

The following manuscript is written by Dr Fraser Mustard, a scientist who for more than 10 years has promoted early child development for all children nationally and internationally. He outlines the complex socioeconomic and political factors our society faces to create more equity in child development, noting that the recently released World Health Organization report on the social determinants of health has a chapter titled, 'Equity from the start' (chapter 5). He has also tried to set out the difference between free market capitalism with social accountability, and without social accountability. As he says, the Scandinavian countries as free market economies with social accountability tend to spend more on the early generation than Canadians and Americans do. The challenge he notes is: Can we ensure that our investments for the different age groups meet our goals in social accountability? It is very urgently 'time for action' on his vision!

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Free market capitalism, social accountability and equity in early human (child) development

Fraser Mustard (Founder, Council for Early Child Development)

A University of Chicago Nobel Laureate in economics, ARW Fogel, and a Dutch economist, JW Drukker, found that as the wealth of Western countries improved following the Industrial Revolution, life expectancy increased and the mean height of their populations improved (1,2). Since height is a product of genes and nutrition, they concluded that improved health was related to improved socioenvironments and better nutrition of children, not improvements in health care.

Today, the health of populations in developed countries is a socioeconomic gradient. These health gradients (3) are linear, which means that whatever the socioeconomic factors influencing health today are, they affect everyone in society, including the wealthiest. The effect, however, is greatest on the poorest members of society.

The Canadian Institute for Advanced Research's (CIAR) population health program led by Robert Evans (University of British Columbia [Vancouver, British Columbia]) examined the factors contributing to the health gradients in Canada and other countries. They concluded that in the United Kingdom, Canada and the United States (US), the major factor contributing to inequities in health was more than poverty and a lack of health care (3).

Hertzman et al (4) – members of the CIAR's population health program – proposed that the socioeconomic conditions in early life affected adult health (physical and mental) throughout life. They and others suggested that the development of the brain and related biological pathways in early life were important factors. This led to the hypothesis that if the socioeconomic gradient in health was influenced by brain and biological pathway development in the early years, it was possible that there were similar socioeconomic gradients in education and behaviour (5). The CIAR established a program in human development to explore the concept. The scientists in this program found that the socioeconomic

gradients in literacy, numeracy and behaviour were similar to the health gradients (6). They suggested that the effect of experience in early life on the development of the architecture and function of the brain was important in contributing to inequities in health and education.

In 2002, the CIAR established a new program, 'Experience-based Brain and Biological Development' to study how genes and experience shape brain development that influences health, learning and behaviour trajectories throughout life.

DEVELOPMENTAL NEUROBIOLOGY

Developmental neurobiology research provides insights into how early development can set socioeconomic trajectories for life in health, learning and behaviour (7). The function of neurons is not just produced by their genes (nature), but also by experiences in early life (nurture). Experience in early life includes adequacy of nutrition; quality of water and sanitation; stimuli such as touch, sound, vision, drugs and injury; and diseases caused by viral and bacterial infections. The effects of early experience on neuron function and neural pathways in early life affect the architecture and function of the brain.

Experience-based brain development in early life affects:

- Emotion;
- Temperament;
- Social functioning;
- Perceptual and cognitive ability;
- Mental health and behaviour;
- Physical health;
- Physical activity such as skiing, swimming, hockey, etc; and
- Language, literacy and numeracy capability.

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Accepted for publication October 29, 2008

We now understand how experience can activate and modify the function of normal DNA in neurons. Developmental neurobiology research explains how epigenetic processes are affected by experience that can modify how genes function. Szyf et al (8) studied the development of the neurobiological pathways in rats that affect behaviour (the limbic hypothalamic-pituitary-adrenal pathway). Their research showed that the intensity of the rat mother's licking of her pups in the first six days affected the function of the hippocampus and the behaviour, memory and capability of the pups as they matured. The hippocampus is an important regulator of the stress pathways that influence glucocorticoid (human – cortisol: rats – corticosterone) blood levels. Cortisol affects the brain (emotions and behaviour) and other organs every day. Szyf et al (8) found that rat pups that are poorly licked by their mother's in early life have methylation of the cytosine base in the DNA of the genes that regulate the production of the glucocorticoid receptor in the hippocampus (epigenetics) (9). This depresses the function of the gene, leading to reduced glucocorticoid receptor availability in the hippocampus. Thus, the body loses a pathway that helps regulate the levels of glucocorticoids (cortisol) in the blood. Cortisol affects tissues throughout the body, including the brain. Excess cortisol can be damaging to cells and can contribute to poor health.

Another example of gene-environment interaction and epigenetic processes comes from studies of the New Zealand Dunedin birth cohort. Caspi et al (10) found that adverse conditions in early life led to increased risk for depression in adult life for individuals with the short gene structure for the serotonin transporter gene. Those with the long gene structure who were brought up in an adverse environment were resilient. Those with the short gene structure who were brought up in good caring environments were not at an increased risk for depression.

