ISSOP
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Early Childhood Interventions
Science, Systems and Policies Promoting
Healthy Development of Vulnerable Children

The science of brain development

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outline

- How research changed our concepts about early brain development

- Mechanisms of brain development, factors affecting it and implications

The science(s) of brain development

- Developmental psychology
- Neuropsychology
- Epidemiology
- Biopsychology
- Social psychology
- Psychoneuroendocrinology and -immunology
- Genetics/epigenetics
- Development economics
- …

All contributing, beyond specialism, to:

an holistic, comprehensive, ecological (biopsychosocial) view of child development

Changing concepts about brain development

Once upon a time…

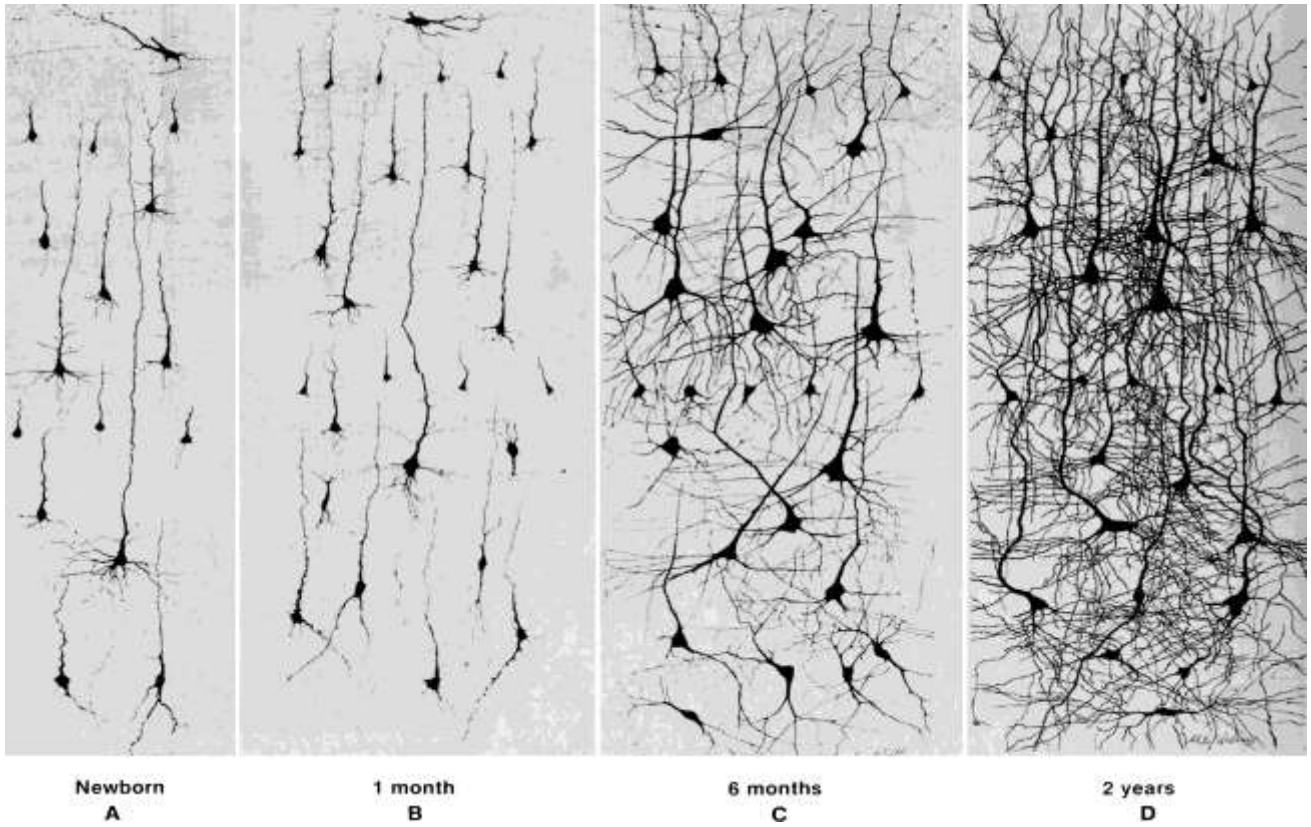
- Brain development is genetically determined
- What happens in the very first periods of life has relatively little importance
- Brain development is linear
- Newborn babies and young infants are passive recipient

Today

- Brain development i is the result of interaction between genes and environment
- Early experience has important effects as it shapes the neurobiological bases of brain functions
- Brain development presents function-specific sensitive phases, when brain plasticity is maximal
- Newborn babies and young infants play an active role in determining their own development

Brain development depends on interaction: primarily, with caregivers

Most of child brain develops in the first 1000 days



…and brain plasticity is maximal in this period

Each main function has a sensitive period where the opportunity for establishing experience-dependent new neural connections and networks is maximal

