A Benefit-Cost Analysis of the University of Oregon Brain Development Lab's PCMCA program

By
Michael Pierce

Eshwari Rao

Presented to the Department of Economics, University of Oregon, in partial fulfillment of requirements for honors in Economics.

under the supervision of
Prof. Bruce Blonigen

June 2009

A Benefit-Cost Analysis of the University of Oregon Brain Development Lab's PCMCA program

Abstract: This paper uses comparative benefit analysis to analyze both the costs and benefits of PCMCA. While we did not have long-term data for PCMCA specifically, this paper uses BCAs of previous early childhood interventions that did have follow-up data, up to 40 years worth. Building upon these BCAs, we compare the PCMCA to other programs, most notably Carolina Abecedarian and Perry Preschool. The costs analysis consists of both actual costs from the pilot program, as well as estimated costs of a statewide implementation. This paper finds that the estimated benefits of PCMCA far outweigh the costs; the benefit cost ratio is estimated to be 9.6:1.

Approved: _____ 6/5/2009

Bruce Blonigen

Date

ACKNOWLEDGEMENTS

The authors would like to thank the researchers at the University of Oregon's Brain Development Lab who helped us understand the PCMCA program, Helen Neville, Jessica Fanning, Scott Klein, Eric Pakulak, Theodore Bell, and Linda Heidenreich. Their dedication to improving the lives of our Nation's children is truly commendable. The authors are also grateful for the guidance of their supervisor Bruce Blonigen and his colleague Joe Stone of the Economics Department; their insight and expertise were invaluable.

TABLE OF CONTENTS

I. Introduction

The growing evidence that poorer children begin their lives with lower skills than those of their more privileged peers has called for intervention to help narrow this gap. Neurological research has developed the notion of "Neuroplasticity", which refers to the changes that occur in the brain as a result of experience (Hodge, 2008). At a younger age, children's brains are said to be more plastic: their capability for enhancement and the vulnerability to deficit is much stronger than at later stages of life (Neville and Stevens, in press). This concept has implications for early childhood interventions; it suggests that early interventions will be more effective than those in later in life. These types of programs have the goal of improving educational opportunities for children from low-income households and findings regarding brain plasticity and learning have resulted in the increased support for them. Our thesis provides a benefit- cost analysis (BCA) of "Parents and Children Making Connections with a Focus on Attention" (PCMCA), a specific intervention program designed by Professor Helen Neville and her colleagues in the Brain Development Lab at the University of Oregon. The goal of this project is to provide a thorough framework through which decision makers can interpret long term benefits of early childhood development programs.

In order to provide a greater understanding of our research problem, this paper will begin with a discussion of early childhood development and the problem of the "achievement gap". Following this, we will conduct a literature review which outlines the results of significant intervention programs (both past and present), to build upon

prior knowledge of the subject. We will then proceed to explain the PCMCA intervention and analyze both the program's costs and its potential benefits. This thesis will finish with a discussion of the potential setbacks and limitations of our analysis.

II. Literature Review

This section of the paper will examine past early childhood intervention programs and analyses. The section will begin with a discussion of the achievement gap and its roots in early childhood development. Following this, the section will focus on three high-quality early childhood interventions- *The Carolina Abecedarian Project, the Perry Pre- School Project and the Chicago Child- Parent Centers*- and the federally funded nationwide preschool program *Head Start*. These studies are some of the only interventions to have long term follow up data and to have been subject to rigorous analyses. The long-term nature of these studies (each has over 20 years of follow-up data) and numerous analyses of their efficacy by different researchers, gives the results found in these studies credibility. As a result, the discussion of these studies in a literature review of early childhood interventions is very relevant.

According to *An Ounce of Prevention* (2005), "The achievement gap is in essence a gap in opportunity". Nationally, in 2000, young adults living in families in the lowest income quintile were 6 times as likely to drop out of school as those in families in the highest income quintile. This disparity in achievement between low and high socioeconomic groups begins long before high school. For example, differences in

vocabulary growth between children from low and high income families can be seen as young as 18 months and by age three, the average child from a low income household knows half as many words as a child from a high income household (Ibid, 2005). More generally, the gap between readiness for entering kindergarten (measured by achievement scores as well as social skills) between children from low and high income households is significant and is shown in Figures 1 and 2 of Appendix C (Barnett & Belfield, 2006A). This gap widens still as children reach school age and by grade three there is an obvious disparity between achievement scores from children from low income and high income households (Ibid, 2006).

According to McCain and Mustard (cited in Wise [et al.], 2005), the first three years affect brain development in a way that "will affect learning health and behavior throughout life" and is key to the idea of starting off on "the right foot" when it comes to positive learning and behavioral patterns. This is supported scientifically by the idea of "Neuroplasticity." Neuroplasticity refers to the brain's ability to change (organize and reorganize) its structure as a result of internal (genetic) factors, as well as external (experiential) factors that lead to new learning" (Hodge, 2008). Apart from genetic factors, learning is highly dictated by the environment and activities in which we are involved. At a younger age brains are more "plastic" which means that young brains are more moldable and open to a better quality and higher rate of learning than older brains (Ibid, 2008). However, neuroplasticity also refers to the fact that young brains are more vulnerable than older brains which makes them more likely to be harmed by negative factors in their environment. As a result, neuroplasticity can act as a "double

edge sword" (Neville and Stevens, in press). This makes it important for there to be increased opportunity for positive influences in a child's environment.

The widening of the achievement gap and decreased plasticity of the brain with age suggest intervention at a young age to be more effective than intervention in later life. This will be assessed in our literature review empirically though looking at past interventions. Intervention early acts as a preventative method of dealing with the achievement gap by equalizing opportunities. As well, intervention in childhood capitalizes on the greater plasticity of young children's brains. Starting children off with positive experiences of learning through early intervention can put them on the right path to learning later, resulting in the multiplier effect of increased learning in later life.

The Carolina Abecedarian Project

The Carolina Abecedarian Project was an intensive model of early childhood education for poor, at risk children (Campbell et al. 2002). The program started in 1971 with a pilot study and continued in 1972 with the enrollment of 111 participants selected based on socioeconomic factors which classified them as high risk. Of these participants 57 were randomly assigned to the experimental group and 54 to the control group (Ibid, 2002). The children belonging to the experimental group were then enrolled in a full-day, full-year childcare program. These children took part in a unique curriculum which involved "educational games" with adult- child interactions such as talking to the child, showing the child toys or pictures and encouraging the child to react to his or her environment. These games were designed to develop skills in cognition, adaptive

behavior, and had a special focus on language. Additionally, these games evolved to support the increase in the child's abilities as they grew.

48 months later when the children reached school age, they were again randomly assigned to different groups for a continuation of this study for school aged children. At this stage of the study, the treatment and control groups from the preschool study were split in half and assigned to a different treatment or control group. There were now four groups: participants who had received the preschool treatment and would be receiving the school- age treatment, participants who had received the preschool treatment but would not receive the school- age treatment, participants who had not received the preschool treatment but would receive the school- age treatment, and participants who received nether the preschool or school- age treatment. Families involved in the school age intervention were assigned a "home school resource teacher" for the first three years the child was in school who would act as a link between the school and home. This intervention emphasized parental involvement in the child's learning. Individual activities based on the child's classroom needs were given to the parents every other week to provide the parents with a recommended focus area for their child (Campbell et al. 2002).

The Carolina Abecedarian project produced a number of positive results. Follow up studies measuring participants at age 21 demonstrated some of these results. Some examples of these positive cognitive and educational measures were: improved IQ scores (4.5% higher than comparable children not enrolled in the program), reduced need for special education from 48 to 25% and a decline in grade retention from 55 to

31% from the treatment versus control groups. In terms of economic well being, participants showed higher rates of workplace participation and employment in high skilled jobs as well as higher real incomes on average. Finally, in regard to health, participants showed a positive impact through the reduction of teen pregnancy rates from 45 to 26% as well as reductions in drug use (Isaacs, 2008). The program was expensive however, averaging $42,871 per child for the program making it less feasible to implement on a large scale (Isaacs, 2008).

The Perry Pre- School Project

The Perry Pre school project was another intensive preschool program aimed at benefitting higher risk children, this time in Michigan. It started in the 1960s and consisted of a sample of 123 children, 58 of whom were randomly assigned to the program and 65 to the control group. The participants were 3 and 4 year old African American children who came from a disadvantaged background (Barnett et al. 2006B). Participants took part in classes that operated for 5 days a week during the academic year (Isaacs, 2008). The curriculum consisted of the following: a center- based program for 2.5 hours per day for each weekday, home visits for 1.5 hours per weekday and weekly group meetings of parents. This program had a very low child to teacher ratio (5:1) and cost approximately $15, 000 per participant for the 2 year program (Barnett et al. 2006B).