SOCIOECONOMIC FACTORS AND EQUITY IN HUMAN DEVELOPMENT

One of the questions that arise from all these studies is, 'What is the relationship between factors influencing the social environment and early human development and equity in health and cognitive functions, such as literacy, and noncognitive function, such as behaviour?'. A study (11) by the US Department of Education on adult (16 to 65 years of age) literacy, based on the Organisation for Economic Co-operation and Development population literacy studies, found that approximately 50% of the US population were at levels 1 and 2 (low). Fifty per cent of the population at level 1 had major health problems (mental, emotional and chronic disease). Less than 2% of the population at level 5 (high) (5% of the population) had health problems. Literacy was also a socioeconomic gradient. Health was a gradient when plotted against the literacy capability of the population. This relationship between literacy competence and health is not unexpected in view of what we now know about how experience affects brain development in the early years, and sets brain and biological pathways that affect health and cognitive and noncognitive functions.

Data from birth cohort and population studies (12-14) show that adverse human development in early life leads to poor cognitive function and behavioural and health problems (physical and mental) in later stages of development.

One of the most robust studies showing the critical importance of early human development comes from studies of Romanian orphanages. Studies (15-17) in the US, Canada and the United Kingdom have examined the effect of adoption time on the development of these children. Children adopted into Canadian middle-class families within four to six months of birth showed better development than those adopted later (16). The children adopted eight or more months after birth had abnormal brain development, low metabolic activity in the brain and abnormal electroencephalographies. These children showed significant behavioural problems, such as attention-deficit hyperactivity disorder and antisocial behaviour. The children who were adopted later had lower IQ scores than the children adopted early. In an American study (16) of children in Romanian orphanages, children placed in a foster-parenting program in Romania were compared with those who remained in the orphanage. The striking finding from this study was that the noncognitive and cognitive development of the children who remained in the orphanage was markedly below that of children who were removed from the orphanage and placed in foster care in Romania.

EARLY CHILD DEVELOPMENT AND SCHOOL PERFORMANCE

In terms of school performance, there is now substantial evidence that children who have poor development from birth to six years of age tend to not perform well in primary schools. Hertzman et al's (22) study of child development in British Columbia at the time children enter kindergarten, found that children who did poorly when tested with the Early Development Instrument at school entry did not do well in the grade 4 language, literacy and numeracy tests. In a New Zealand study (20), researchers found that the ability of children at the time of school entry basically determined how well most students performed in literacy and mathematics up to 14 years of age within the school system. The schools did not significantly enhance the performance of the majority of the children who showed poor development at the time of school entry.

Small randomized, controlled trials (23,24) in the US showed that high-quality early human development programs substantially improved school performance and reduced behavioural problems in the school system and in adult life. The Council of Early Child Development in Canada recommends the establishment of early child development programs integrated with the primary schools (25).

SOCIETIES AND SOCIOECONOMIC CHANGE

Societies with equity in health, learning and behaviour tend to be societies that have good caring and supportive social environments for families with young children. The Scandinavian countries have high-quality early child development programs and a high-performance level in literacy and health (26). They can be considered as free market capitalist countries with social accountability. Another country that

shows good health and literacy measures is Cuba (27). The Cuban government operates a noncompulsory program in early human development that begins with pregnancy and is extensively used by most families with young children (28).

EQUITY AND SOCIAL ACCOUNTABILITY

Social investments by societies for different age groups show considerable country variation. Lynch (29), in a study of resource allocation for the different age groups, found that in the US, the allocation for early human development was much less on a per capita basis than the allocation for the older age groups. In Scandinavian countries, support for families and young children is much better than in Canada and the United States. The Scandinavian countries also provide good health care and other support for the elderly.

The quality of societies and their equity in health and education is strongly influenced by the public policies that affect early human development. In today's world, with exponential growth in new knowledge and in new technologies, there is increasing competition for talent (30). The National Academy of Sciences (USA) concerned about this problem has recently released a report by Augustine (31) entitled, 'Is America Falling Off the Flat Earth?'. He stated that "only providing leading edge human capital, can America continue to maintain a high standard of living – including providing national security – for its citizens". He argued that America must repair its kindergarten to grade 12 educational system. He identified a problem, but failed to take into account that early human development influences the course of children in the education system, and that America underinvests in the younger generation. Heckman (32) concluded that to improve the quality of the US population (health, education and behaviour), the country must increase investment in the early years of human development. The cost to individuals in Canadian society of mental health and addiction problems, and crime and violence related to poor early human development, is orders of magnitude greater than putting in place quality early child development programs (14,33).

