

National Child Day Forum

Winnipeg, MB

**Epigenetics: A Revolution in
Understanding Child and Youth
Development**

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The Founders' Network

November 16, 2010

CIFAR/Founders' Network Interaction with Manitoba

1. Roos' and Manitoba Centre 1990
2. Universities and the Knowledge-based Society – May 1994 – Globe & Mail article
3. Kathleen Guy meeting, Manitoba - 1995
4. Minister Tim Sales 2000 – Healthy Child Manitoba
5. 2008 application of EDI in Manitoba

1. **What have we learned** – The first stage of human development affects the next stages.

2. **What have we done**

- Attempted to integrate government departments
- Established a ministry of education to support development from conception to adolescence – Pascal's Ontario report
- Experience and gene function (epigenetics)

Stages of Human Development

- | | |
|---------|----------------------|
| Stage 1 | Conception to birth |
| Stage 2 | Birth to age 6 |
| Stage 3 | Age 6 to adolescence |
| Stage 4 | Adolescence to adult |

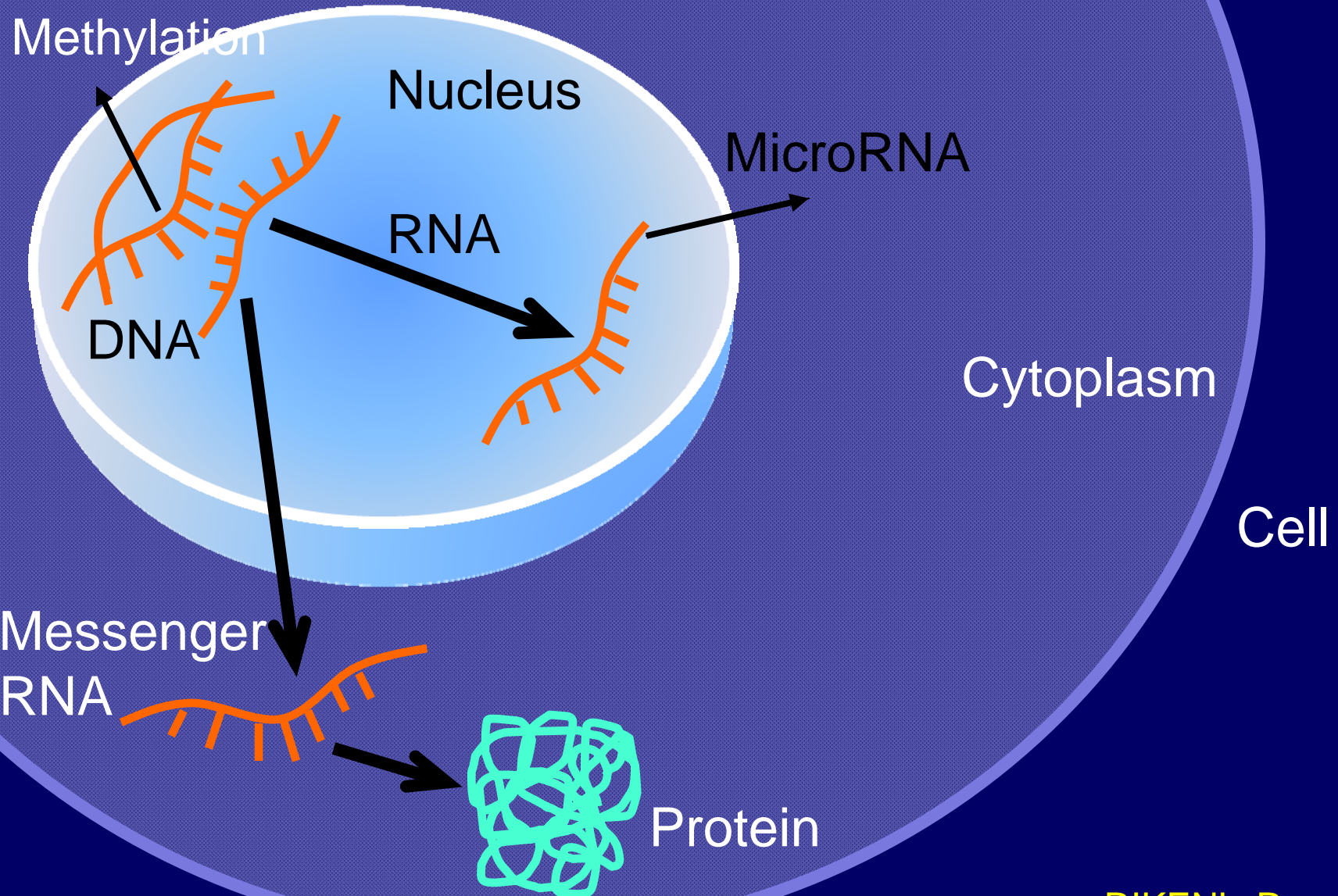
Experience-Based Brain and biological pathway development in the early years of life sets neurological and biological pathways that affect throughout life:

- Health (physical & mental)
- Learning (literacy)
- Behaviour

Brain Development

1. 100 billion neurons (conception to 6 months after birth).
2. How do neurons (with the same genes) differentiate?
3. Now do neurons form synapses (trillions)?

Genetics and Epigenetics



Brain and Human Development

Nature

Nurture

Genes → Epigenetics ← Stimulation and Nutrition

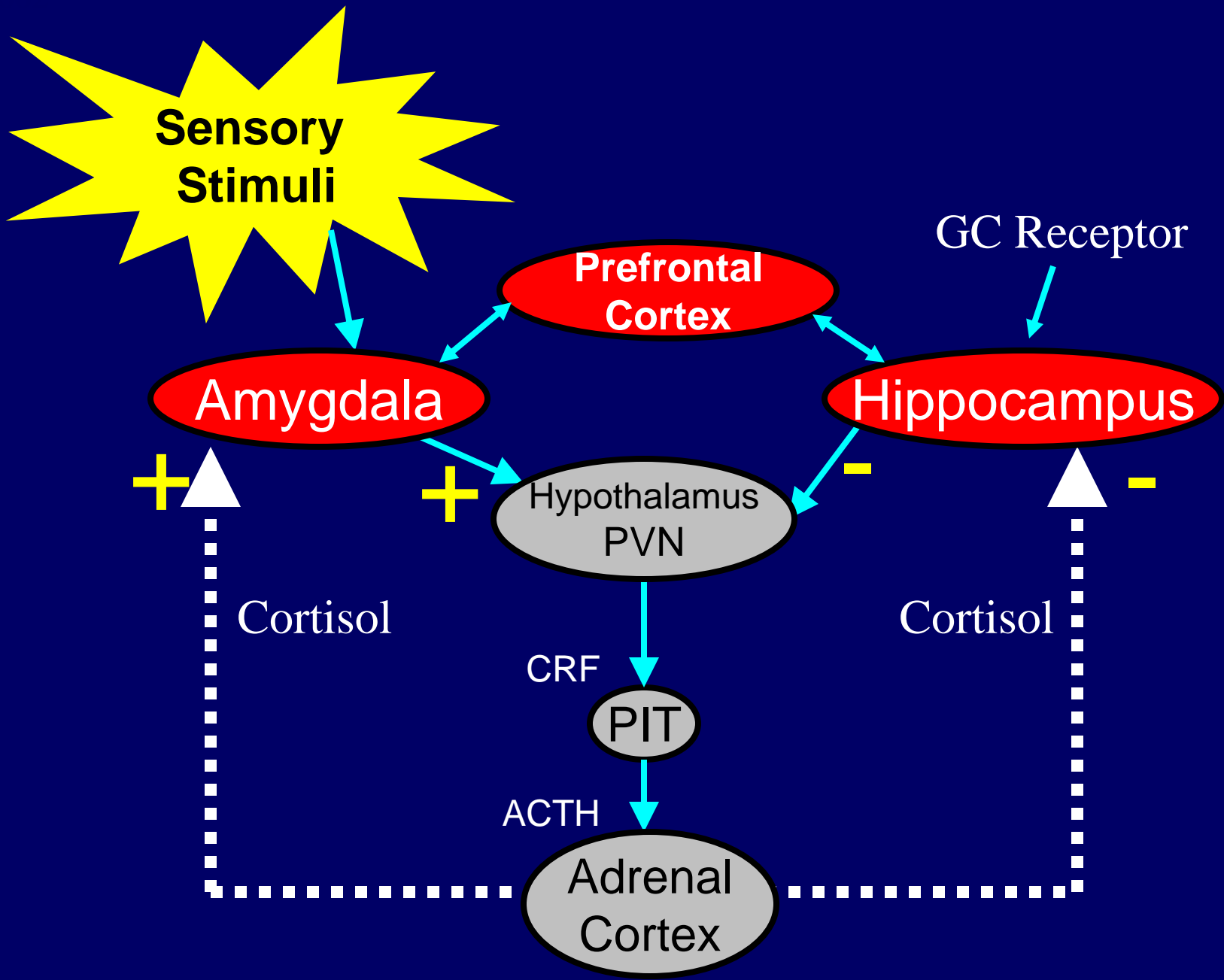
Gene Function

Neurobiological Pathways

Physical Health Mental Health Behaviour Learning

The Limbic Pathway (stress)

- **Health (physical and mental)**
- **Behaviour**



Stress Pathway and Health

Cortisol – Over Production

Behaviour, depression, type II diabetes, cardiovascular disease, memory, immune system function, drug and alcohol addiction