Long term results from the Perry Pre School Project have been extensively recorded using follow up surveys given to program participants. The most recent

analysis was conducted in 1999-2002, participants were age 40. Grade retention for participants in the treatment group versus the control group was 17% to 38% and 66% of the treatment group graduated from high school opposed to 45% of the control group. Increased workplace well being was shown by higher earnings and employment rates as well as less receipt of welfare or social services by participants. In addition, Perry preschoolers were less likely to be arrested as adults and teen parenting rates fell from 83% to 57% between groups (Isaacs, 2008).

Chicago Child-Parent Centers

The Chicago Child-Parent Centers (CPC) is a federally funded preschool program currently operating at 24 sites in high-poverty neighborhoods throughout the city. The program opened in 1967 with the goals of promoting children's academic success and facilitating parental involvement in children's education. CPC's preschool program is three hours per day, five days per week during the 9-month school year, and usually includes a summer program (Reynolds, et. al., 2002). Over half of the CPC sites also offer after-school services during the first and second grade; this is facilitated by the fact that CPC's are located in or close to public elementary schools. The program is relatively low-cost: the two-year preschool program averages $6,913 per child (Isaacs, 2008).

While the costs for the centers are known, the long-term benefits of the CPC were not rigorously studied until 2002. Reynolds et. al. conducted a detailed cost-benefit analysis of the program using a sample of 1,286 children whom they tracked using the Chicago Longitudinal Study until age 21. They used a quasi-experiment in

which a comparison group was matched to a program group using "age, eligibility for intervention, and family socioeconomic status" (Reynolds, 269). While this set-up is not ideal- a true experiment with random selection and a control group would be best- the authors provide convincing statistical evidence (e.g., statistically equivalent percentages of single parent families and average Bendersky and Lewis risk index) that initially the two groups were nearly identical; this makes their results more convincing.

Their analysis found that benefits accumulated to both the individuals in the program and society as a whole. This was due to a wide range of measured differences between the two groups (CPC and non-CPC) at age 21: less grade retention, special education, juvenile detention and crime, coupled with greater educational attainment. This last fact allowed the authors to project greater differences in the future between the two groups, such as higher earnings (and thus tax payments) and lower rates of incarceration. When both measured and projected statistics are summed, a final benefit to cost ratio of 7.14:1 was calculated for the two-year preschool portion of CPC. Additionally, 1.41:1 and 6.11:1 ratios were found for the school age (first through third grade) and extended (preschool through second or third grade) programs, respectively. These findings are consistent with theories of neuroplasticity previously discussed; the earlier interventions were more cost-effective.

Table 1 summarizes the findings of the different early childhood interventions and highlights areas that these studies did not measure. These inconsistencies are an area in which this project hopes to encourage improvement.

Table 1: Measured Effects

	Effect	Perry Preschool	Chicago CPC	Carolina Abecedarian
Cognitive/Emotional	*IQ-SR*	+		+
	IQ-LR	-		-
	Behavior		-	
Education	*Achievement-SR*	+	+	+
	Achievement-LR	+	+	+
	Special Education	+	-	+
	Grade Repitition	-	+	+
	High School Graduation	+	+	+
Economic Well-Being	*Crime*	+	+	.
	Employment	+	-	+
	Welfare	+		
Health	*ER Visits*			
	Teen Pregnancy	-		+
	Illicit Drug Usage	+	+	

Key	
+	Significant positive effect
-	Insignificant effect
	Unmeasured

Head Start

Head Start began as part of the 1965 "War on Poverty" by Lyndon Johnson. It is a federally funded program that provides early childhood education and care to disadvantaged children ages three and four. It has been receiving larger amounts of funding over the years, increasing from $96 million in 1965 to nearly $7 billion in 2006

(Currie, 2001 and Isaacs & Roessel, 2008). Its goal is to ensure that all children enter school "ready to learn." Local agencies receive federal grants and provide preschool education, medical, dental, and mental health care, nutritious meals, and services for parents. Most of the programs are center-based and operate half-day during the academic year (Isaacs and Roessel, 2008). Due to the nature of the program- federal funding but local autonomy- quality of care varies significantly across the U.S.

Head Start's effectiveness is a topic of heated debate, with the consensus being that while it is not nearly as effective as the model early childhood programs (e.g., Carolina Abecedarian Project), it still produces positive but modest results. This is based on several BCAs, the most prominent being a national random-assignment evaluation that found "small to moderate positive effects for children assigned to Head Start compared to a control group of children not assigned to the program" (Isaacs & Roessel, 9). These gains were in important areas for early childhood development: pre-reading, pre-writing, vocabulary, and literacy skills, along with increased use of health care and improved parental engagement.

III. PCMCA

The Parents and Children Making Connections with a Focus on Attention pilot program (PCMCA) at the University of Oregon's Brain Development Lab is designed as an add on to the federally funded Headstart program. This is significant as it has the potential to add the high quality and attention to detail of a small-scale study onto the

breadth of outreach of a federal program. The program has two components: parent centered education and child developmental training.

The Brain Development Lab's programs have seven objectives, three for the children and four for parents. The programs aim to increase children's: self-awareness of their attentional states across environments, dynamic self-monitoring abilities of their attentional states, and overall knowledge of age-appropriate processes of attention regulation. Additionally, the parents should: increase home predictability and consistency, encourage dynamic self-monitoring for parental language and its interaction with child behavior, increase developmental knowledge for age-appropriate achievement levels to encourage positive and realistic expectations across cognitive domains, and develop a parental strategy 'tool-kit' of age-appropriate techniques to enhance child cognition and decrease child behavior problems (Neville, 2008).

From 2004- 2006, the Brain Development Lab designed 2 interventions. One, the ABC, focused on child- based learning. In this time period, the children's activities for this program were designed and developed. The other, the PCMC, a parent based intervention, was designed, developed and piloted. Further development of these programs led to the 2 integrated integrations that are being piloted now (2007-2009). These programs are "integrated" in that they contain both a parent and child training component, the difference is on the emphasis of the training. The first model, "Attention Boost for Children" (ABC) emphasizes child-based instruction; 19 hours per week are devoted to child-centered education using daily 40-minute pullout sessions during the normal Head Start day, while 5 hours are focused on parents. The second

model, PCMCA contains 16 hours of parental training and 6 hours (40 minutes per week) of child-focused sessions.

Measurement of the objectives from the interventions was conducted prior to and after 8 weeks of training. In children electrophysiological measures were employed to measure attention, syntax, semantics and behavioral measures. Language, attention, memory, non-verbal intelligence, pre-literacy, and numeracy were measured using standardized measured of IQ, language etc. After the intervention, electrophysiological changes were present as a result of increased activation in sites in the child's brain. Parent questionnaires were used to evaluate children's social competence, problem behaviors, temperament, and stress as well as to measure their own language behaviors, disciplinary behaviors, and perceived family stress.

Results from the PCMCA program were found to be more significant so it is this intervention on which the BCA will be conducted. This program was designed to be beneficial to the child in two folds: through parental training and through direct child training. Parents in the intervention were taught "evidence based strategies to improve communication with their children, promote children's critical thinking skills and to decrease family stress". Post training, parents reported lower levels of stress related to parenting and increased the use of "child directed language" which encourages higher participation by children in child- parent interactions (Fanning et al cited in Neville and Stevens, in press). Children with parents who took part in the training showed improvements in measures of language, non- verbal and IQ compared to those in the control group. PCMCA has a much shorter training time for the child than ABC.

However, positive results in the non- cognitive and cognitive measures of the child were much stronger for PCMCA children. This shows the strong role parent interactions play in shaping their child's learning habits and points again to a nurturing environment being essential for child brain development.

Intervention Analysis

To asses the benefits of an early childhood intervention, it is important that all the potential benefits that may result because of the program are being accounted for. Table 1 in the previous section shows measured effects from three big intervention programs, the Carolina Abecedarian Project, the Perry Pre- School Project and the Chicago Child- Parent Centers it can be seen that there are discrepancies between what each study has measured. Since they do not all measure the same thing, it makes comparison across the different programs difficult. For example, participants in the Perry- Pre School program displayed IQ improvements in the short run. The Chicago-Child- Parent Centers did not measure this. As a result, even if participants did display positive IQ changes not having measured this means that a potential positive result from this intervention is missing. Particularly, there is little documentation of measurements of health benefits from these three programs. This is an area which needs to be addressed as the benefits which stem from better health are large, both to the individual and to society as a whole.

Figure 3 in section 5 of this paper shows a list of all potential effects and benefits which this intervention could result in. These come from combining benefits displayed

in other interventions. Though some of these benefits may not occur, realizing that they potentially could happen is important as the data needed for their measurement can be collected from the start of the intervention and there is less likelihood of missing out on a benefit that the program has.

Effects largely occur in the short run and cannot be monetized. However, these effects later lead to benefits which can be monetized. For example, savings to taxpayers and society is important to account for. Having a list of all potential effects and benefits provides a standardization which allows for different interventions to be compared. If researchers all measure the same things the merits of each program and those which are more beneficial than others can be identified. Having this allows for the best and most effective programs to be implemented.

