Looking Backward:
How Childhood Experiences Impact a Nation's Wealth

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I'm a Canadian, an economist, and a father. As a Canadian I believe in the importance of community and compassion. As an economist I understand the importance of competitiveness to our country's prosperity. And, since I'm a father, I want my children to grow up in a country that it is both compassionate and prosperous.

So it disturbs me to hear people in public policy circles say that our core Canadian values of community and caring are being sacrificed on the altar of competitiveness. Competitiveness is not a pagan god – it is a roadmap to prosperity. And I find it equally disturbing to hear it suggested that public money destined for children is wasted and would be put to better use in the hands of business.

I believe that this country should set its sights on becoming the richest nation in the world. And, having spent more than a decade studying the policies that Canada needs in order to reach that goal, I have come to understand that there is no simple solution, no single policy or shortcut that will get us there.

Rather, we need a set of complementary policies. Many of these policies involve investing in people. And the way to do that – not the only way but the most cost-effective way – is to invest in people when they are young. Many would agree with that statement because it makes sense instinctively. Others might disagree for the same reason. But, as an economist, I say it because I've examined the research and have concluded that it's simply a fact.

I wouldn't have said that ten years ago. At that time, when faced with studies that purported to demonstrate a direct link between early childhood interventions and the long-term economic performance of individuals, I was interested but not convinced. At that time there were just too many parts of the puzzle missing for the statistician in me to be moved. Put

simply, it's not easy to prove that something that happens to a person in childhood is the cause of something else that happens when the person is much older. There are just too many other factors that could have come into play during the intervening years.

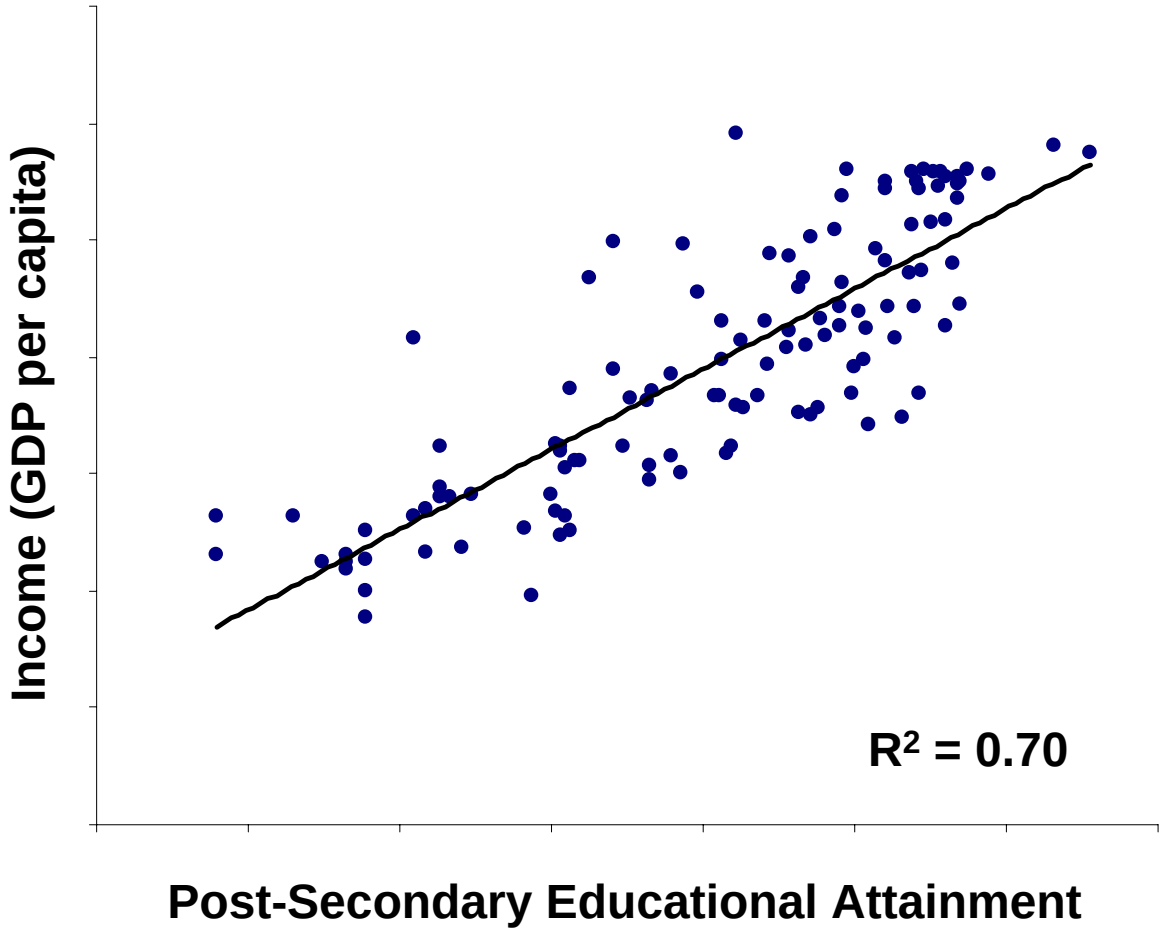
So, ten years ago, I questioned the methodology of the research; I found the holes too big and too numerous to agree that the case had been made. But not now. Over the last decade science has filled in many of the gaps, so that now the picture is much more complete. We can clearly see the links between childhood interventions and a host of productivity-enhancing policies, policies that Canada must consider if it is to become the richest and the most livable jurisdiction in the world. In other words, this country's core values of community and caring are a tremendous asset, a necessary part of any uniquely Canadian strategy for promoting competitiveness and prosperity.