Cortisol – Under Production

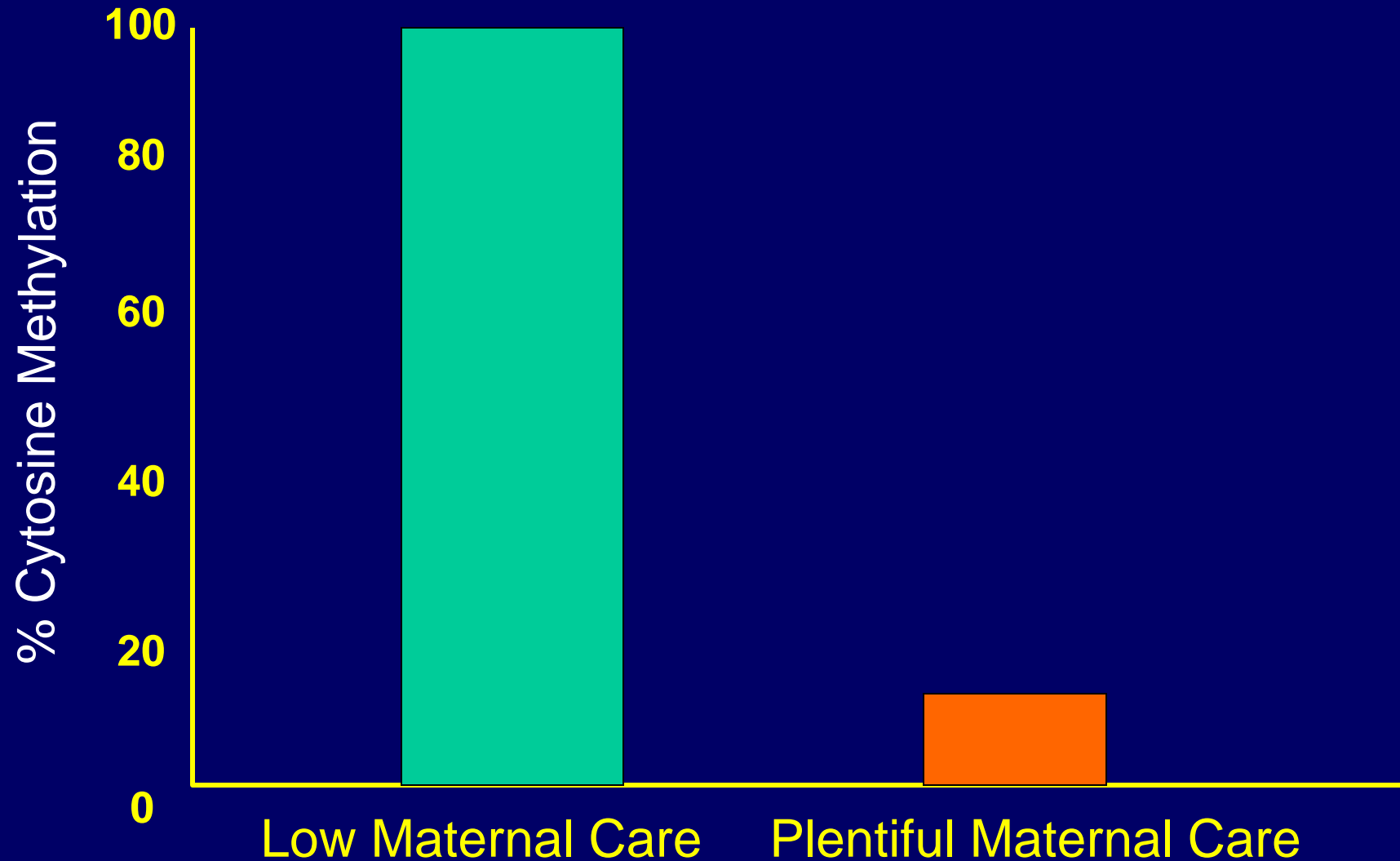
Chronic fatigue syndrome, fibromyalgia, immune system (autoimmune disorders) rheumatoid arthritis, allergies, asthma

Kaiser Permanente – ACE Study

(Adverse Early Childhood Experience)

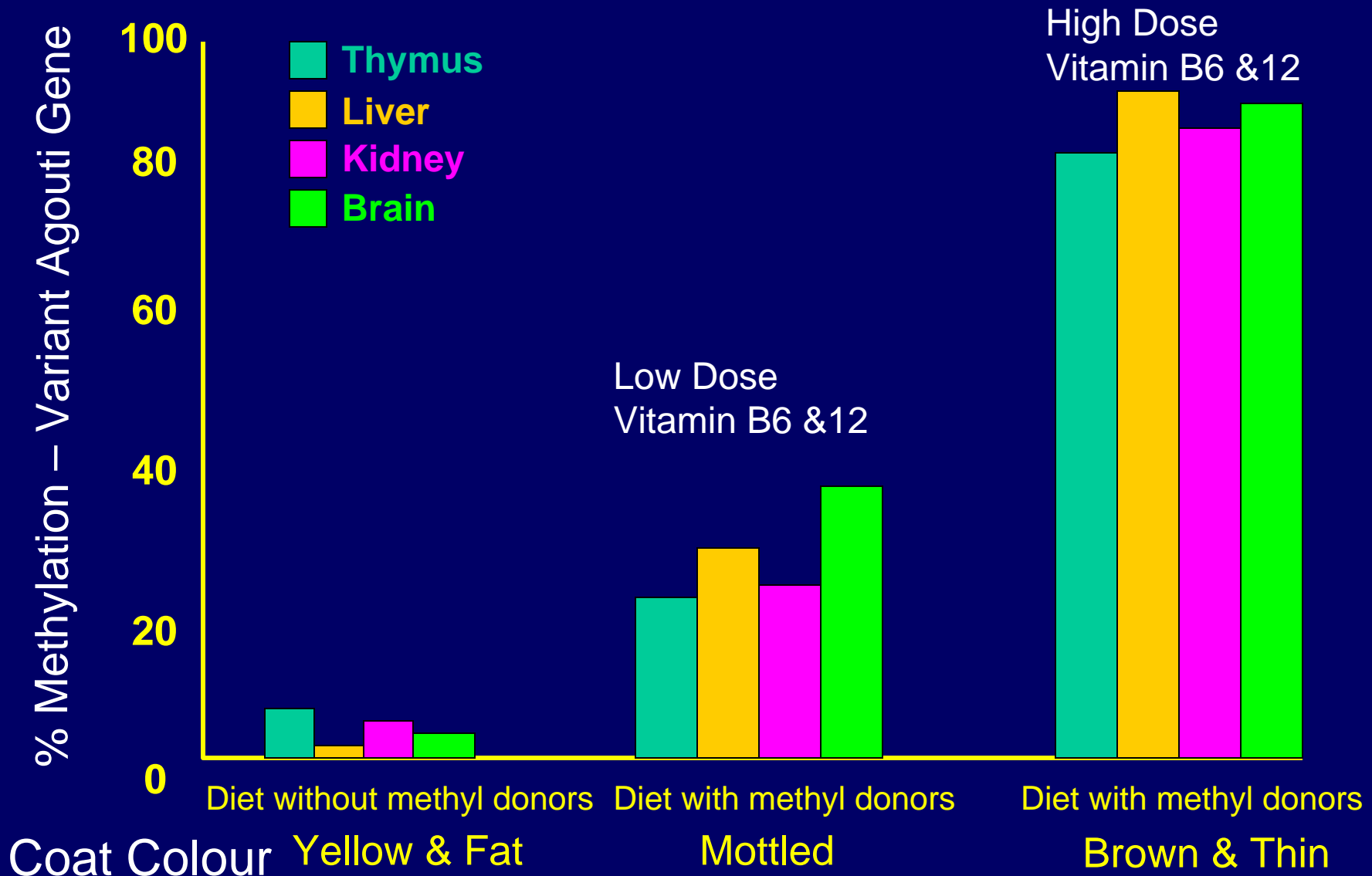
- Ischemic heart disease
- Blood pressure
- Obesity
- Drug and alcohol addiction
- Depression
- Suicide

Methylation of GR Gene (hippocampus) and Behaviour - Rats



Methylation of DNA

Maternal Diet and Phenotype - Mice



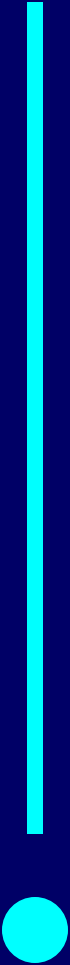
Nutrition Effects on Agouti Gene



Adapted from D.R. Jirtle

Mental Disorders

- Monozygotic Twins



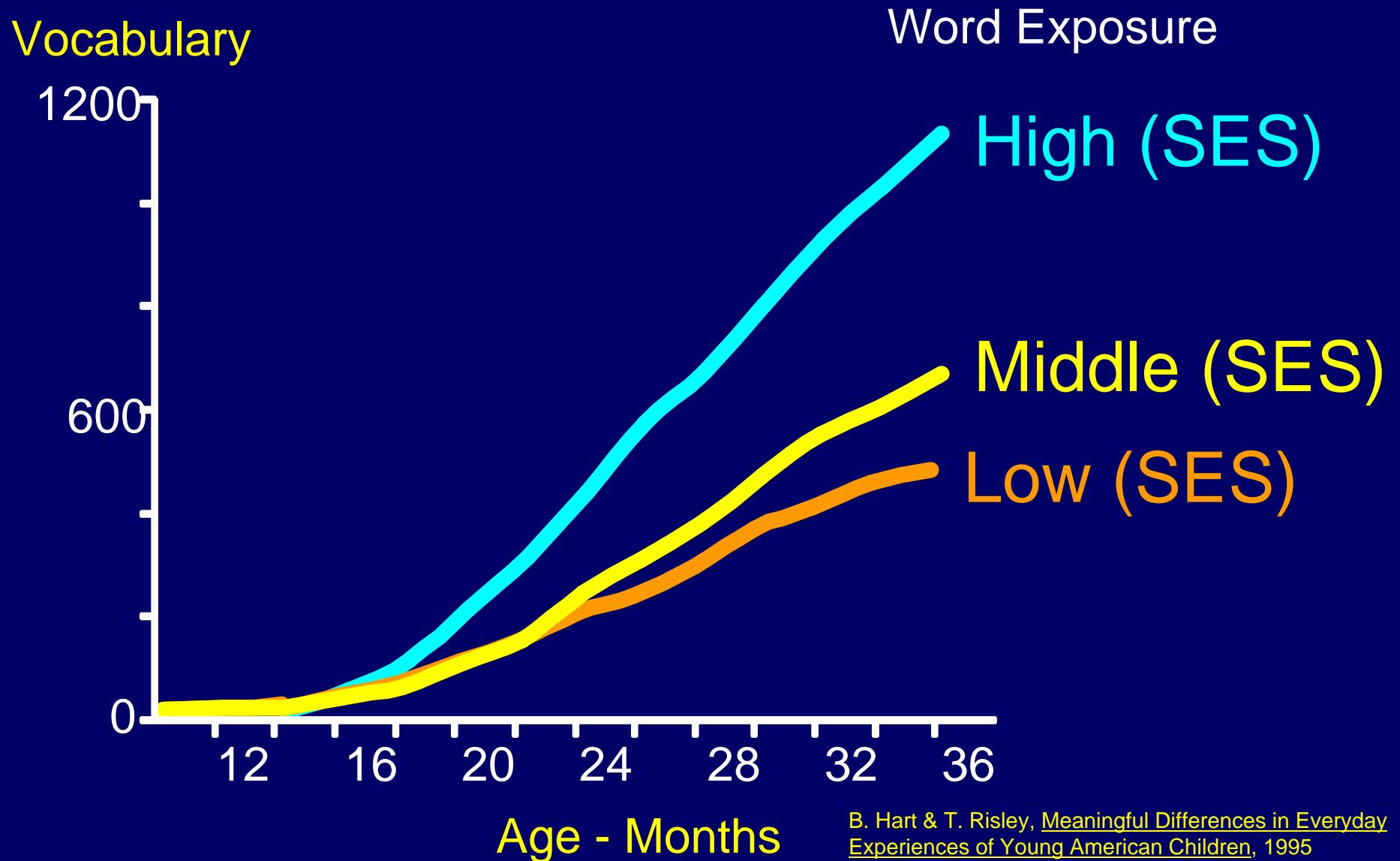
For many mental disorders, monozygotic twins (same genotype) who are reared in the same family are discordant (different phenotype) as adults in 20% to 30% of the cases – epigenetic effect.

