

Children's Mental Health Ontario (CMHO) Conference:

Designing Our Future

Toronto, Ontario

---

**Experience-based Brain  
Development in Early Life and Mental  
Health and Behaviour Problems**

---

By J. Fraser Mustard  
The Founders' Network

November 26, 2007

# CIAR - History

---

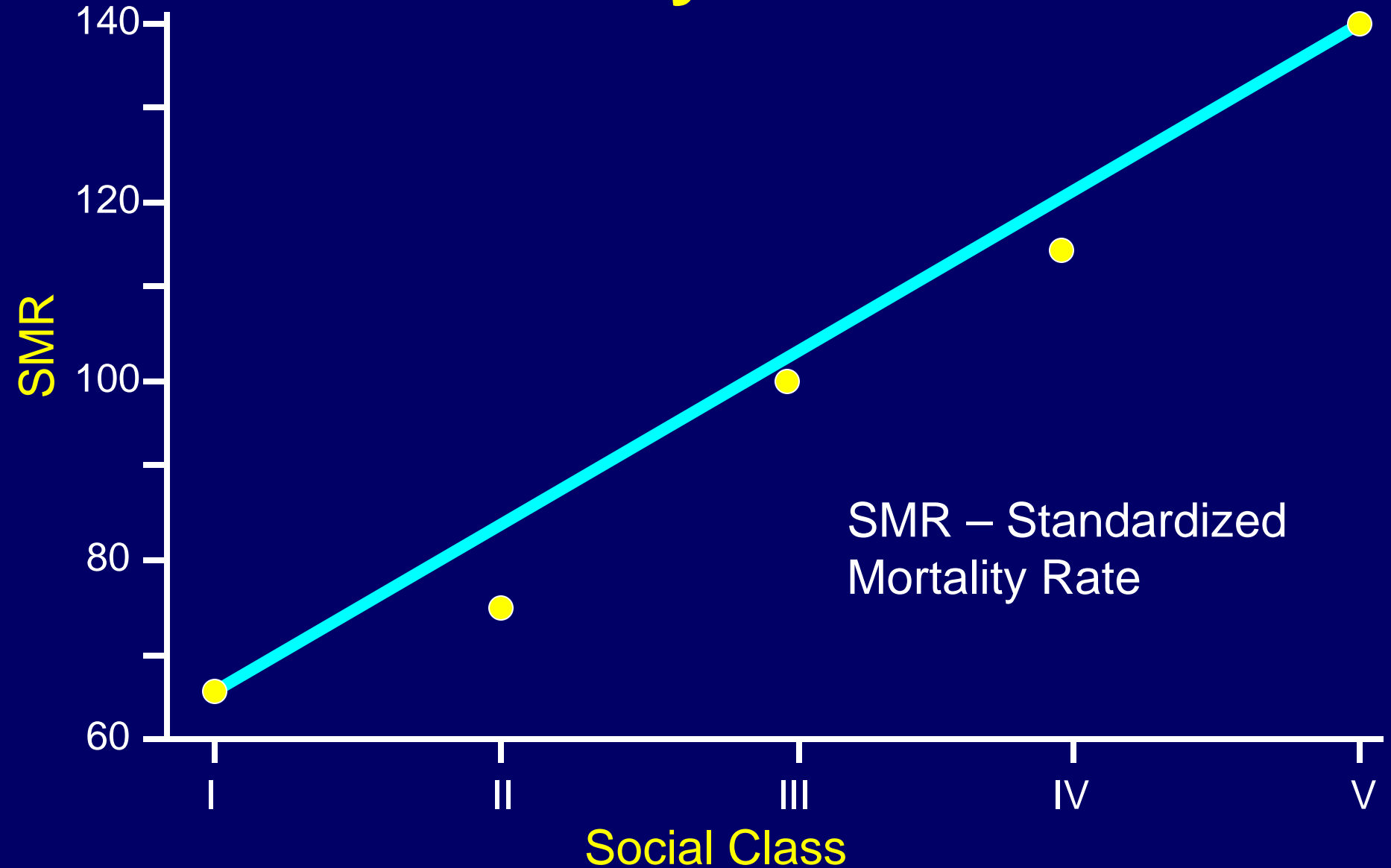
- Population Health
- ↓
- Human Development
- ↓
- Experience-based Brain and Biological Development

---

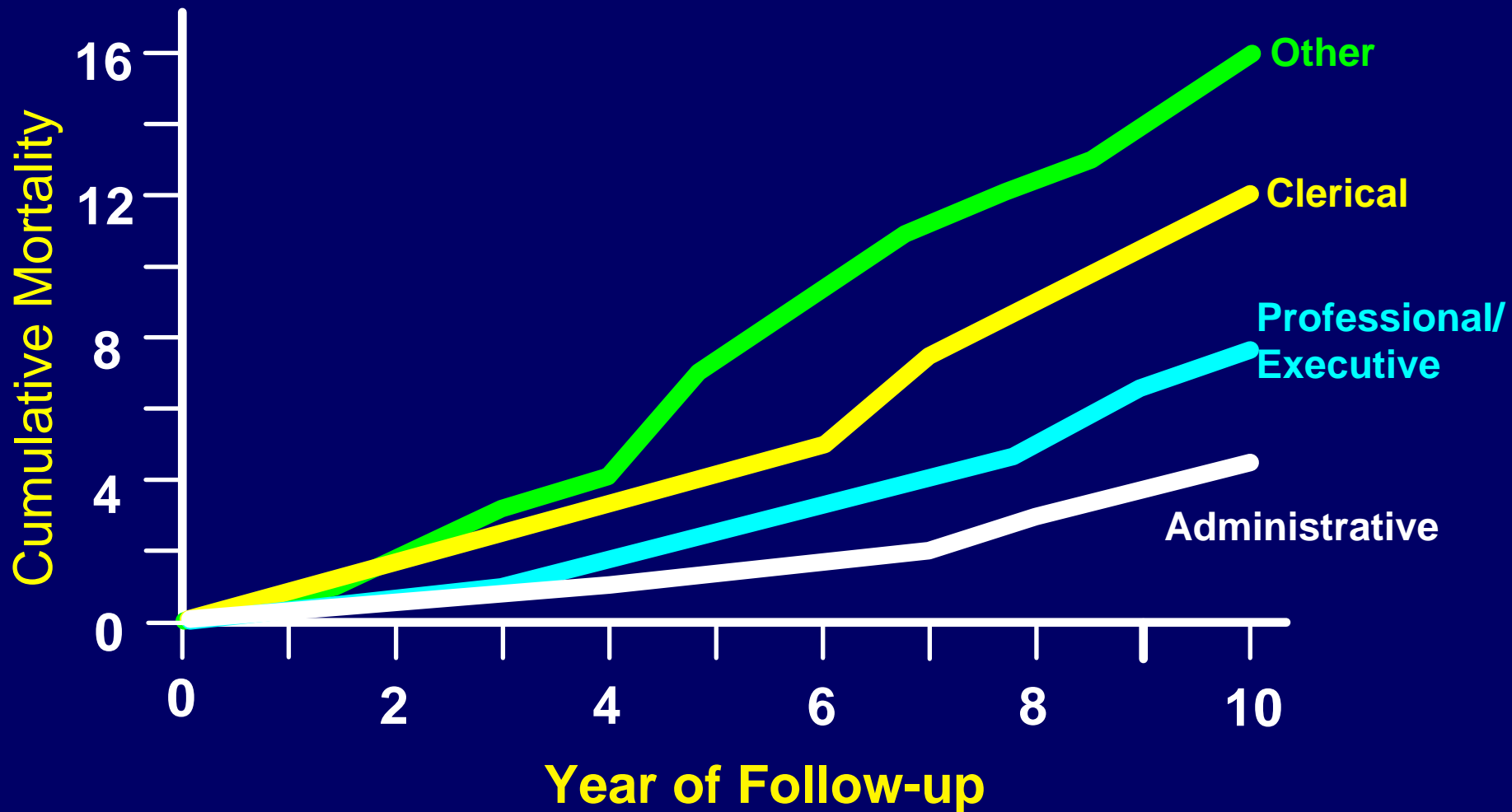
HEALTH

---

# Socio-Economic Gradient and Mortality – Men UK



# U.K. CIVIL SERVICE Mortality - All Causes



# Age Adjusted Odds Ratios CHD - Whitehall Study

## Civil Service Grade

**HIGH**

**LOW**

***Non-Adjusted***

**1.00**

**1.50**

***Adjusted***

**Work**

**1.00**

**1.18**

**Risk Factors**

**1.00**

**1.30**

**Fully**

**1.00**

**0.95**

# Life Cycle and Health

---

In Utero - Barker et al

Early Years - Power and Hertzman

Adult Life - Marmot et al

Biological embedding in the early years  
(Epigenetics)

# ECD Swedish Longitudinal Study and Adult Health

Number of Adverse ECD Circumstances\*

0      1      2      3      4

Adult Health

Odds - Ratios

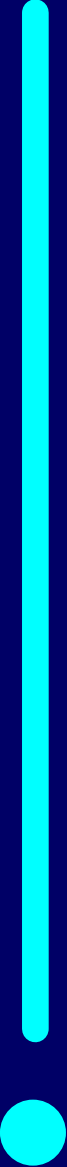
General Physical	1	1.39	1.54	2.08	2.66
Circulatory	1	1.56	1.53	2.91	7.76
Mental	1	1.78	2.05	3.76	10.27

\* Economic, family size, broken family and family dissention

# Health Problems Related to Early Life

---

- Coronary Heart Disease
- Non-insulin Dependent Diabetes
- Obesity
- Blood Pressure
- Aging and Memory Loss
- Mental Health (depression)
- Behaviour (addiction, ADHD)



"Follow up through life of successive samples of birth has pointed to the crucial influence of early life on subsequent mental and physical health and development."

Acheson, Donald - Independent Inquiry into Inequalities in Health, 1998

---

# Human Early Experience & Development

---

# Substance Abuse and Childhood Abuse

## *Odds Ratios for Drug and Alcohol Use*

Exposure to Child Abuse*	<u>Odds Ratios for Drug and Alcohol Use</u>	
	<u>Drugs</u>	<u>Alcohol</u>
0	1.0	1.0
1	2.7	2.0
2	2.9	4.0
3	3.6	4.9
4+	4.7	7.4