Before I go any further I had best clear up one important misconception in the business community. The "Children's Agenda" is not about pumping billions of dollars into daycare centres for children. To make the point with just one example, Children's Agenda advocates insist on the need for parent-tot centres where the focus is not on babysitting, but on teaching parents how to provide an enriching environment for their children. The Children's Agenda is *not* about government-sponsored babysitting.

Let's look at some of the policies that could constitute a Children's Agenda and some of the research that justifies those policies, beginning with post-secondary education. The link between the post-secondary educational attainment of a country's population and its national income is one of the most important correlations in economics. See Figure One.

Canada ranks very high in terms of the proportion of its population with at least some post-secondary education and, not surprisingly, it is a rich country. However, Canada's post-

Figure 1. Human Capital Is Strongly Associated With High Incomes



Each country's income (as measured by gdp per capita) is plotted against the proportion of its population with at least some post-secondary education. Each point represents one of 119 countries around the world. Income differences across these countries are huge: the richest is over 60 times richer than the poorest. The figure shows that education explains 70 per cent of these vast international differences in gdp per capita.
Source: Data on gdp per capita are purchasing power parity adjusted from the authoritative Penn World Tables. Data on post-secondary education are from Robert J. Barro and Jong-Wha Lee "International Data on Educational Attainment: Updates and Implications." Harvard Center for International Development Working Paper #42, 2000. All data are for 1990.

secondary attainment disguises some serious shortcomings. First, what matters is not post-secondary education *per se*. Income is linked only to the proportion of the population with a post-secondary degree from a university, [1] while Canada's high educational attainment is largely driven by non-university post-secondary education. When only university education is considered, our rank among OECD countries drops from first to fifth.

In addition, we do downright poorly in many advanced professional degrees. When it comes to MBAs, for example, we graduate only half as many per capita as does the United States.[2] So, if Canada is to establish itself as the richest jurisdiction internationally, we will have to graduate more students from universities and from the highest-quality four-year community colleges. We will also have to graduate more students with advanced professional degrees.

How can we achieve that goal? Well, it turns out that students from low-income households are much less likely to attend university than their peers from more prosperous homes. See Figure Two.