Sensitive periods

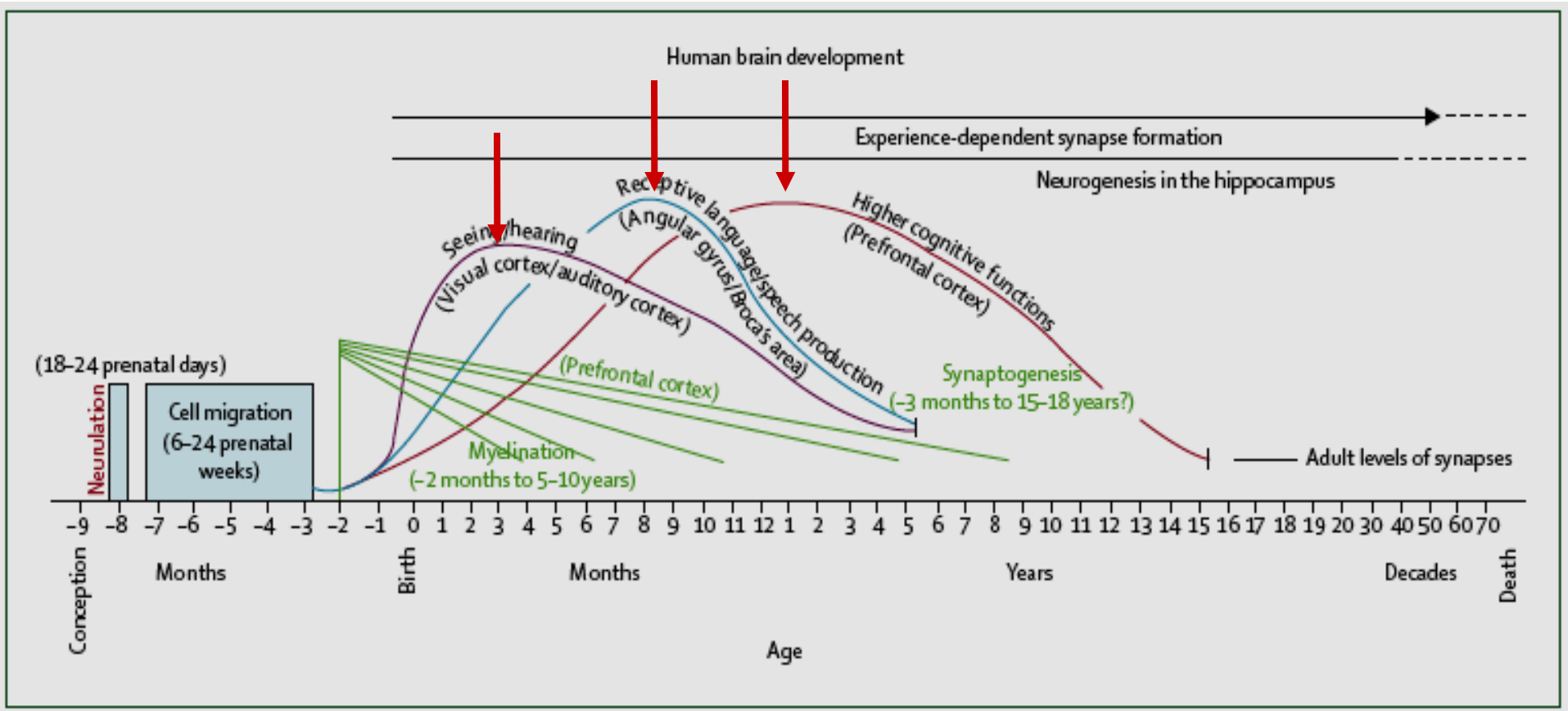


Figure 1: **Human brain development**
Reproduced with permission of authors and American Psychological Association[17] (Thompson RA, Nelson CA. Developmental science and the media: early brain development. *Am Psychol* 2001; **56**: 5–15).

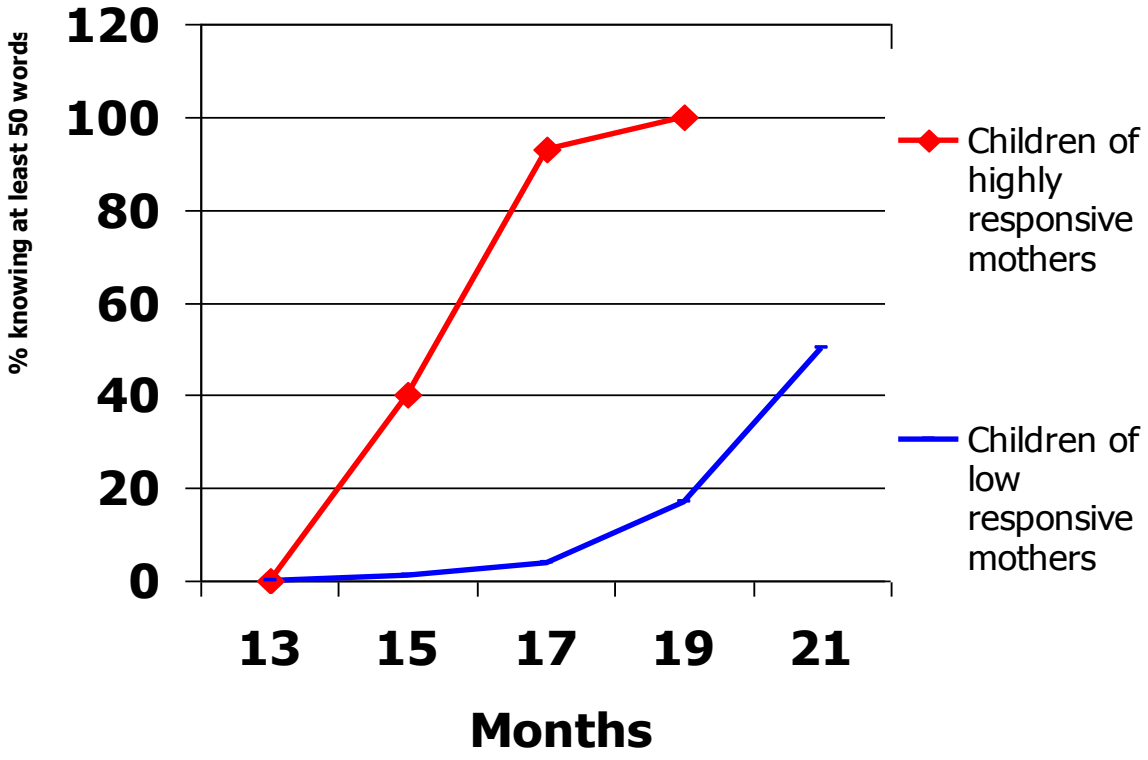
How environment shapes gene expression (epigenetics)

Mice mums that are not able to lick their baby-mice induce a methylation of promoter-activator of cortisol receptors, predisposing them to a life of stress if in the first postnatal week (epigenetic vulnerability window).

The effect is reversible if baby-mice are taken care for by normally caring mice mums before the end of this period (opportunity window)

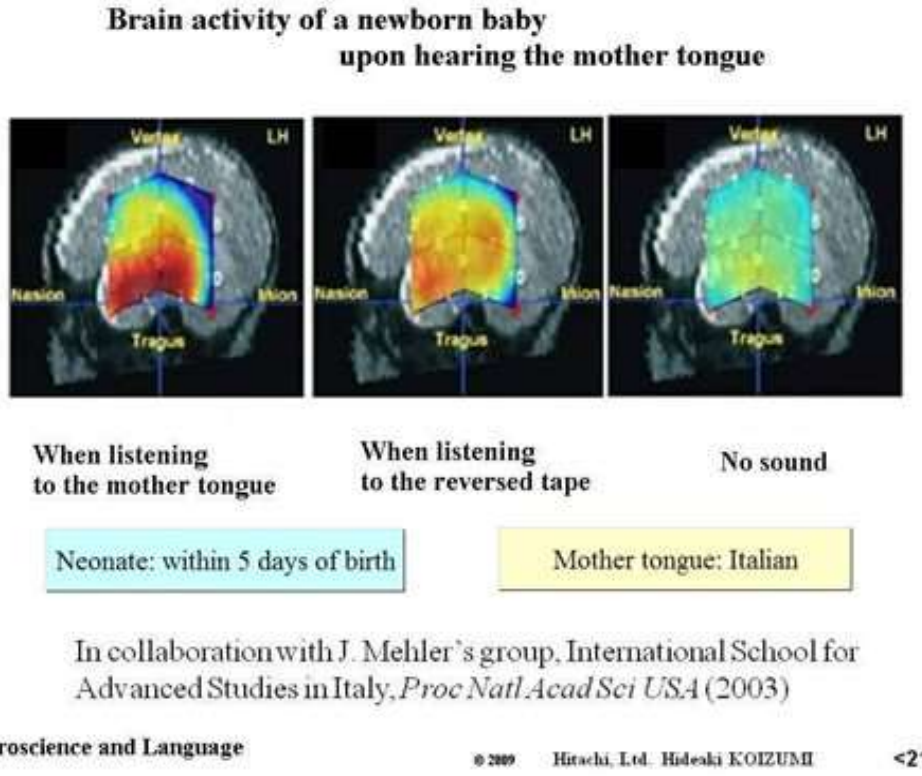
(Mathews HL, Janusek LW. Epigenetics and psychoneuroimmunology. *Brain Behav Immun* 2011;25:25-3)

