



Center for School, Health and Education


Public Health Capacity Building Assistance for SBHC Leaders
A CDC Funded Learning Series



The Impact of Poverty on Brain and Cognitive Development in Elementary School-Aged Children


Presented by
Kathryn Hanling
Center for School, Health and Education
American Public Health Association





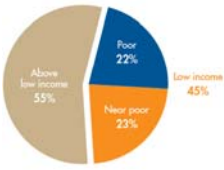
The Impact of Poverty on Brain and Cognitive Development in Elementary School-Aged Children

Center for School, Health and Education
Kathryn Hanling
July 28, 2015



The Impact of Poverty on Brain and Cognitive Development in Elementary School-Aged Children
Project Motivation

Figure 1: Children in middle childhood by family income, 2013




There are more than 24 million children in middle childhood (age 6 through 11 years) in the United States.

- 45 percent – 10.9 million – live in low-income families
- 22 percent – 5.4 million – live in poor families

©National Center for Children in Poverty (www.nccp.org)
Basic Facts about Low-income Children: Children 6 through 11 Years, 2013

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The Impact of Poverty on Brain and Cognitive Development in Elementary School-Aged Children
Project Overview

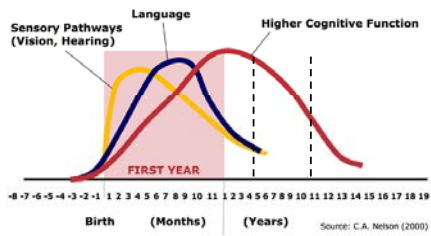
1. Normal Brain Development
2. Poverty and the Brain
3. Mediators
 - Social and emotional challenges
 - Health and safety
 - Chronic stress
4. Academic and Behavioral Manifestations
5. Potential Interventions



Section 1:

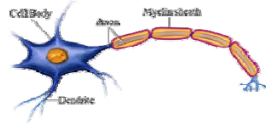
Normal Brain Development in Elementary School-Aged Children

Human Brain Development
Neural Connections for Different Functions Develop Sequentially



Inside the Brain
Myelination

Gray matter growth declines after age 7 while white matter growth increases linearly with Time (Toga et al, 2006).



This process, called myelination, is responsible for increased conduction speed and strength across neuronal synapses.

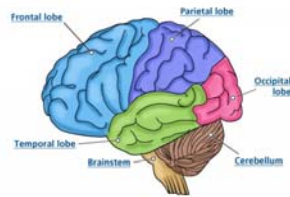
Myelination = efficient learning!

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Inside the Brain
Frontal Lobe & Cortex Growth

- Second growth spurt of the frontal lobes between the ages of 6 and 11 (Anderson, 2002)
- The cortex thickens ~0.10-0.15 mm per year between the ages of 5 and 11 in the brain regions responsible for language learning (Toga et al, 2006).



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Cognitive Feats
Executive Functioning



9



Cognitive Feats

Executive Functioning

During elementary school...

Executive Function	Period of rapid development (years)
Attentional control	9

(Anderson, 2002; Halliburton and Gable, 2003)

10



Cognitive Feats

Executive Functioning

During elementary school...

Executive Function	Period of rapid development (years)
Attentional control	9
Information processing	9-10

(Anderson, 2002; Halliburton and Gable, 2003)

11



Cognitive Feats

Executive Functioning

During elementary school...

Executive Functions	Period of rapid development (years)
Attentional control	9
Information processing	9-10
Cognitive flexibility	7-9

(Anderson, 2002; Halliburton and Gable, 2003)

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Cognitive Feats

Executive Functioning

During elementary school...

Executive Function	Period of rapid development (years)
Attentional control	9
Information processing	9-10
Cognitive flexibility	7-9
Goal setting	7-10

(Anderson, 2002; Halliburton and Gable, 2003)

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Cognitive Feats

Executive Functioning

During elementary school...

Executive Function	Period of rapid development (years)
Attentional control	9
Information processing	9-10
Cognitive flexibility	7-9
Goal setting	7-10
Concrete reasoning	7-11

(Anderson, 2002; Halliburton and Gable, 2003)

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Cognitive Feats

Executive Functioning

During elementary school...

