(0.0353)
Mother Has a Job	0.513	(0.357)	0.513	(0.357)
Significant Other	-1.943*	(0.804)	-1.943*	(0.804)
Number of Children	0.249*	(0.111)	0.249*	(0.111)
GAF Score	0.0167	(0.0222)	0.0167	(0.0222)
Constant	0.227	(1.719)	0.227	(1.719)
N	194		194	
Pseudo-R^2	*0.18*			

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7 Discussion

7.1 Extensions of the Cunha Model

Extensions of the Cunha (2006) model of capital production hold several interesting theoretical implications for the timing of investments in children. While the neuroscience community has already established early childhood as the most sensitive period in child development, the Cunha model offers economists a way to examine the policy implications this timing effect formally.

One important policy implication is equity-efficiency tradeoffs in child investments, which manifest when capital formation exhibits dynamic complementarity.[13] To illustrate why dynamic complementarity leads to an equity-efficiency tradeoff, Cunha (2006) considers a two period childhood before adulthood[14] (i.e. t = 1 is early childhood, t = 2 is adolescence, and t = 3 is adulthood) with a constant elasticity of substitution (CES) production function:

$$\theta_3 = f_2\left(h, \theta_1, [\gamma(I_1)^{\varphi} + (1-\gamma)(I_2)^{\varphi}]^{\frac{1}{\varphi}}\right). \qquad (6)$$

for $0 \leq \gamma \leq 1$ and $0 \leq \varphi$. In this function, φ represents the substitutability of I_2 for I_1, and γ represents a capability multiplier that "determines the relative productivity of investments in the

[13] Dynamic complementarity occurs when , and implies that stocks of capital in period t (θ_t) increase the productivity of future investments (I_{t+1}).
[14] Neither Cunha (2006) nor this paper attempt to argue, however, that childhood occurs in two stages; rather, the model is presented in two stages for simplicity.

different periods" (Cunha 2006). Here, a higher γ implies that early investments are more productive than adolescent investments. It is worth noting that adult stock of human capital after the two stages of childhood, θ_3, will become the h variable for the next generation of children (i.e. $\theta_3 = h$). Thus, the problems or systematic inequalities of one generation may be passed on to the next. Cunha (2006) extends this logic to examine generational effects with the model; however, these applications are beyond the scope of this study. Nevertheless, his findings suggest that early interventions could have long-term ramifications.

To examine the equity-efficiency tradeoff more closely, consider two extremes: perfect complementarity and perfect substitutability between investments in two childhood time periods. Under perfect complementarity ($\varphi = -\infty$), the CES production function of capital becomes

$$\theta_3 = f_2(\min\{I_1, I_2\}). \tag{7}$$

When investments in both time periods are perfect complements, it is inefficient for a social planner to invest in disadvantaged adolescents (low h, low I_1) in the second time period, and efficient to invest in advantaged adolescents (high h, high I_1). Thus, an equity-efficiency tradeoff exists between childhood investments in adolescence, because the efficient allocation of investment resources does not promote equity and support more disadvantaged populations. Perfect complementarity in the Cunha CES function also implies that, after high investment in early childhood (high I_1), investment in adolescence should also be high in order to reap the benefits of early intervention. Optimal allocation of investment resources when $\varphi = -\infty$ becomes $I_1 = I_2$.

In contrast, when $\varphi = 1$, the investments between childhood stages become perfect substitutes, and the CES production function becomes:

$$\theta_3 = f_2([\gamma(I_1) + (1-\gamma)(I_2)]). \tag{8}$$

Under the perfect-substitute condition, the optimal decision of when to invest in a child is determined by the opposing effects of γ and the interest rate. As the interest rate increases, it is efficient to shift investment towards the second stage, while as γ increases it is efficient to invest early. Ultimately, early investment is the optimal decision if $\gamma > (1-\gamma)(1+r)$. The implication of the perfect-substitute condition is that deficits from the first period can be completely remediated in the second period with sufficient investment. Much like the Becker-era single-period childhood assumption, this condition seems intuitively unreasonable considering the recent work of the neuroscience community.

Thus, we can rule out the case of perfect substitutes and look at cases where φ is not one of the two extremes. Cunha (2006) describes the ratio of early to adolescent investments for an interior solution where $-\infty < \varphi < 1$ as

$$\frac{I_1}{I_2} = \left[\frac{\gamma}{(1-\gamma)(1+r)}\right]^{\frac{1}{1-\varphi}}. \tag{9}$$

Once again, γ and the interest rate oppose each other. While the perfect-complement condition demonstrated an extreme case of equity-efficiency tradeoff, a tradeoff still exists for the interior solution when dynamic complementarity exists. This extension of the Cunha model, combined with the neuroscience literature presented in this paper, provides a thorough and compelling case for investing early in young children. Given the window of opportunity early childhood presents, evaluating the interventions used to invest in children is essential.