back and forth, continuous interaction is key in language development



disadvantage starts early and depends on the quality of early interactions

Learning starts well before birth

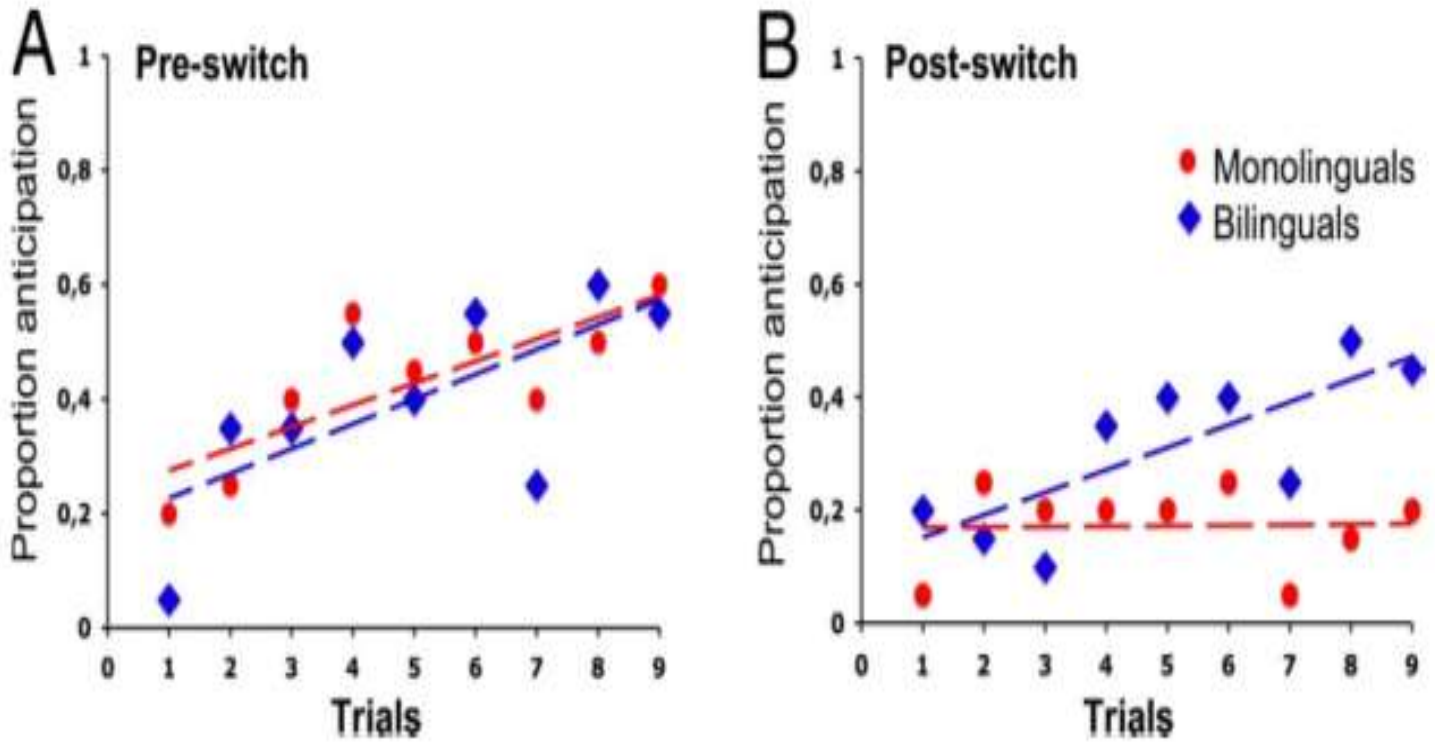


Very premature babies (VPN) (<1250 gr, 28 weeks GE) exposed to the voice of their parents start their vocalizations much earlier than VPN who were not exposed

Pediatrics 2011;128:910–916

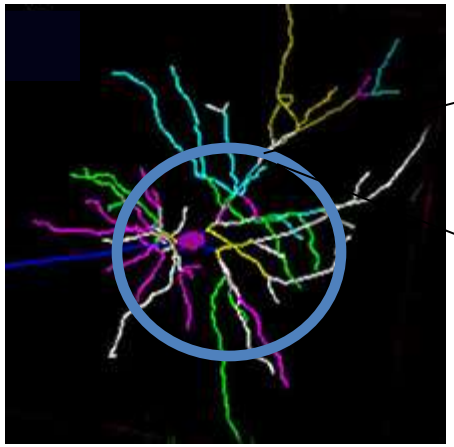
and continues soon after: effect of bilingualism at few months of age: advantage in executive functions (i.e. learning attention switch) in bilinguals

(Kovacs & Mehler, PNAS 2009).