The Evidence Rating System

In 2005, The Australian Institute of Family Studies and the Melbourne Institute of Applied Economic and Social research collaborated and published a large scale study of how to analyze the effectiveness of Early Childhood Interventions. 108 different intervention programs from all over the world were identified. Of these 32 were selected to be reviewed and were rated based on their adequacy of design and implementation. Also, the outcomes from each of these programs were examined. Specifically the study aimed to provide a better view on how cost benefit analyses of early childhood interventions should be conducted and what necessary aspects should

be included in the design of intervention programs for this to be possible (Wise et all, 2005).

An aspect of the Australian study that is included in this project is the "Evidence Rating System". According to Sanders (2003) cited in Wise et al (2005), "Evaluations of interventions should be systematic, comprehensive and use rigorous scientific controls, such as randomized trials and sufficient statistical power, to find meaningful program effects". The Evidence Rating System provides a framework for researchers to use when designing their program so that all the factors needed for analyzing the effectiveness of their program are available. The Evidence Rating System is listed in Table 2, which also includes a brief explanation of each criteria and a column which identifies criteria which are fulfilled, to be fulfilled in later stages of the study and criteria which will be addressed in this project.

Table 2: Evidence Rating System

Criteria	*Explanation*	*Fulfilled*
1) Appropriate Evaluation Design Methodology	-Appropriate control and comparison groups to allow for BCAs to be carried out.	Yes
2) Pre- Intervention Data	- Baseline information to analyze changes as a result of implementation.	Yes
3) Intermediate follow-up and long-term follow-up	- To determine SR/ LR effects. - Follow up data should be regularly collected to do this.	*
4) Representative sample of participants in the evaluation	- Evaluation sample must be representative of the whole sample that received the intervention.	*
5) Low attrition at follow-up	- Attrition acceptable if no	*

and non-random attrition	more than 10% lost at each follow- up time point.	
6) Adequate statistical power	-Consideration of case- to-variable ratio. -Minimum of 5 participants for every characteristic measured.	*
7) Appropriate analytic approach	-Appropriate statistical techniques.	*
8) Reliable measures	- Tools to measure outcomes are standardized.	**
9) Appropriate choice of measures	- How outcomes are to be measured important for integrity of study.	**

*Not yet measurable/ to be fulfilled
** To be addressed in thesis

The first two criteria of the Evidence Rating System are accounted for in the design of PCMCA. There is an appropriate control and treatment group: Head Start kids without PCMCA treatment and Head Start kids with PCMCA treatment. Pre intervention data is available for these kids to allow for measurement of changes as a result of the intervention carried out. However, a number of criteria from the Evidence Rating System are not yet measurable. Specifically, measures 3 to 7 cannot be known until long term data are available. For instance, attrition cannot yet be determined as the program is fairly new. What is more important at this stage is acknowledging these different principles which are important design elements of intervention programs. Taking these into account during the design process and throughout the intervention allows for stronger, more accountable feedback of the effectiveness of the intervention.

The focus of this thesis will be criteria 8 and 9, Reliable Measures and Appropriate Choice of Measures. These criteria will be accounted for by providing an

explanation on how a Benefit Cost Analysis should be carried out. From the benefits side, a list of all possible benefits that could come about as a result of Professor Neville's program will be provided. In the short term, proven effects from her intervention will be looked at and in the long run benefits with a monetary value will be presented. This will be done through extrapolation by looking at results from similar interventions and applying to them to the PCMCA program. From the cost side, a calculation of costs for the current pilot program as well as cost spreadsheets for the program if it were to be implemented state wide will be carried out.

Comparative Analysis

While there have been numerous early childhood interventions, far fewer have undergone a BCA. Wise et. al (2005) report that their rigorous search of the literature yielded 108 interventions but only eight that included a BCA. This limits the relevancy of past results to our BCA; we were unable to find a perfect match for the PCMCA program in the literature. However, this paper attempts to correct for this by using comparative analysis and determining the extent to which the PCMCA replicates portions of previously studied programs.

Wise et. al categorize early childhood interventions into five "clusters": cluster 1:targeted, child focused, centre based, preschool age; cluster 2: targeted, parent focused, home visits, all ages; cluster 3: targeted, family economic/welfare focused, all ages; and cluster 4: targeted, holisitic, various locations, all ages. PCMCA fits most closely within cluster 4: it contains "parent skills training and a child education

component," (8) and is administered both at the center and at the child's home, through phone calls with parents. Out of the interventions in this cluster, only two have had previous BCA's, Carolina Abecedarian and Starting Early Starting Smart. However the latter did not include intermediate or long-term follow up data and so has limited usefulness. Conversely, the Carolina Abecedarian BCA is very thorough and includes follow-up data until the age of 21. Thus it is useful to determine the characteristics that Carolina Abecedarian and PCMCA share.

Both interventions attempt to harness the power of neuroplasticity in order to improve the lives of disadvantaged children. The Carolina Abecedarian project aimed to investigate "the malleability of impoverished children's intellectual and cognitive development given early environmental support and enrichment." (Campbell et. al, 2002) While their aims are similar, the Carolina Abecedarian was a much more intensive intervention, involving full day care for 3, 5, or 8 years (or 0 for the control group).

IV. Cost Analysis

This section will describe the costs associated with the PCMCA pilot intervention and then provide projected costs for a statewide model. This section will also analyze the costs using an economic framework from Blonigen et. al. (2008). See Table 3 for the costs associated with the pilot program, and Table 4 for the projected costs of a statewide implementation.

Before beginning an analysis of the costs, we will first clarify the pilot programs' costs (Table 3). The ABC expense (1) accounts for both the teacher ($12/hour for 27

hour) and his/her assistant ($9/hour for 27 hours). The PCMC expense (2) is due to the PCMC instructor's wage ($29/hour) and the hours worked, which consist of: 27 hours for preparation, 45 hours in the interventions, 35 hours in weekly parent phone consultations, and 9 hours in makeup sessions for a total of 116 hours. The food cost (3) is much higher than a cafeteria's meal expense because takeout is generally ordered from local restaurants in Eugene. The total cost per family for food was $292.50; this is unrealistically high. In fact, food costs make up 27% of the total costs for the pilot program. Gift cards (4) are used as incentive for the parents to attend the PCMCA sessions. A $5 card is given to each parent who attends, and each session there is a lottery drawing for one $20 gift card. Childcare expense (5) consists of three childcare staff ($9/hour for 3 hours per session), a Head Start teacher ($35 per session), and a food manager ($12/hour for 4 hours per session).

Table 3: Pilot Program Costs

Direct intervention costs			
	ABC teacher(1)	$ 567	
	PCMC instructor(2)	$3,364	
	Materials	$ 400	
Total direct intervention costs			$4,331
Administrative costs			
	Meetings	$ -	
	Coordination	$ -	
	Training	$ -	
	Recruitment	$ -	
Total administrative costs			$ -
Incentive costs			
	Food (3)	$2,340	
	Gift Cards (4)	$ 560	
	Childcare Staff (5)	$1,476	
Total incentive costs			$4,376
Total pilot program costs for one 8-week term			$8,707
Familes served			8
Average cost per Head Start family served			$1,088

It is not sufficient merely to examine the costs of the pilot program. There is a significant difference between the cost structure of the pilot program and the expected costs of a statewide

model. This disparity is due to the distinction between fixed and marginal costs. Fixed costs "do not vary significantly with the size of the program... [while variable costs] do vary with the size or the extent of implementation of the program" (Blonigen et. al., 9 (2008)). An example of a relatively fixed cost in early childhood intervention would be the salary of an administrator running the program: whether the program serves one hundred or two hundred children, she will draw about the same salary. Alternatively, teachers' salaries could be an almost fully variable cost: for every increase in eight children, another teacher must be hired. It should be noted however, that almost no cost is truly fixed; if the aforementioned program became too large for one person to manage, the administrative costs would double, as a second manager would be necessary. This is called a step cost, where the cost is fixed over a certain interval but "steps up" when the threshold is crossed. Thus, fixed and variable costs exist across a continuum; it is not usually a binary distinction between a fixed and variable cost.

The PCMCA intervention's costs range from partly fixed and partly variable to fully variable. The costs that are fully variable include ABC teachers, PCMC teachers, materials, food, and childcare staff. These costs vary in direct proportion to the number of families served; the per-family cost should be identical between the pilot and statewide programs. An additional variable cost that was not included in the pilot program was training costs (2). This analysis estimated training using a certification program. The estimate in (2) was arrived at as follows: 8,814 families in Head Start necessitate 110 PCMC teachers, assuming 6 sessions taught, per teacher, per year. Obtaining the PCMC certification will be free of charge, but the teacher instructing the certification course will be paid $29/hour. Training is estimated

Table 4: Statewide Model Costs

Direct intervention costs		
*ABC teachers**	$ 624,736	
*PCMC instructors**	$ 3,706,287	
*Materials**	$ 440,700	
Total direct intervention costs		$4,771,723
Administrative costs		
Meetings	$ 17,600	
Coordination (1)	$ 108,000	
Training (2)	$ 669,155	
Recruitment	$ 3,000	
Total administrative costs		$ 797,755
Incentive costs		
Food (3)	$ 492,879	
Gift Cards	$ -	
*Childcare Staff**	$ 1,626,183	
Total incentive costs		$2,119,062
Total program costs for statewide program in first year		$7,688,540
Familes served		8,814
Average cost per Head Start family served		**$ 872**

to last for 100 hours. In addition to PCMC instructors, 110 ABC teachers will also be needed. Their certification will take 50 hours and the instructor, less specialized, will be paid $15/hour. Thus by the beginning of statewide implementation there would be a cadre of trained and certified PCMC and ABC instructors ready to implement the PCMCA program.