Executive Function	Period of rapid development (years)
Attentional control	9
Information processing	9-10
Cognitive flexibility	7-9
Goal setting	7-10
Concrete reasoning	7-11
Emotional regulation and morality	7-11

... develop rapidly.

(Anderson, 2002; Halliburton and Gable, 2003)

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Cognitive Feats

Language Development

Crucial language skills develop alongside executive functions.

Verbal reasoning includes:

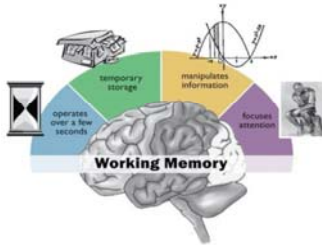
- Speaking
- Reading
- Writing



(ASHA, "Your Child's Communication")

Cognitive Feats

Memory Capacity and Duration



- Working memory improves, which requires attentional control
- Long term memory develops, giving neurons the ability to make strong, lasting connections

"Cognitive Development in Middle Childhood", 2015

Normal Brain Development

Conclusion

- Under normal circumstances, a child's brain grows in areas specific to language, memory, and executive control during the elementary school years.

... but what happens when the child is living in poverty?

Section 2:

The Impact of Poverty on Brain Maturation and Cognitive Abilities in Elementary School



Poverty & the Brain

What does the research show?

Poverty changes the way the brain develops and to what extent it develops.

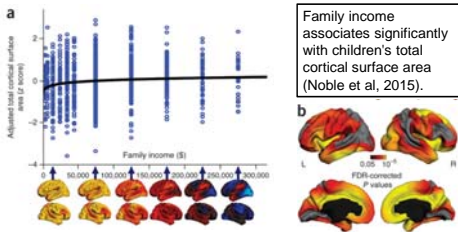
Two main categories:

- Disparities in the brain itself (size, thickness, rate of growth, architecture)
- Disparities in cognition (lags in language, executive control, memory, etc.)



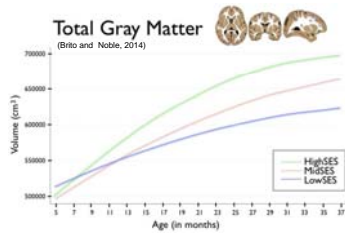
Poverty & the Brain

Reduced Brain Surface Area



Poverty & the Brain
Cortical Thinning

Low SES → Reduced Cortical Thickness

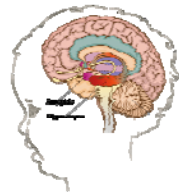


Gray matter consists of the connections between neurons, called synapses. The cortex is comprised of gray matter and is responsible for advanced thought and action.

Low SES associates with cortical thinning (excess pruning) and excess myelin, especially in the prefrontal cortex and temporal lobes (responsible for reasoning and language) (Sheridan and McLaughlin, 2014).

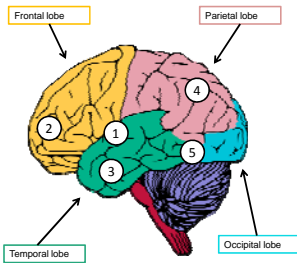
Poverty & the Brain

Low SES → Altered Brain Architecture



Poverty has been shown to decrease the size of the hippocampus and amplify connections to the amygdala. The hippocampus and amygdala help regulate stress, memory, and emotional processing (Noble et al, 2012).

Poverty & Cognition
The 5 Neurocognitive Systems

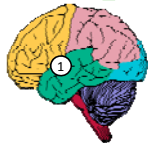


1. Left perisylvian/language system
2. Prefrontal/executive system
3. Medial temporal/memory system
4. Parietal/spatial cognition system
5. Occipitotemporal/visual cognition system

(Farah et al, 2009)

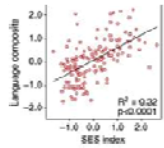
Poverty & Cognition

Impact on System 1: Language



A study on first graders found that SES has a significant, direct relationship with elementary school language abilities, including:

- Vocabulary
- Phonological awareness
- Syntax



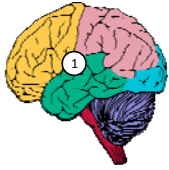
(Hackman and Farah, 2009)

Poverty & Cognition

Impact on System 1: Language

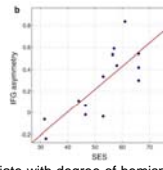
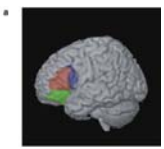
In a study with 6-9 year olds, SES accounted for differing levels of activation in the left fusiform gyrus, important for visual word recognition.