\* Scale: 0 none  
4 intense

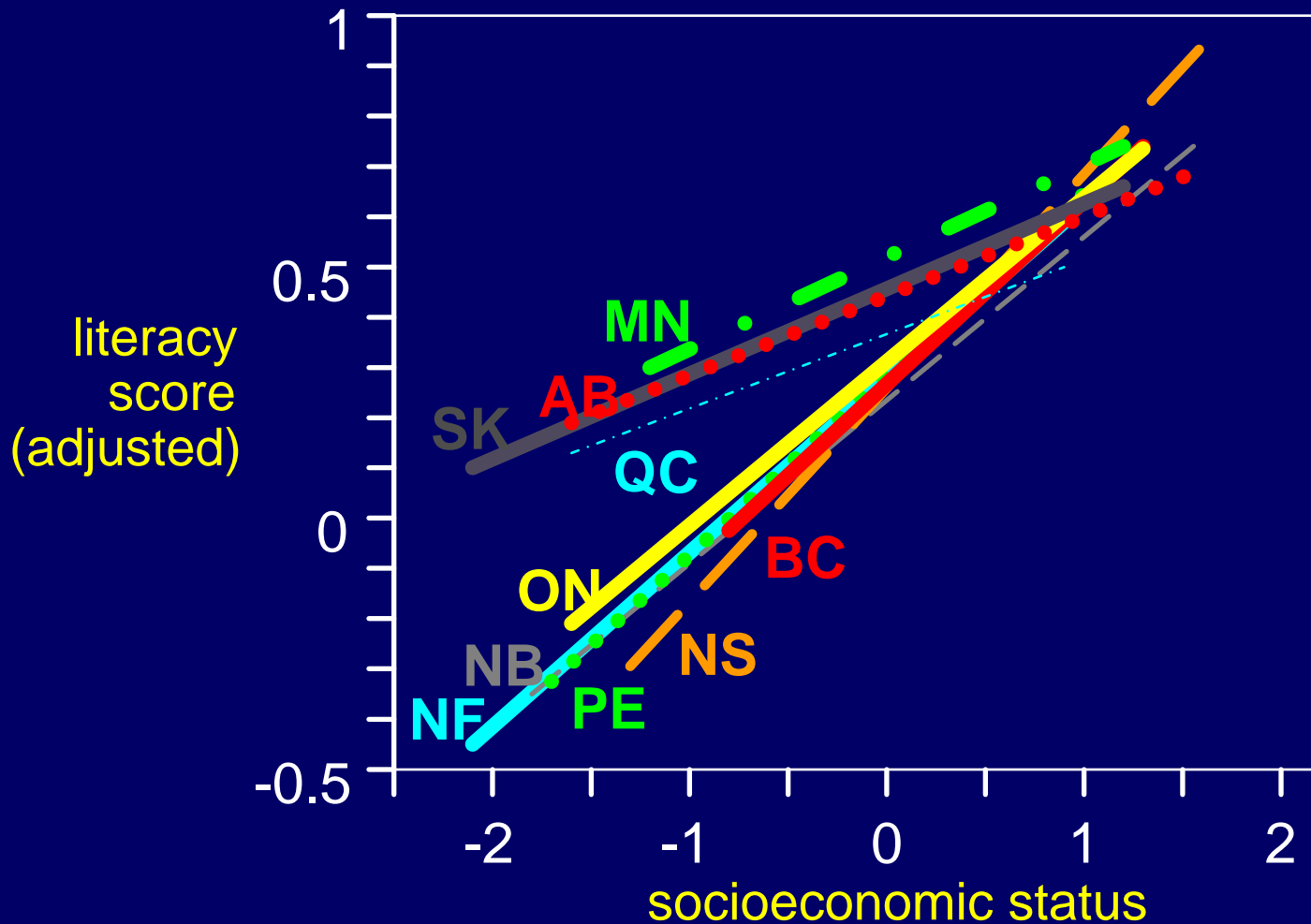


## **Early Learning and Criminal Behaviour**

"Significant correlation with registered criminality (teenage) appeared for language development at 6, 18, and 24 months

**Stattin, H. et al *Journal of Abnormal Psychology* 102; 369, 1993**

# Literacy and SES Gradients for Youth by Province 1994



J. Douglas Willms, "Literacy Skills of Canadian Youth"  
Atlantic Centre for Policy Research in Education, University  
of New Brunswick, October 21, 1996. Prepared for Statistics Canada.

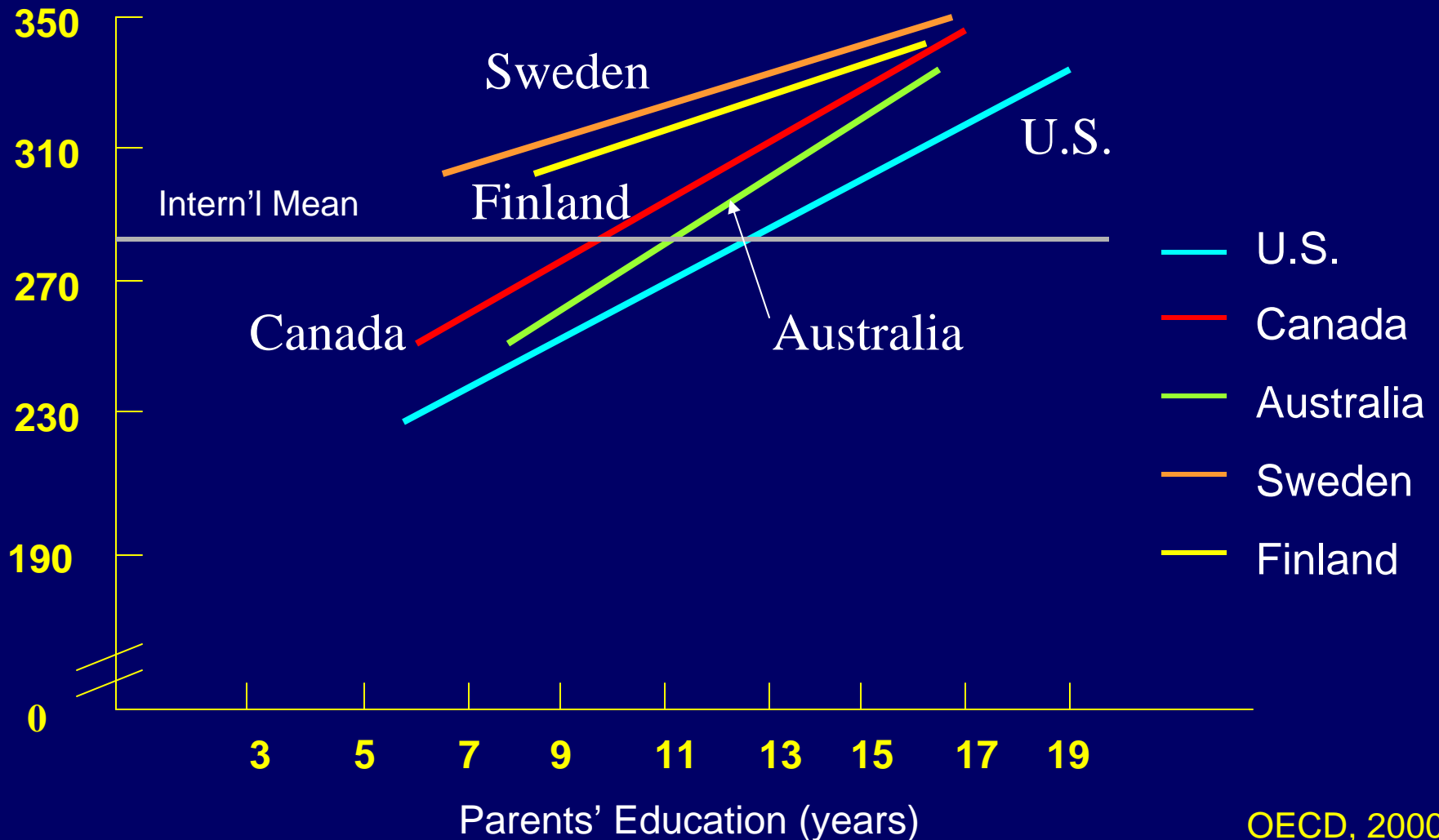
# Document Literacy

## 1994 – 1998, Ages 16 to 65

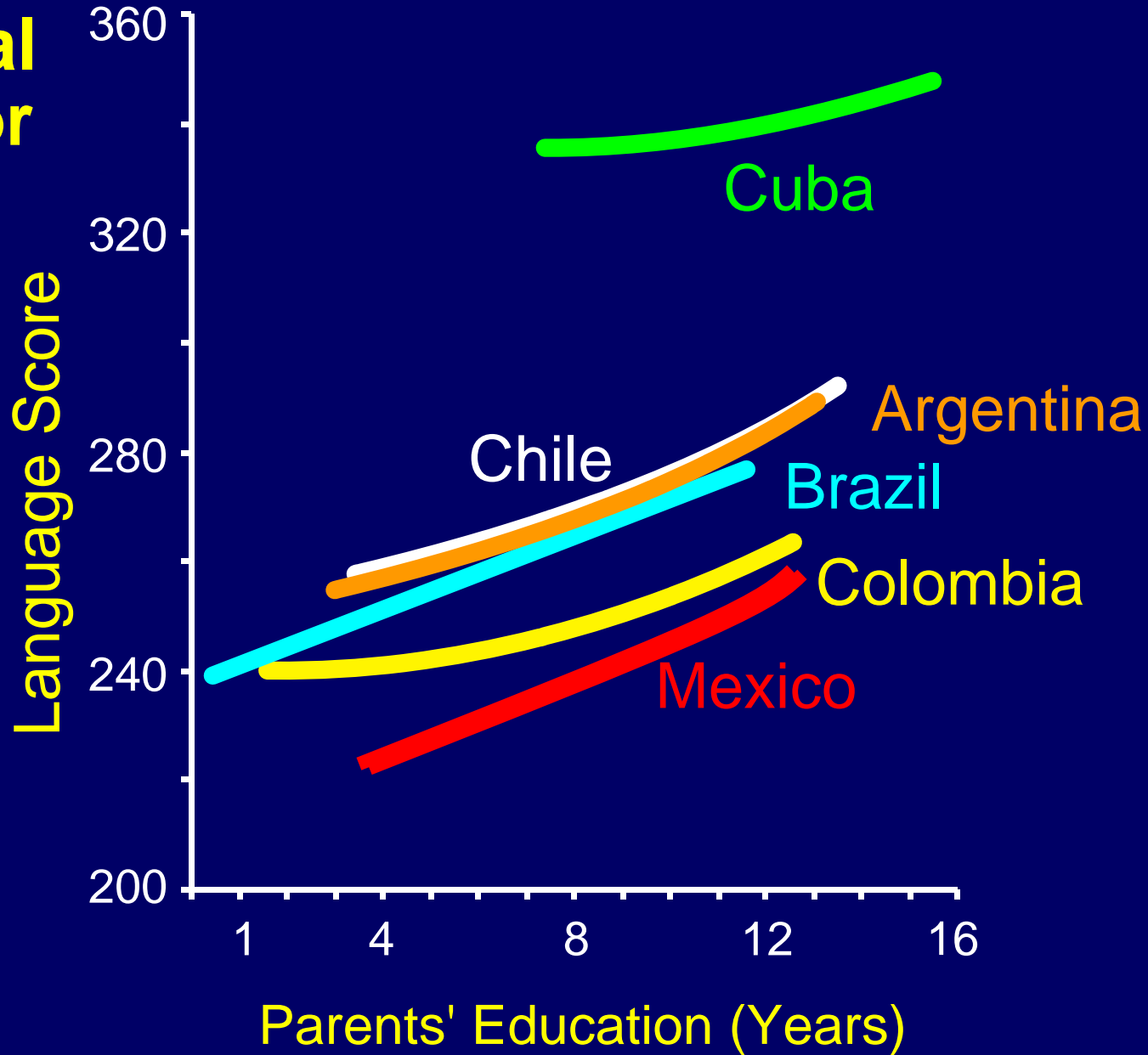
	<b>Level 1 and 2</b>	<b>Level 4 and 5</b>
Sweden	23%	34.0%
Canada	42%	23.0%
Australia	43%	17.0%
United States	48%	18.0%
Chile	85%	3.0%
Mexico	84%	1.7%