In contrast to fully variable costs, this analysis determined that several costs of the program have components that are fixed in nature. Average cost of food would likely decrease in a statewide implementation, as inexpensive cafeteria food service companies would be used in contrast to take-out food in the pilot program. The food cost (3) was calculated by using cafeteria prices for the children's meals ($2/child) and slightly higher costs ($3/adult) for the adult's meals. It was estimated that a family would, on average, consist of one parent, one child, and a sibling. In addition to the fully variable costs, there are some associated costs that have a fixed component, the administrative costs. These costs were not included in the pilot program, but if they were, the average cost per child would decrease when changing to a statewide model. For example, this paper estimated two administrators would be necessary to run this addition to Head Start on a statewide basis. Administrative cost for coordination (1) was calculated for two administrators each earning $54,000. While their salaries are a significant cost in absolute terms, when they are divided amongst the 8,814 families participating in Oregon's Head Start (Department of Education, State of Oregon, 2008) they become negligible. This paper estimated yearly costs for meetings, and advertising costs to boost awareness, from Blonigen et. al. (2008)..

V. Program's Effects

This section of the thesis will look at the effects of PCMCA. We make an important distinction between "Effects" and "Benefits". Effects is a term used to describe any outcome of the intervention, both observed and unobserved, and both those that are immediate and those that are longer run. Benefits will be the effects that we can observe and measure. Though we cannot assign a monetary value to many of the effects, a causal chain stemming from these positive outcomes will allow us to estimate the potential long- run benefits of these effects. This is discussed in Section VI.

Effects from PCMCA will be presented through looking at proven results (short-run effects) which were presented in a poster by the UO Brain Development team and also by examining predicted effects (medium run effects) in which the program may result.

Proven Effects

Both children and parents enrolled in the PCMCA program have displayed positive changes in a number of aspects. In parents positive results have been reduced stress levels and more affirmative interactions with their children. In children, these have been in school readiness measures: cognition, attention and self- regulation.

A. Parent

It has been widely documented that in low socioeconomic families stress levels are higher which are associated with the use of physical discipline of children by

parents, a function largely related to parental stress (Bates et al, 2000). This treatment can result in serious neurological consequences as well as increased stress levels in children (Newton & Vandeven, 2005). Further, prolonged exposure to stress has been shown to negatively impact cognitive development and learning as child stress in at risk families is likely to be a large contributor to behavioral problems and learning difficulties (Lupien et al. 2007, Fisher & Stoolmiller 2008).

Self- reported stress levels by parents after participation in the PCMCA fell. The parent stress index used to measure this included a range of raw scores from 90 to 150 measuring stress levels. Before the PCMCA, average parental stress levels were at 119.55 on the index. Following the intervention they were at 110.10 which show a reduction of approximately 9.15 points post intervention. On a similar index measuring Family stress levels, where the range of the index was 180 to 240, a reduction of 17.5 on the stress index was observed. This is a much greater fall than was seen in parent stress levels alone and reinforces how much of an influence parental stress could have on child stress levels.

A large portion of the parent training in the PCMCA was for parents to be more child directed in their expressive language. Improvements in this area help to boost a child's attention. Three measures of this were: Utterance length, Lexical Diversity and Speech Length. A Higher Mean length of Utterance (MLU) is associated with the use of more syntactically complex language which is associated with greater language proficiency. It has been shown that the best model for a child's learning of language is for the parent's MLU to more closely match the child's MLU. PCMCA parents reduced

their MLU from 5.11 to 4.53. Related to this, speech rates of parents' fell from 61.36 to 49.66 words per minute, again facilitating child linguistic learning. Lexical Diversity refers to the range of a person's vocabulary and is measured by the Type- Token Ratio (TTR). The TTR is the ration of different words (type) to the total number of words (token). Parents in the PCMCA showed an increase from 0.37 to 0.40 in their TTR.

B. Child

Three measures of child cognition that have shown measured improvements with PCMCA training are Non- Verbal IQ, Receptive Language, and Regulation. Children in PCMCA had increased non- verbal test scores from 102.68 to 113 on the Standford Binet (a standardized test of IQ). They also displayed an increase in receptive language scores from 91.95 104.74 which was measured by the CELF- 4 (a language assessment method). Therefore in terms of IQ in the short run and better usage of language, children in the PCMCA program showed significant improvements.

The third measure of child cognition, regulation, was measured by the number of behavioral problems in children over a 5 day period. The number of behavioral problems in children who were enrolled in the PCMCA program fell 51 to 35 over the 5 day period. The significance of this was described by Blair (2002) where it was expressed that children who have difficulty in regulating their emotions generally have difficulty in developing higher order processes such as attention, memory and problem solving.

A child's early academic skills are some of the components of school readiness. According to *An Ounce of Prevention* (2005), by age three a child from a low income

household knows half as many words as a child from a high income household. More generally, the gap between readiness for entering kindergarten between children from low income and high income households, measured by achievement scores in pre- math and pre- reading as well as social skills, is large (Ibid, 2005). Children in the PCMCA program showed increased accuracy in pre- numeracy and letter identification. Children were able to identify 53% of letters post intervention as opposed to 32% pre-intervention. As well, early development assessments of numeracy showed an increased percentage of accuracy pre to post test from 42 to 57% (Fanning et al, 2009).

Predicted Effects

Predicted effects are benefits which occur in the medium run. They are the stepping stone between the positive short run effects that the PCMCA has had and the long run benefits which could possibly occur and which will be monetized in the next section. Predicted effects will be reasoned out by looking at past interventions such as the Perry pre school project and the Carolina Abecedarian.

Interventions such as the Carolina Abecedarian project and the Perry Pre- school project showed positive IQ gains in the short run. However, this effect is argued by many researchers to fade in the long run (Isaacs, 2008). Despite this, the programs found there to be less grade repetition and higher rates of high school graduation in treated subjects in the respective programs versus those in the control groups. Participants in the PCMCA displayed similar characteristics to participants in the Carolina Abecedarian and the Perry- Pre school projects. School readiness measures

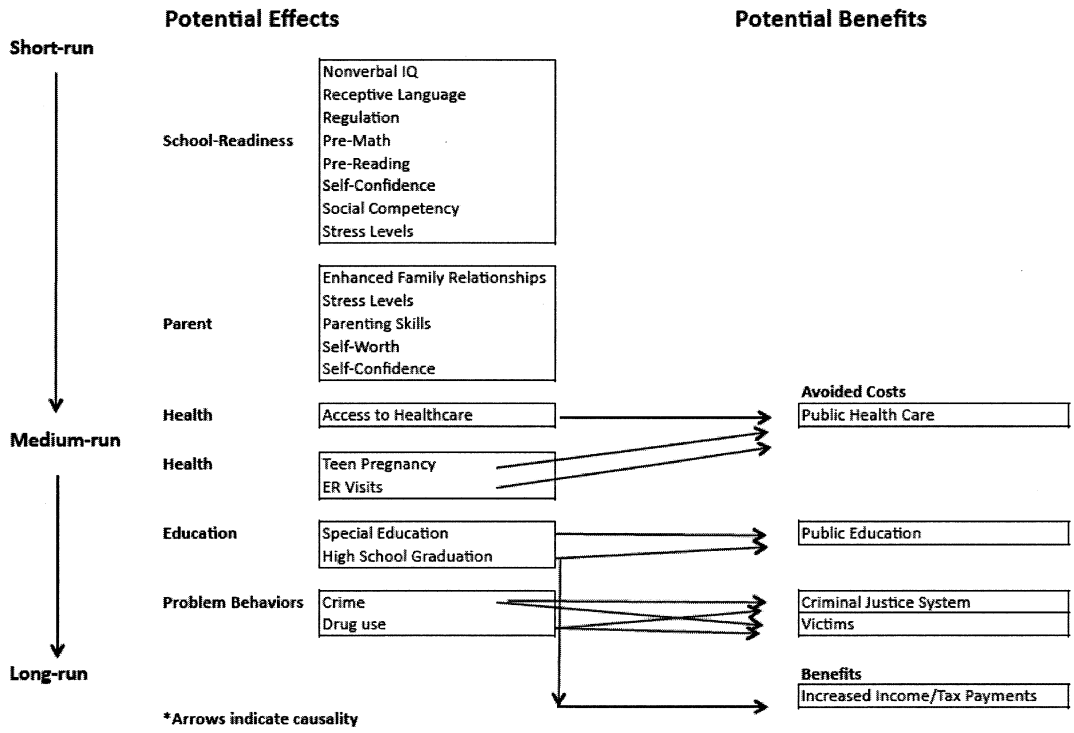
such as pre- math and pre- reading as well as social competency are some of these similarities. An indicator of achievement later in life is related to self- regulation. According to Blair (2002), there is a correlation between emotionality and cognitive development. A survey of teachers found that they thought of children as more ready to learn and when they have better regulation of their emotions rather than more strictly cognitive measures. Children in the PCMCA program displayed less behavioral problems than those in the control group. By having better regulation of their emotions and being more ready to learn, children may have better achievement in the short run which could lead to higher long term achievement translating to higher graduation rates and a lower need for special education.