Early Human Development
and
Literacy

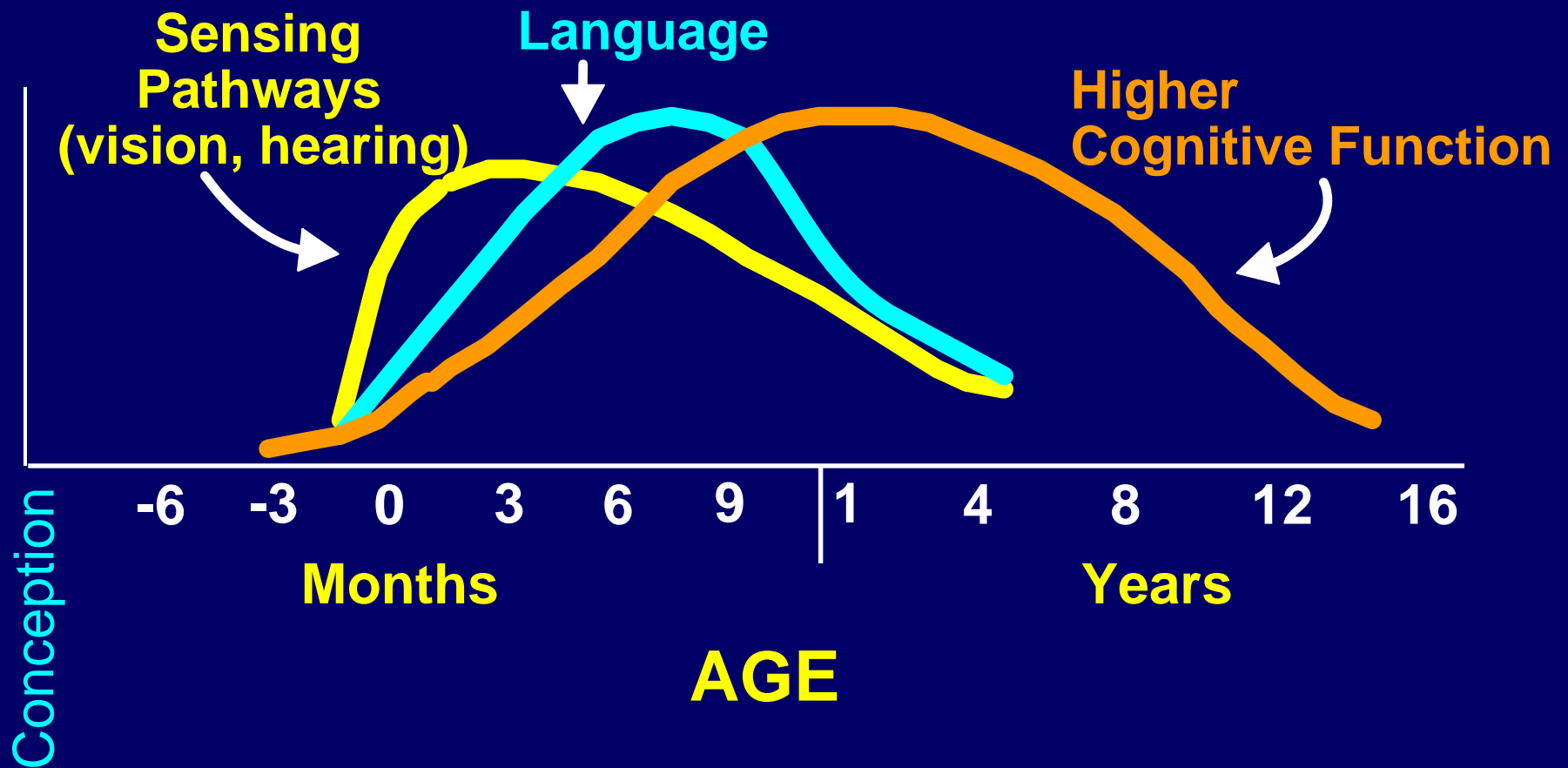
Early Child Development and Language

- Starts early – first 7 months – neurons differentiate language sounds (e.g. English, Japanese)
- Sets capability for mastering multiple languages
- Sets literacy and language learning trajectory for the second and third stages of development

Vocabulary Growth – First 3 Years



Human Brain Development – Language and Cognition



New Zealand Education Study

Student Performance at Age 5 and 14 - %

Highest Quartile

Lowest Quartile

At age 5

At age 5

Performance at Age 14

Performance at Age 14

(% Above Median)

(% Below Median)

Mathematics

87

91

Reading

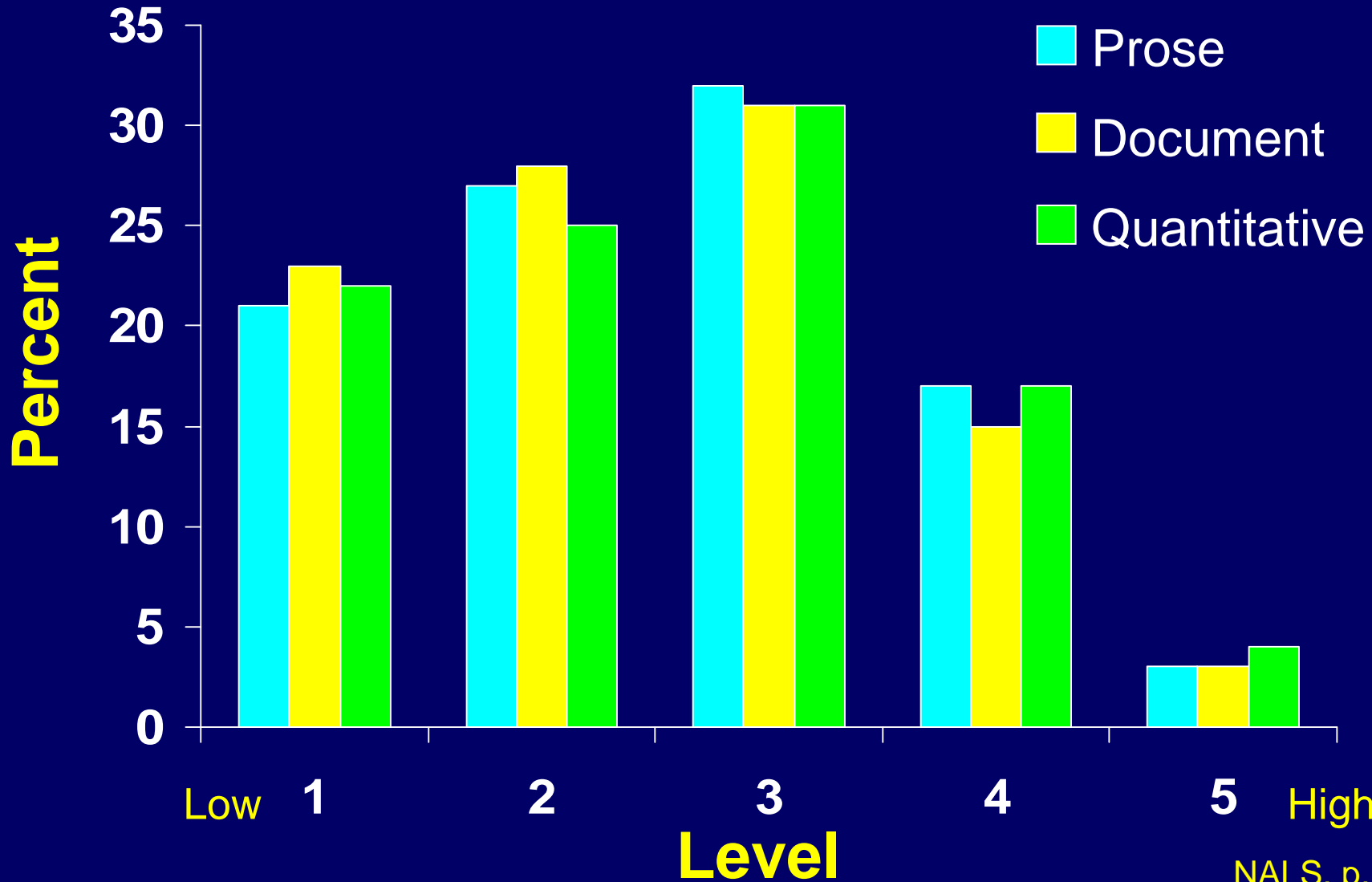
94

85

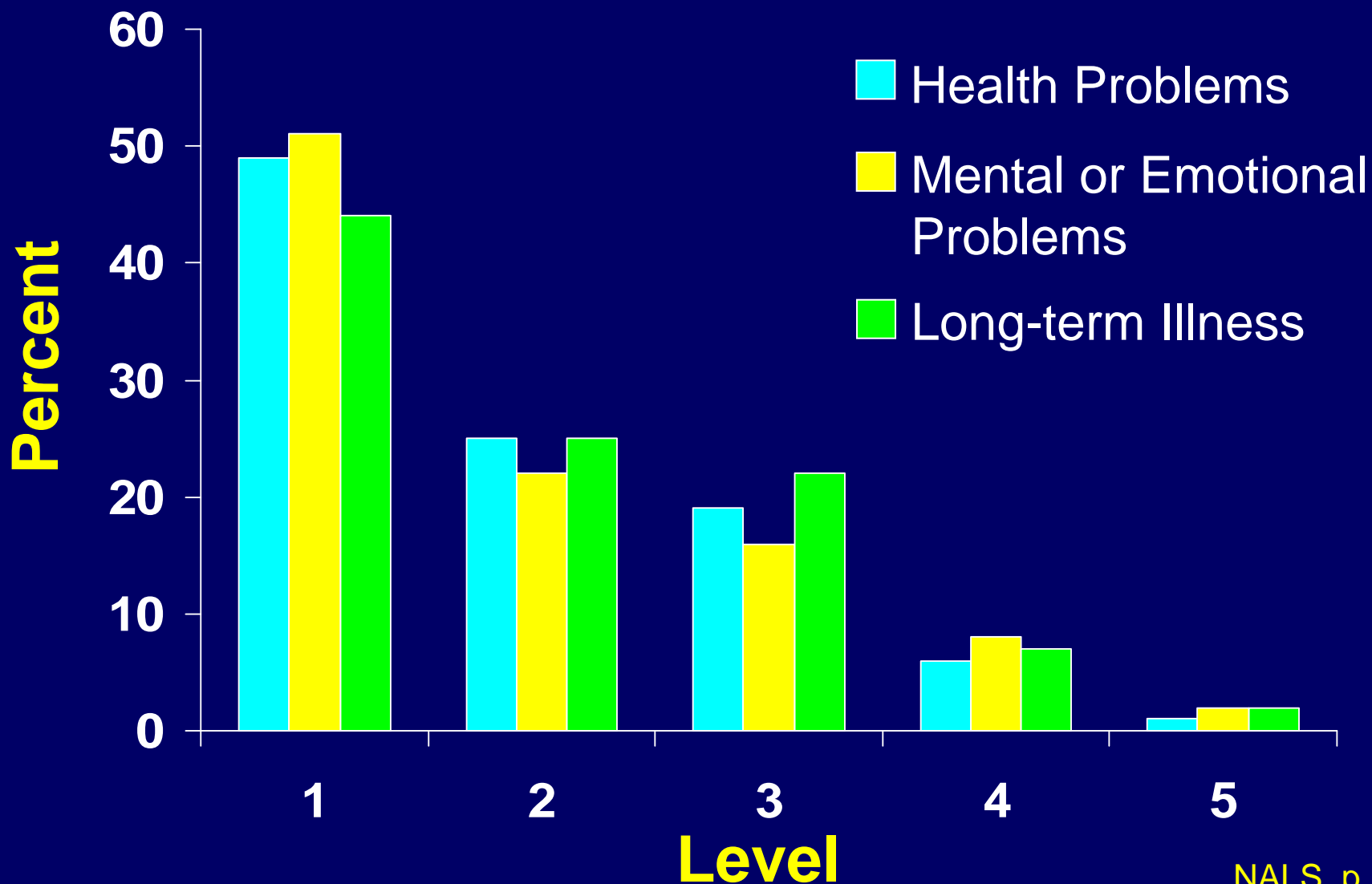
OECD Literacy

The capacity to identify, understand, interpret, create and communicate knowledge using written materials.