8.2 Penfield's Treatment Relative to Other Programs

Testing the second hypothesis of this paper revealed that Penfield's PCT treatment significantly improved the behavioral strengths and reduced the behavioral problems of children in the experimental group. Given this encouraging result, the natural follow-up question is how do these results and the program's costs compare to other interventions? Table 8 summarizes the Family Support and Early Education intervention programs discussed in this paper and compares both costs and duration. The immediate observation comparing Penfield Children's Center's PCT program to other interventions is the significant difference in costs and duration.

Table 8. Major findings and costs per child per intervention.

Program	Major Findings	Program Duration	N	Costs[a]
	Family Support			
Penfield Parenting Young Children	Significant improvement of behavior strengths, reduction of behavior problems	8 weeks	81+	$516
PCIT International[b]	Significant reductions in disruptive behavior, maintained through school environment	Varies[c]	N/A	$1,025
Yale Child Welfare Research Program	Reduced the need for special school services in children; improved school behavior; no effect on IQ	2.5 years	17	$41,635
	Early Education			
Carolina Abecedarian Project	Permanent increase in adult IQ; decreased reliance on public assistance and increased participation in skilled labor force	5 years	111	$76,400
High/Scope Perry Preschool	Increased lifetime earnings, employment; decreased criminal activity; no IQ effects	2 years	123	$18,500

[a] All costs reported per-child, per intervention, and in 2010$.
[b] Cost figures for PCIT International represent the results of a meta-analysis by Aos (2004).
[c] PCIT treatment continues indefinitely until either treatment goals are met or families quit the program.

The PCT program provides treatment over a much shorter amount of time, and at significantly less expense. In a previous follow-up study of the Penfield PCT program, Fox and Mattek (2012) found that increases in Prosocial ECBS score and decreases in Challenging ECBS score persisted a year after treatment.[15] Nothing in the early intervention literature suggests that expense or treatment duration is a necessity for effective treatment or positive results. Given the significant results found in this paper and the one-year maintenance of results that Fox and Mattek (2012) discovered, the Penfield PCT program could potentially serve as a nimble, low-cost way of treating behavior problems in children from low-income families that complements educational interventions. Future studies of Penfield's treatment should look for systematic differences in economic outcomes (e.g. employment, education, and wages) between control and experimental groups to motivate the increased use of this intervention.

[15] This follow-up study occurred before the clinic introduced a control group, however.

8.3 Potential Cost-Savings Channels

Now that Medicaid is reimbursing Penfield's PCT treatment, a new analysis of treatment benefits to society should be made. This paper helps complete the first step. Children do indeed improve their behavioral health and Noncognitive skills over the course of treatment, as shown by the estimation of Equation 4.1 and 4.2. For psychologists and clinicians solely (and rightfully) concerned with improving health on an individual level, analysis of the program might stop here. Considering the budget constraints of Medicaid and the challenge policymaker's face to optimize net benefits to society, however, the economic work is not done. Given how recently the program started, it will be several years before an evaluation can show any effects on schooling, employment, or delinquency that the program might have. The most impressive cost-benefit analyses of early childhood intervention programs waited decades before designing matched-pairs comparisons and estimating the broad effects of treatment (Nores & Belfied 2005; Barnett & Masse 2007). Waiting decades to measure the benefits of PCT treatment while tax dollars are spent is undesirable, thus the discussion section of this paper concludes with a brief description of several potential cost-savings channels in the order by which they could be estimated.

8.3.1 Increased Labor Participation and Productivity of Parents

Childcare constraints have shown to significantly decrease labor force participation and productivity (Shellenback 2004). Penfield Children's Center's target candidate for treatment is a child with emotional and behavioral problems that place additional childcare constraints on their parent(s). Thus, as treatment continues to significantly reduce child behavioral problems, any increase in parent(s)' labor force participation could be immediately observed and attributed as a program benefit.

8.3.2 Decreased False-Positive Special Education Enrollment

Perhaps the most controversial cost-savings channel that Penfield's treatment could impact is the frequency with which ex-participants enroll in special education. To be clear, no behavioral therapy program can or should prevent a child that needs special education services from obtaining them. That said, literature in the education studies community acknowledges that a systematic overrepresentation of children from minority and low-income households exists in the special education system today, with some fraction of those students enrolled as false-positives (Artiles & Trent 1994). Reducing challenging behavior, especially in minority students, may reduce the frequency with which false-positive enrollments are made. Keeping false-positive children out of special education classrooms reduces costs for state and local governments,[16] and educates those children at the appropriate level. The average child in this first wave of PCT patients was nearly 3.5 years old; thus, relationships between treatment and special education could be researched within two to four years.

8.3.3 Decreased Delinquency in Adolescence

Early intervention programs often cite decreased delinquency as an effect of treatment (Olds et. al. 1998), and resources exist to value the cost of specific crimes to society (Miller & Cohen 1996; Cohen 2004). Tracking delinquency and crime rates in program participants can begin immediately; however, major results of doing so may not appear for several years.