In terms of health, females in the treated group of the Carolina Abecedarian project displayed lower rates of teen pregnancy than those in the control group and illicit drug use by participants in the Perry Pre school project was less than that of the control group. These are also related to problem behavior. If problem behavior is lessened in the short run, it does not have the chance to compound over the years and translate into crimes, leading to high costs to society. If effects from participants in the PCMCA are similar to those in the Carolina Abecedarian and the Perry pre school project, it is possible that teen pregnancy rates may fall in treatment groups and problem behavior in later life such as crime and drug use may fall.

Figure 3 below depicts the effects and benefits in which the PCMCA program may result. It lists the short term effects which participants have experienced and how that may translate to medium run effects. These medium run effects can then be

reasoned out to long run benefits which are largely seen as avoided costs to society. Researchers have assigned monetary values to these avoided costs. Arrows indicate causality between effects and benefits.

Figure 3: Effects and Benefits



VI. Benefit Analysis

The PCMCA's intervention strategy is very new; it started last year. As such we will not have the follow up data to be able to directly measure long-term benefits stemming from the effects described in the previous section. In addition to this, in our research process we have found comparison of the benefits across the different intervention programs to be difficult as at the time the interventions took place,

researchers were testing different hypotheses. Our thesis provides a comprehensive framework for examining all the benefits of the PCMCA intervention strategy, and will aid the program in identifying and measuring benefits as the program matures.

The lack of long-term follow-up data from early childhood interventions has made it difficult to analyze the benefits of these programs. The Perry Pre- School, Carolina Abecedarian and the Chicago Parent Center programs are the majority of the handful of programs where long-term data are available. The problem is that analyses of the programs did not measure the same things or look for benefits in the same areas. For example, participants of the Carolina Abecedarian and Perry- preschool program both displayed positive effects on their IQs in the short run; the Chicago Child Centers did not measure this. In terms of economic well being, the Perry preschool program had positive significant impacts on crime rates, employment, income and reduced welfare payments. On the other hand improvements in income were not measured in analyses of the Chicago Child Centers, and crime rates were not measured in the Carolina Abecedarian program. Neither analyses of the Chicago Child Centers or the Carolina Abecedarian included the impact on welfare payments. The discrepancy in what was measured in analyses of the different programs complicates comparisons of the benefits across programs and results in underestimating potential benefits. Overall, researchers cannot comment directly on effects for traits that they do not measure.

Predicted Benefits

While the PCMCA program has demonstrated success in improving the measurements of both cognitive and non-cognitive skills, these enhancements do not themselves have an immediate monetary value. In order to assign a dollar amount to the benefits of this early childhood intervention program, it is necessary to either measure differences between the treatment and control groups decades after the initial study, or extrapolate expected benefits based on the outcomes of similar programs. This analysis chooses the latter course due to the extremely lengthy time horizons necessary to fully compute all of the benefits from an early childhood program; ideally, researchers would keep in contact with every participant in both treatment and control groups (and document any differences) for the entirety of their lives. This paper will analyze the results of previous BCAs and determine which benefits may be reasonably expected to accrue from this intervention. The primary BCAs will be those done on Carolina Abecedarian (Barnett and Masse, 2005), Perry Preschool (Belfield et. al., 2005) and Chicago Child-Parent Centers (Reynolds, et. al., 2002).

These interventions each lasted one or two years, but the BCAs used follow-up data from participants for many years after their childhood. Their time frames for the Carolina Abecedarian, Perry Preschool, and Chicago Child-Parent Center BCAs were twenty-one years, forty years, and twenty-one years, respectively. This allowed the analyses to document observed changes in such variables as crime rates, reported drug usage, and salary. Differences in these characteristics between the treatment and control groups were converted into monetary benefits to society. The following section will first discuss the benefits that the previous BCAs have found, and then will project,

with certain assumptions, the benefits that could be expected to arise in the future from children enrolled in the PCMCA intervention.

As discussed in the previous section on effects, increased educational attainment is commonly shown to occur with participation in an early childhood education program. While staying in school longer is beneficial for the critical thinking and other skills one develops, it is relevant to an economic analysis because of the relationship between education and wages earned.

Based on the demonstrated relationship between education and wages (Miller and Hornseth, 1967), Barnett and Masse (2005) estimate that the Carolina Abecedarian intervention's positive effect on children's educational attainment is worth $37,531 per child. In order to fully account for this benefit, they also subtract the added cost of education, $8,128, for a net educational benefit of $29,403. The Chicago CPC study found an even stronger increase in educational attainment than in the Carolina Abecedarian intervention; benefits in the form of increased tax payments due to higher projected wages (as a result of proven increase in educational attainment) amounted to $64,673 per participant (Reynolds, et. al., 2002). In the Perry Preschool analysis, data were available on the participants through age 40. The authors found that "the program group is more likely to be employed, has higher earnings, and relies less on economic support from family or friends" (Belfield, et.al, 166). Using a 3% discount rate, the study calculated a total of $72,960 per participants from increased education, higher wages, and subsequent tax payments.

High-quality early childhood interventions have produced significant benefits to society through improving the earnings profiles of their participants. The three previously mentioned studies documented changes in high school graduation and two year and four year university attendance. This makes for a more productive workforce and is captured by the increase in wages.

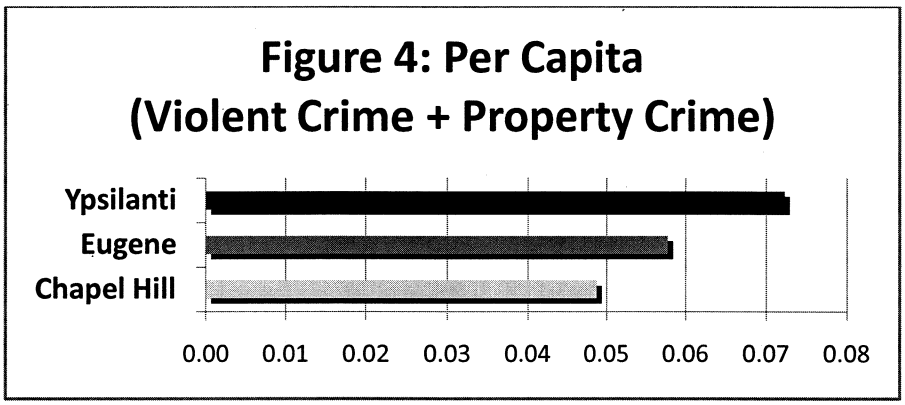
Predicted avoided costs

In addition to the explicit benefits that have been found in early childhood programs, there are implicit benefits by way of avoided costs. These are often a majority of the documented benefits in early childhood programs. These interventions aim to improve the children's lives and thus steer them away from crime and drugs. Thus, the primary avoided costs that have been found for these programs have been from the criminal justice system, health care, and public education.

A. Criminal justice system

Crime poses a cost both to victims and taxpayers. Victims endure pain and suffering, while taxpayers foot the bill for prosecuting and jailing criminals. Thus, a reduction in criminal activity would be a valuable benefit to society. Early childhood programs vary in the degree to which they have been able to demonstrate reduction in crime. In the Carolina Abecedarian BCA, no significant difference was found between treatment and control groups. However, in the Perry Preschool Project follow-up researchers found strong differences in crime rates for the treatment and control

groups (Belfield et. al. 2005) leading to an estimate of a reduction in costs of $378,440 to society. These avoided costs are a significant reason why the Perry Preschool BCA



If both programs were successful early childhood intervention programs, why was there such a difference in crime reduction? Barnett and Masse (2007) suggest two possible answers: differences in the curriculum or differences in the environments. The former explanation might explain some of the difference, but since the curricula are not quantifiable, this paper will focus on the latter. Barnett and Masse (2007) observed that Chapel Hill, NC (the site of Carolina Abecedarian) has relatively low crime rates, especially when compared to Ypsilanti, MI (Perry Preschool), whose crime rate is 70% higher. This difference led to the suggestion that in Chapel Hill, "there simply was not much crime to prevent." (Barnet and Masse, 121) In order to determine how Eugene compared with Chapel Hill and Ypsilanti this paper used the FBI's database of crimes (2006) to analyze the per capita rate of violent and property crimes. Chicago was excluded because according to the FBI's website "The data collection methodology for the offense of forcible rape used by the Illinois state UCR Program (with the exception of Rockford, Illinois) does not comply with national UCR Program guidelines. Consequently,

their figures for forcible rape and violent crime (of which forcible rape is a part) are not published in this table." Eugene's crime rate falls in-between the two cities', as depicted in Figure 4.