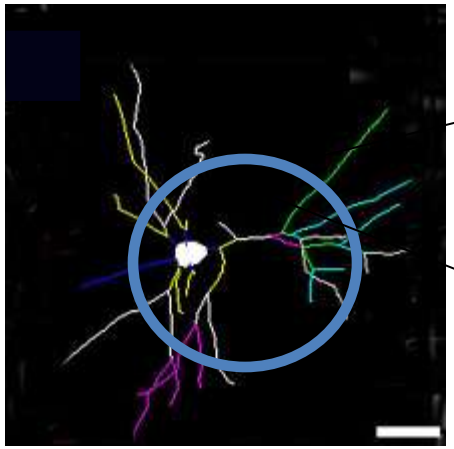
What happens to neuronal development as a consequence of toxic stress and/or lack of interactions

Normal neuronal development



Typical neuron with multiple connections

Neuronal development under toxic stress



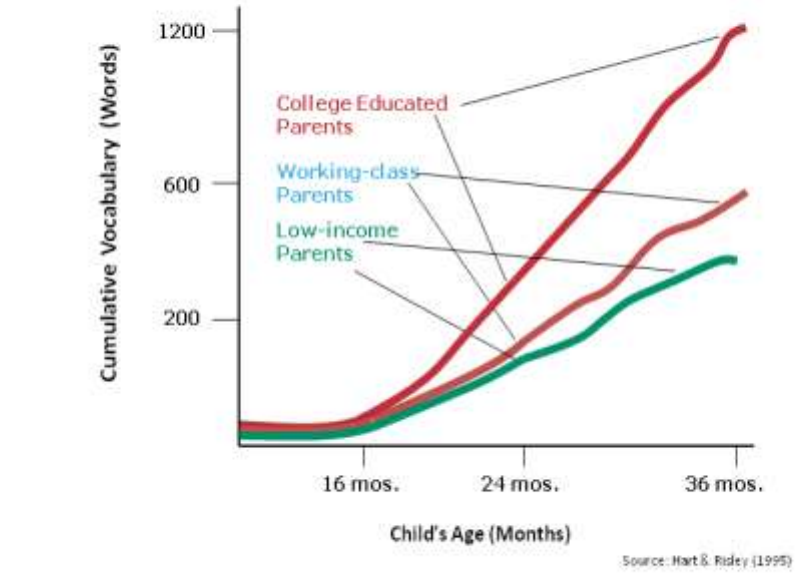
Damaged neuron with poor and reduced connections

Prefrontal Cortex and Hippocampus

Radley et al. (2004); Bock et al (2005)

Less and poorer input ⟹ less and poorer output

Inequities in language development occur very early and are strong contributors to social and economic inequities



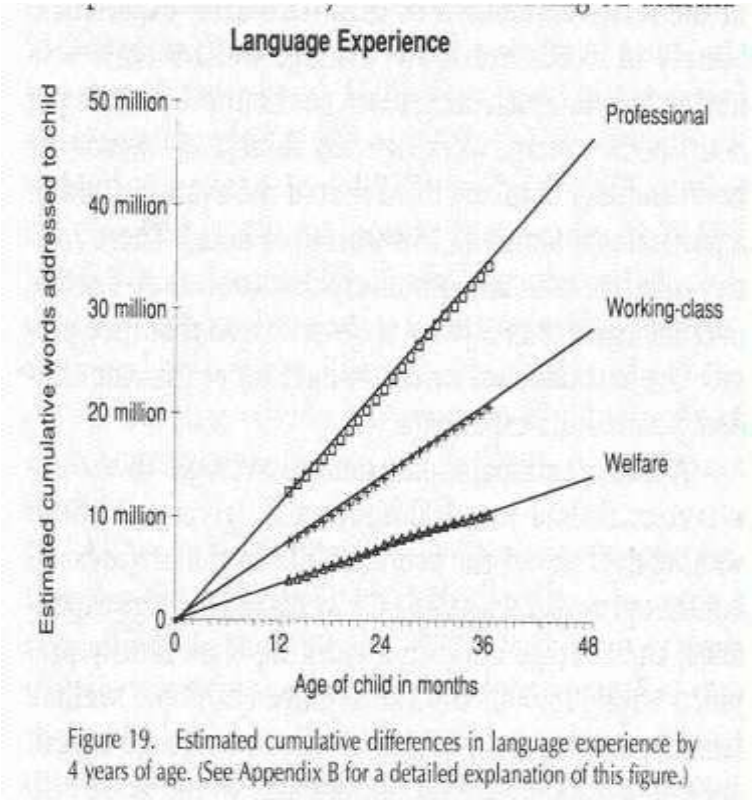


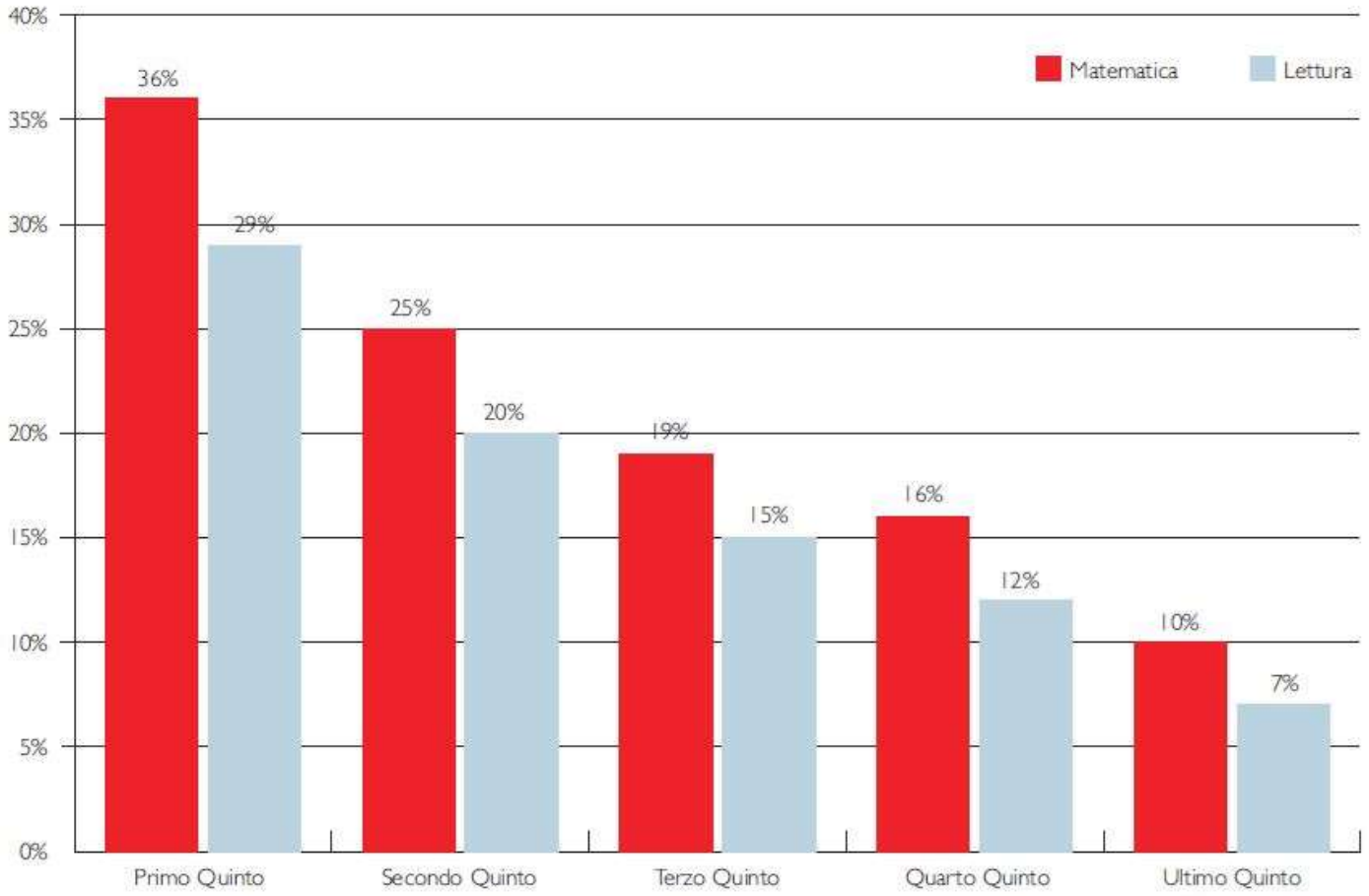
Figure 19. Estimated cumulative differences in language experience by 4 years of age. (See Appendix B for a detailed explanation of this figure.)