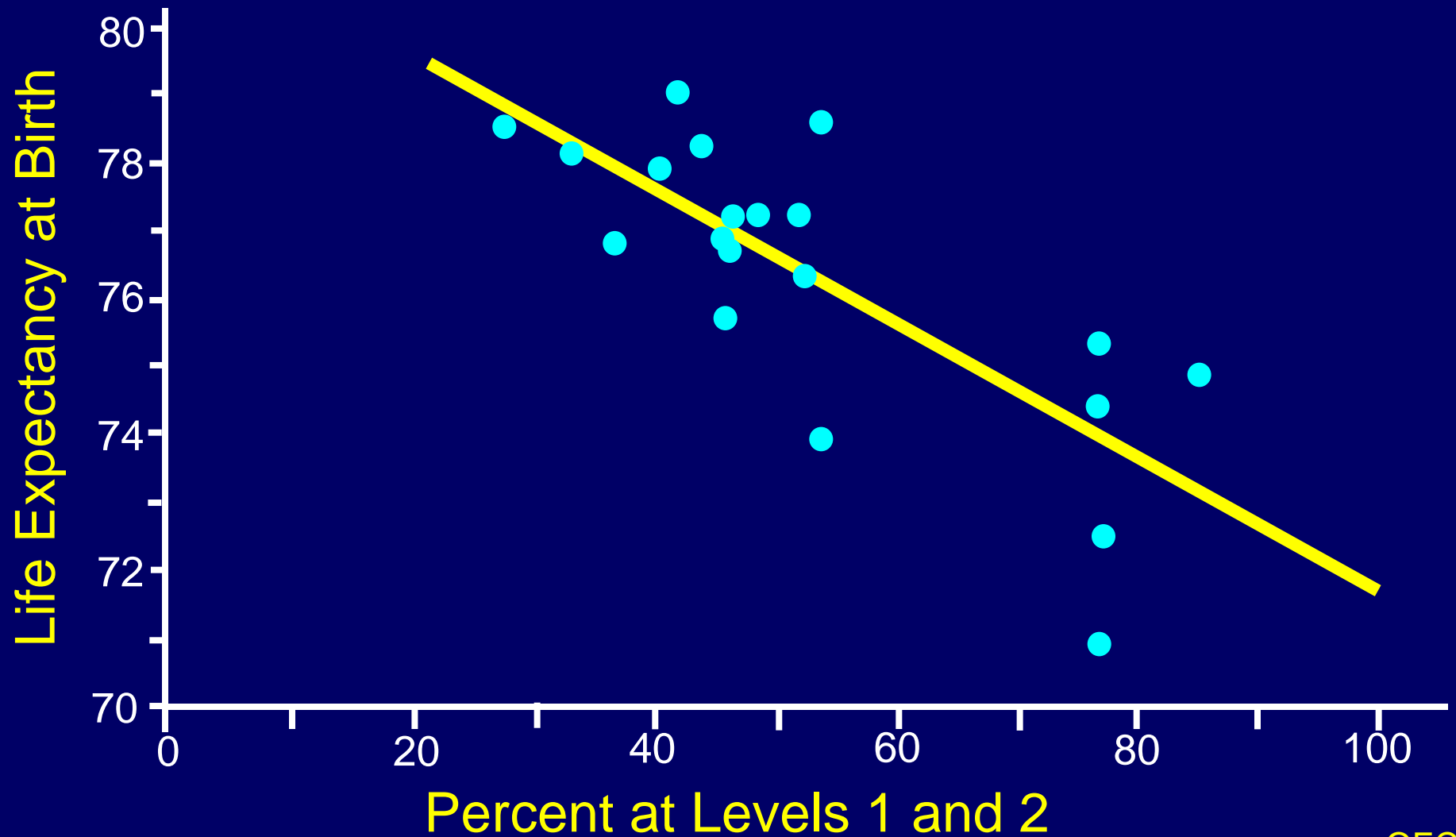
Literacy Levels for the Population Ages 16 to 65 – USA



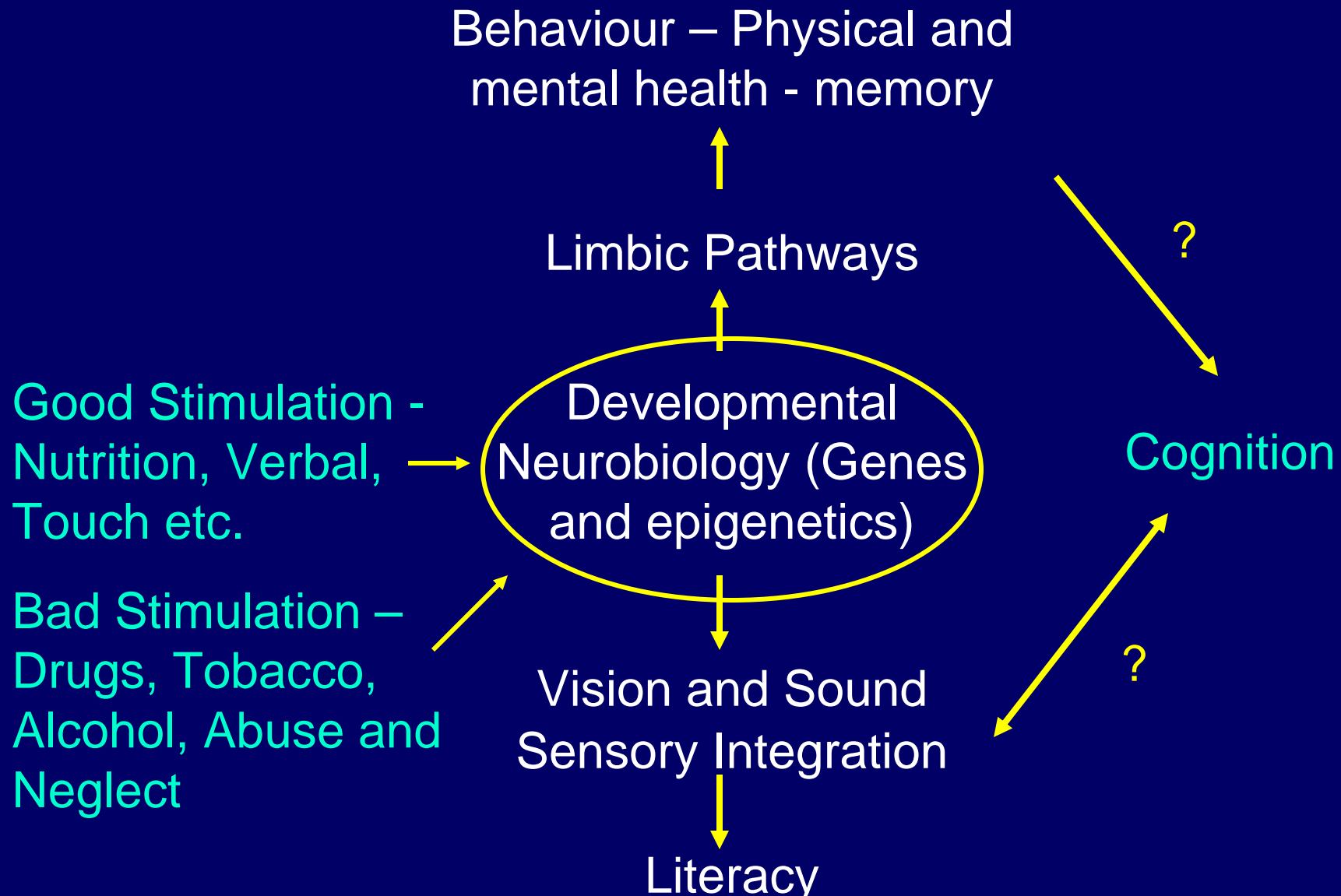
Literacy Levels (Quantitative) and Physical, Mental or Other Health Conditions – USA



Life Expectancy & Literacy



Early Human Development



The Bell Curve – 1994

Herrnstein and Murray

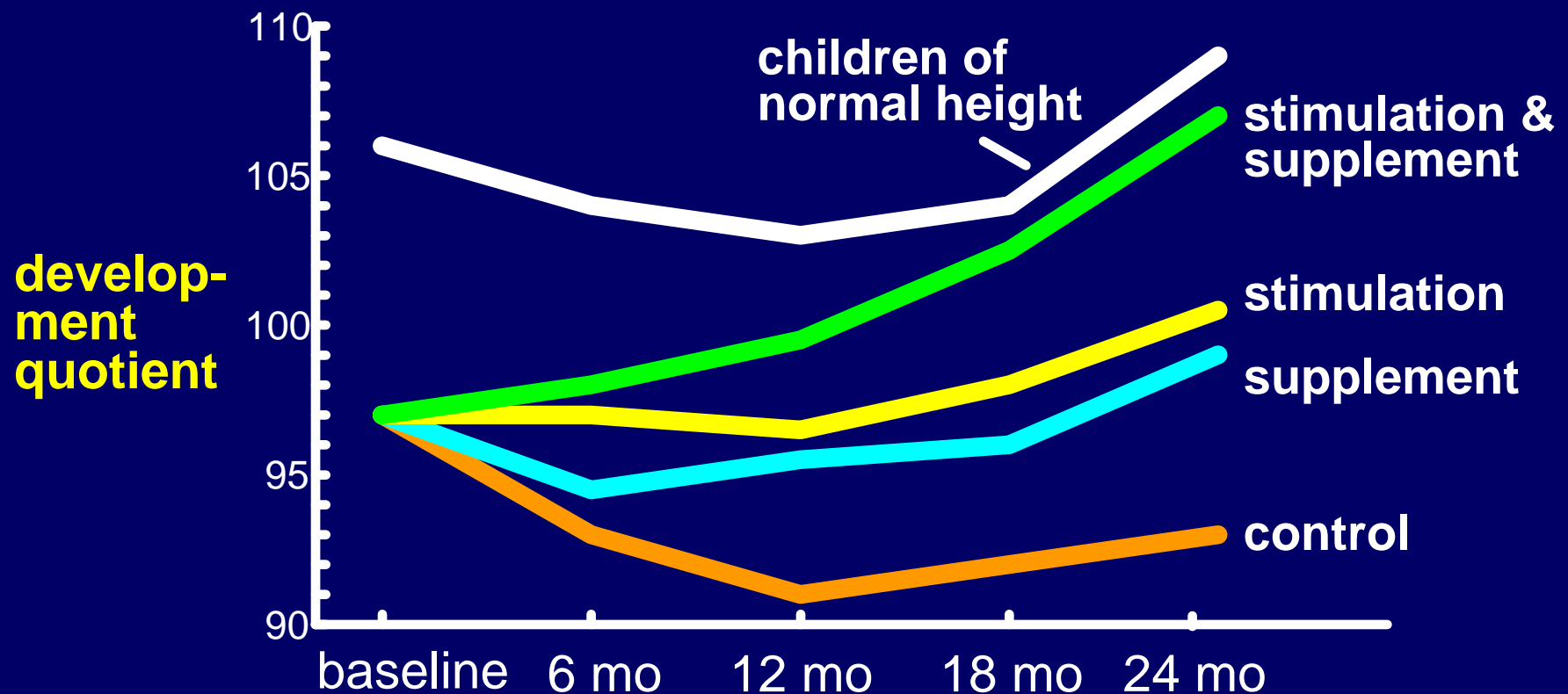
1. IQ is largely genetically inherited
2. IQ is correlated with socioeconomic success
3. Socioeconomic success or failure is largely genetically caused

Return of Developmental Plasticity

- Gilbert and Epel, 2009,
Ecological Developmental Biology
- Waddington, 1957 - Epigenetics

Human Experiments

Mental Development of Undersized Children (Low Height for Age) : The Jamaican Study



Grantham-McGregor

A “Natural” Experiment: Romanian Orphan Adoption

Children adopted into middle class homes after 8 months in the orphanages show at 11 years in contrast to children adopted early:

1. Abnormal brain development (small brain, low metabolic activity, abnormal EEG)
2. Social and cognitive problems (IQ loss)
3. High vulnerability to behavioural problems (ADHD, aggression, quasi-autism)

Bucharest Early Intervention Project

Foster parent care vs orphanage care

The children who were youngest when placed in foster parent care are approaching normal development, a recovery that sadly does not seem to be occurring in children first placed in foster care after the age of 2.