# Socioeconomic Gradients for Document Literacy Scores

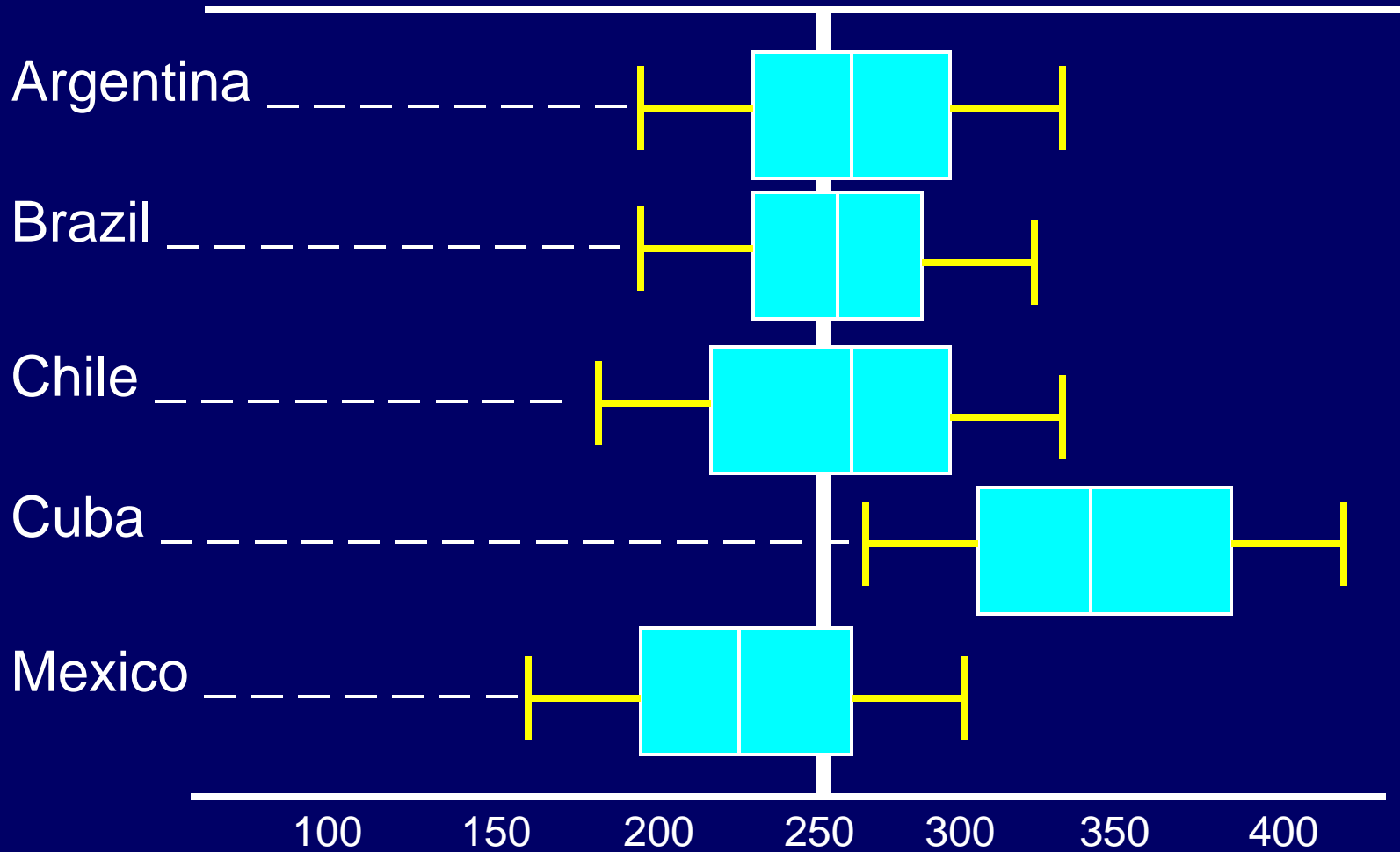
Mean Scores



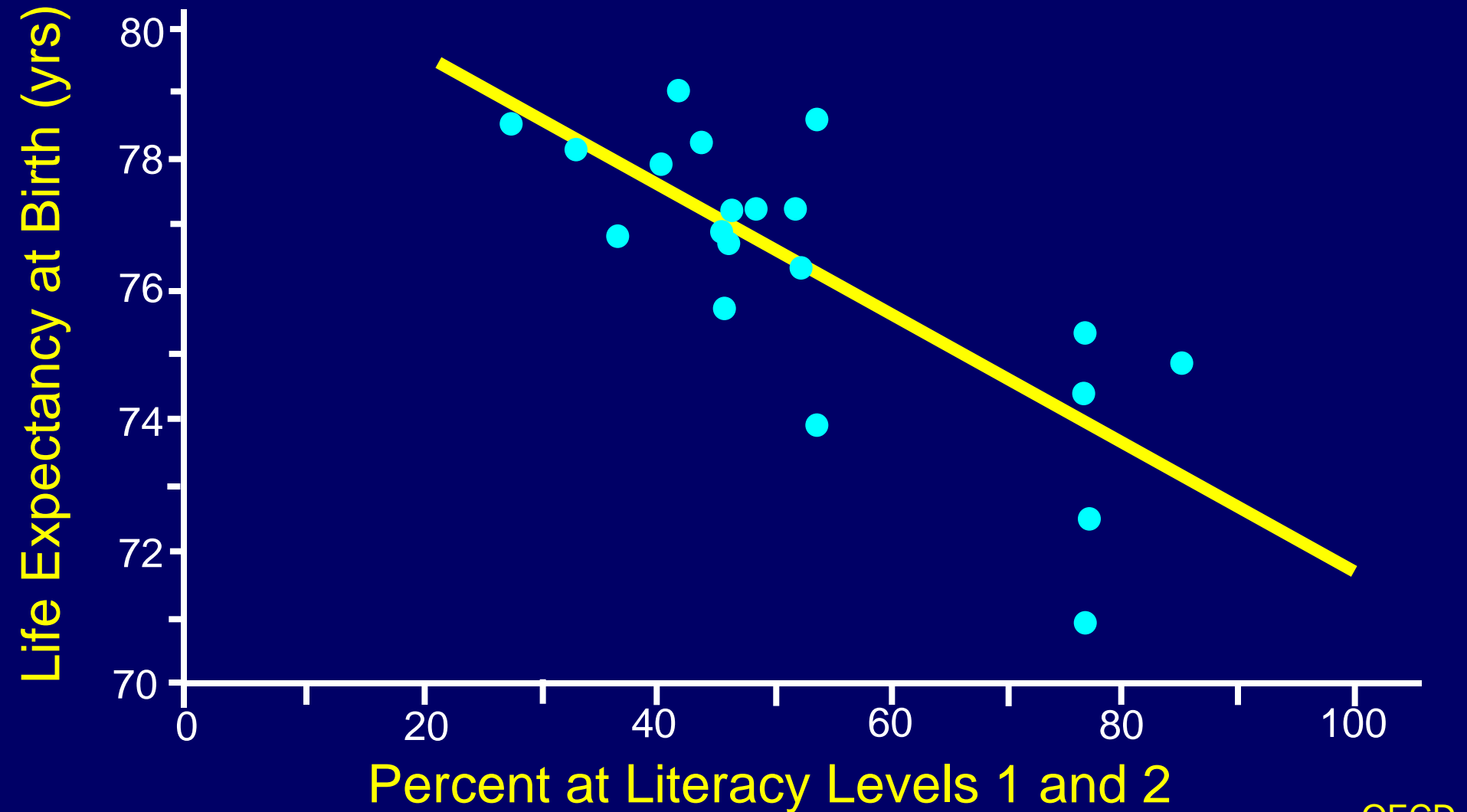
# Sociocultural Gradients for Language Scores By Country (grade 3)