The same happens for all brain functions, including executive functions and "soft skills"

The late consequences of scarce and/or poor early interactions

Proportion of children who do not reach the minimum competence in mathematics and literacy by SES quintiles

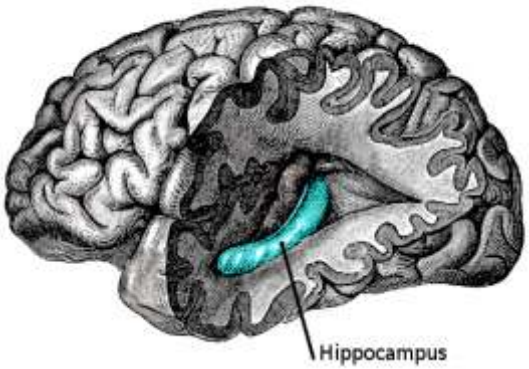
(Italy, data from PISA survey)

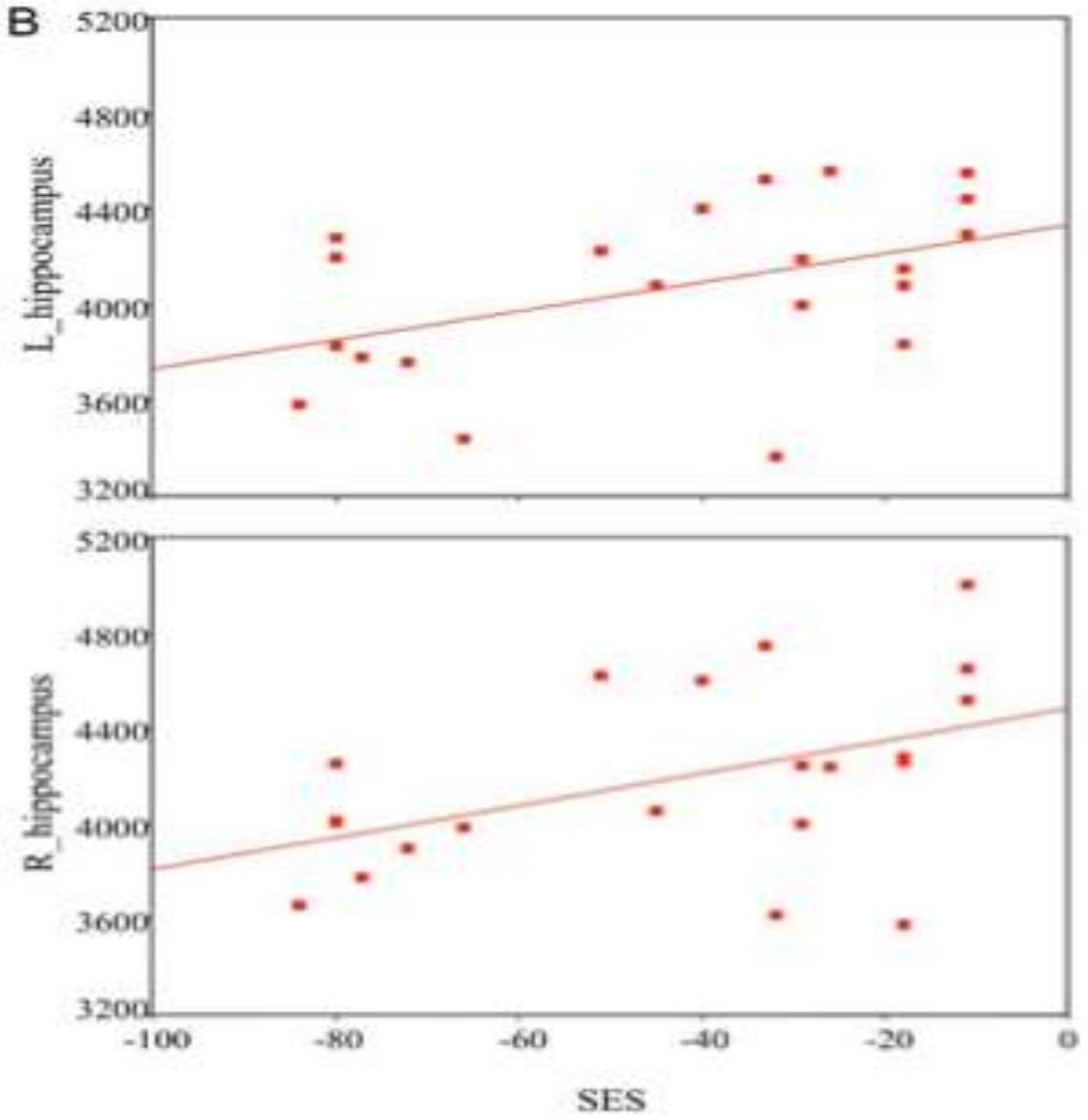


The roots of inequity: socio-economic status (SES) and brain growth

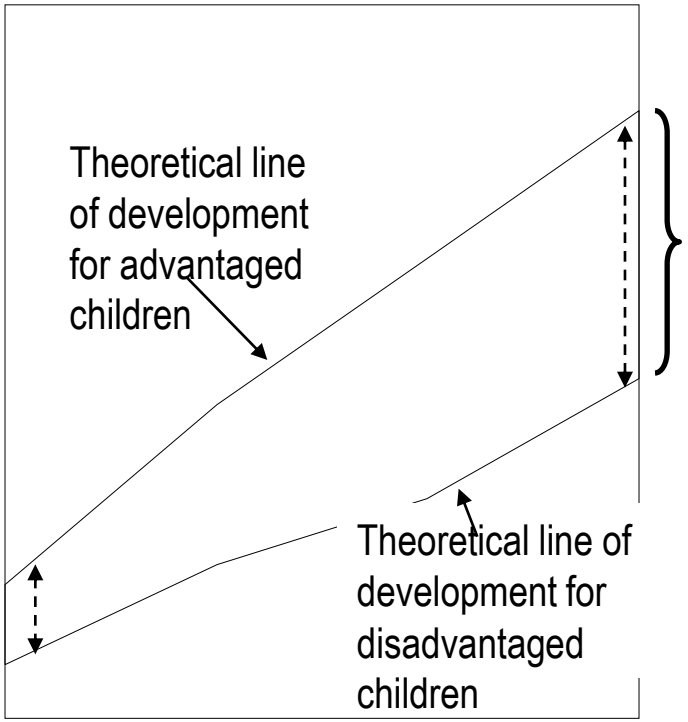
Co-relation between grey matter volume and hyppocampus volume and SES

(Luby et al. PNAS, 2012)