B. Health Care

There have been significant health benefits found from previous early childhood interventions. Teen parenting rates for the treatment group in the Carolina Abecedarian intervention were 26% compared to 45% in the control group. Single motherhood rates for female participants in the treatment group in Perry Preschool were 57% in contrast to 83% in the control group. Carolina Abecedarian participants smoked less frequently, leading the researchers to project benefits of $17,800 due to the increase in years employed (Barnett and Masse, 2007). Another potential benefit that has not yet been measured is a reduction in emergency room (ER) visits. These visits are costly to the taxpayer; the average cost of an ER visit by an uninsured person, borne by taxpayers, is $1000 (Roser, 2009).

C. Public education system

Early childhood programs have achieved cost-savings for public educational institutions through decreasing the amount of grade repetition and the placement of students in special education. Repeating a grade adds another year of costs for the school, while special education, as compared with standard curriculum, is more expensive because it is resource and time intensive. Many high-quality early childhood

programs developed the children's cognitive and non-cognitive skills to such an extent that the treatment group had significantly less grade repetition and special education. In the Carolina Abecedarian BCA, the rates of grade retention decreased from 65% to 34%, and placement in special education fell from 49% to 31%, when the treatment group was compared with the control group (Barnett and Masse, 2007). This resulted in significant cost savings to society, calculated at $8,836 per child. The Chicago Child Parent centers also found significant improvements on both measures, yielding an avoided cost of $5,971 per child (Reynolds, Temple, Robertson, and Mann, 2002). Additionally, Perry Preschool Program improved the outcomes of its participants, and calculating a savings of $8,434 per child (Belfield, Nores, Barnett, Schweinhart, 2005).

Benefits of PCMCA

This section will produce monetary estimates of specific benefits that could be expected to arise from the PCMCA program. Several assumptions are needed, the first being proportionality. This intervention will be significantly shorter than previous high quality early childhood interventions; it lasts eight weeks compared to one or two years. Due to this difference this paper will assume that, for example, an eight-week intervention will produce half of the benefits of a comparable sixteen-week intervention. This is a strong, but necessary assumption. The second assumption will be scalability. The short-term improvements in the children's cognitive and non-cognitive measures found in the pilot study will (we will assume) be replicated if the program is adopted on a larger scale, in this case, statewide. A final assumption relates to the

population of children in the study as opposed to the state of Oregon Head Start participants as a whole. The treatment and control groups in the pilot differ in a significant way from Head Start children in that in the experiment they are all right-handed, primary English speakers with no significant emotional or cognitive impairments. Thus the gains these children experienced as a result of the intervention will be assumed, not proven, to extend to the other Oregon Head Start children.

With these assumptions given, this paper calculated the following benefits. Our results are displayed in Table 5.

Table 5: PCMCA (3% Discount Rate) 8 Week Program

Cost	$ 872
Benefits	
Participants' Future Earnings	$ 1,155
Earnings of Future Generations	$ 176
Maternal earnings	$2,115
K-12 education	$ 272
Smoking/health	$ 547
Higher education costs	$(250)
Aid to Families with Dependent Children (Welfare Payments)	$ 6
Crime	$4,234
Childcare	$ 113
Total Benefits	$8,368
Net Present Value	$7,496
Benefit:Cost Ratio	**9.6:1**

Participant earnings, Earnings of future generations, maternal earnings, K-12 education, smoking/health, higher education costs, and welfare payments were calculated using the data from Barnett and Masse's (2007) BCA on the Carolina Abecedarian program. See table of comparative BCA's (Table 6) for data. This program was chosen due to its similarity to PCMCA in terms of type of intervention, foci/benefit, intervention location, and focal age of children. Our assertion is based upon the classifications used in (Wise et. al., 2005). We scaled the benefits to account for the discrepancy in the length of the

programs: Carolina Abecedarian lasted five years, while PCMCA lasts eight weeks. We divided the benefits found from the Carolina Abecedarian program by 32.5 to change a five-year program (260 weeks, or 32.5 sets of 8-week intervals) into a comparable 8-week intervention.

For benefits due to reduced crime, we found that Eugene's crime rate falls in between Chapel Hill, N.C. (site of Carolina Abecedarian) and Ypsilanti, MI (site of Perry Preschool). We therefore decided to compute the average across the two BCAs and again scale the benefits to an eight-week time frame. The two BCAs differed in the way in which they accounted for childcare: Carolina Abecedarian subtracted the cost of childcare from its costs, while Perry Preschool added the cost of childcare as a benefit to the family. While the two approaches should yield similar results, we decided to use the Perry Preschool's method and count the childcare as a benefit to parents. We used the Perry Preschool's benefits of childcare and scaled them to an eight-week program (also should find hourly cost of childcare in Oregon (multiply by 16) to make estimate more accurate).

Due to the importance of the Carolina Abecedarian and Perry Preschool BCAs to our calculations, they are presented, along with the PCMCA in Table 6. This facilitates comparison between the three programs.

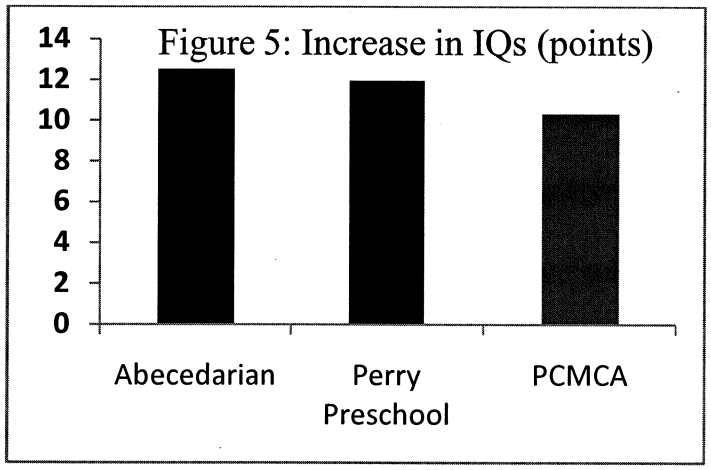
Table 6: Comparative BCAs of Early Childhood Interventions

	Carolina Abecedarian	Perry Preschool	PCMCA
Cost	$35,864	$15,166	$872
Benefits			
Participant Earnings	$37,531	$64,526	$1,155
Earnings of Future Generations	$5,722		$176
Maternal Earnings	$68,728		$2,115
K-12 Education	$8,836	$8,434	$272
Smoking/health	$17,781		$547
Higher Education Costs	-$8,128	-$1,290	-$250
Welfare Payments	$196	$763	$6
Crime	$0	$171,473	$4,234
Childcare	*	$906	$113
Total Benefits	$130,666	$244,812	$8,368
Net Present Value	**$94,802**	**$229,646**	**$7,496**
Benefit:Cost Ratio	**3.64:1**	**16.14:1**	**9.6:1**

So far, we estimated benefits under three assumptions: proportionality, scalability, and the similarity of the sample to the population of Head Start children. In particular, the assumption of proportionality allowed the paper to adjust the benefits found in the longer studies to the shorter time span of the PCMCA intervention. However, these studies have all measured changes in the children from the beginning of their interventions to the end. Instead of assuming similar efficacy, we could instead compare the changes in the children over the different interventions. If a shorter program achieved the same effects as a longer program, then the benefits should not be reduced to account for the reduced length. Ideally, each program would use the same tests and indices to measure the children before and after the interventions. However, as the study of children's brain development has changed and progressed, so have the tests and scales. The PCMCA uses Evoked Response Potential to measure a number of

its outcomes through analyzing brain activity patterns. This consists of measuring the activity in the brain after exposure to stimuli. For example, if researchers wanted to measure children's attention, they could use this technology to determine whether each child listening to a story has activation in the relevant neurological area. During the time of the Abecedarian and Perry Preschool interventions, this type of measurement was not possible.

The Carolina Abecedarian, Perry Preschool, and PCMCA measured children's development in very different ways, but there was one scale used by all three: the Stanford-Binet intelligence quota test. This score allows comparison of the three programs independent of their size, location, or duration. Figure 5 presents the measurements for the three different programs.[1] These results indicate that using the proportionality assumption would lead this analysis to underestimate potential benefits from the PCMCA program. Although the PCMCA's duration is less than 10% of the Perry Preschool's, their benefits to the children's IQ scores were only 2 points less. Using only this measure of efficacy, we would reduce Abecedarian and Perry Preschool's benefits by a smaller degree than we did using duration as a scaling factor.