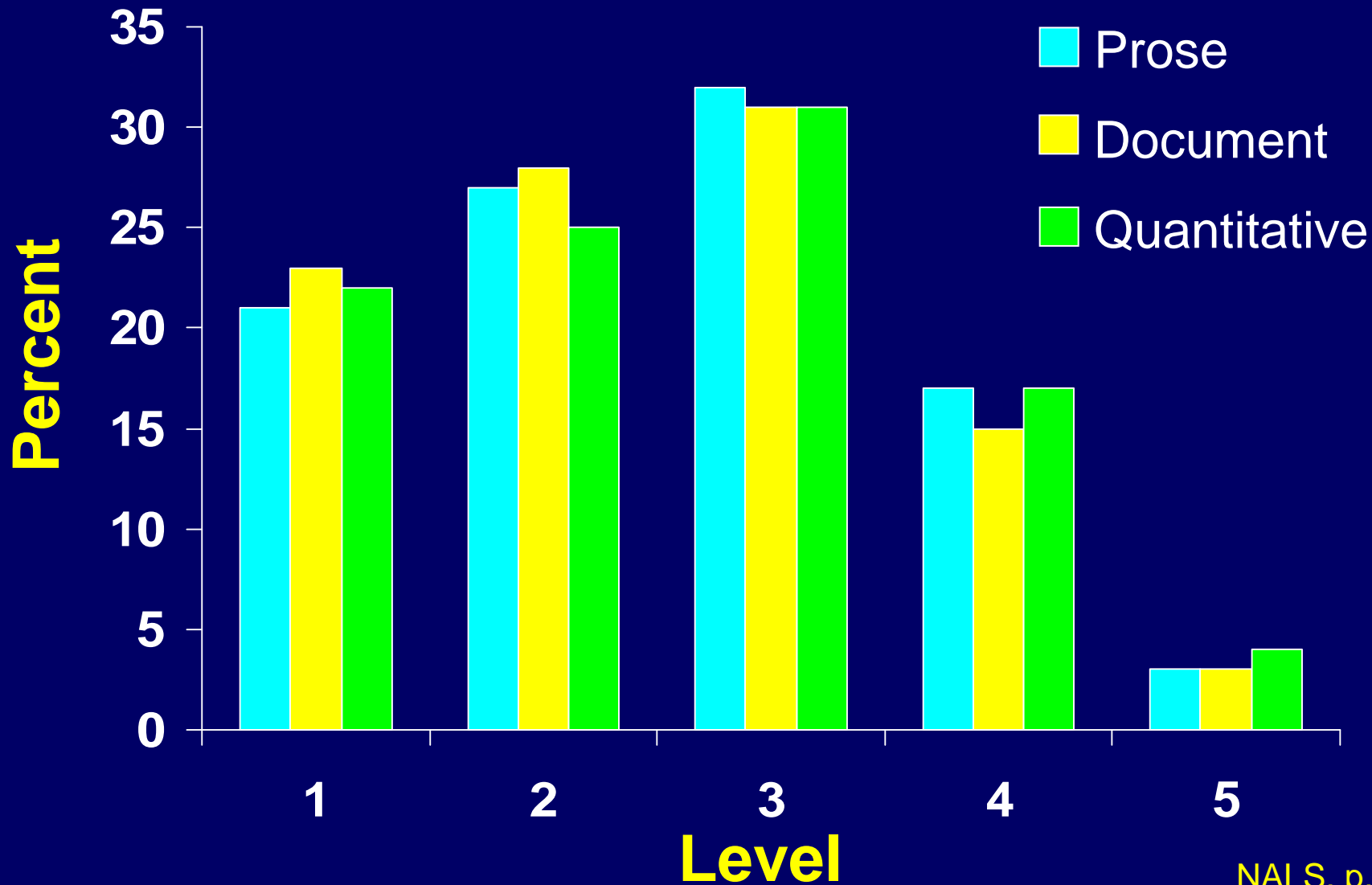
# Grade 3 Language Scores



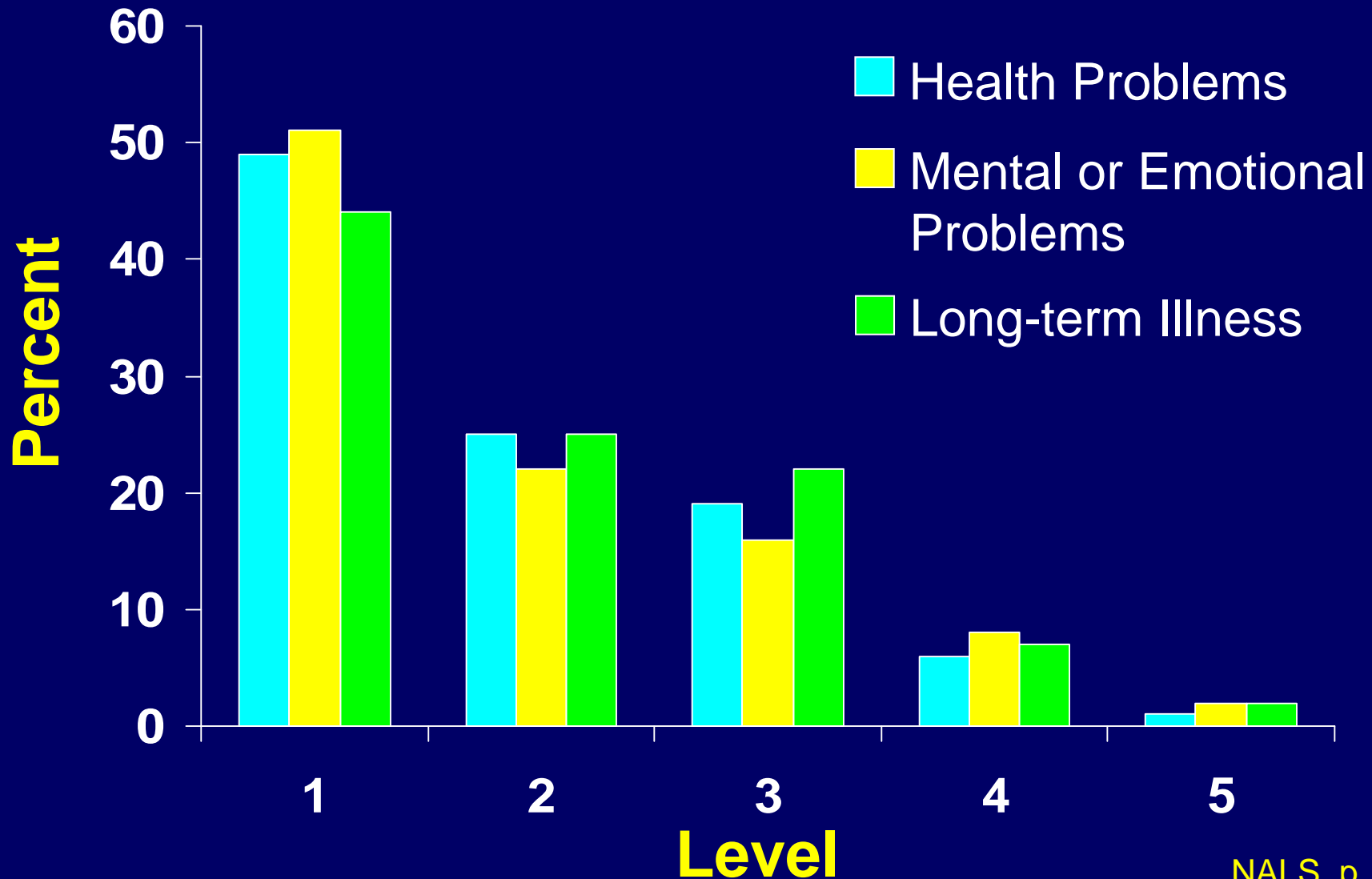
# Life Expectancy & Literacy



# Literacy Levels for the Total Population – USA



# Literacy Levels by Physical, Mental or Other Health Conditions – USA (Quantitative)



---

“How do social  
experiences  
get under the skin?”

Ron Barr

Experience-Based Brain Development in the early years of life sets neurological and biological pathways that affect:

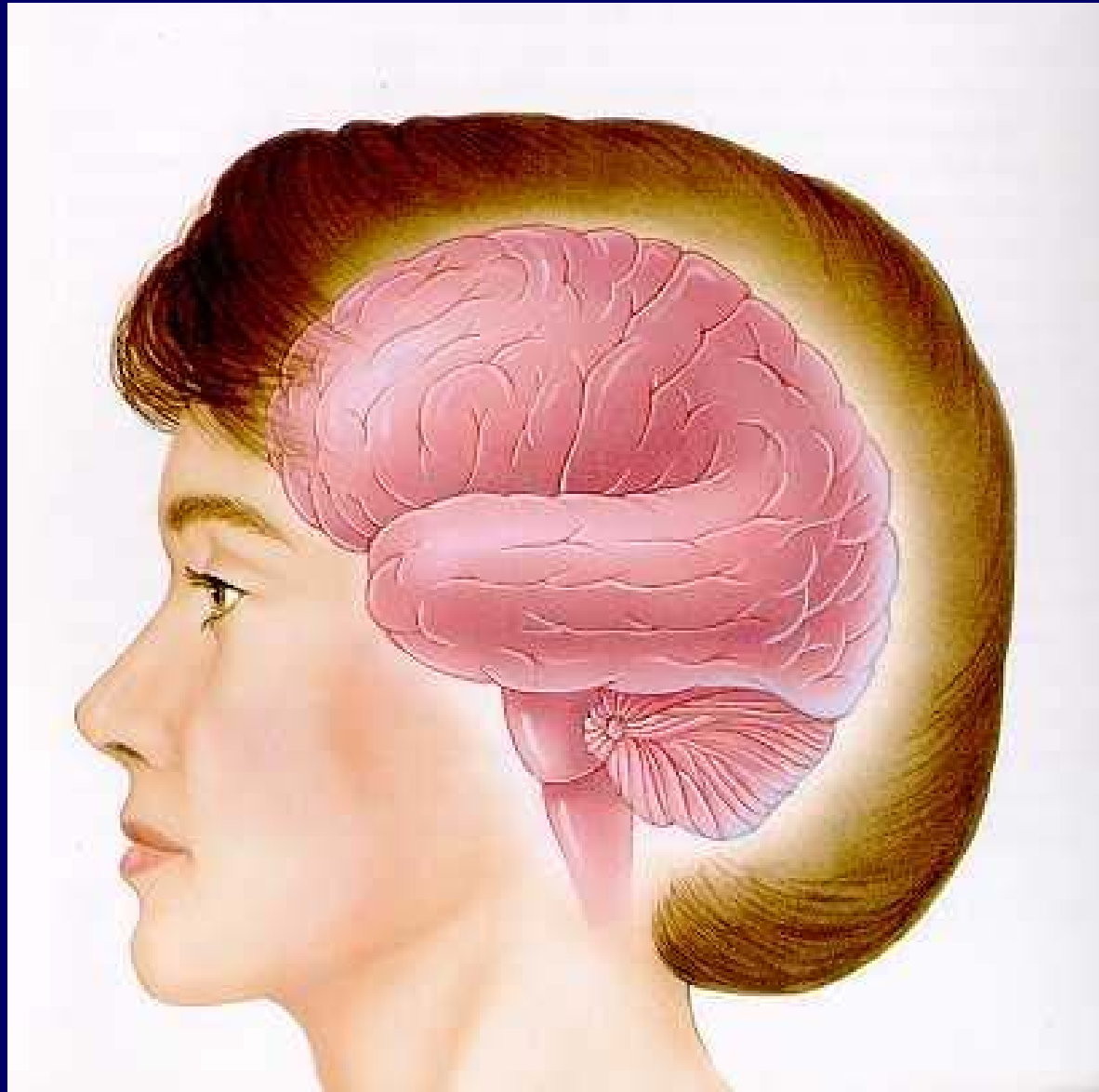
---

- Health
- Learning
- Behaviour

# Economist Magazine

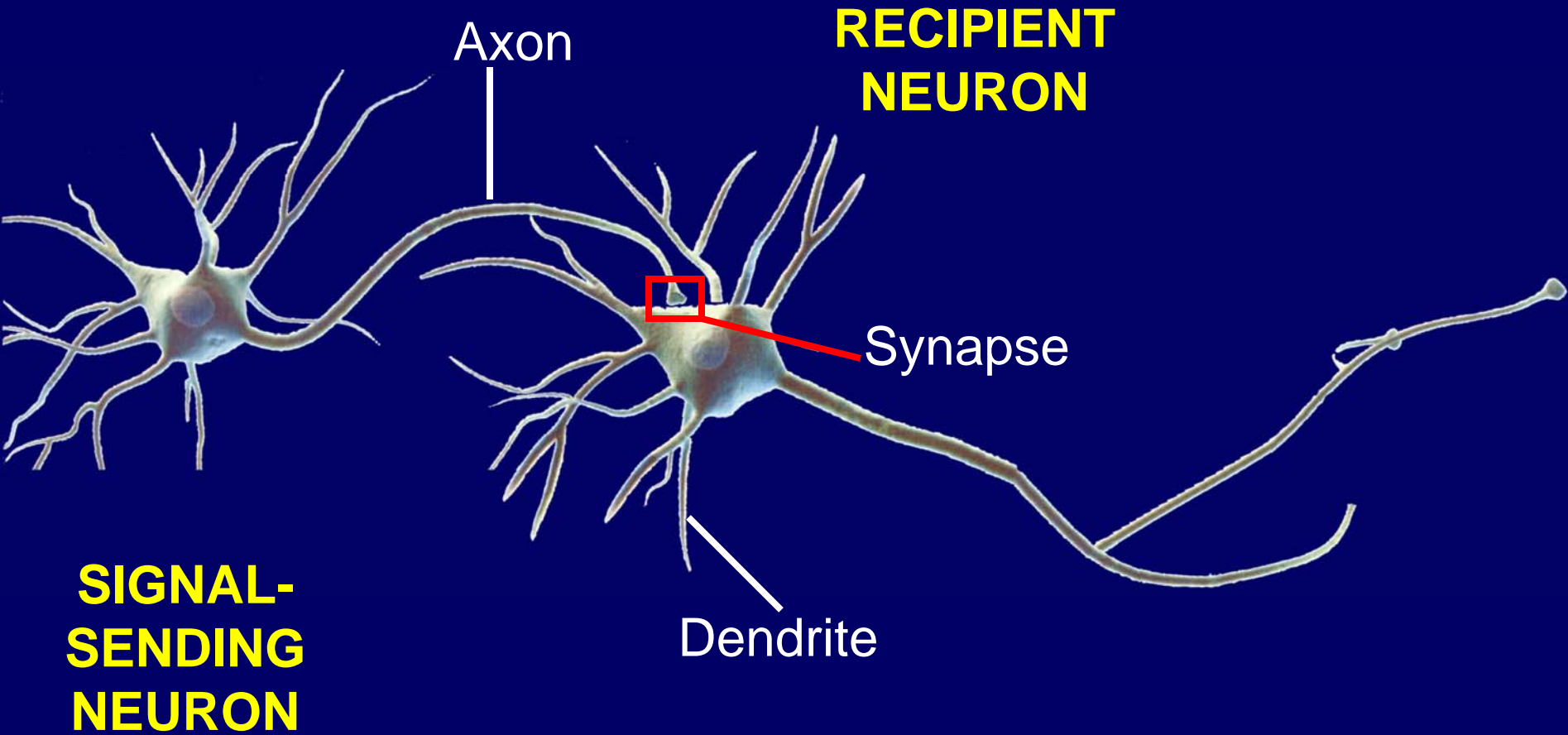
---

- September 21, 2006 – Learning Without Learning (Epigenetics)
- October 7, 2006 – A Survey of Talent
- December 23, 2006 – A Survey of the Brain
- June 14, 2007 – RNA - Really New Advances (microRNA)



[The Hostage Brain](#) , Bruce S. McEwen and Harold M. Schmeck, Jr., 1994.