Children who start behind, stay behind, if no action is taken



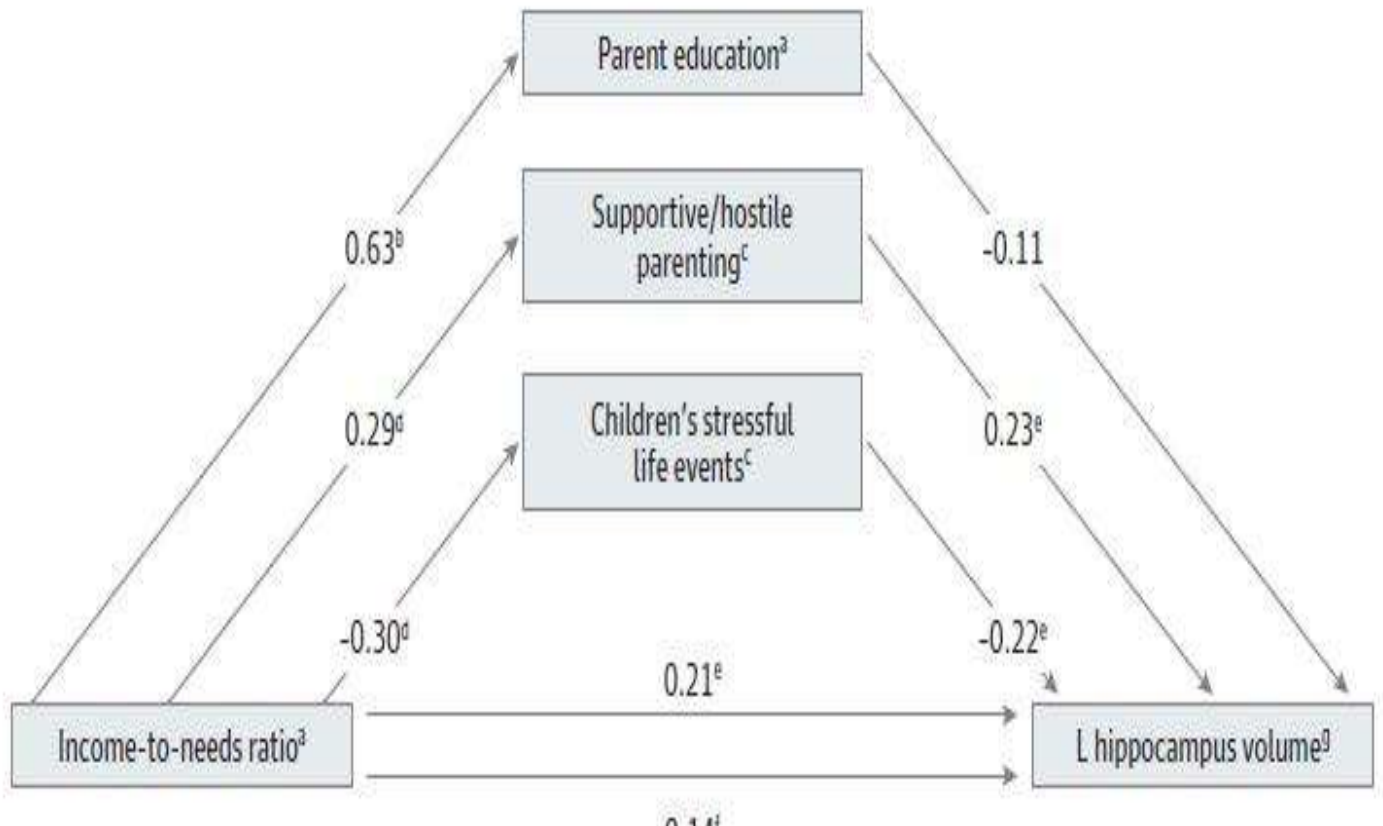
Outcomes gap that policies and programmes must attempt to fill*

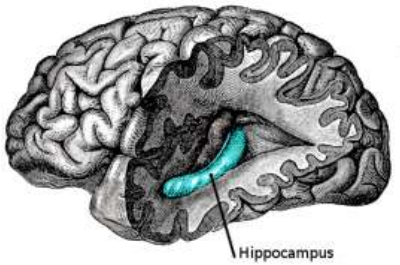
Birth	**0-3 years**	**3 – 6 years**	**6 – 10 years**
-Mother's health -Infant's health & nourishment	-Infant's health & nourishment -Cognitive stimulation	-Quality & level of preschool experience	-Quality & level of primary education

Investment in ECD is A POWERFUL EQUALIZER (WHO Commission on SDH)

Poverty acts through a variety of factors: nutrition, health, parental education, parental care and adverse events