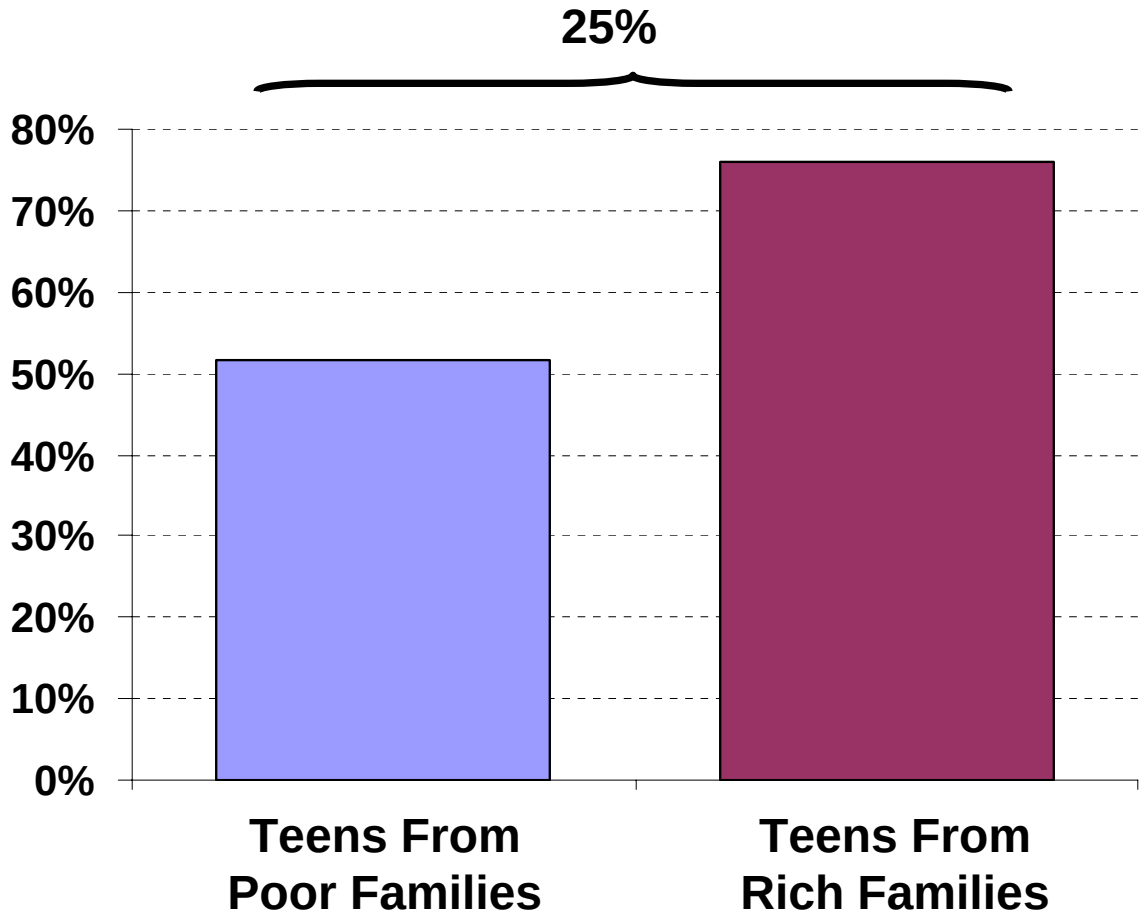
Students are a national asset, and poorer households are a potentially large source of them. From this information most people would conclude that the best way to promote higher university enrolments is to make education less expensive. And, in fact, current education policy is dominated by the view that tuition subsidies are the best way to do so. This is a mistake.

It turns out that the low participation rates among teens from poor households can be traced back to a very young age, when they are already inadequately prepared for school. This

[1] Non-university post-secondary education explains a scant 4% of the differences in gdp per capita among OECD countries (the only countries with the non-university data). This result should not be construed as a criticism of the best community colleges. Non-university post-secondary education ranges in extremes from excellent 4-year programs offered by first-rate community colleges to questionable 3-month certifications offered by fly-by night operations.

[2] *Closing the Prosperity Gap: First Annual Report*, Ontario Task Force on Competitiveness, Productivity and Economic Progress, November 2002.

Figure 2. Canadian Post-Secondary Participation Rates by Income: Evidence for Further Tuition Subsidies or Lack of Demand?