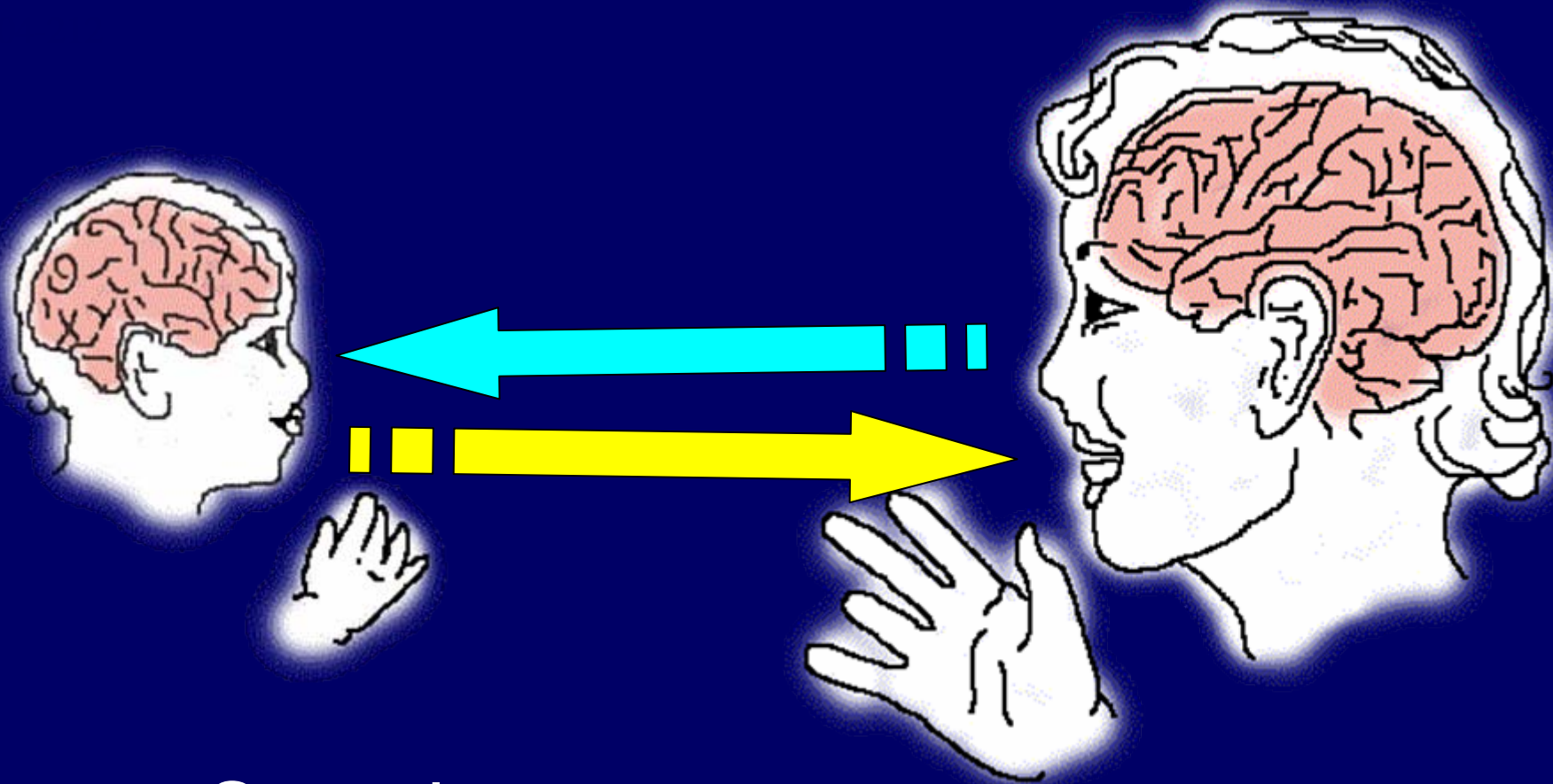
# Two Neurons



---

# SENSING PATHWAYS

---



- Sound
- Vision
- Smell

- Touch
- Proprioception
- Taste

# Vision and Hearing Critical Period

---

Eye cataracts at birth prevent normal development of vision neurons in the occipital cortex  
(Hubel and Wiesel)

Cochlear defects at birth impair hearing development  
(Rauschecker and O'Donoghue)

# Brain Pathways

---

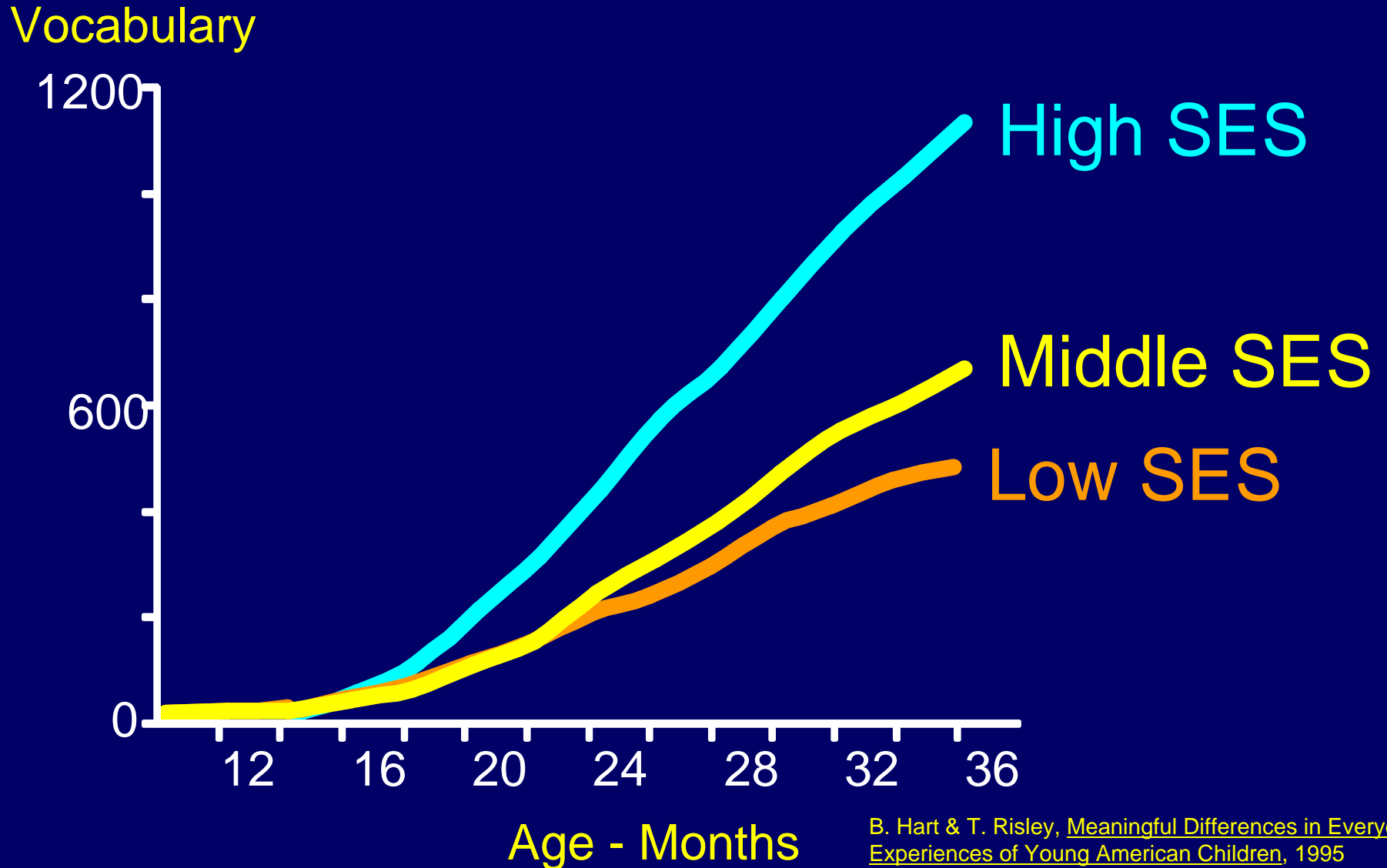
- “Higher levels of brain circuits depend on precise, reliable information from lower levels in order to accomplish their function.
- Sensitive periods for development of lower level circuits ends early in life.
- High level circuits remain plastic for a longer period.”

# Early Child Development and Language

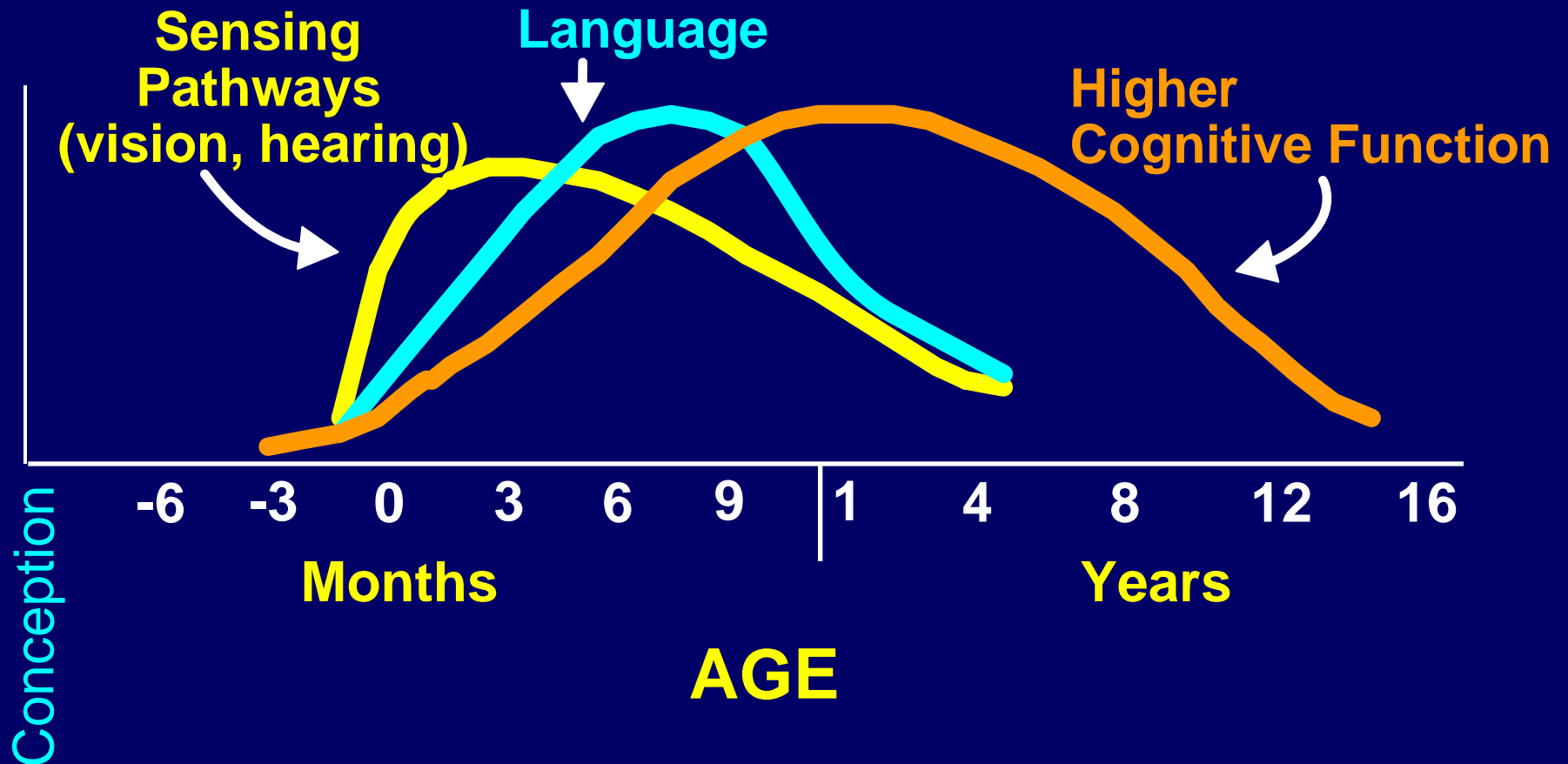
---

- Starts early – first 7 months
- Sets capability for mastering multiple languages
- Sets literacy and language trajectories

# Vocabulary Growth – First 3 Years



# Human Brain Development – Language and Cognition



# Early Brain Development and Criminal Behaviour

Significant correlation with registered criminality (teenage) appeared for language development at 6, 18, and 24 months