Low SES children showed a stronger connection between activation of this area and phonological awareness (Noble et al, 2006 as cited in Hackman and Farah, 2009).



Poverty & Cognition

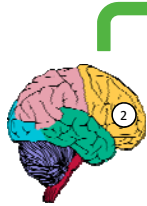
Impact on System 1: Language



SES was found to directly associate with degree of hemispheric specialization in the left inferior frontal gyrus (important for language and executive function) during a rhyme identification task in 5 year olds (fMRI), suggesting lower SES children have a delay in normal language development (Raizada et al, 2008 as cited in Hackman and Farah, 2009).

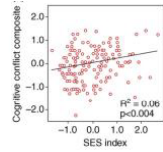
Poverty & Cognition

Impact on Sys. 2: Executive Functions



Studies on K-1st graders show that SES has a significant, direct relationship with executive functioning abilities such as:

- Behavior inhibition
- Sorting ability
- Attentional control



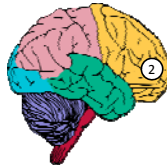
(Hackman and Farah, 2009)

Poverty & Cognition

Impact on Sys. 2: Executive Functions

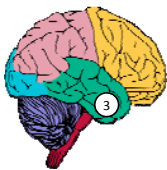
Compared to higher SES children, low SES children 3-8 years old have more difficulty suppressing distracting stimuli (Stevens et al, 2009 as cited in Hackman and Farah, 2009).

High SES children also tended to recruit the prefrontal cortex more often than the low SES children, indicating an increased ability to utilize selective attention mechanisms (Kishiyama et al, 2009 as cited in Hackman and Farah, 2009).

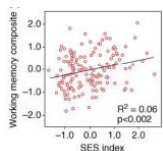


Poverty & Cognition

Impact on System 3: Memory



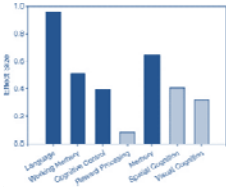
A study on first graders found that SES has a significant, direct relationship with working memory ability.



(Hackman and Farah, 2009)

Poverty & Cognition

How Do the Cognitive Functions of Children in Poverty Differ?



"The association between SES and neurocognitive development is highly significant and varies significantly in strength across the neurocognitive systems tested. SES disparities in language and memory ability are most pronounced. Working memory ability also differs, along with a weaker trend toward differing cognitive control ability. Visual and spatial cognition were not found to differ significantly..." (Farah et al, 2006).

Poverty & Cognition

The Impact on Mental Health



Improved SES overtime results in decreased mental health problems.

The more exposure a child has to poverty, the more at risk that child is for mental health problems.



(Reiss, 2013)

Poverty & Cognition

Impact Overtime

Increased likelihood of chronic disease and co-morbidities (Reiss, 2013; Burke, 2015)

Heightened fear response in adulthood (Gianaros et al, 2008 as cited in Hackman and Farah, 2009)

DIRECT CONNECTION TO LONG-TERM HEALTH!

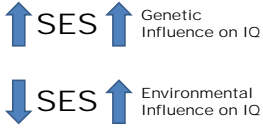
Chronic Health Problems Among U.S. Adults, by Poverty Status -- 2011
Poverty status is based on Gallup's best estimate of those in poverty according to the U.S. Census Bureau's 2011 thresholds

	In poverty	Not in poverty	Difference (pct. pts.)
% Depression	30.9	15.8	15.1
% Asthma	17.1	11.0	6.1
% Obesity	31.8	26.0	5.8
% Diabetes	14.8	10.1	4.7
% High blood pressure	31.8	29.1	2.7
% Heart attack	5.8	3.8	2.0
% Cancer	6.3	7.1	-0.8
% High cholesterol	25.0	26.0	-1.0

Jan 2-Dec 31, 2011
Gallup-Healthways Well-Being Index

Poverty & Cognition
More evidence

IQ heritability is dependent on SES:



(Turkheimer et al, 2003 as cited in Hackman and Farah, 2009)

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Poverty & Cognition
More evidence

- Increase in family income → better vocabulary (Azma, 2013) and graduation rates (Duncan et al, 1998)
- 30% of language ability variance can be explained by SES alone (Farah et al, 2006).
- Half the variance in IQ can be explained by environmental factors (Azma, 2013).
- More time spent in poverty → more severe the deficit in memory (Evans and Schamberg, 2009)
- The impact of poverty on development is larger for siblings who were younger during the period of poverty than for older siblings, indicating, again, an environmental influence on development (Farah et al, 2006).

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Section 3:

The Mediators Between Poverty, Brain Development, and Academic Success



The Mediators
How do the pieces connect?

APHA

The Mediators
Between Poverty and Brain Development Disparities

Social and emotional challenges

Health and safety

Chronic stress

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APHA

The Mediators
Emotional and social challenges

1. Mental health (Reiss, 2013)
2. Lack of parental support and cognitive stimulation (Farah et al, 2009)
3. Lack of relationships/interactions with others (Jensen, 2009)

What's the Impact?

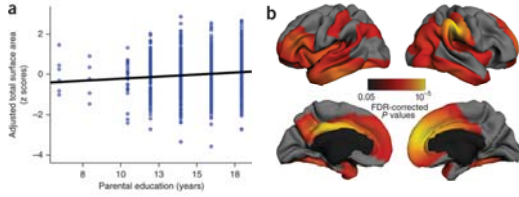
1. Childhood depression, maladaptive social conduct, emotional dysregulation, increased chances of developing mental disorder
2. Lack of resources and supervision, substandard education, parents uninvolved in child's academics, parental depression, chronic stress and increased chance of abuse/neglect
3. Bullying, smaller group of peers/support system

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APHA

The Mediators

Parent education is linearly associated with cortical surface area.



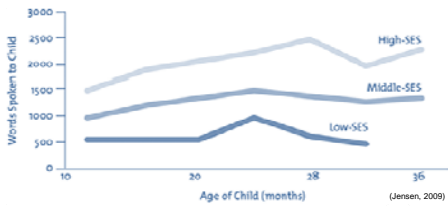
(Noble et al, 2015).

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The Mediators

- Cognitive achievement, in general, is mediated by cognitive stimulation, for example, the amount of daily parent-child speech interactions mediates language development (Farah et al, 2009).



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The Mediators

- Cognitive achievement, in general, is mediated by cognitive stimulation, for example, the amount of daily parent-child speech interactions mediates language development (Farah et al, 2009).
- Language skills are also mediated by access to books (Jensen, 2009).
- System 3 performance (working memory) can be predicted by social and emotional nurturance (Farah et al, 2009).



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The Mediators

Health and safety

- 1. Violence, neglect and abuse
- 2. Substandard housing
- 3. Insufficient healthcare
- 4. Food insecurity
- 5. Prenatal environment

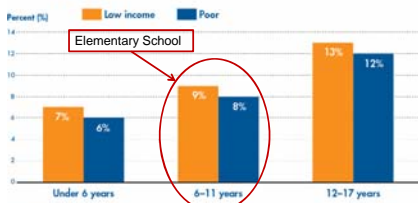
What's the Impact?

- 1. Mental health problems and chronic stress
- 2. Over crowding, exposure to traffic and environmental hazards, respiratory disease, psychological distress
- 3. Increased risk of death from infection or injury
- 4. Poor nutrition and physical health, increased risk of asthma, obesity and low IQ
- 5. Exposure to drugs and alcohol in the womb, birth defects

Jensen, 2009; Taras, 2005; Farah et al, 2009

The Mediators

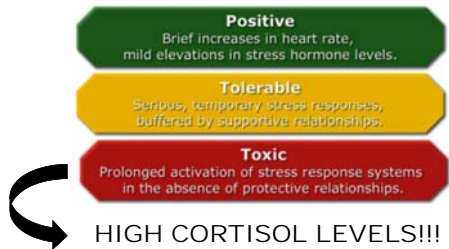
Figure 11: Percentage of children uninsured in low-income and poor families by age, 2013



©National Center for Children in Poverty (www.nccp.org)
Basic Facts about Low-Income Children: Children 6 through 17 Years, 2013

The Mediators

Chronic stress: What is it?