[1] See Appendix D for a complete table of IQ changes from the three programs

Although the results from comparing IQ scores are encouraging, we decided to use the more conservative approach to estimating benefits, scaling based on duration. Improving the child's IQ score is one of many goals of the PCMCA program, and we felt it was inappropriate to focus only on this measure. In fact, the use of IQ as the only measure of comparison is flawed because the short-term IQ gains generally fade out as the children grow older. In both the Abecedarian and Perry interventions, the initial improvements in IQ for the treatment group were lost over time: in the Perry intervention, by the beginning of the third grade the IQs of the treatment and control groups were nearly identical. This suggests that the differences in the two groups later in life (e.g., high school graduation rates, income) were not due solely to increases in IQ. This is unsurprising, as a multitude of factors affect a child's development. The interventions improved many of them, resulting in the later differences between the treatment and control groups. Unfortunately, the changes in the many other factors involved in a child's future well being, including regulation, attention, and language, could not be compared across the programs. The use of newer tests in the PCMCA design are a result of advances in the field; comparing their results to those of the tests from the 1970's amounts to comparing apples to oranges.

VII. Summary and Conclusion

This paper has illustrated a significant problem in American society: the achievement gap. Findings in neuroscience offer a deeper understanding of this issue.

Although traditional statistics demonstrating this gap focus on differences in high school dropout rates or income earned as an adult, neuroplasticity suggests the gap begins much earlier. Young brains have a greater capacity to learn, but are also more susceptible to damaging experiences that impair the child's ability to learn throughout his or her life. Research has demonstrated that programs addressing societal ills such as crime and poverty are most effective when they are targeted towards at-risk children; an ounce of prevention is worth a pound of cure. There have been numerous early childhood interventions that have attempted to improve the lives of at-risk children. However, few of these studies produced sufficient data to prove their effectiveness. The three major American studies, the Carolina Abecedarian, Perry Preschool, and Chicago Child Parent Centers, are some of the only studies with sufficient long-term data to demonstrate benefits to society based on high quality early childhood intervention. Each of these studies were subject to thorough BCAs and were found to have significantly positive net benefits.

The Brain Development Lab's prior research found parental education to be more effective than child training alone. They designed a holistic hybrid intervention, the PCMCA, that aimed to improve a child's school readiness through two different approaches. The first approach was direct, targeting the child through cognitive training with a focus on attention; the second approach was indirect, aiming to improve the child's environment by providing parents with exercises and techniques designed to aid the child's development.

This paper adopted many of the criteria developed by the Australian Government, to properly design and analyze an early childhood intervention. The list of design criteria was named the "Evidence Rating System" and documented 9 necessary aspects to be incorporated into the design of an early childhood intervention. The PCMCA does not yet fulfill a number of these criteria because of the lack of long term data. Therefore many of the criteria will have to be addressed in the future. This paper focuses on fulfilling 2 of the criteria: Reliable measures and appropriate choice of measures. The study used extensive data and analyses of past interventions to classify them into categories based on type of intervention, foci/ benefit, intervention location and focal age of children. From this, the interventions were placed in different clusters: the PCMCA most resembles interventions in cluster 4: parent skills training with a child education component.

Participants in the PCMCA have displayed positive results from the training. In parents there were lower reported stress levels and improved language and communication skills with their child. In children, improvements in non- verbal IQ, receptive language, regulation, executive function, pre- math and pre- reading skills were found. These short term proven effects can be translated into medium run effects such as less special education, higher educational attainment, less drug use and lower rates of pregnancy. Extrapolation to obtain these medium run effects largely came from what was shown in past intervention programs and studies showing the link between early learning and these social trends.

A large component of this project was to provide a systematic way for researchers to account for benefits. Though benefits from the PCMCA program specifically cannot be discussed in the long run as long term data is not yet available, it has been useful looking at other early childhood interventions to gage what possible benefits could be. Through examining measured benefits from a number of past interventions, we have provided a list of potential effects and benefits (Table 1, Appendix D) that PCMCA could have on participants. This we hope will provide a solid outline for researchers in early childhood development to account for more possible benefits and reduce the likelihood of not measuring something that may be significant.

While long-term data for PCMCA is not available, this paper provided a BCA through comparative analysis of similar early childhood interventions. We presented costs for the pilot program, and projected costs for a statewide implementation using economic analysis. After estimating costs, we began to investigate benefits. Using both the Carolina Abecedarian and Perry Preschool projects' extensive BCAs, the authors estimated and monetized the potential benefits from the PCMCA program. In order to extrapolate benefits, the authors made three key assumptions: proportionality, scalability, and the generalization that gains made by the treatment group would be shared by Head Start participants as a whole. After making these assumptions and estimating benefits, The statewide costs were compared to the previously calculated benefits and the authors found a benefit:cost ratio of 9.6:1. This suggests that investment in the PCMCA program on a statewide level would produce many times the benefits of its costs, provided the assumptions this paper made in calculating the

benefits were accurate. While extremely positive, this figure is not unrealistic; due to neuroplasticity investments in early childhood education have shown to be more effective than interventions later in life. Furthermore, the improvements in the children's IQ scores in the PCMCA intervention were only marginally less than the improvements after the much longer Abecedariand and Perry Preschool interventions. This suggests that the PCMCA is a more effective intervention, and scaling down the benefits based on duration may lead to underestimation of true benefits. However, we found that scaling based on duration accounted for several other factors in addition to IQ scores and so provided a more comprehensive way of scaling the interventions. Nevertheless, our final estimate, although very positive was almost certainly on the conservative side. By harnessing the power of compounding experiences, early childhood interventions continue to accrue benefits for the child throughout his or her life.

VIII) Limitations, Suggestions for Future Research

This paper has provided an overview of the early childhood education literature and relevant BCAs. However, the authors were unable to find an intervention with a comparatively short (eight weeks) time frame. This made comparative analysis subject to some strong assumptions; assuming a five year program will be proportional in its effects to an eight-week program is not necessarily accurate. Additionally, the assumption that gains shown by participants in the pilot program will translate into all

of Oregon Head Start children is strong. The children in the pilot program were all right-handed, native speakers of English, and had no significant cognitive impairments. Children in Oregon's Head Start program are a much more diverse group than that. It is far from certain that the gains shown by the children in PCMCA could be duplicated in a less homogenous group of children.

Secondly, though we tried to include all of the potential benefits that had been measured in other programs, it is important to note that there are other benefits which have been missed in this analysis. For example, this paper did not discuss effects of better childhood education on the child "spilling over" and also benefiting others. This could occur through their more positive interactions with classmates, siblings, and parents. How to monetize this would be a question for further research.

In the cost analysis, some of the costs (such as training, advertising, and administrative) in the statewide implementation were adopted from Blonigen et. al (2008). While this is a reasonable accommodation, it would have been more realistic to use actual costs from the PCMCA. However, the PCMCA pilot program's costs were not exhaustive: the pilot program did not account for administrative, training, or advertising costs. Furthermore, the method of training that would be used if the program were adopted on a state-wide basis has not been determined. Different training programs could have vastly different cost structures than the training costs estimated in our paper.

Future researchers in early childhood education should focus on attempting to capture all of the potential benefits of a program. As this paper demonstrated in Section

IV, measurements have been inconsistent across programs; this has almost certainly led to systematic underestimation of benefits. Secondly, in the development stages of their pilot programs, researchers should account for all of the costs in implementing the program, including hours spent training staff members and working on administrative tasks. This will facilitate the development of an appropriate cost structure for not only their current program but also for a larger scale implementation.

Works Cited and Consulted

Barnett W.S., & Belfield C. R., (2006A) "Early Childhood Development and Social Mobility", *The Future of Children,* Vol. 16, No. 2, Fall

Barnett S, Belfield C R, Nores M, Schweinhart L., (2006B), "The High/ Scope Perry Preschool Program: Cost- Benefit Analysis Using Data from the Age- 40 Followup", *The Journal of Human Resources,* Vol. 41.

Barnett, W.S., Masse, L., (2005), "Comparative benefit-cost analysis of the Carolina Abecedarian program and its policy implications." *Economics of Education Review,* 26, pp 113-125.

Bates J.E., Dodge K.A., Pettit G.S., Pinderhughes E.E., (2000), "Discipline Responses: Influences of Parents' Socioeconomic Status, Ethnicity, Beliefs About Parenting, and Cognitive Emotional Processes", *Journal of Family Psychology*, Vol 14. No 3, pp 380-400.

Belfield, Clive., Nores, Milagros,. Barnett, Steve., Schweinhart, Lawrence, (2006), "The High/Scope Perry Preschool Program Cost-Benefit Analysis Using Data from the Age-40 Followup." *The Journal of Human Resources*, XLI, 162-190.

Bier man K.L., Nix R.L., Greenberg M.T., Blair C., & Domitrovich C.E., (2008), "Executive functions and school readiness intervention: Impact, moderation, and mediation in the Head Start REDI program", *Development and Psychopathology*, Vol. 20, pp 821-843

Blair, Clancy, (2002), "School Readiness: Integrating Cognition and Emotion in a neurobiological conceptualization of children's functioning at school entry." *American Psychologist*, 57, 111-127.