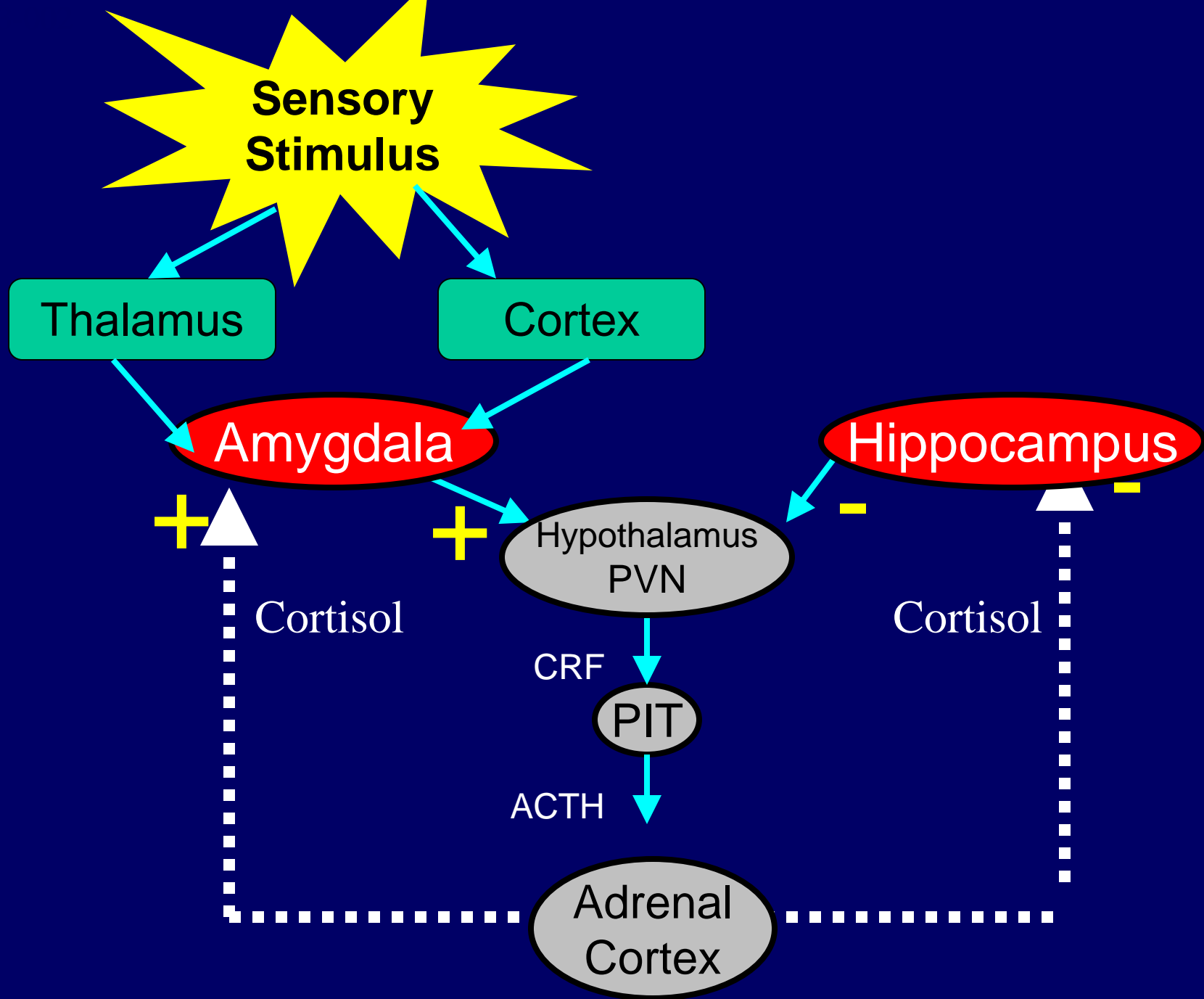
**Stattin, H. et al -*Journal of Abnormal Psychology*102; 369, 1993**

# Stress

---

## Limbic HPA Pathway

---



# Limbic HPA Pathway - Stress

---

## Cortisol – Over Production

Behaviour, depression, diabetes, malnutrition, cardiovascular disease, memory, immune system, drug and alcohol addiction

## Cortisol – Under Production

Chronic fatigue syndrome, fibromyalgia, immune system (autoimmune disorders) rheumatoid arthritis, allergies, asthma

# Stress Pathway and Sensory Stimuli

---

Touch in the Early Period is Critical

- Rats – Mothers licking pups
- Monkeys – Peer vs mother rearing
- Humans - Attachment

Individual differences in stress reactivity of the adult are determined by maternal behaviour during infancy

**HIGH LG**

**LOW LG**

**Development of  
Stress Reactivity**

**Modest Stress  
Reactivity**

Reduced Risk  
for Disease

**Increased Stress  
Reactivity**

Increased Risk for Heart  
Disease, Type II Diabetes,  
Alcoholism, Affective  
Disorders, Brain Aging, etc.

# Environment Affects Gene Function

---

- Epigenetics
- MicroRNAs
- Candidate Genes

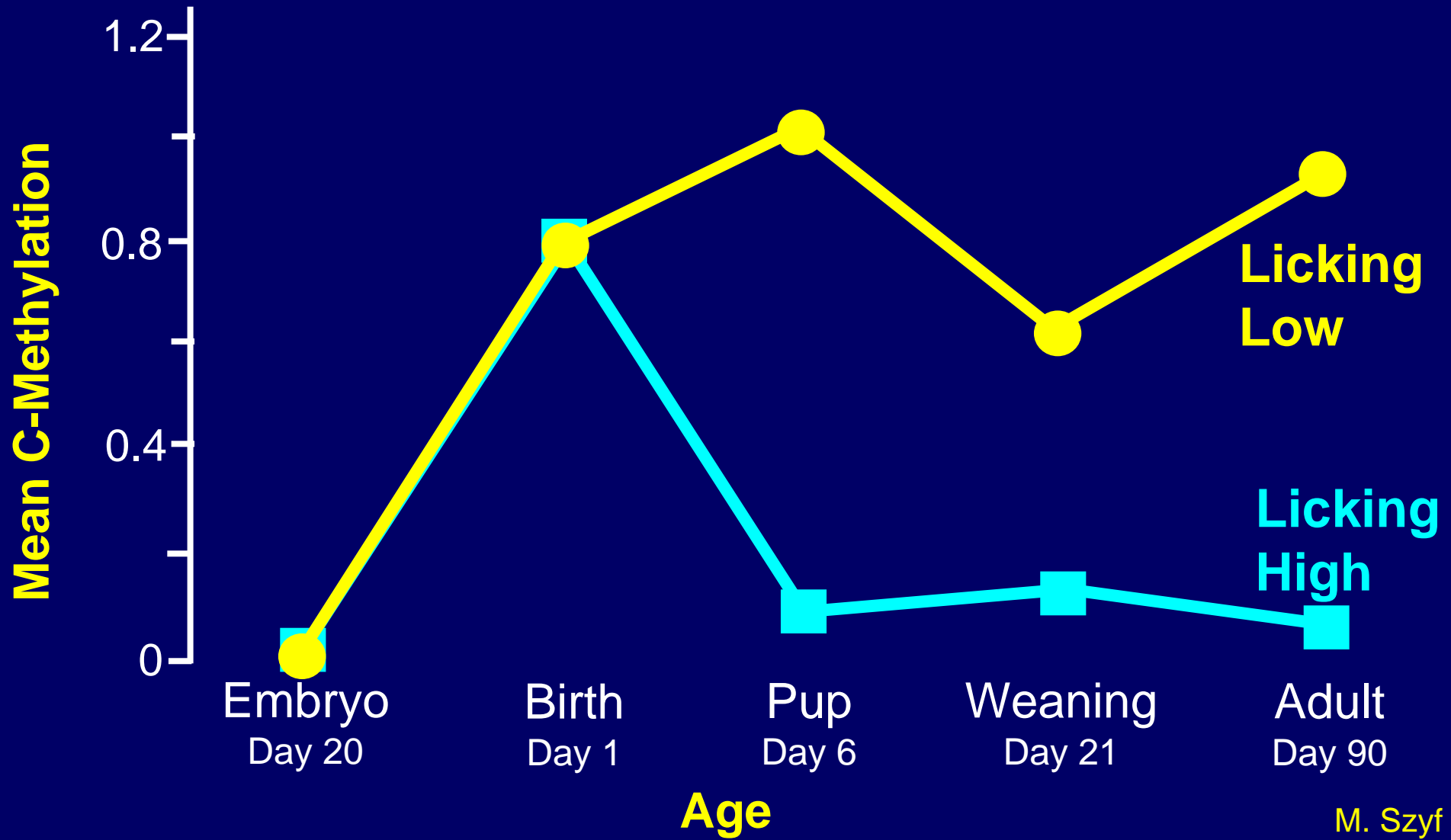
# Epigenetics

(heritable without changes in DNA sequence)

---

- Methylation of DNA (cytosine)
- Histone acetylation

# Hippocampal GR(1<sub>7</sub>) Region 16 (5' NGFI-A RE) Methylation Timeline





# Rhesus Macaque Monkeys – Serotonin Transporter Gene

---

Poor nurturing in infancy

- Long allele, no behaviour problems
- Short allele, significant behaviour problems and alcohol addiction

---

“Maltreatment at an early age can have enduring negative effects on a child's brain development and function.”

---

*Martin Teicher*  
*Scientific American, 2002*

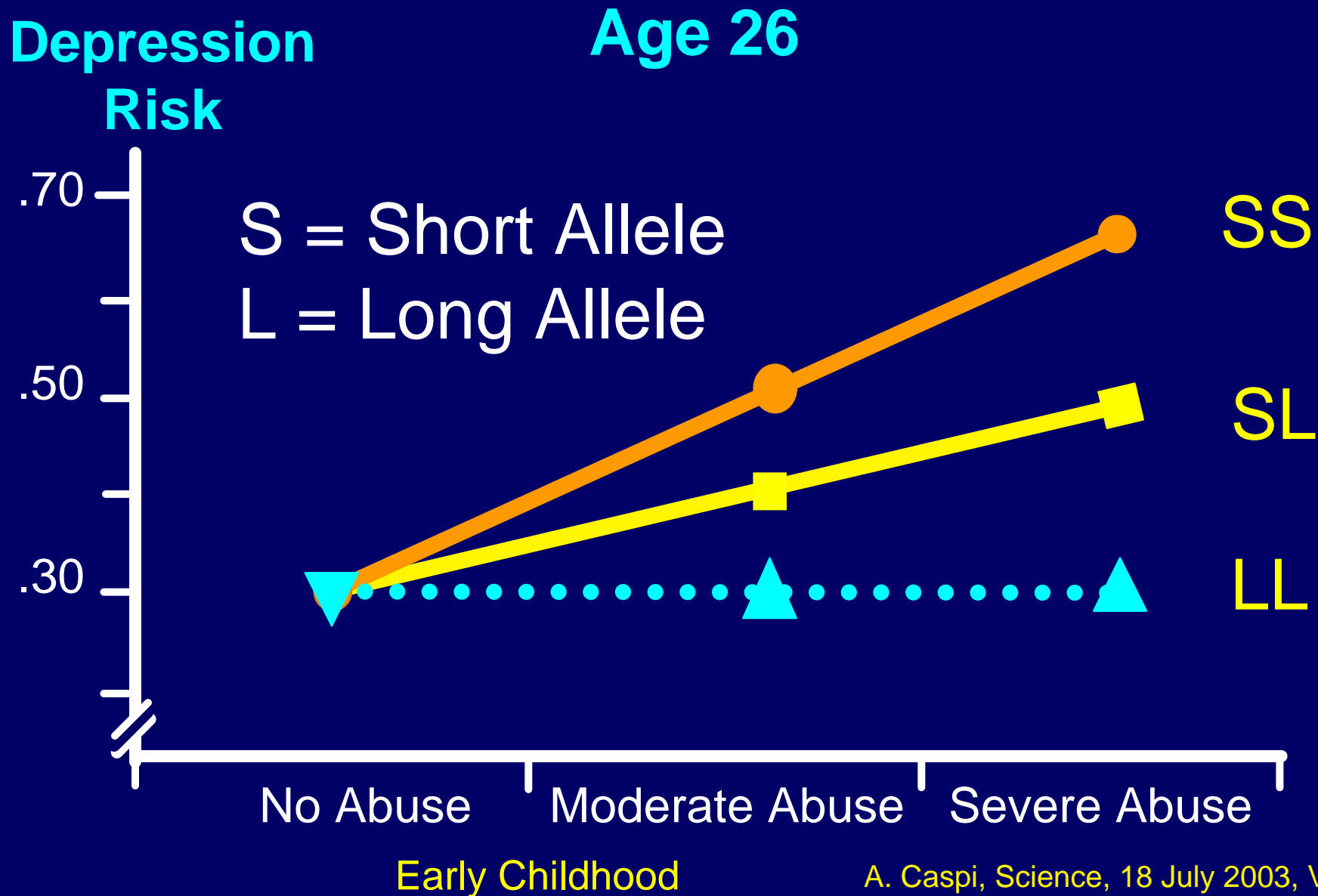
---

"The aftermath ... can appear as depression, anxiety, suicidal thoughts or post-traumatic stress - or as aggression, impulsiveness, delinquency, hyperactivity or substance abuse."