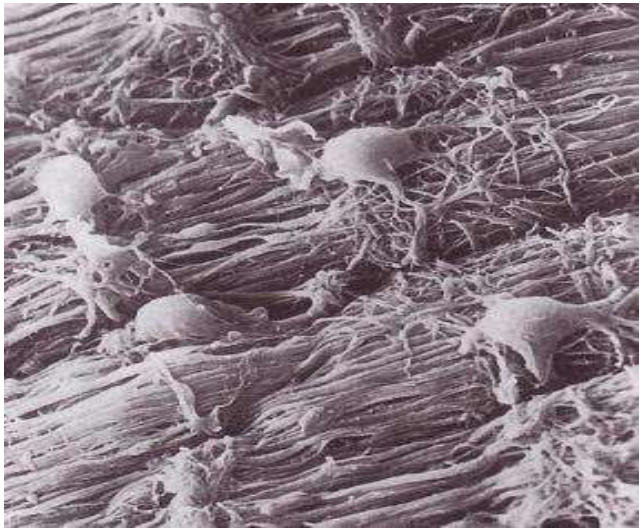
(Luby et al. JAMA Ped 2013)

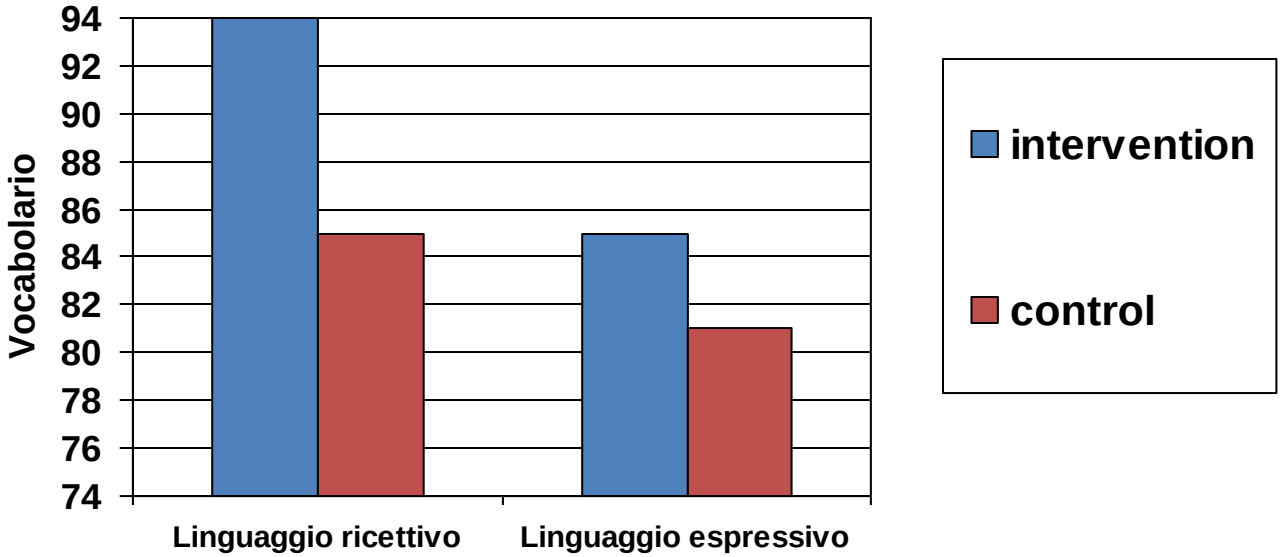




The mechanism:

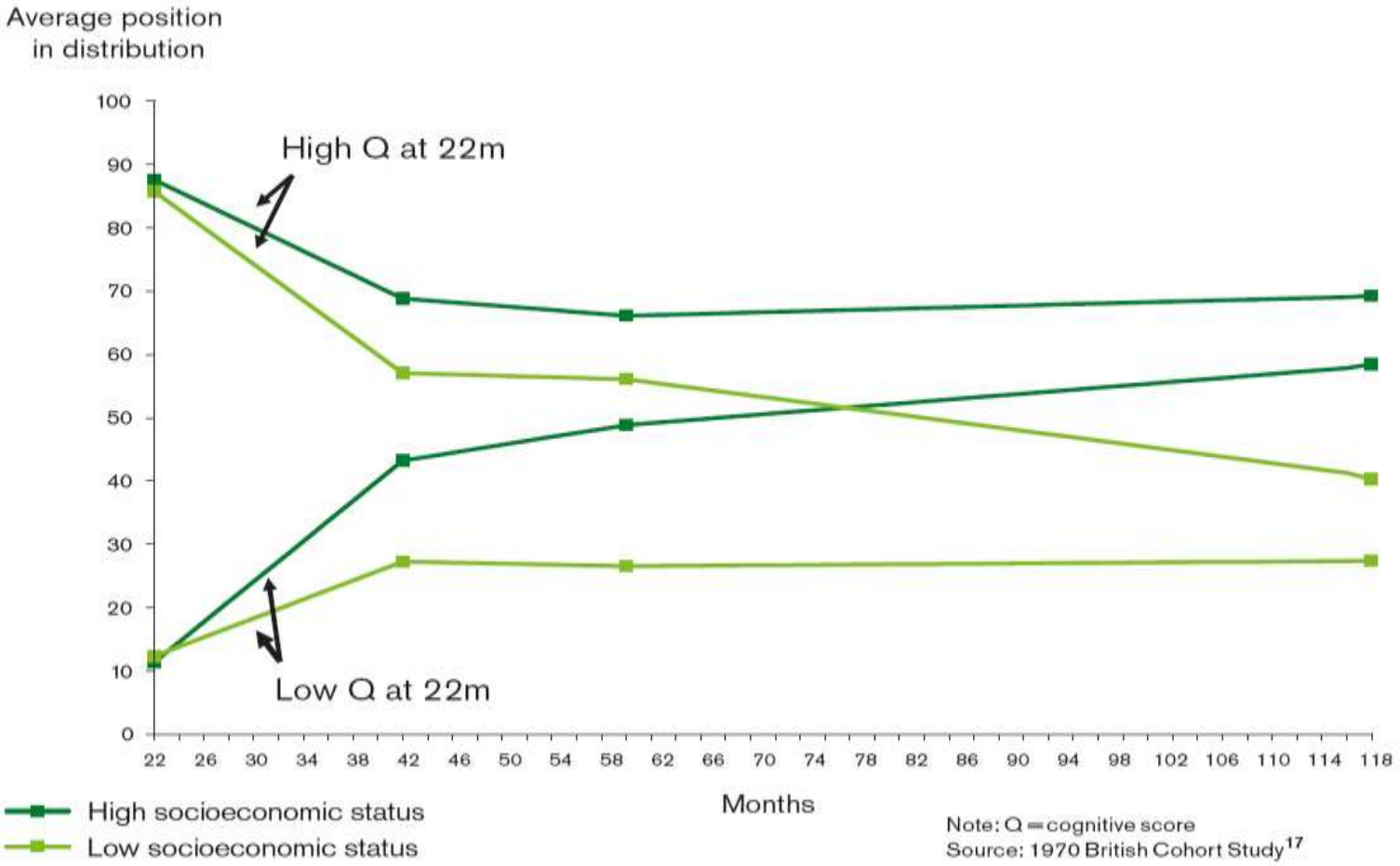
positive, responsive parenting ➡ neural networks ➡ cognitive and non-cognitive skills