Harvard Center on the Developing Child

The Mediators

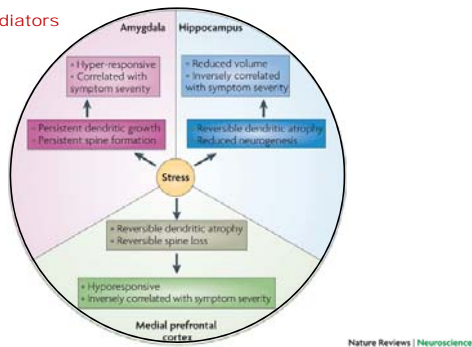
Chronic stress

1. Suppressed immune system (Middlebrooks and Audage, 2008; Burke, 2015)
2. Altered gene expression (Tyrka et al, 2015)
3. Brain development (Middlebrooks and Audage, 2008, McEwen and Gianaros, 2010)

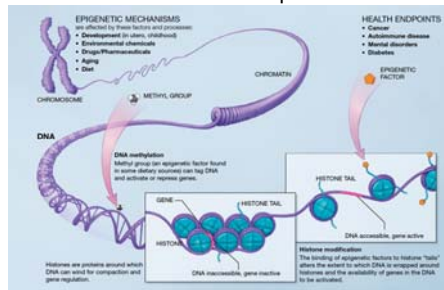
What's the Impact?

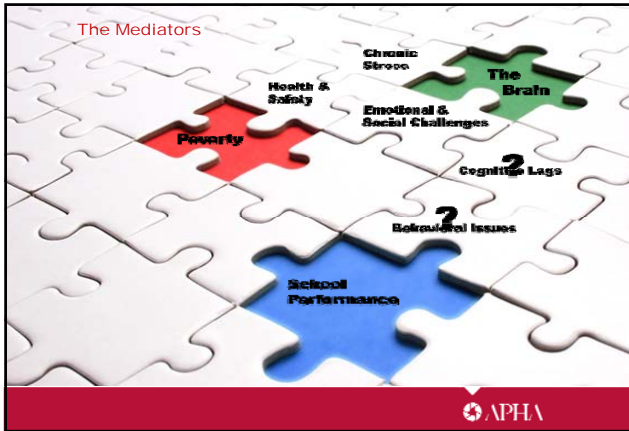
1. Increased risk of disease and early death
2. Impairs immune system and stress response
3. Altered brain circuitry, reduced neurogenesis, excess myelin, glucocorticoid receptor resistance (Noble et al, 2012)
 - Cortical pruning of the prefrontal cortex
 - Neuronal death in the hippocampus
 - Increased activation of the amygdala

The Mediators



Poverty & the Brain Altered Gene Expression





The Mediators

Between Brain Development Disparities and Academic Success

Cognitive lags:

- Language
- Executive functioning
- Memory
- Social and emotional regulation

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APHA

Poverty, Stress, and Regulation

1 in 5 children growing up in poverty have increased risk for social-emotional difficulty (Evans & English, 2002; Evans, 2004)

Children who experience early adversity are more likely to exhibit challenges with executive functioning and self-regulation (Gunnar, 2000; Bos et al, 2009)

- The chronic fear, anxiety, and stress associated with unpredictable or chaotic environments can disrupt brain architecture, particularly those involved with executive function and emotion management

Toxic Stress & Neural Development

(Center on the Developing Child, 2013)

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APHA

“All the data shows it isn't about poor people, it's about people who happen to be in poverty. All the data suggests it is not the person, it's the context they're inhabiting.”

- Eldar Shafir, Princeton

Section 4:



The Academic and Behavioral Manifestations of Poverty's Impact on the Brain

Academic and Behavioral Manifestations

Poverty Impacts School Performance

Cognitive lags result in academic difficulties and inappropriate school behavior.