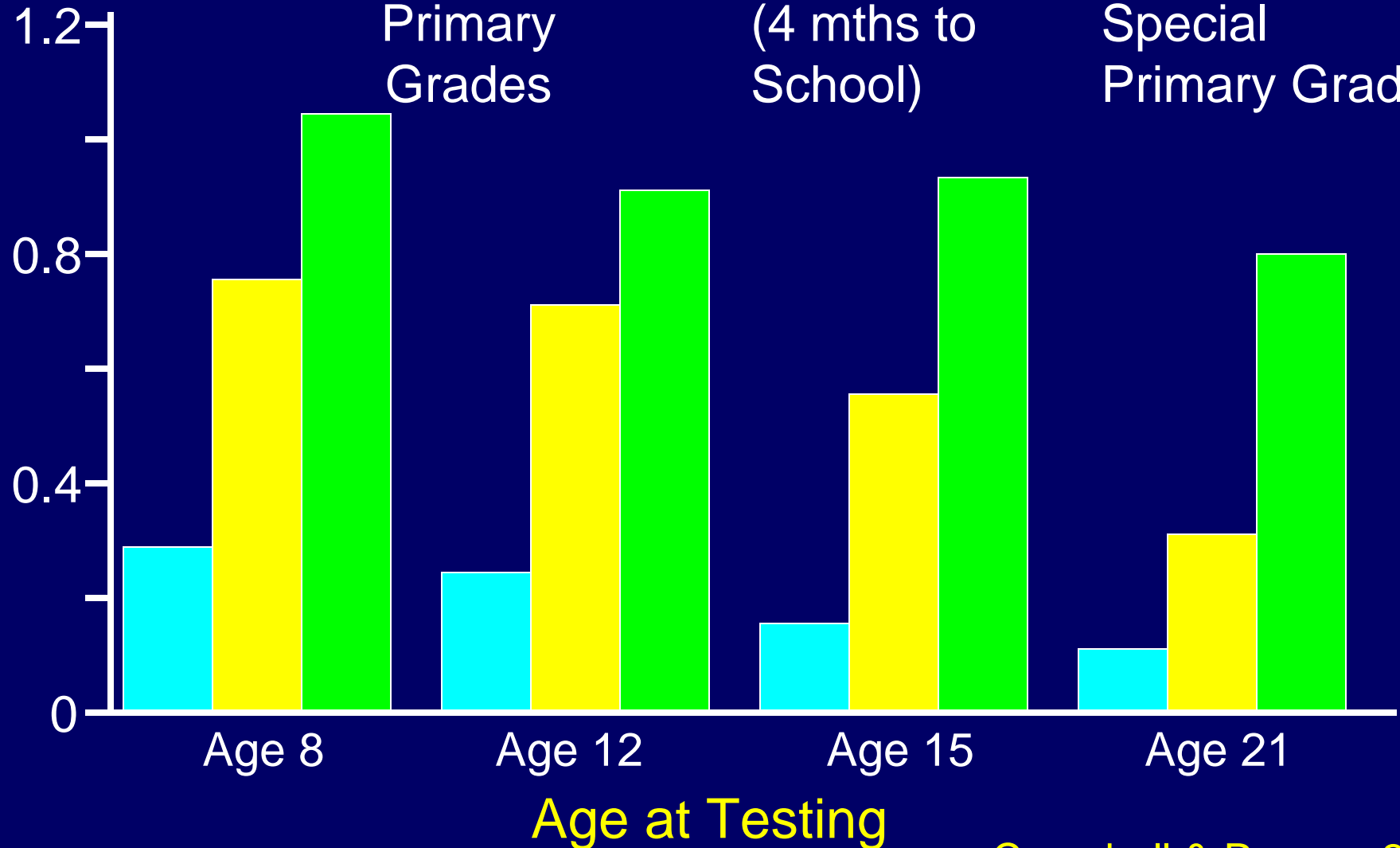
Abecedarian Study – Reading

Effect Size

Special
Primary
Grades

Preschool
(4 mths to
School)

Preschool &
Special
Primary Grades



Population Studies

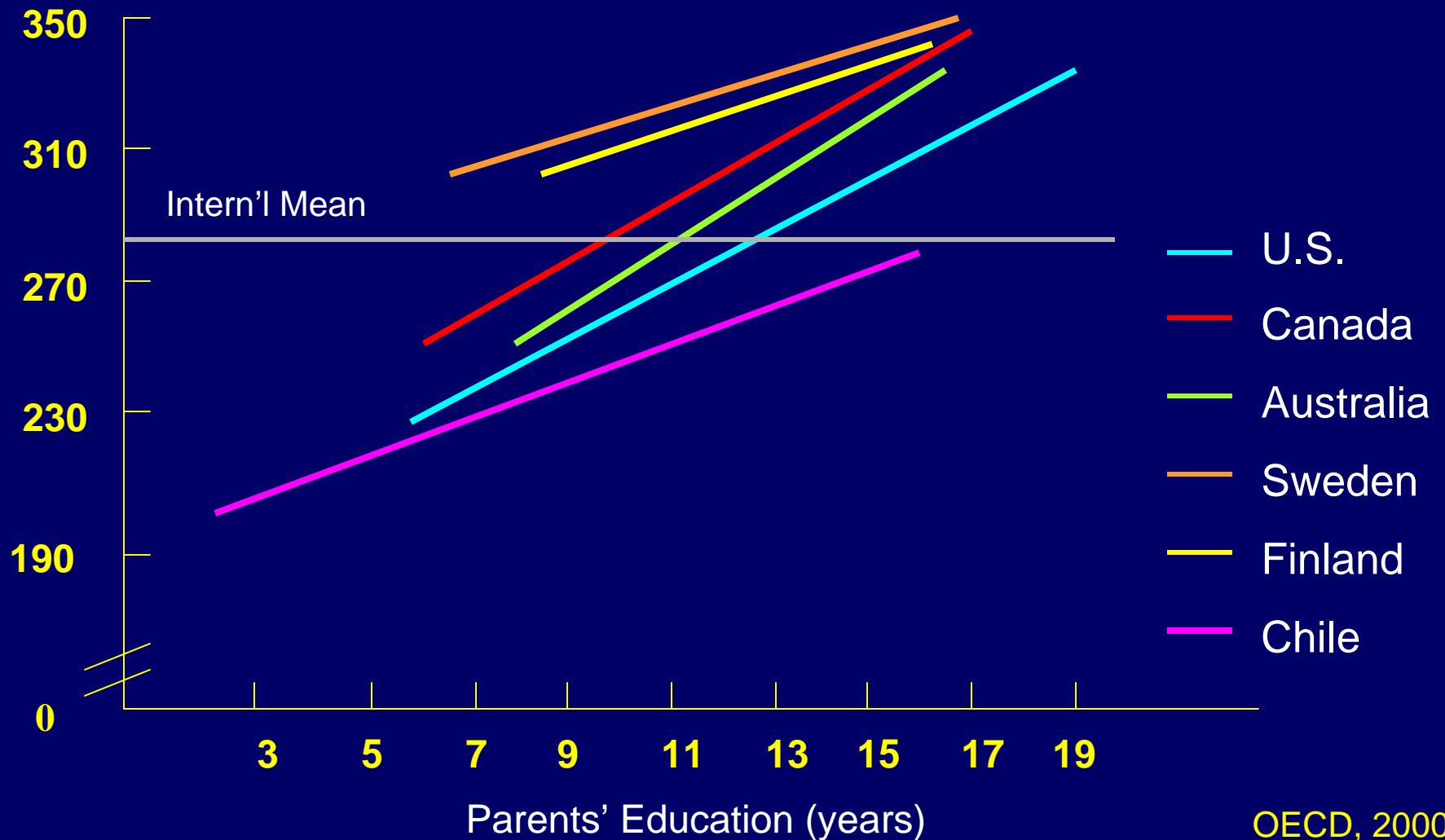
Manitoba Education and Health

All Cause Mortality (Deaths / 1000)

	Education Level				
	Q1	Q2	Q3	Q4	Q5
	<i>least</i>				<i>most</i>
1986	8.73	7.93	7.45	7.17	7.00
1996	8.83	7.53	7.26	6.88	5.99

Socioeconomic Gradients for Adult Document Literacy Scores (16 to 65)

Mean Scores



OECD, 2000

Document Literacy 1994 – 1998, Ages 16 to 65

	Level 1 and 2	Level 4 and 5
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%

Sweden Early Human Development

- Ministry of Education and Science
- Preschool Ages 1-7
- Access – Age 1-2, 2-3, 3-4, 4-5
45%, 86%, 91%, 95%

Parental leave:

390 days at 80% income

90 days flat rate

Total 480 days

Sweden Education Expenditure

	Cost/Student	Enrollment
Preschool* (1-6)	\$16,500	80 – 95%
Compulsory School (7-16)	\$10,500	Compulsory

* Maternal and parental paid leave 480 days

Scandinavia and Canada

Child Poverty Adult Literacy (16-25)