The figure shows Canadian post-secondary participation rates by income level. Seventy-six per cent of teens from rich families entered the post- secondary system while only 51 per cent of teens from poor families did so: a rich-poor gap of 25 percentage points. Families with teens aged 18-21 were ranked by after tax household income. 'Poor' families are those in the bottom quartile and 'rich' families are those in the top quartile.
Source: Tamara Knighton and Sheba Mirza, "Postsecondary Participation: The Effects of Parent's Education and Household Income" *Education Quarterly Review*, 2002, Vol. 8(3). 'Poor' ('Rich') means in the bottom (top) quartile of the after-tax household income distribution.

lack of preparation leaves them behind at every stage of elementary and secondary schooling. The cumulative effect of always being behind is that, by age 18, these teens simply do not have what it takes to succeed in university. A university education is outside their skill sets.

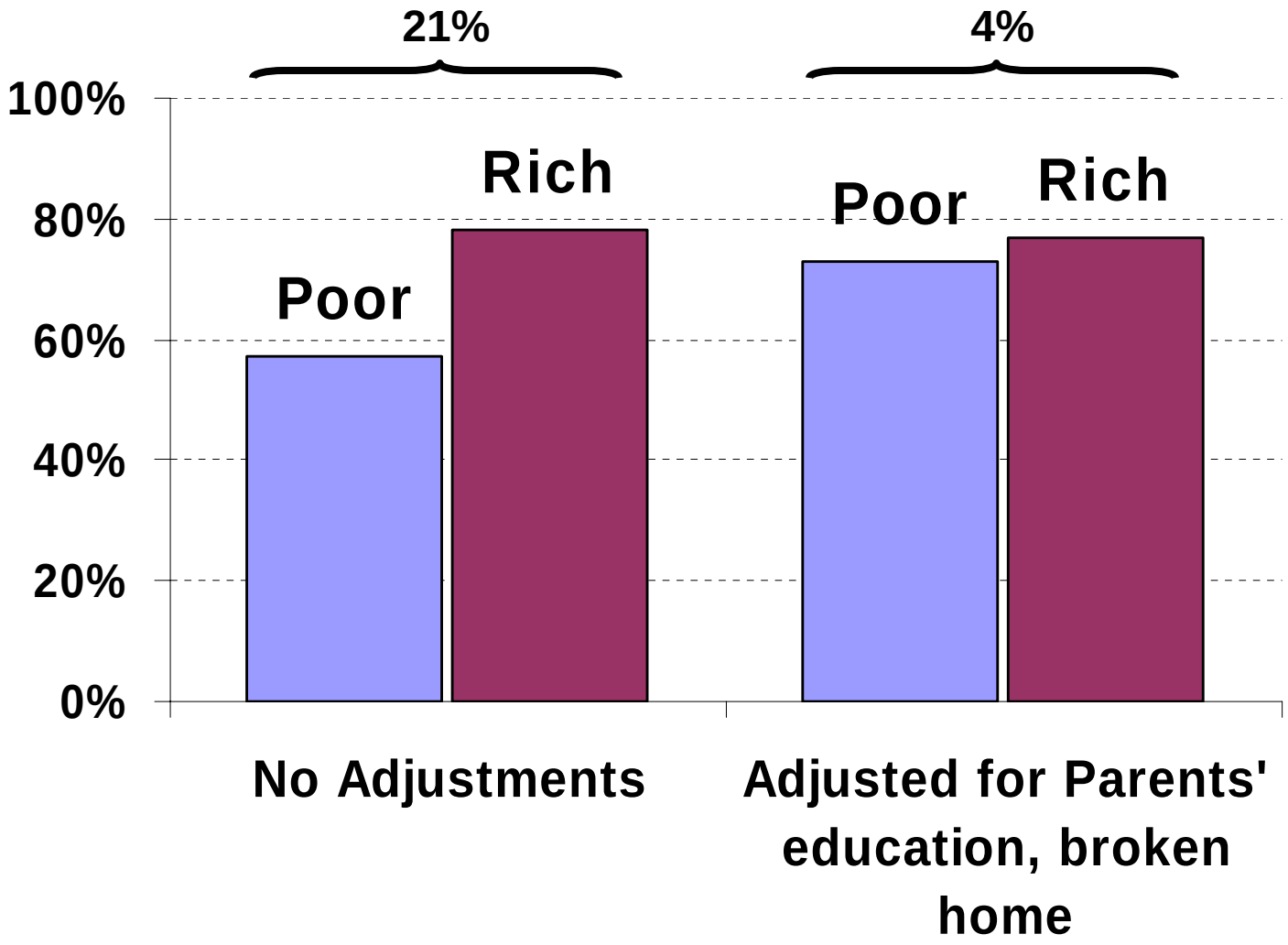
The evidence for this comes from the U.S., where there is also a huge rich-poor gap in post-secondary education. At the University of Michigan a large cohort of teens has been tracked every year since 1979. When first interviewed, these teens are given the AFQT skills test, what most people would call an IQ test. Let's have a look only at the students in the top quartile of the test results, the ones you'd expect to have the smarts for admission into a post-secondary institution.