Academic and Behavioral Manifestations

How poverty affects behavior and academic performance

Type of Manifestation	Examples
Cognitive/Academic	<ul style="list-style-type: none"> • Impaired attention and concentration • Reduced cognition, creativity, and memory • Reduced motivation, determination, and effort • Reduced neurogenesis • Poor grades
Behavioral	<ul style="list-style-type: none"> • Acting out • Impatience and impulsivity • Limited range of behavioral responses • Absence/tardiness
Social	<ul style="list-style-type: none"> • Gaps in politeness and social graces • Diminished social skills and judgment • Less empathy for others' misfortunes • Low self esteem
Health	<ul style="list-style-type: none"> • Increased likelihood of depression • Higher rates of illness and untreated disabilities

(Jensen, 2009)

Academic and Behavioral Manifestations

What's expected?

THE BIG 6

1. Show respect to every student and every adult.
2. Use words that compliment, help, and support people.
3. Settle differences peacefully, together.
4. Take care of the school, your belongings, and the belongings of others.
5. Always be where you are supposed to be.
6. Always try to perform better than you did yesterday.

HALLWAYS AND STAIRS

RESPECT OURSELVES
 WALK!
 Look where you are going

RESPECT OTHERS
 Be quiet
 Walk to the right, in a line

RESPECT PROPERTY
 Hands and pencils off the walls and displays

SELF TO SELF
 Keep space between yourself and others

FOLLOW DIRECTIONS
 Be ready to hear directions
 Stop at check points

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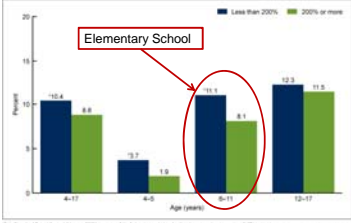
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Academic and Behavioral Manifestations

ADHD Misdiaognoses

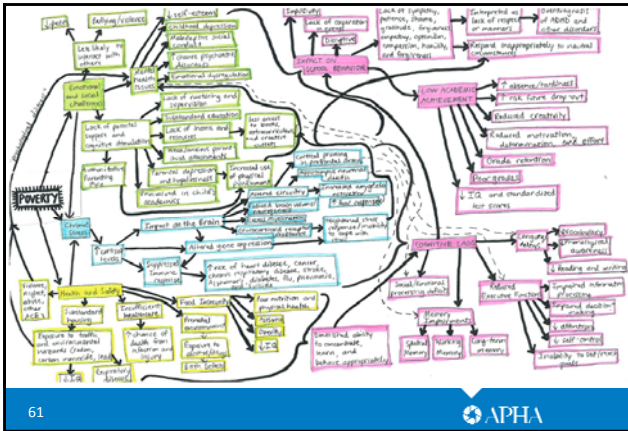
Figure 4. Children aged 4-17 years with diagnosed ADHD, by age and poverty status, United States, 2011-2013

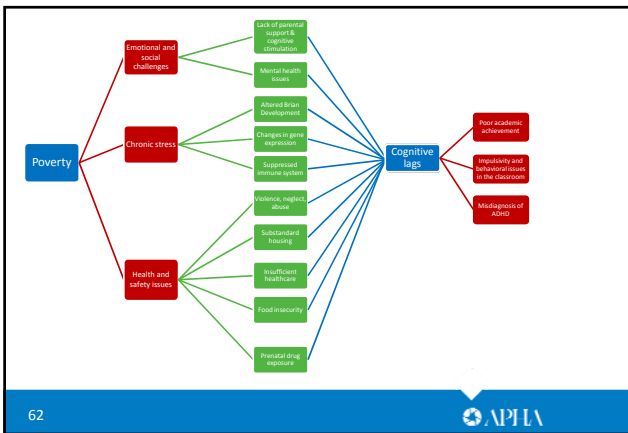


- A disproportionate number of young children receiving ADHD medications are underprivileged (Rappaport, 2014).
- The behaviors that result from chronic stress and financial instability can be misinterpreted as a lack of respect or manners which often lead to ADHD diagnoses.

Figures are affected from children at 2015 or more of the total poverty level within the same age group at 11.7%.
 *ADHD rates are based on household prevalence of a sample of the nation's representative U.S. population. Poverty status is defined by being income at a percentage of the federal poverty threshold. ADHD prevalence rates are shown with 95% confidence intervals.
 SOURCE: CDC/NCHS, National Health Interview Survey, 2011-2013.