%

Level 4&5

Finland

2.8

Norway

3.4

36%

Sweden

4.2

34%

Canada

15.0

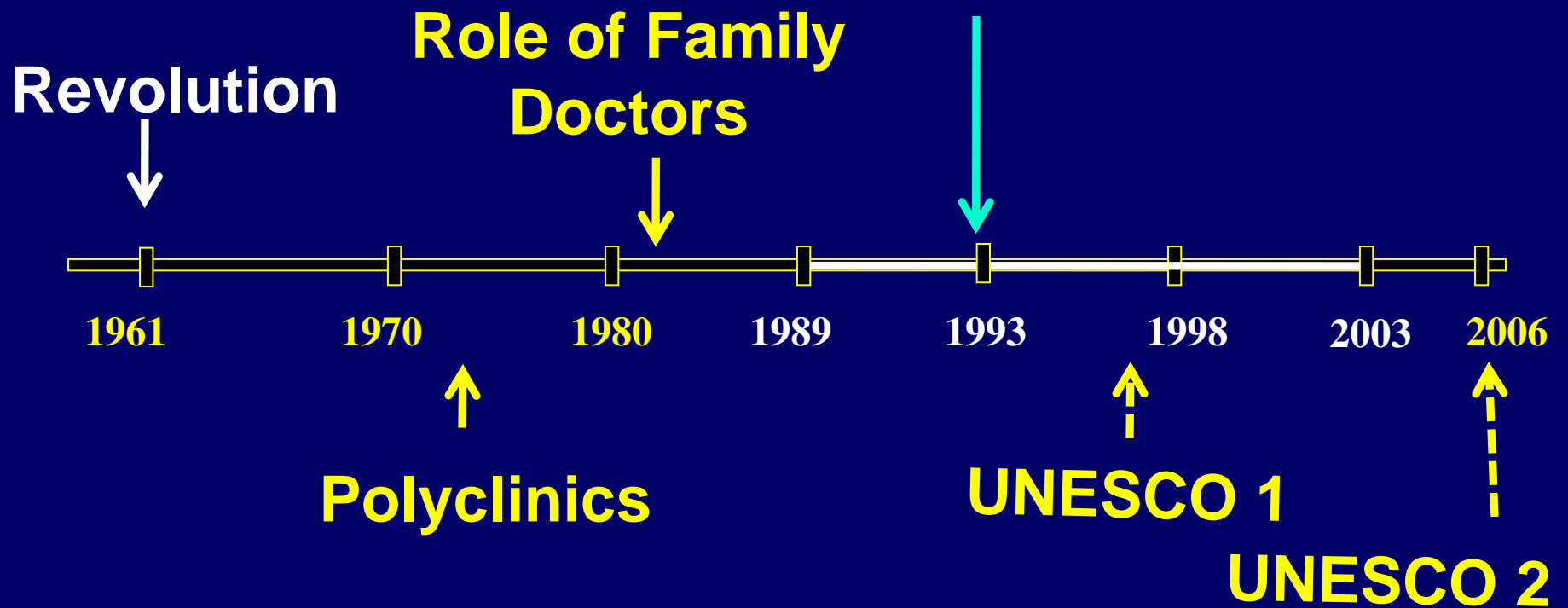
23%

Cuba

- Developed in the 1970s an integrated structure for healthy early human development – the polyclinics and family medicine
- 1994 – started Educate Your Child
- In terms of health and learning, Cuba is outstanding

Early Human Development in Cuba

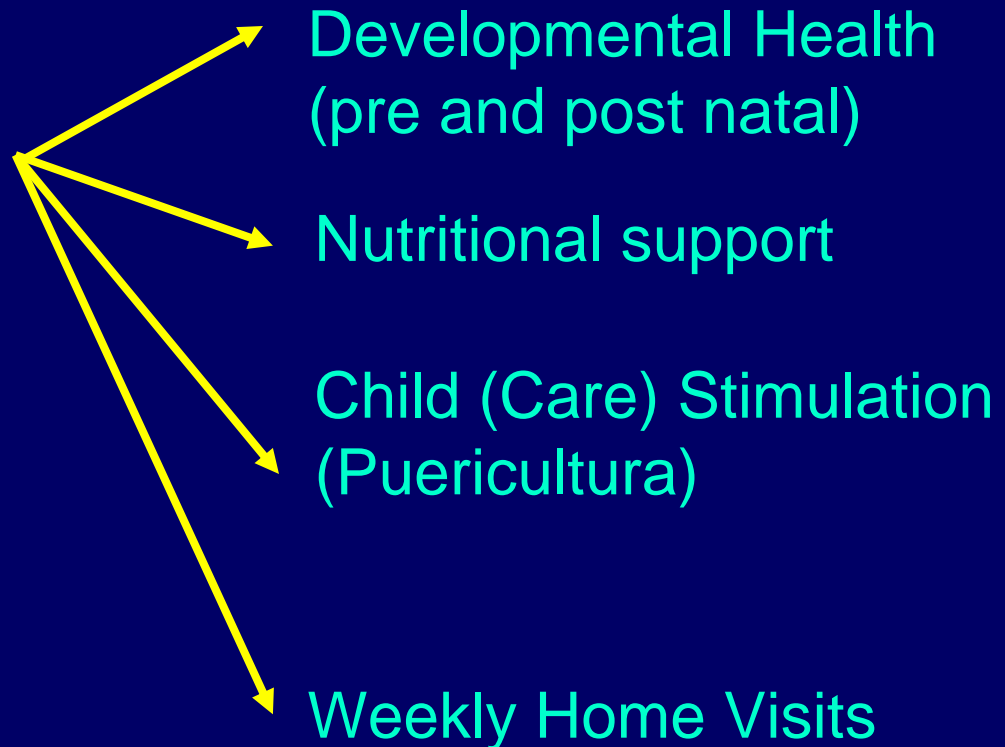
Educate Your Child



Community Polyclinics

Pregnancy to Age 6

**Services provided by
Community Polyclinics**



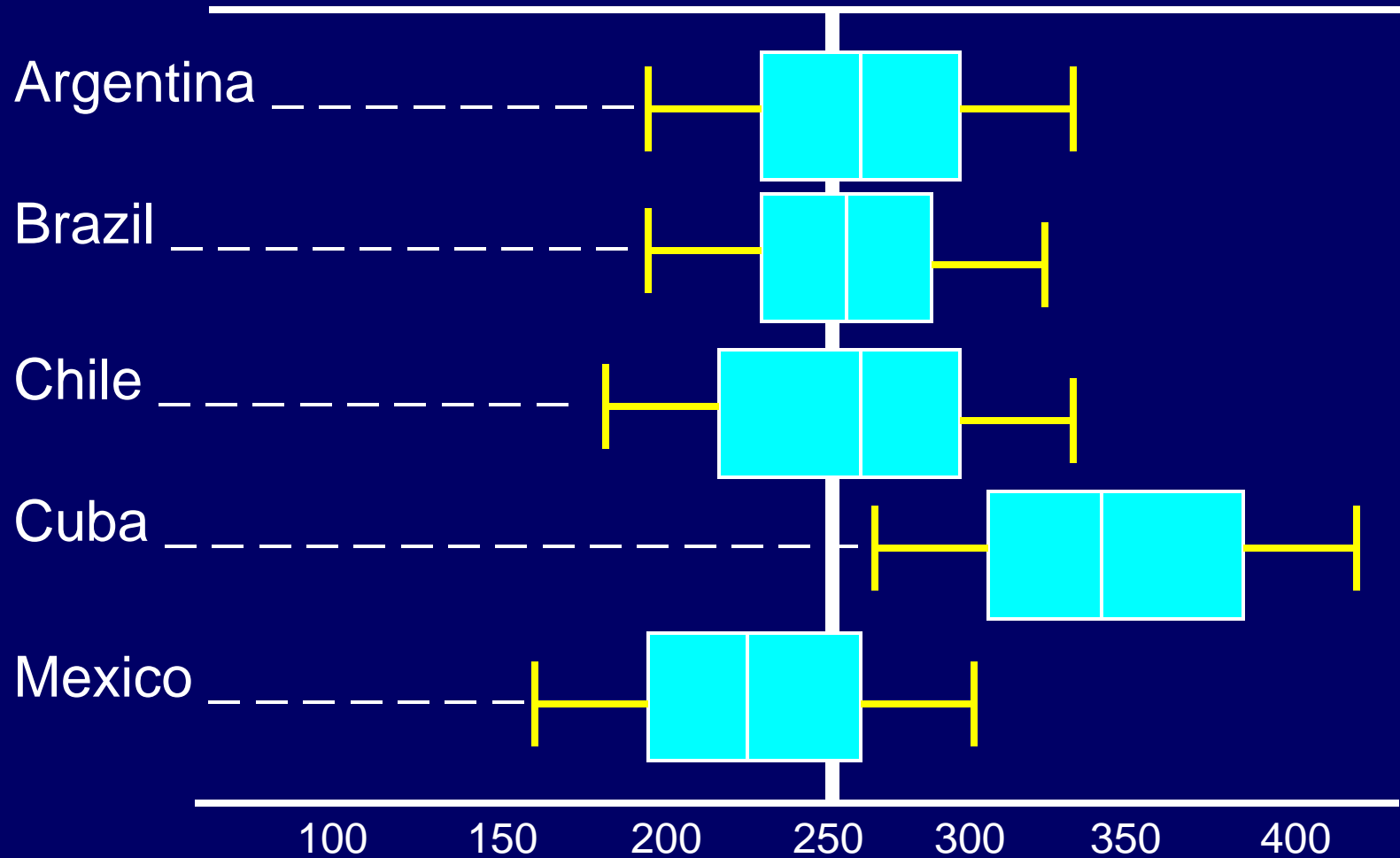
Health Data

Cuba

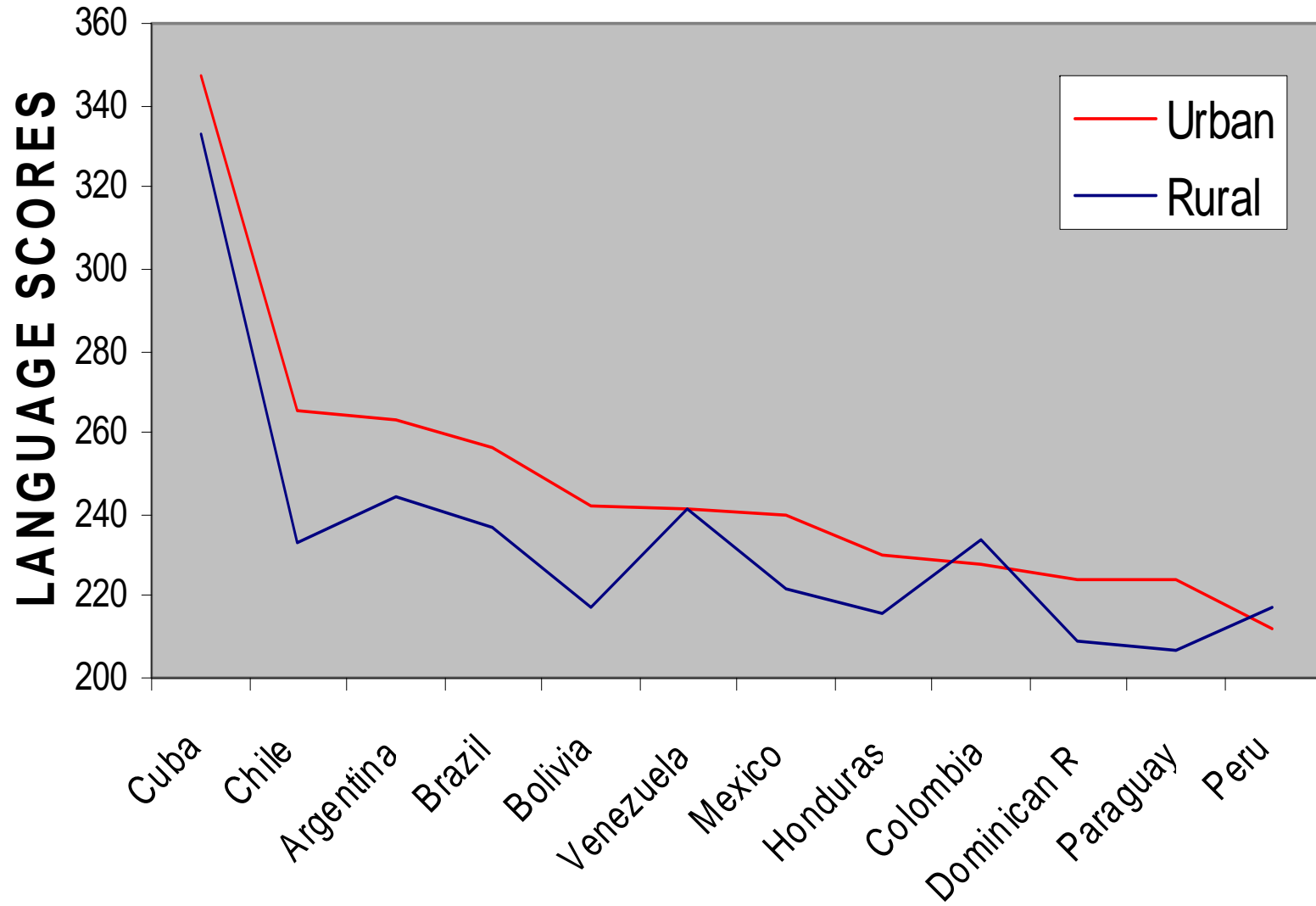
UNESCO Postneonatal Mortality Rate per 1000, comparison of 1990 and 2010