REFERENCES

1. Fogel RW. *The Fourth Great Awakening*. Chicago: University of Chicago Press, 2000.
2. Drukker JW. *Paradoxes of Modernization and Material Well-Being in the Netherlands During the Nineteenth Century*. Chicago: University of Chicago Press, 1997.
3. Evans RG, Barer M, Marmor TR. *Why are Some People Healthy and Others Not?* New York: Aldine De Gruyter, 1994.
4. Hertzman C, Frank J, Evans R. Heterogeneities in health status and the determinants of population health. In: Marmor TR, Barer M, Evans RG, eds. *Why are Some People Healthy and Others Not?* New York: Aldine De Gruyter, 1994.
5. Keating DP, Mustard JF. Social economic factors and human development. In: Ross D, ed. *Family Security in Insecure Times*. Ottawa: National Forum on Family Security, 1993:87-105.
6. Keating DP, Hertzman C. *Developmental Health and the Wealth of Nations*. New York: The Guilford Press, 1999.
7. Summarized in Mustard JF. Experience-based brain development: Scientific underpinnings of the importance of early child development in a global world. In: *Early Child Development from Measurement to Action*. Washington: The World Bank, 2007.
8. Szyf M, McGowan P, Meaney MJ. The social environment and the epigenome. *Environ Mol Mutagen* 2008;49:46-60.
9. Meaney MJ. Maternal care, gene expression, and the transmission of individual differences in stress reactivity across generations. *Annu Rev Neurosci* 2001;24:1161-92.
10. Caspi A, Sugden K, Moffitt TE, et al. Influence of life stress on depression: Moderation by a polymorphism in the 5-HTT gene. *Science* 2003;301:386-89.
11. U.S. Department of Education. *Adult Literacy in America: A First Look at the Findings of the National Adult Literacy Survey*. Washington: U.S. Department of Education, 2002.
12. Mustard JF. *Early Child Development and Experience-based brain development: The Scientific Underpinnings of the Importance of Early Child Development in a Globalized World*. Washington: The Brookings Institution, 2006.
13. McCain MN, Mustard JF, Shanker S. *Early years study 2: Putting science into action*. <<http://www.councilcd.ca/cecd/home.nsf/pages/about.html>> (Version current at November 3, 2008).
14. Mustard JF. *Early childhood development: The best start for all South Australians*. <<http://www.thinkers.sa.gov.au/>> (Version current at November 3, 2008).
15. Nelson CA. *Cognitive recovery in socially deprived young children: The Bucharest Early Intervention Project*. *Science* 2007;318:1937-40.

16. Le Mare L, Kurytnik K, Audet K. The implications of early institutional caregiving for the social-emotional development of internationally adopted children. *Child Fam J* 2006;9:16-26.
17. Rutter M, O'Connor TG; English and Romanian Adoptees (ERA) Study Team. Are there biological programming effects for psychological development: Findings from a study of Romanian adoptees. *Dev Psychol* 2004;40:81-94.
18. Research studies summarized in McCain M, Mustard JF, Shanker S. Early years study 2. Toronto: Council for Early Child Development, 2007.
19. Wylie C. Competences at Age 14 and Competency Development for the Competent Learners Study Sample. Wellington: New Zealand Council for Educational Research, 2004.
20. Egerton, Bynner M. Gaining Basic Skills in the Early Years: The Dynamics of Development from Birth to 10. United Kingdom: Institute of Education, 2001.
21. Tremblay RE, Nagin DS, Séguin JR, et al. Physical aggression during early childhood: Trajectories and predictors. *Pediatrics* 2004;4:e43-50.
22. Hertzman C. Seven uses of the EDI: The case of British Columbia. the Measuring Early Child Development conference. Vaudreuil, Quebec, 2006.
23. Schweinhart LJ, Barnes HV, Weikart DP. Significant Benefits: The High/Scope Perry Preschool Study Through Age 27. Ypsilanti: High/Scope Educational Research Foundation, 2005.
24. Ramey CT, Campbell FA, Burchinal M. Persistent effects of early childhood education on high risk children and their mothers. *Appl Dev Sci* 2000;4:2-14.
25. Pan-Canadian Interactive Literacy Forum. <<http://cmec.insinc.com/literacyforum/>> (Version current at November 3, 2008).
26. Organization for Economic and Cooperative Development. Starting Strong II. Paris: OECD Secretariat, 2006.
27. United Nations Educational Scientific, and Cultural Organization (UNESCO) Institute for Statistics. World Education Indicators. Paris: UNESCO, 2002.
28. UNESCO. Country profile prepared for the Education for All Global Monitoring Report 2007. Strong Foundations: Early Childhood Care and Education Cuba Early Childhood Care and Education (ECCE) programmes. Geneva: UNESCO International Bureau of Education (IBE), 2007.
29. Lynch J. Age in the Welfare State: The Origins of Social Spending on Pensioners, Workers, and Children. New York: Cambridge University Press, 2006.
30. The Economist. The battle for brainpower: A survey of talent. London: The Economist, 2006.
31. Augustine NR. Is America Falling Off the Flat Earth? National Academy of Engineering and Institute of Medicine of the National Academies, 2007.
32. Heckman JJ. The economics, technology and neuroscience of human capability formation. National Bureau of Economic Research, Working Paper No. 13195, 2007.
33. Gnam W, Sarnocinska-Hart A, Mustard C, Rush B, Lin E. The economic costs of mental disorders and alcohol, tobacco and illicit drug abuse in Ontario, 2000: A cost-of-illness study. Toronto: Centre for Addiction and Mental Health, 2006.
34. Commission on the Social Determinants of Health. Closing the gap in a generation: Health equity through action on the social determinants of health. Final Report of the Commission on Social Determinants of Health. Geneva: World Health Organization, 2008.