Graph source: National Center for Health Statistics, 2015





Section 5:

Potential Interventions

Interventions



"Our school-based model identifies the strengths and needs of every student and links each child to a tailored set of intervention, prevention, and enrichment services in the school or community. We efficiently and cost-effectively address the in- and out-of-school factors that impact students' academic, social-emotional, family, and physical well-being.

City Connects, formerly Boston Connects, is active in 63 sites across Boston and Springfield, Mass.; New York City; and Ohio (public and private schools)."

Age range: elementary and K-8 schools

<http://www.bc.edu/schools/foee/cityconnects/>

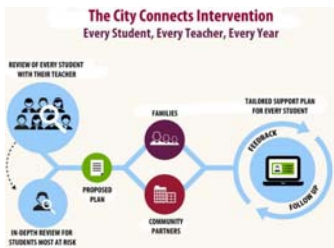


Interventions



Implementation:

- Support plan for each child
- Individual student reviews for children with intensive needs
- Partnerships between the School Site Coordinator and community services
- Family involvement
- Electronic records for monitoring



<http://www.bc.edu/schools/foee/cityconnects/>



Interventions



Implementation:

- Support plan for each child
- Individual student reviews for children with intensive needs
- Partnerships between the School Site Coordinator and community services
- Family involvement
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Results:

- Report card scores for grades 3-5 were significantly higher
- 3rd grade MCAS math scores, 6-7th grade overall GPAs, 6th grade math GPAs, and 6-8th ELA (English test) and MCAS (Massachusetts Comprehensive Assessment System) math scores were higher (Walsh et al, 2014)

<http://www.bc.edu/schools/foee/cityconnects/>



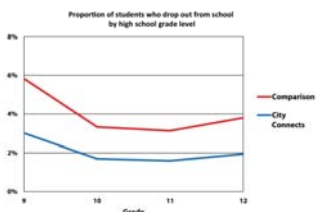
Interventions



Implementation:

- Support plan for each child
- Individual student reviews for children with intensive needs
- Partnerships between the School Site Coordinator and community services
- Family involvement
- Electronic records for monitoring

Results:



<http://www.bc.edu/schools/foe/cityconnects/>



Interventions

Child Parent Center (CPC) Program

"The Chicago Child-Parent Centers (CPCs) provide comprehensive educational support and family support to economically disadvantaged children and their parents. The guiding principle of the program is that by providing a school-based, stable learning environment during preschool, in which parents are active and consistent participants in their child's education, scholastic success will follow. The program requires parental participation and emphasizes a child-centered, individualized approach to social and cognitive development."

Age range: pre-K to third grade

<http://www.promisingpractices.net/program.asp?programid=98&overview>



Interventions

Child Parent Center (CPC) Program

Implementation:

1. Structured curriculum of learning activities focused on teaching basic language and math skills
2. Low child to teacher ratios
3. Parent program that encourages parental involvement
4. Outreach activities
5. Staff development
6. Health and nutrition services
7. Student support services

Results:

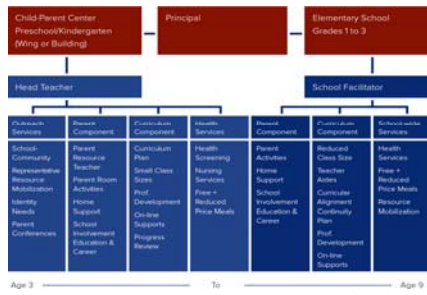
Children who participated in the program for 1-2 years had higher high school graduation rates, more years of school completed overall, and lower rates of juvenile/violent arrests and school dropout (Reynolds et al, 2001).

<http://www.promisingpractices.net/program.asp?programid=98&overview>



Interventions

Child Parent Center (CPC) Program



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Interventions

Programs focused on executive functioning...

1. Head Start
2. Tools of the Mind
3. Chicago School Readiness Program

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Interventions



"Head Start promotes the school readiness of young children from low-income families through agencies in their local community. Head Start and Early Head Start programs support the comprehensive development of children from birth to age 5, in centers, child care partner locations, and in their own homes. Head Start services include early learning, health, and family well-being."