Blonigen, B., Harbaugh, W., T., Singell, L., D., & Horner, R., H., (2008) "Application of economic analysis to school-wide positive behavior support (swpbs)" programs. *Journal of Positive Behavior Interventions*, 10, 5-19.

Campbell F. A, Ramey C.T, Pungello E, Sparling J, Miller- Johnson S., (2002), "Early childhood education: Young Adult Outcomes From the Carolina Abecedarian Project", *Applied Developmental Science,* Vol. 6, No1, pp42-57

Cohen, Mark, (1998), "The Monetary Value of Saving a High-Risk Youth." *Journal of Quantitative Criminology*, 14, 5-32.

Currie, J (2001). "Early childhood education programs", *Journal of EconomicPerspectives*. 15, 213-238.

Da Silva L, Webster E, Wise S, Sanson A, 2005, "The Efficacy of Early Childhood Interventions", *Australian Government: Australian Institute of Family Studies*

Fanning J.L., Currin J., Klein S., & Neville H.J., (2009), "Enhancing Neurocognitive Function in Head Start Preschoolers: Comparing the Efficacy of Two Attention Training Programs", *University of Oregon, Dept of Psychology- Brain Development Laboratory*

Fisher A.P. & Stoolmiller M., (2008), "Intervention effect on foster parent stress: Associations with child cortisol levels", *Development and Psychopathology,* Vol. 20, pp1003-1021

Heckman, J. (2006). "Skill formation and the economics of investing in disadvantaged children", *Science*, 312, 1900-1902.

Hodge M, (2008), "What is "neuroplasticity" and why do parents and SLPs need to know", 2 May

Isaacs, Julia. [Ed.] (2008). "Impacts of early childhood programs." *Brookings Institute*

Lupien, S.J., Maheu, F., Tu, M., Fiocco, A., & Schramek, T.E. (2007). The effects of stress & stress hormones on human cognition: Implications for the field

Morrissey T W. & Warner M.E. (2007), "Why Early Care and Education Deserves as Much Attention, or More, that Prekindergarten Alone", *Applied Development Science*, Vol. 11, No. 2, 57-70

Neville, H. (January 2008) IES Executive summary, 1-8.

Neville, H. (November 2008) Interim progress update, 1-2.

Newton A.W., & Vandeven A.M., (2005), "Update on Maltreatment with a special focus on Shaken Baby Syndrome", *Current Opinion in Pediatrics,* Vol. 17, Issue 2, pp246-251

Ramey, C.T. & Campbell, F.A. (1984), "Preventive education for high-risk children: cognitive consequences of the carolina abecedarian project." *American Journal of Mental Deficiency*, vol. 88, no. 5, pp. 515-523.

Rayner S.& Riding R.J., (2001), *Self Perception*, Greenwood Publishing Group, USA

Reynolds, A.J., Temple, J.A., Robertson, D.L., & Mann, E.A. (2002). "Age 21 cost benefit analysis of the title I Chicago child-parent centers". *Educational Evaluation and Policy Analysis*, 24, 267-303.

Roser, Mary. (April 1, 2009), "Task force seeking ways to divert non-emergencies away from emergency rooms". *Austin American Statesman*, Austin, Texas.

"Starting Early to Close the Achievement Gap", 2005, *Ounce of Prevention Fund,* Chicago

Stevens, C. and Neville, H. (in press). Profiles of Development and Plasticity in Human Neurocognition. In M. Gazzaniga (ed.), The Cognitive Neurosciences IV

Weikart D.P., Deloria D.J., Lawser, S.A., (1970), "Longitudinal Results of the Ypsilanti Perry Preschool Project", *U.S Department of Health, Education & Welfare Office of Education*, Final Report, Vol. 2 (of 2)

Wise, Sarah., Silva, Lisa., Webster, Elizabeth., Sanson, Ann, (July 2005), "The efficacy of early childhood interventions." AIFS Research Report, 14.

Yaillen, J., Blair, N. (2006). "A benefit cost study of a new preschool program based on neuroplasticity". Retrieved from: http://economics.uoregon.edu/honors

BCA Statistical References

Oregon Head Start Statistics:

U.S. Department of Health and Human Services,(2009), "Head Start Program Fact Sheet Fiscal Year 2008" and "FY 2007 Head Start Program State Allocations and Enrollment." Retrieved from:

http://eclkc.ohs.acf.hhs.gov/hslc/About%20Head%20 Start/dHeadStartProgr.htm

Oregon Head Start Enrollment data:

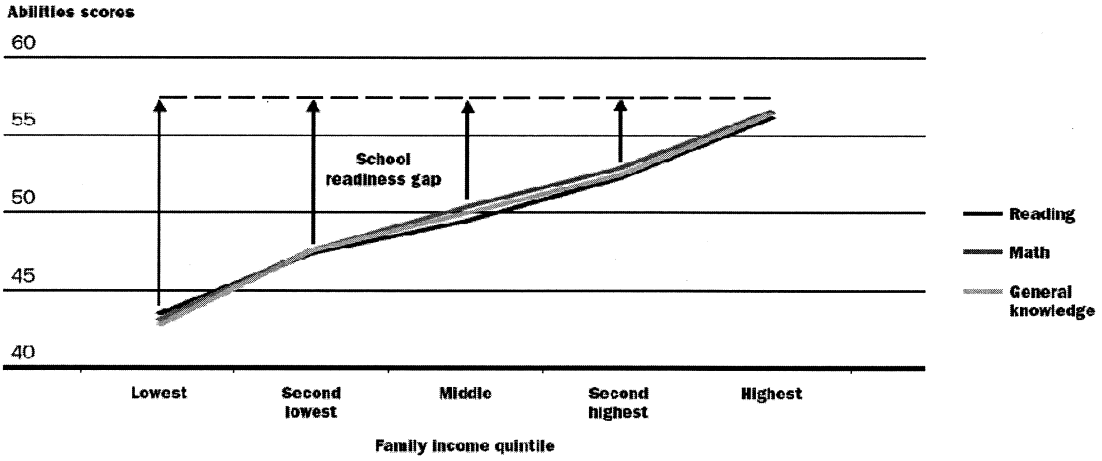
State of Oregon Department of Education. Education Subcommittee, Benchmark and Key Performance Measure Data, March 2009. Retrieved from Oregon.gov

Meal estimates:

Bryan ISD School Nutrition Services, pricing information obtained from http://www.bryanisd.org/default.asp?pageID=181

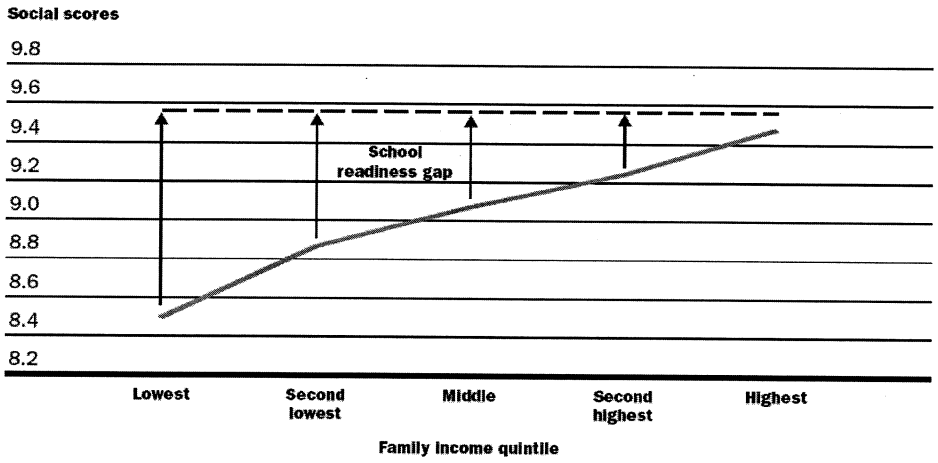
Appendix C

Figure 1. Abilities of Entering Kindergartners, by Family Income, National Data, Fall 1998 (reported by NIEER from ECLS-K)



Source: W. Steven Barnett, Kirsty Brown, and Rima Shore, "The Universal vs. Targeted Debate: Should the United States Have Preschool for All? *Preschool Policy Matters* 6 (New Brunswick, N.J.: NIEER, 2004).

Figure 2. Social Skills of Entering Kindergartners, by Family Income (NIEER Analysis of ECLS-K)



Source: See figure 1.

(Charts cited in Barnett et. al 2006A)

Appendix D

Comparative Changes in Stanford-Binet IQ Test*

	Abecedarian		
	Control	Treatment	Difference
2 Years Old	84.79	95.88	11.09
3 Years Old	84.27	100.7	16.43
4 Years Old	89.19	101.7	12.51

	Perry Preschool		
	Control	Treatment	Difference
After 1 Year	83.4	95.8	12.4
After 2 Years	82.7	94.7	12
After 3 Years	85.4	90.5	5.1

	PCMCA
Difference between pre/post in treatment group	10.32

Control Groups scores remained constant

*Scores in Grey were used in our analysis