Role of genes and role of the environment

A favourable family environment (SES used as a proxy) can partially reverse the effect of unfavourable genes and viceversa



We know that

Gaps start early and increase progressively

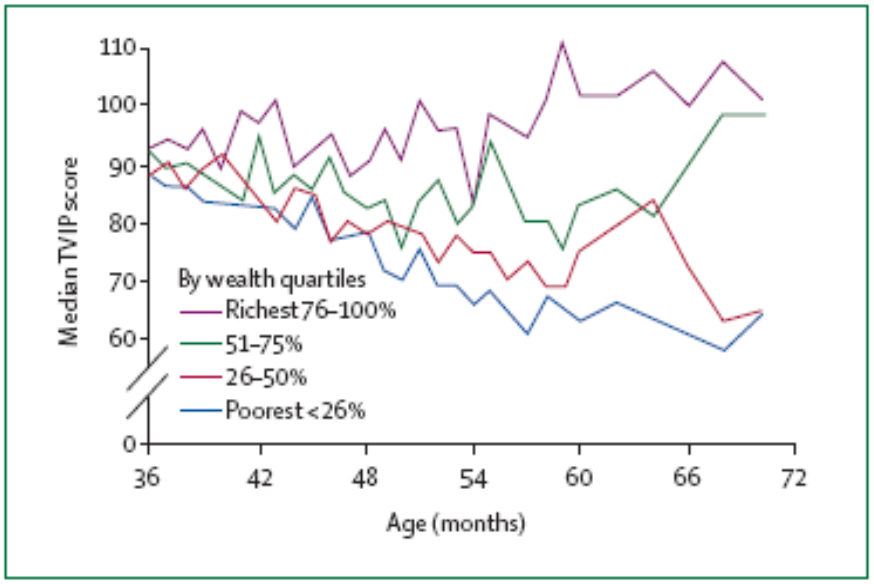
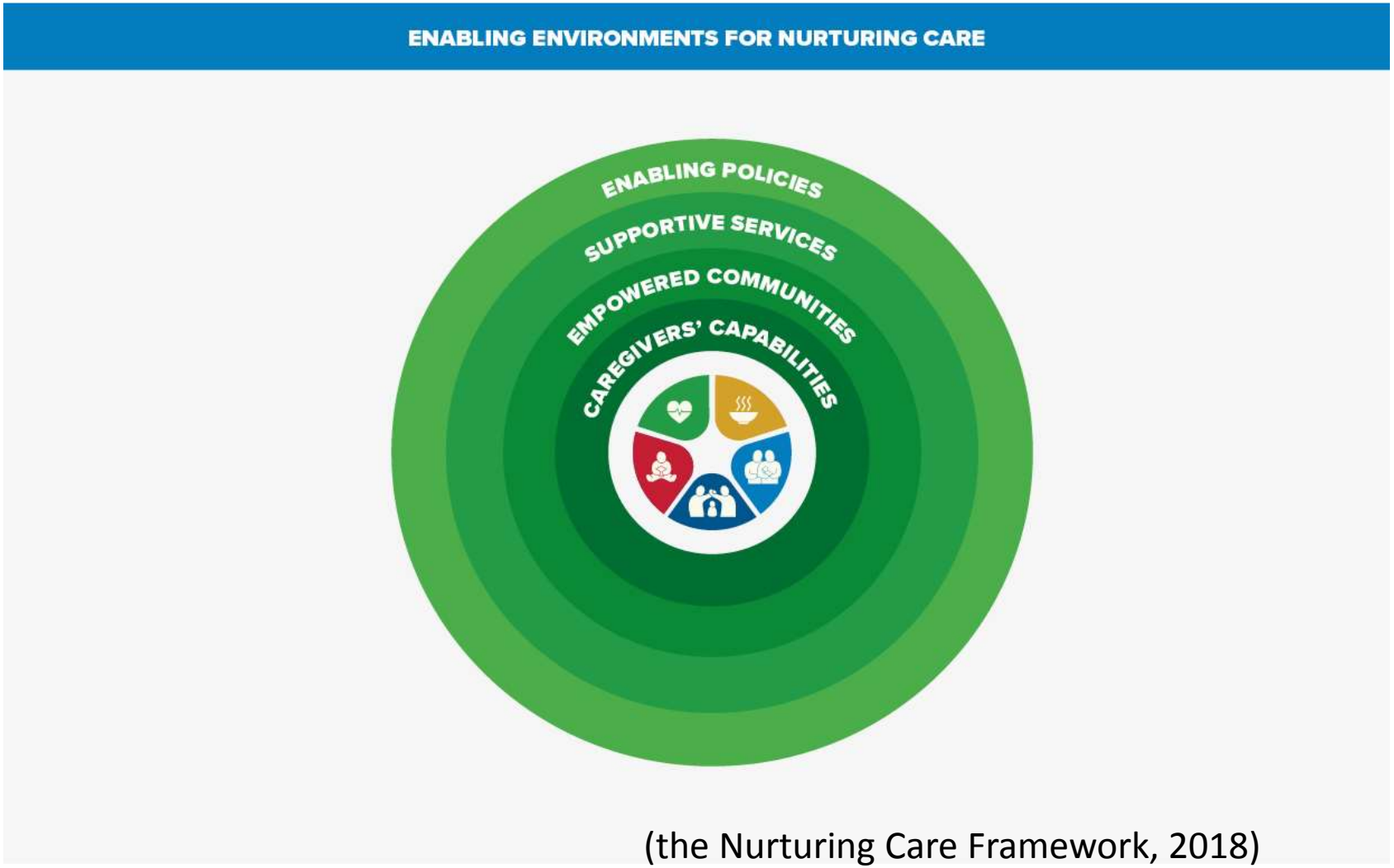


Figure 3: Vocabulary scores of Ecuadorian children aged 36 to 72 months by wealth quartiles
TVIP=Test de Vacabulario en Imagenes Peabody. Reproduced with permission from the authors.[70]

Gaps can be prevented or reduced

scalata sociale
Guglielmo Rispoli

Brains do not grow in a vacuum, families do not act in a vacuum: society is the primary caregiver!



(the Nurturing Care Framework, 2018)