---

*Martin Teicher*  
*Scientific American, 2002*

# Serotonin Transporter Gene Experience in Early Life - Depression



# Romanian Adoption Project

## Scores at 10.5 Years

	CB	EA	RO
IQ	108	99	85
Language Score	106	99	88
Behaviour	13%	9%	43%

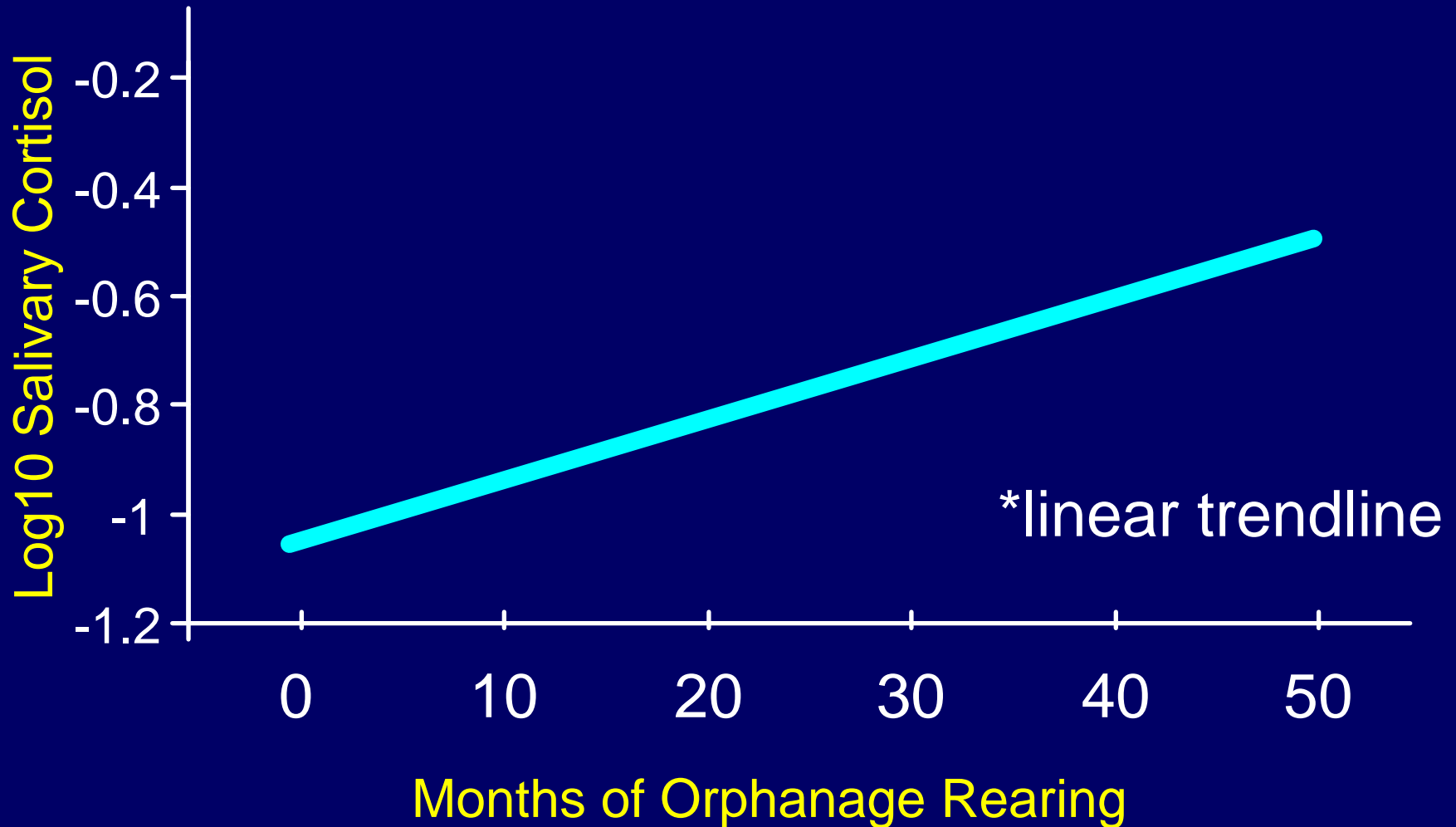
CB - Canadian Born

EA - Early Adopted

RO - Romanian Orphanage

L. Le Mare

# Evening Cortisol Levels Increase with Months of Orphanage Rearing \*



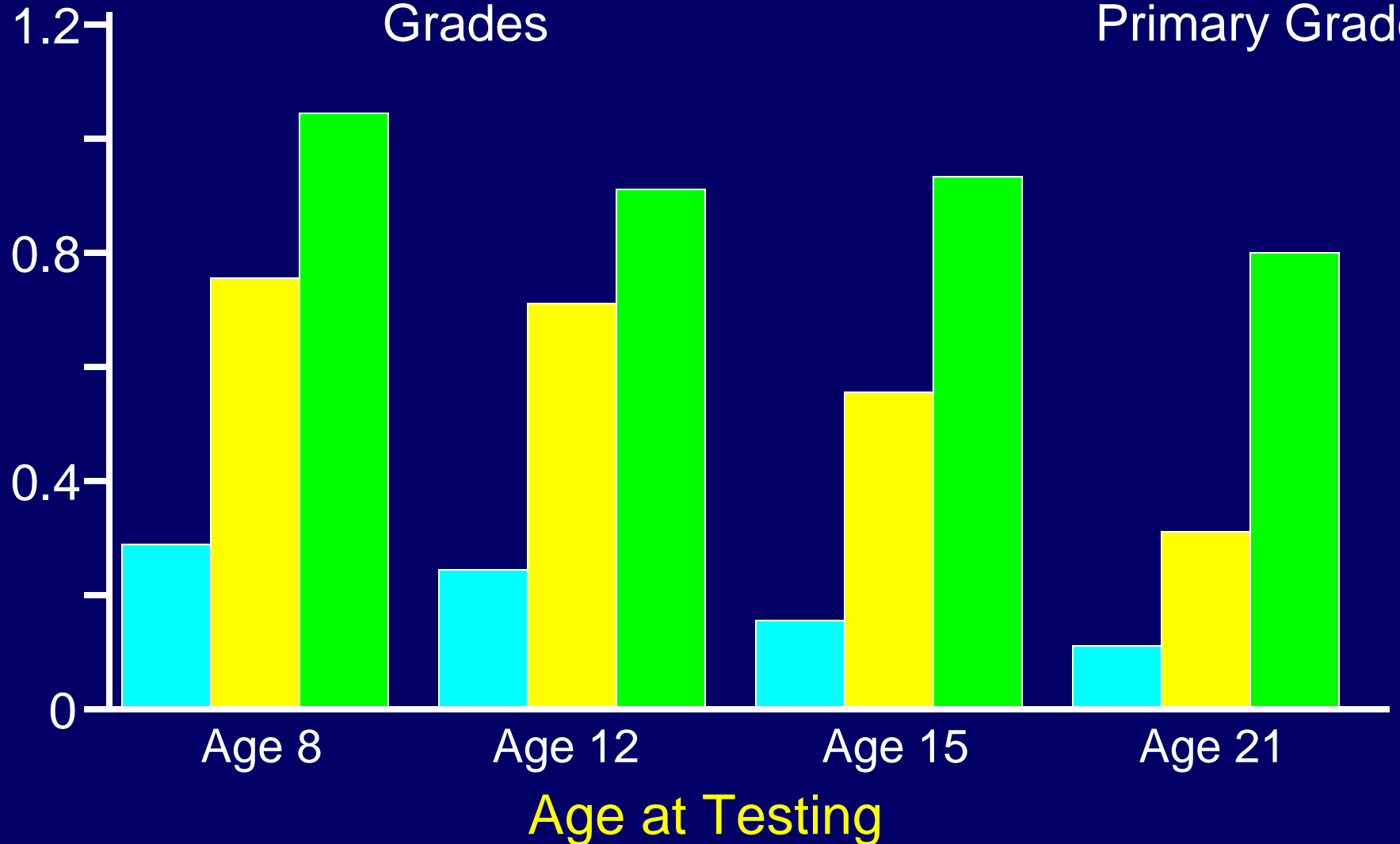
# Abecedarian Study – Reading

Effect Size

Primary  
Grades

Preschool

Preschool &  
Primary Grades



---

# OUTCOME MEASURES

---

# Early Development Instrument (EDI)

---

- Physical health and well-being
- Social knowledge and competence
- Emotional health/maturity
- Language and cognitive development
- Communication skills and general knowledge

# EDI Results – Vancouver Districts

---

District	Income \$	EDI Results % scoring in bottom 10%
1	12,000-24,000	34.5
2	24,000-37,000	27.5
3	37,000-49,000	21.5
4	49,000-62,000	15.0
5	62,000-74,000	8.5

# Vancouver EDI Numeracy

# of Vulnerabilities	% Failing Grade 4	% Not Passing Grade 4
0	7.5	12.3
1	11.8	22.2
2-3	18.7	33.8
4-5	27.5	55.6

# Vancouver EDI Reading

# of Vulnerabilities	% Failing Grade 4	% Not Passing Grade 4
0	13.6	17.8
1	26.7	33.9
2-3	29.5	43.1
4-5	48.4	68.3

# Decrease in the % of vulnerable children as a result of improved ECD in Western Australia

	Year	
	2003	2006
Floreat	47.22%	14.3%
Wembley	47.11%	11.8%

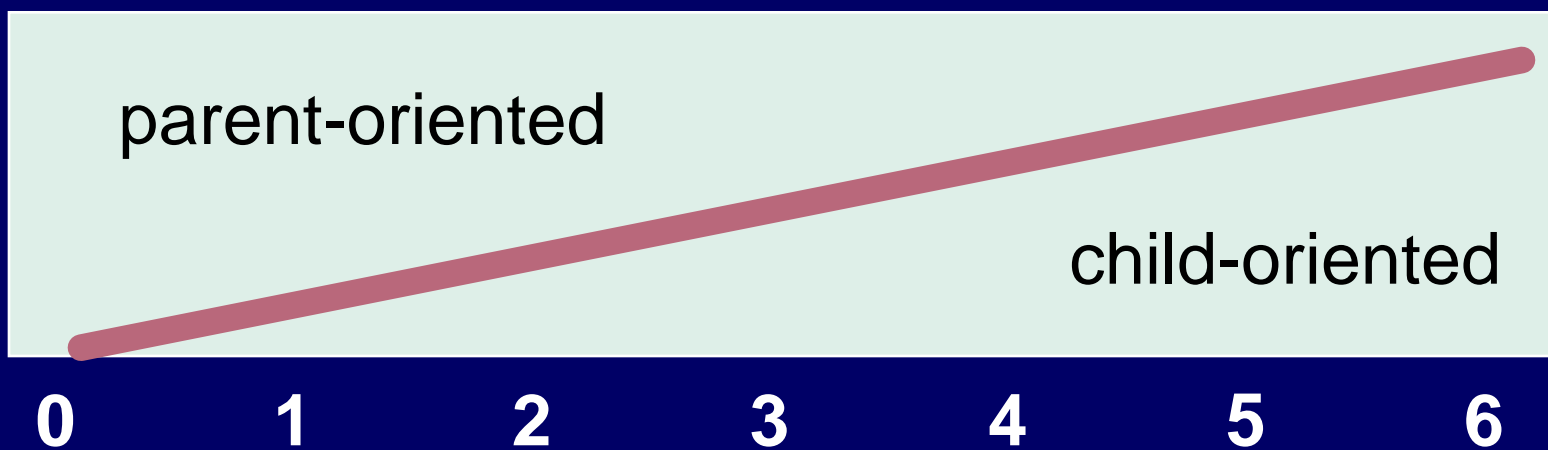
# Success by Ten

## Early Child Development

---

- Intervene early
- Intervene often
- Intervene effectively

# Source of Brain Stimulation



## Components of Early Childhood Development and Parenting Centres:

- ECD & care (parental and non-parental) arrangements
- Play-based learning (problem-based)
- Resources
- Prenatal & postnatal supports
- Nutrition programs

# Parental Leave

---

Provide 18 months parental leave with income support, followed by one day weekly leave for both parents until age three to be involved in the Early Child Development & Parenting Centre.