- Program includes:
- Enhanced language and emergent literacy instruction
 - Mental health consulting
 - Promoting Alternative Thinking Strategies (PATHS) curriculum

<http://www.acl.hhs.gov/programs/ohs>
<http://www.channing-beta.com/prevention-programs/paths/paths.html>

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Interventions



"Tools of the Mind is a research-based program combining transformational early childhood pedagogy with an innovative curriculum that helps young children to develop the cognitive, social-emotional, self-regulatory, and foundational academic skills they need to succeed in school and beyond. Currently, Tools of the Mind has two complementary modules: one designed to be used with children aged 3-4 in pre-K and preschool settings, and the other designed for kindergarten."

<http://www.toolsofthemind.org/>



Interventions



Children are instructed to plan scenarios and act them out with rules they create. This engages children's attention and supports the use of executive functions.

Curriculum Components

- Comprehensive curriculum
- Child-initiated activities
- Teacher-guided activities
- Scaffolded dramatic play
- Embedded self-regulation
- Focus on private speech and mediators



Tools of the Mind, 2012

<http://www.toolsofthemind.org/>



Interventions

Chicago School Readiness Program



"CSRP is a federally-funded randomized control-trial intervention lead by Dr. C. Cybele Raver, professor of applied psychology and vice provost for academic, faculty and research affairs at NYU. The aim of CSRP is to improve low-income, preschool-aged children's chances of success in school."

Focus on classroom structure and routine to have an effective and supported learning environment.

<http://steinhardt.nyu.edu/hdsc/csrp/>



Interventions

Results

Head Start, Tools of the Mind, and the Chicago School Readiness Program (CSRП) improve self-regulation and improve academic achievement (Ursache et al, 2012).



In order to improve...	Classroom Action Steps
Academic performance	<ul style="list-style-type: none">• Build core skills that may be lacking (memory, focus, vocabulary, fluency, problem-solving, self-esteem, etc.)• Employ a cognitively challenging curriculum• Incorporate homework into class time• Utilize turn-taking and group projects that require collaboration• Use role-play, hands-on crafts, and physical activity in lessons• Provide tutors• Include weekly problem solving sessions• Use real world applications
Social skills	<ul style="list-style-type: none">• Remind students to thank classmates• Teach turn-taking and basic meet-and-greet skills
Confidence and sense of control	<ul style="list-style-type: none">• Give respect to the students first• Share decision making with the class• Provide hope, support, and coping strategies• Be inclusive• Celebrate achievement• Empower students by teaching them to set their own goals• Educate caregivers and teachers• Foster relationships between students, their peers, and their teachers
Health	<ul style="list-style-type: none">• Recognize signs of chronic/acute stress and offer stress reduction techniques• Provide exercise options and nutritious foods• Provide on-site physicians and access to medications

(Jensen, 2009)

Classroom Action Steps

What to AVOID:

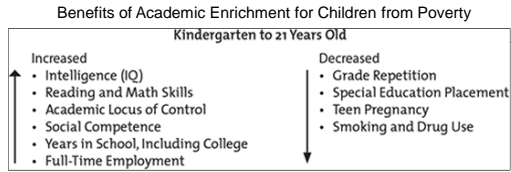
- Avoid directives (such as, "Do this right now!")
- Avoid demeaning sarcasm
- Avoid labeling students
- Reduce classroom parallels to prison

(Jensen, 2009)

Interventions

They work!

Children living in poverty are not destined to cognitive lags and poor academic achievement.



(Jensen, 2009)

The Impact of Poverty on Brain and Cognitive Development in Elementary School-Aged Children

Summary & Conclusion

Poverty impacts the development of the brain during elementary school years which, in turn, impacts cognitive abilities important for school success. With the right interventions, **the impact of poverty can be reversed.**

"The message is not 'if you are poor, your brain will be smaller, and there is nothing that can be done about it'. That is absolutely not the message. Improving access to resources that enrich the developmental environment could potentially change the trajectories of brain development for the better, even in children and adolescents in the age range we studied."

- Elizabeth Savell, researcher, in "Brain development in children could be affected by poverty, study shows"

ABOUT APHA

The American Public Health Association champions the health of all people and all communities. We strengthen the profession of public health, promote best practices and share the latest public health research and information. We are the only organization that influences federal policy, has a 140-plus year perspective and brings together members from all fields of public health. Learn more at www.apha.org.



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