A comparison between the bright kids from "poor" families and those from "rich" ones shows the expected income-related gap. See Figure Three. But what happens when we take into account some early childhood experiences that we would associate more with poor teenagers than rich ones? Following Nobel Prize winner James Heckman, let's control for early childhood experiences as measured by parental education and whether the child came from a broken home.[3] Amazingly, taking into account just these parsimonious measures of early childhood experiences, the rich-poor gap in post-secondary enrolment disappears! The differences between the two groups are neither statistically nor economically significant.

The lesson for us from this analysis is that we cannot boost the number of qualified students entering university simply by tinkering with tuition subsidies. We must do so taking into account that demand for higher education is initiated very early in life.

[3] Pedro Carneiro and James Heckman, "Human Capital Policy," NBER working paper #9495, February 2003. The sample is restricted to white males. In addition to broken home and parental education, the authors control for place of residence (southern state and urban controls).

Figure 3: U.S. Post-Secondary Enrollment for Bright Teens: After Adjusting for Early Experiences, Income Does Not Matter.



Source: Pedro Carneiro and James Heckman, "Human Capital Policy" NBER Working Paper #9495, February 2003. Bright teens are those who placed in the top third of the AFQT test.

It is also useful to know that similar analyses have been done in which family background has also been linked to many other educational outcomes. It turns out to be an important determinant of such diverse outcomes as dropping out of college, dropping out of high school, a child's readiness to learn in Junior Kindergarten, and even cognitive and non-cognitive test results for children at the youngest age for which such tests can be sensibly administered. [4]