# In Ontario and South Australia, about 25% of Children are Vulnerable at Age 5

---

- In Ontario, over 40,000 children
- In South Australia, over 5,000 children

# Cost of ECD-P Centres (Estimate Canada)

---

Age 0 to 6 Population

Universal (2,500,000 children)

**Cost** \$18.5 Billion (1.5% of GDP)

Present Expenditure 0.25% of GDP

# Cost to Individuals and Canadian Society of Poor Early Child Development (estimates)

---

Crime and Violence\*      \$120 Billion/year

Mental Health  
and Behaviour\*\*      \$100 Billion/year

\* Adapted from Heckman. 2006.

\*\* Adapted from Gnam et al. 2006.

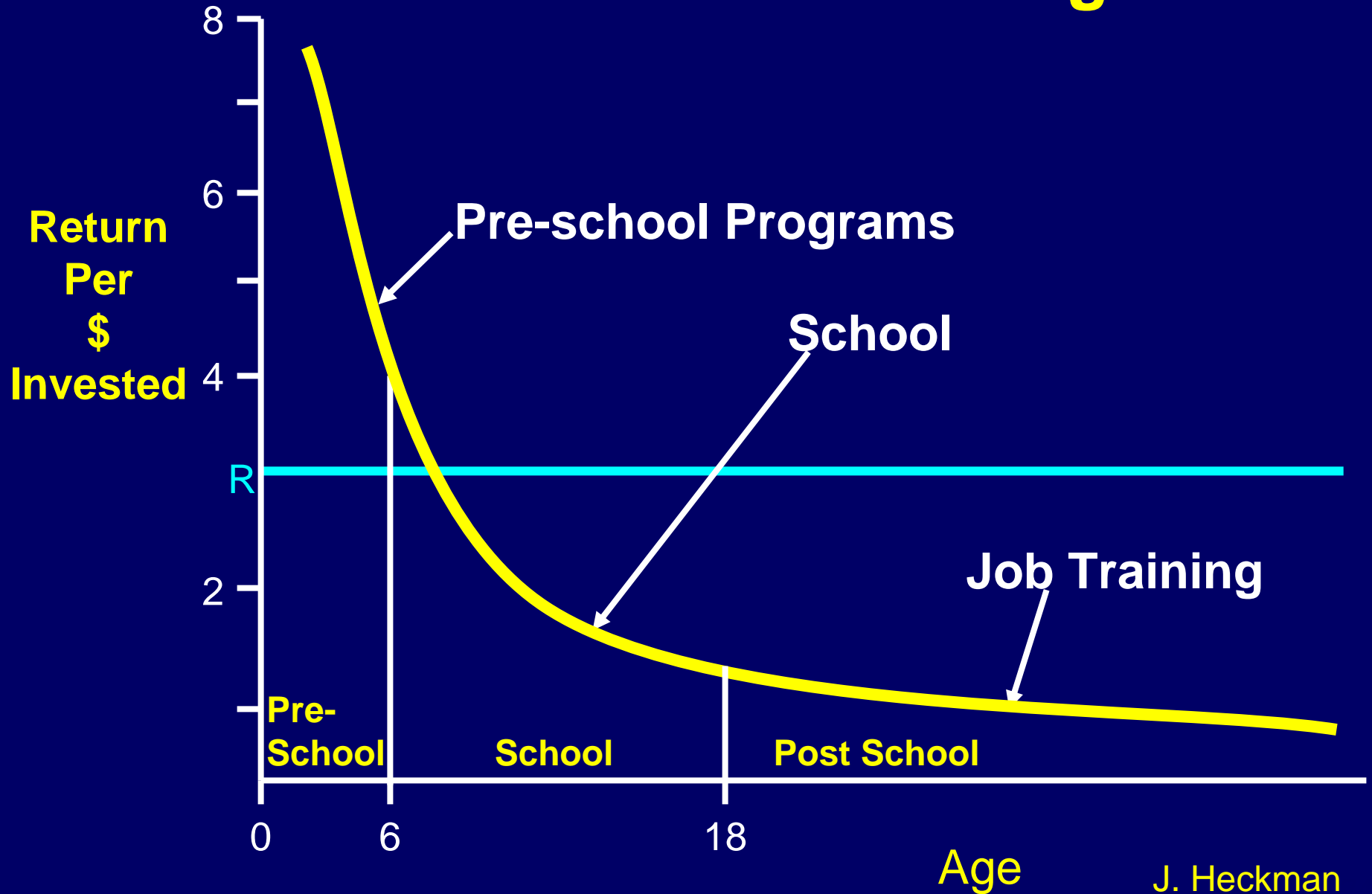
# Policies to Foster Human Capital

---

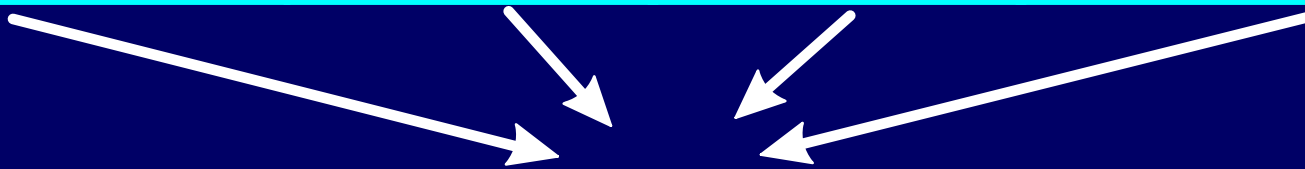
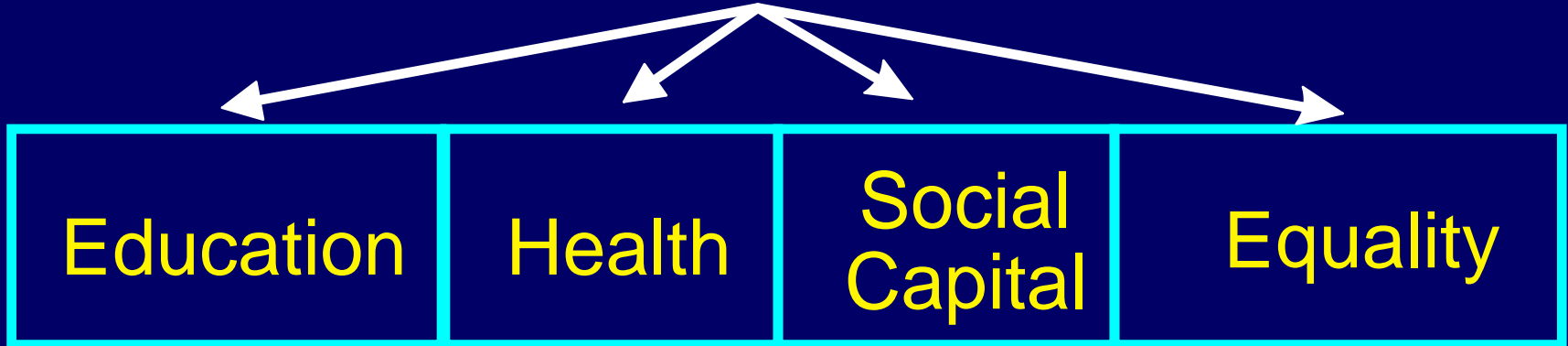
"We cannot afford to postpone investing in children until they become adults nor can we wait until they reach school - a time when it may be too late to intervene."

Heckman, J., 2001  
(Nobel Prize Economics, 2000)

# Rates of Return to Human Development Investment Across all Ages



**ECD**



**Economic Growth**

**Human Development**

# Free Market Capitalism

## Choices

---

- Without social accountability
- With social accountability

*[www.founders.net](http://www.founders.net)*

To download this presentation, go to:  
Slides - Slide Shows

To order copies of Early Years Study 2, go to:  
[www.councilecd.ca](http://www.councilecd.ca)

# References

1. *From Early Child Development to Human Development*. Editor: Mary Eming Young, World Bank, Washington, 2000.
2. *Synaptic Self: How Our Brains Become Who We Are*. Joseph LeDoux, Viking Penguin, New York, 2003.
3. *The End of Stress As We Know It*. Bruce McEwen, Joseph Henry Press, Washington, 2002.
4. *Developmental Health and the Wealth of Nations*. Editors: Daniel P. Keating, Clyde Hertzman, The Guilford Press, New York, 1999.
5. *From Neurons to Neighborhoods. The Science of Early Child Development*. Editors: Jack P. Shonkoff and Deborah A. Phillips, National Academy Press, Washington, 2000.
6. *Early Years Study, Final Report Reversing the Real Brain Drain*. Hon. Margaret Norrie McCain and J. Fraser Mustard, Publications Ontario, Toronto, 1999.

7. *Vulnerable Children*. Editor: J. Douglas Willms, University of Alberta Press, Edmonton, 2002.
8. *Readiness to Learn at School*. Magdalena Janus and Dan Offord, In: Isuma (Canadian Journal of Policy Research) Vol. 1, No. 2, 2000.
9. *Why are some people healthy and others not?* Editors: Robert G. Evans et al, Aldine De Gruyter, New York, 1994.
10. *The Early Years Study Three Years Later*. Hon. Margaret Norrie McCain and J. Fraser Mustard, The Founders' Network, 2002.
11. *Early Years Study 2: Putting Science Into Action*. Hon. Margaret Norrie McCain, J. Fraser Mustard, S. Shanker. Council for Early Child Development. 2007.
12. *Behaviour (Affect), Literacy, and Early Child Development*. J. Fraser Mustard. Paper prepared for the 5<sup>th</sup> International Encounter of Early Childhood. Monterrey, Mexico. 2005.

**13. *Early Child Development and Experience-based Brain Development: Implications for the Continuing Experiments in Civilization.*** J. Fraser Mustard. In: *Early Child Development: From Measurement to Action.* Editor: M.E. Young. World Bank. Washington. 2007.

**14. *What the EDI Is (Not).*** Hillel Goelman and Clyde Hertzman. 2004.  
[www.earlylearning.ubc.ca](http://www.earlylearning.ubc.ca)

**15. *The Balance Within.*** Esther Sternberg. W.H. Freeman. New York. 2000.

**16. *Healthier Societies: From Analysis to Action.*** Jody Heymann, Clyde Hertzman, Morris Barer and Robert Evans, Eds. New York: Oxford University Press. 2005.

**17. *ECD and Experience-based Brain Development: The Scientific Underpinnings of the Importance of Early Child Development in a Globalized World.*** J. Fraser Mustard. Washington: Brookings Institution. 2006. [www.founders.net](http://wwwFOUNDERS.net)

**18. *Success by Ten.*** Jens Ludwig and Isabel Sawhill. Washington: Brookings Institution. 2006.