	1990	2010
Argentina	10.5	3.8
Brazil	23.8	8.2
Chile	7.6	2.1
Cuba	4.6	1.7
Mexico	21.2	8.2

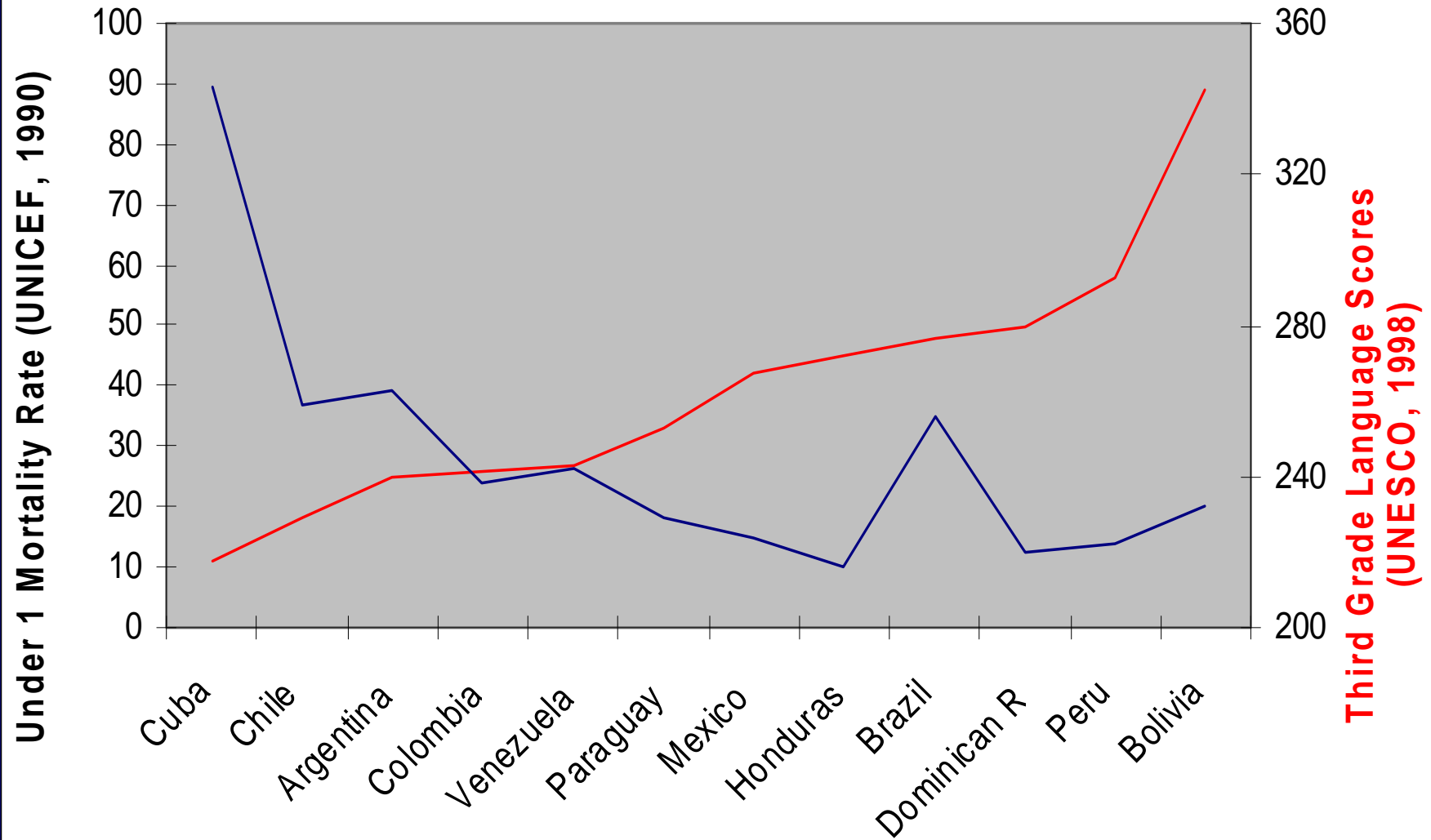
Grade 3 Language Scores



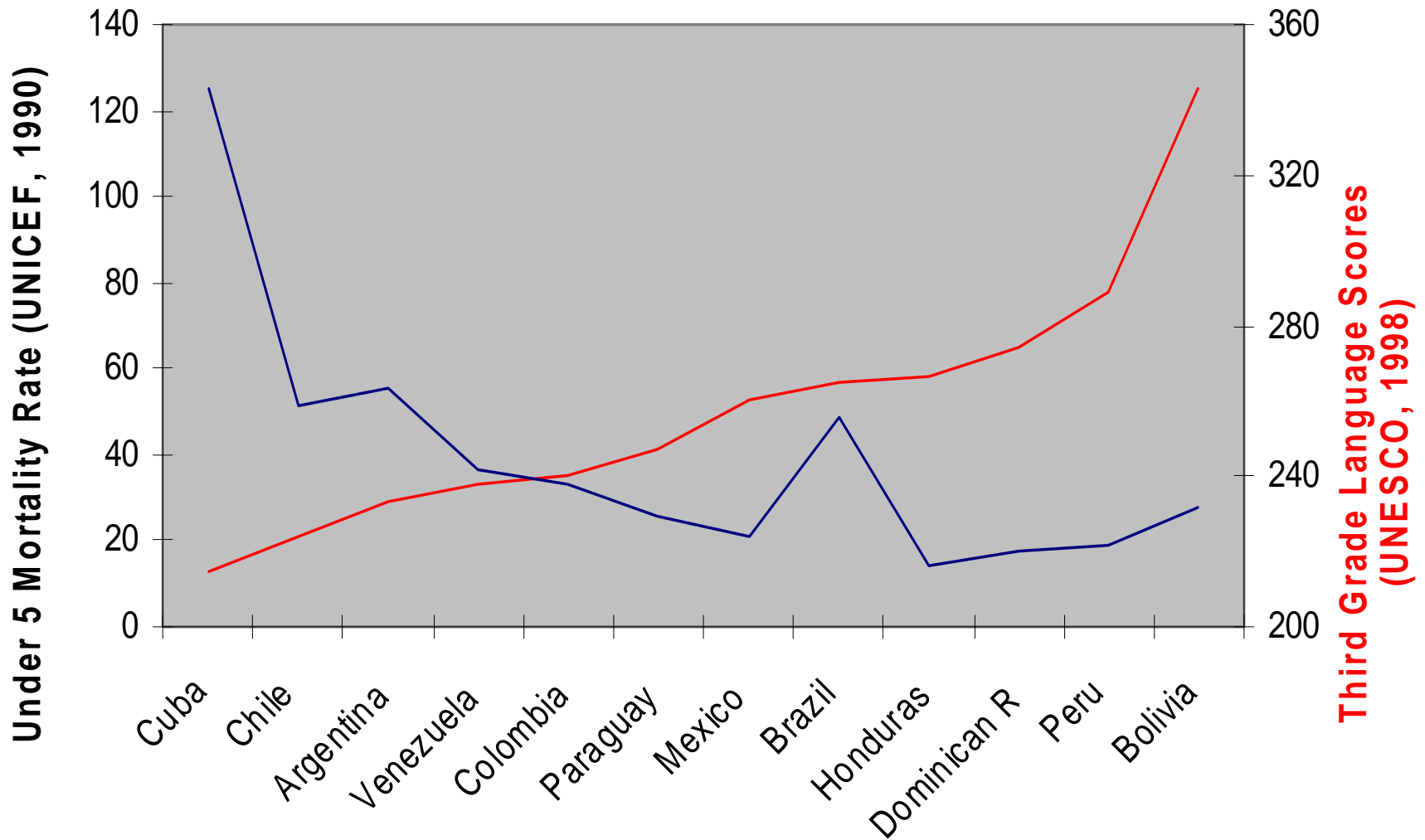
THIRD GRADE LANGUAGE SCORES URBAN VS RURAL (UNESCO, 1998)



Health and Language Scores



Health and Language Scores



Success by Ten

Early Child Development

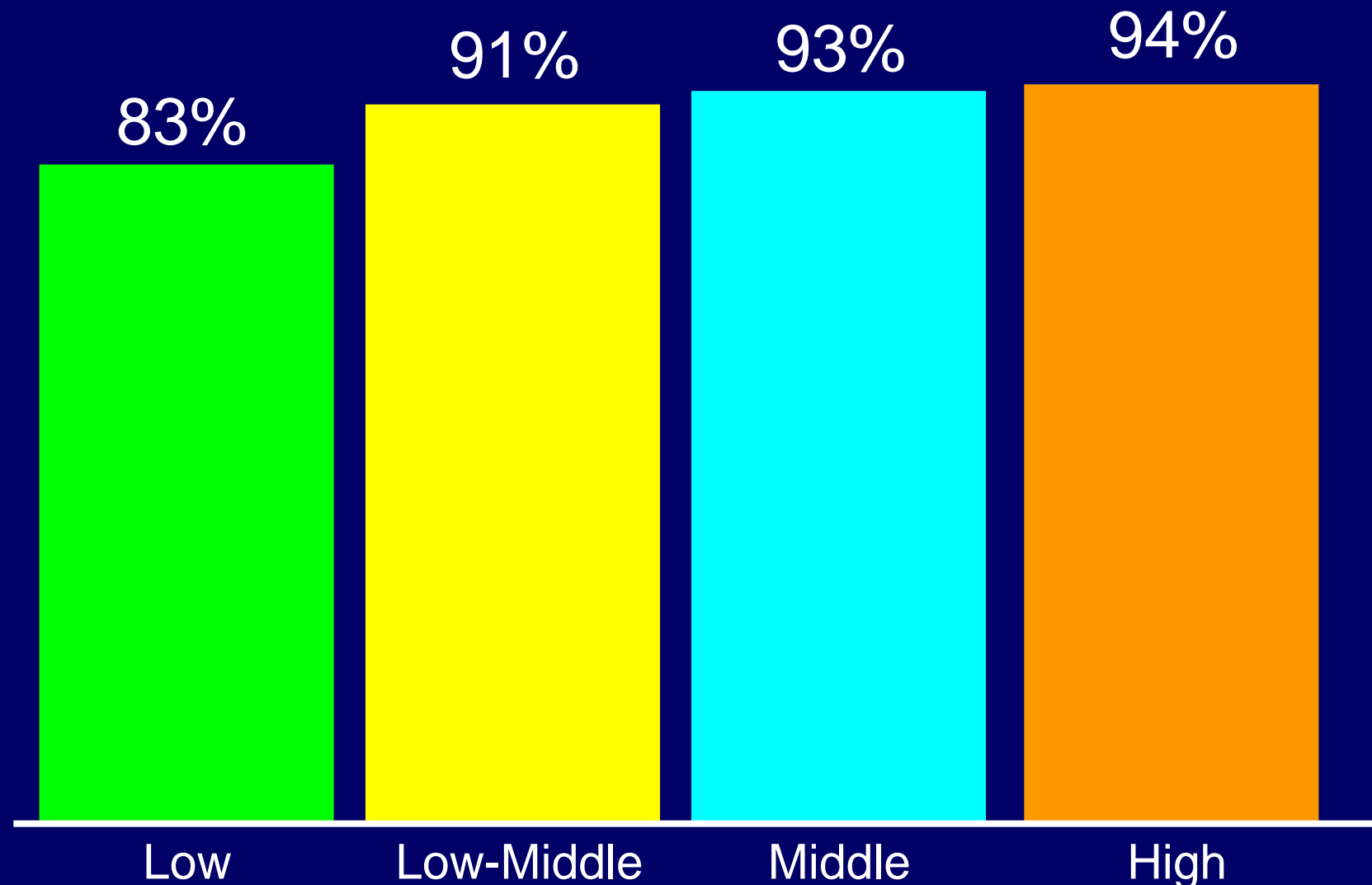
- Intervene early
- Intervene often
- Intervene effectively