8.3.4 Increased Employment or Wages

Finally, a matched-pairs comparison could one day attribute significant effects of treatment participation on employment and income. The High/Scope Perry Preschool intervention witnessed such effects. Given the power of early childhood interventions, evaluations of Penfield's treatment may one day show similar effects, though the cost-saving channels previously described seem more compelling and immediate possibilities.

9 Limitations

Limitations on this paper stem from issues with sample size and the variables available in Penfield's dataset. With 81 observations, the dataset used to estimate the effect of treatment on changes in Challenging and Prosocial ECBS scores is small. However, this sample size is consistent with past early intervention evaluation literature. A larger dataset would have increased the number of control group observations, which could draw greater distinction in the variance between control and experimental groups.

As mentioned in the Data section of this paper, the average change in Prosocial score for black children was lower than even the control group average change. This observation is reflected by the fact that he dummy for black children in the two-stage estimation of change in Prosocial score is significant and negative. Penfield's PCT intervention could potentially be less effective for black children. Or, the sample size of each race could be too small to draw out race-

[16] A 2003 study by the Special Education Expenditure Project estimated that special education costs 1.91 times more than regular education ($12,525 and $6,556, respectively in 2000$). Source: http://csef.air.org/publications/seep/national/final_seep_report_5.pdf

specific treatment sensitivities. In either case, this paper is limited in its ability to conclude that treatment significantly improved Prosocial score across all races.

Early on in the Shaw Study, Penfield reduced the waiting time for the control group to be four weeks instead of eight out of concerns, because four was deemed a sufficient control and eight weeks was deemed an unnecessary withholding of treatment. This paper makes the modest assumption that ceteris paribus, no systematic or random patterns in behavior occur in eight weeks that cannot be captured within four weeks.

Cunha (2006) considers the effects of prenatal human capital in his recursive model of capital formation. An omitted variables bias is thus present for the estimation of all three equations because prenatal variables are not tracked in Penfield's ongoing Shaw study of their treatment. Considering the parent(s)' capital term in the model, mother's Noncognitive capabilities were included in this study but no variables for educational attainment or household income were available to test the effect of cognitive skills or wealth, respectively.

10 Conclusions

Modern economic theory of human capital formation reinforces the neuroscience community's observations on human development, and the insights of both disciplines suggest that investments in early childhood are essential to increasing both Cognitive and Noncognitive skills. Much of the past economic literature has overemphasized the importance of Cognitive capabilities and Educational Interventions, at the expense of considering the role of Noncognitive skills like behavior, motivation, and cooperation.

This paper sought to test how Penfield Children's Center's Parent and Child Therapy program affected Noncognitive skills in low-income children using the Cunha model of capital production. Treatment successfully and significantly led to improvements in Noncognitive capabilities by decreasing behavioral problems and increasing behavioral strengths. Thus, the first main contribution of this paper is the conclusion that the PCT treatment is an effective early investment for increasing Noncognitive human capital. This conclusion comes with the caveat that black children did not post the same treatment gains as white and Latino children.

An attempt to predict which households are at risk of dropping out revealed that young, single mothers with several children were more likely to drop out. These results conform to a priori expectations, but still offer insight into which households Penfield Children's Center should pay closest attention to in order to reduce the rate of drop-outs.

The second main contribution of this paper is the use of the Early Childhood Behavioral Screen to test human capital formation theory. This psychometric behavior measure improves significantly upon the proxy variables for Noncognitive ability used in past economic literature. The Cunha model of capital formation successfully describes determinants of Noncognitive ability when applied to Penfield Children's Center's dataset. The use of segmented Prosocial and Challenging ECBS subscores also illustrates that Noncognitive strengths and weaknesses can be mediated by different terms in the capital production function. This result opens the door for future studies to consider how Noncognitive strengths and weaknesses interact with Cognitive skill in the formation of future stocks of capital.

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Appendix A

Table A.1. ECBS Challenging and Prosocial factor questions.

Challenging Factor Questions	*Prosocial Factor Questions*
Hits Others	*Understands You*
Throws Things at Others	*Sleeps Through the Night*
Has Temper Tantrums	*Plays Well With Others*
Hurts Others	*Cooperates in Getting Dressed*
Bothers Others	*Listens to You*
Is Angry	*Does What You Ask*
Breaks Things	*Eats With a Spoon*
Kicks Others	*Shares Toys*
Takes Toys Away From Others	*Helps Others*
Refuses to go to Bed	*Eats Well*

Data Appendix

Data for this paper came from Penfield Children's Center's Behavioral Clinic. These data were sent to me by Christine Holmes (Christineholmes@penfield.org). As previously mentioned, weather data came from www.weather-warehouse.com and per capita personal income data came from www.bea.gov. Data were added on a yearly basis to the year in which the child was born.