Manitoba Centre for Health Policy

- Population linked database
- Health, early development, education, poverty, socioeconomic factors

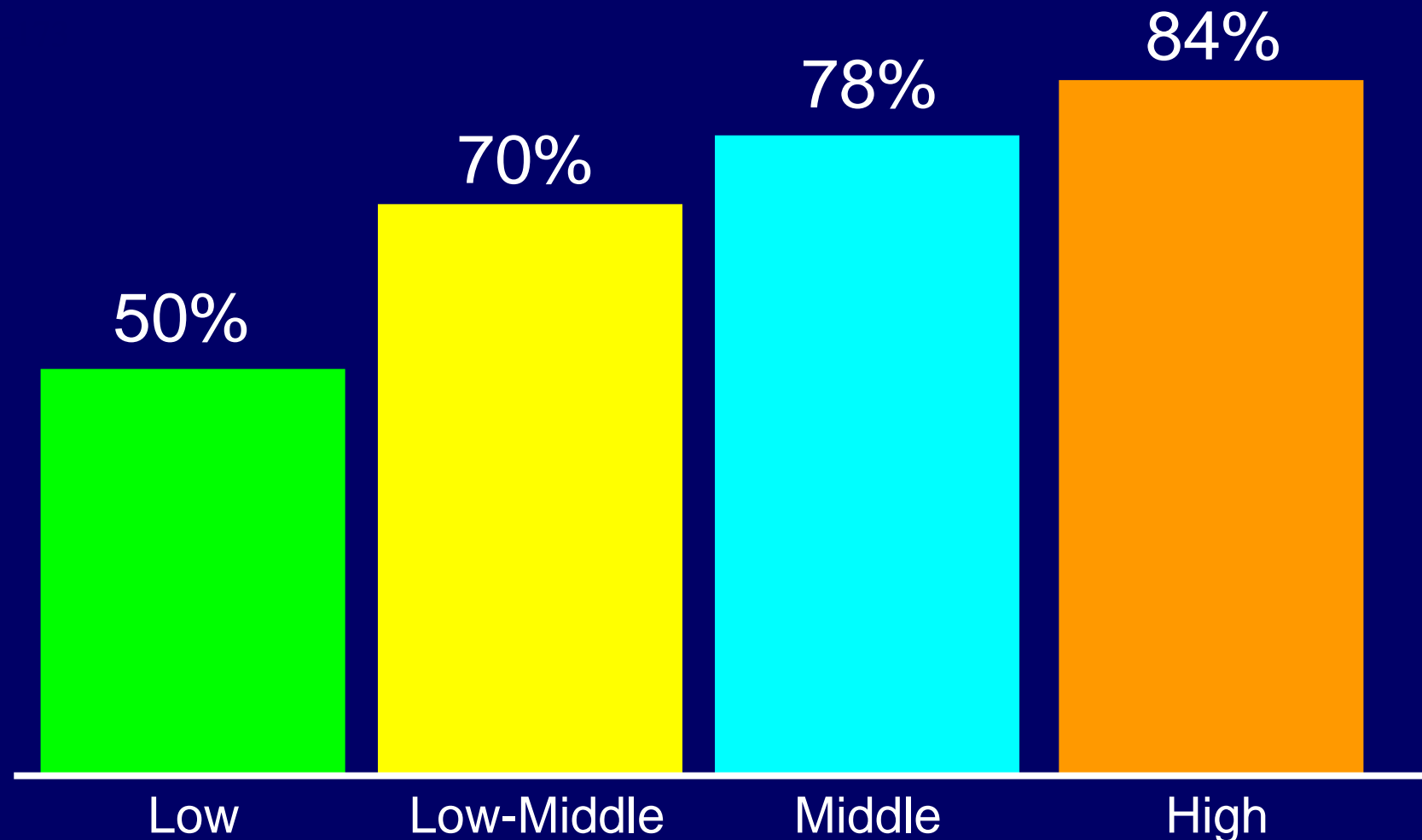
Grade 3 Performance (Language) by SES

Pass Rate of School Test (Winnipeg)

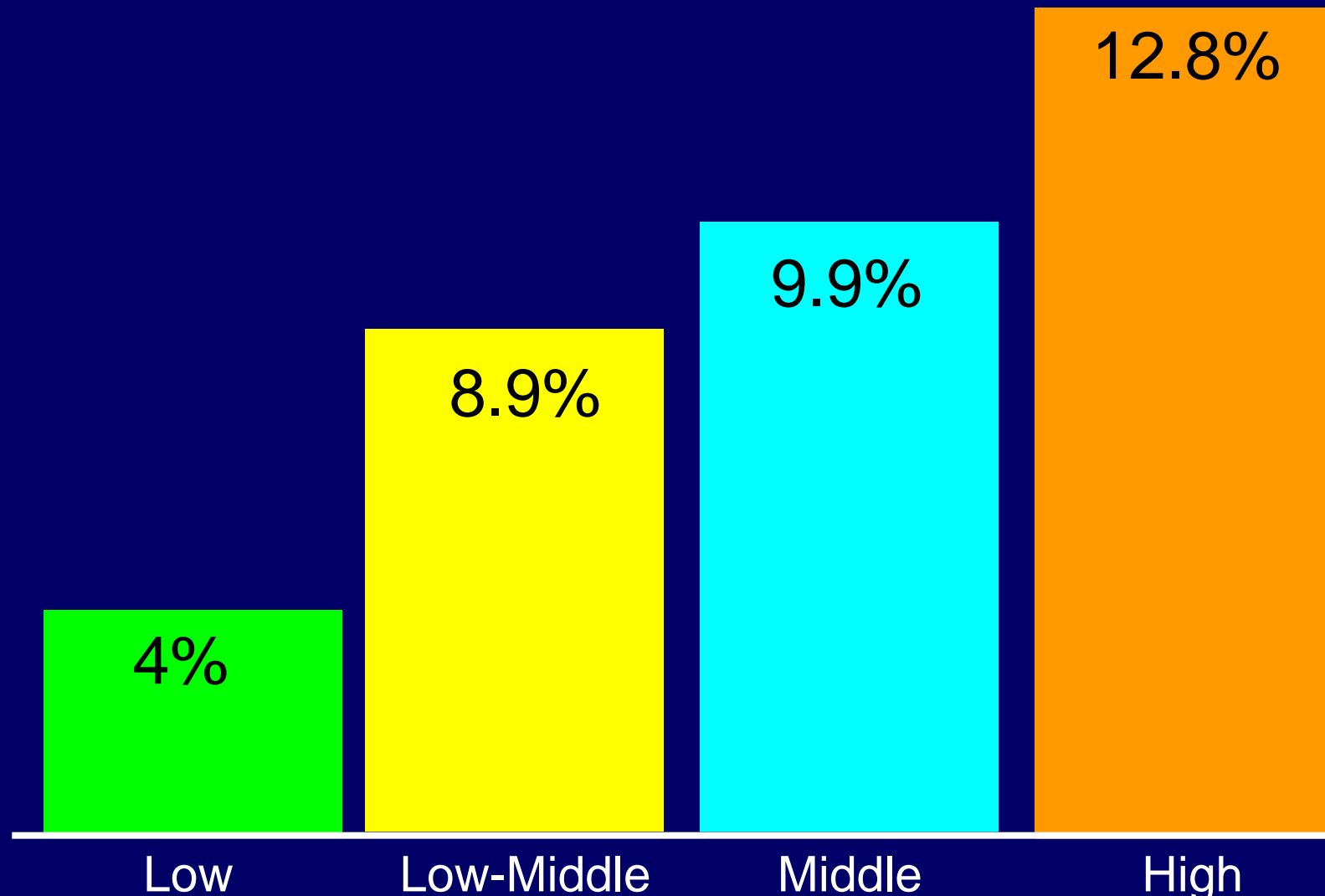


Grade 3 Performance (Language) by SES

Pass Rate of 8-Year Olds Who Should Have Written Test (Winnipeg)



Grade 1 Students in Reading Recovery Program by Winnipeg SES Group



SES

Manitoba Centre

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)

Capitalism with Social Accountability

WHO – Marmot Commission on Social Determinants of Health

Chapter 5 – Equity from the Start

Recommendation 5.1:

WHO and UN Children's Fund (UNICEF) set up an interagency mechanism to ensure policy coherence for early child development such that, across agencies, a comprehensive approach to early child development is acted on.

WHO, 2008

Recommendation 5.2

The Commission recommends that:

Governments build universal coverage of a comprehensive package of quality early child development programmes and services for children, mothers, and other caregivers, regardless of ability to pay.



“Mothers and Others” – Sarah Hrdy

“Unsettling is the finding that 15 percent of children in normal middle class families exhibit symptoms of disorganized attachment.”

Early Child Development and Parenting Centres

- School-based available from pregnancy to school entry
- Provide support for parents (centres and home visits)
- Learning parenting by doing
- Provide non-parental care
- Nutrition and stimulation
- Stage 1 of human development (conception to age 6)

With Our Best Future in Mind – Pascal report (Ontario)

Recommendation 1:

The province should create a continuum of early learning, child care, and family supports for children from the prenatal period through to adolescence, under the leadership of the Minister of Education.

With Our Best Future in Mind – Pascal report (Ontario)

Recommendation 2:

The Ministry of Education should establish an Early Years Division to develop and implement an Early Years Policy Framework that will create a continuity of early learning experiences for children from 0 to 8 years of age.

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

Crime and Violence \$120 Billion/year

Mental Health \$100 Billion/year
Behaviour and
Alcohol and Drug Addiction

Cost of universal high quality ECD
program – about \$22 billion per year
(1.5% of GDP)

Concept of Ministry of Human Development

Integrate developmental
health (not health care)
and education

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