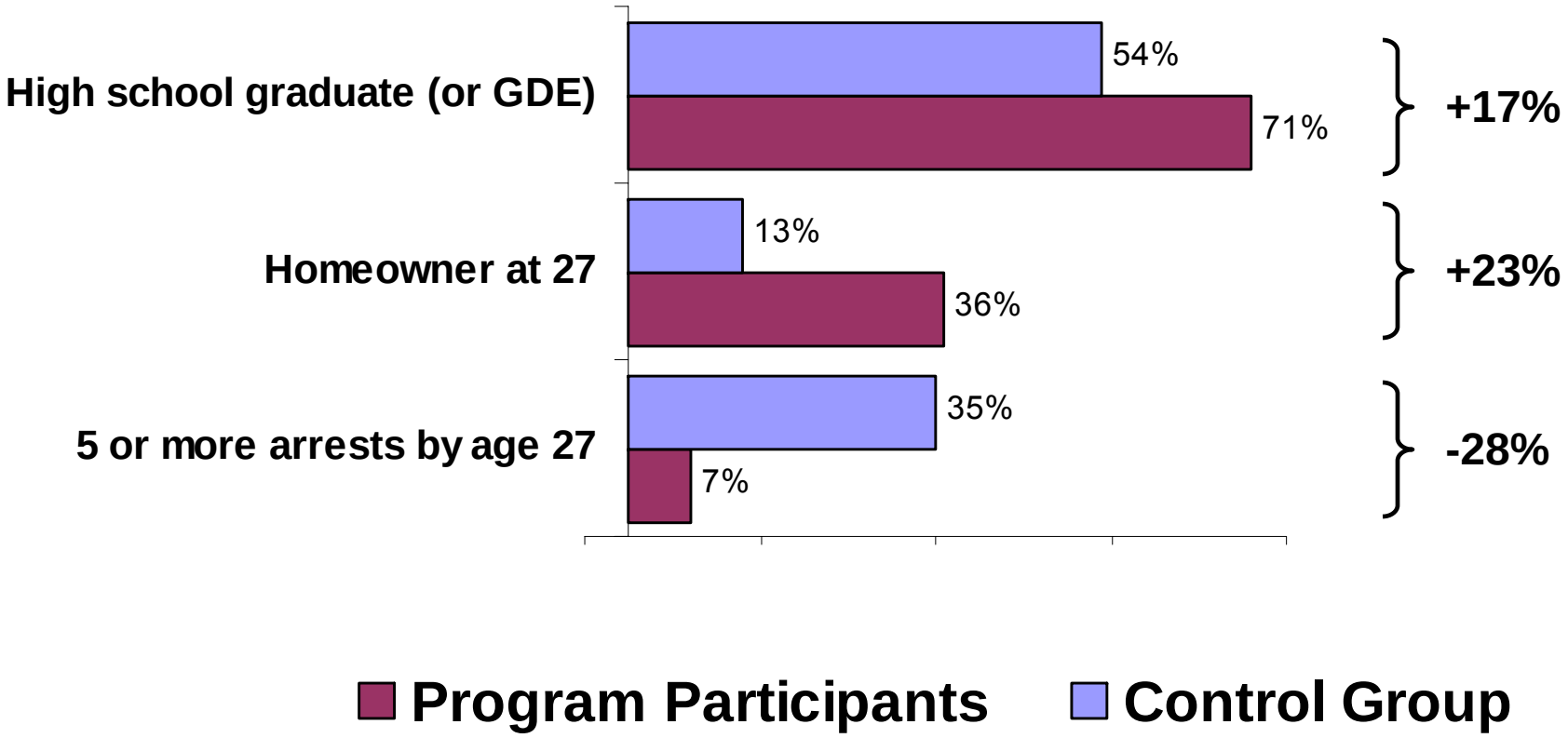
Not only that, but these are only several of many observations that can be drawn from a vast literature on the subject by economists, psychologists and epidemiologists. There many studies showing that early experiences have important effects on educational outcomes throughout life. A common factor – one that is quite disturbing – is that, in much of the research, the early experiences have a cumulative or "snowball" effect, where the skills acquired (or not acquired) in one stage of life affect learning throughout the following stages.

In one famous study of this snowball effect, the Perry Preschool Program of the mid-1960s, a number of disadvantaged, low-IQ, inner-city three- and four-year-olds were randomly divided into two groups. Children in the first group were treated to an enriched pre-school environment that consisted of daily classes and weekly home visits. Those in the second group received no special treatment. The participants have been tracked periodically ever since, most recently at the age of 27. See Figure Four.

The latest results reflect the many benefits that have accrued over the years to members of the group that were given attention more than two decades earlier. To cite only three,

[4] As examples of each point see (1) Todd R. Stinebrickner and Ralph Stinebrickner, "The Relationship Between Family Income and Schooling Attainment: Evidence from a Liberal Arts College With a Full Tuition Subsidy Program," Mimeo, 2002, (2) Lawrence J. Schweinhart, "Benefits, Costs, and Explanation of the High/Scope Perry Preschool Program," April 2003, (3) Janet Currie, Eliana Garces and Duncan Thomas, "Longer Term Effects of Head Start," *The American Economic Review*, 92, Sept. 2002, 999-1012, and (4) Pedro Carneiro and James Heckman, "Human Capital Policy," NBER working paper #9495, February 2003. For a broader picture painted by psychologists and epidemiologists see *Developmental Health and the Wealth of Nations: Social, Biological, and Educational Dynamics*, edited by Daniel P. Keating and Clyde Hertzman, The Guilford Press, New York, 1999.

Figure 4: Early Childhood Interventions: Perry Preschool Program



Source: Lawrence J. Schweinhart, "Benefits, Costs, and Explanation of the High/Scope Perry Preschool Program," April 2003. The sample consists of disadvantaged, low-IQ children, ages 3-4, from Ypsilanti, Michigan. Children were provided with an enriched environment during ages 3-4 and then followed, along with a control group, until age 27.

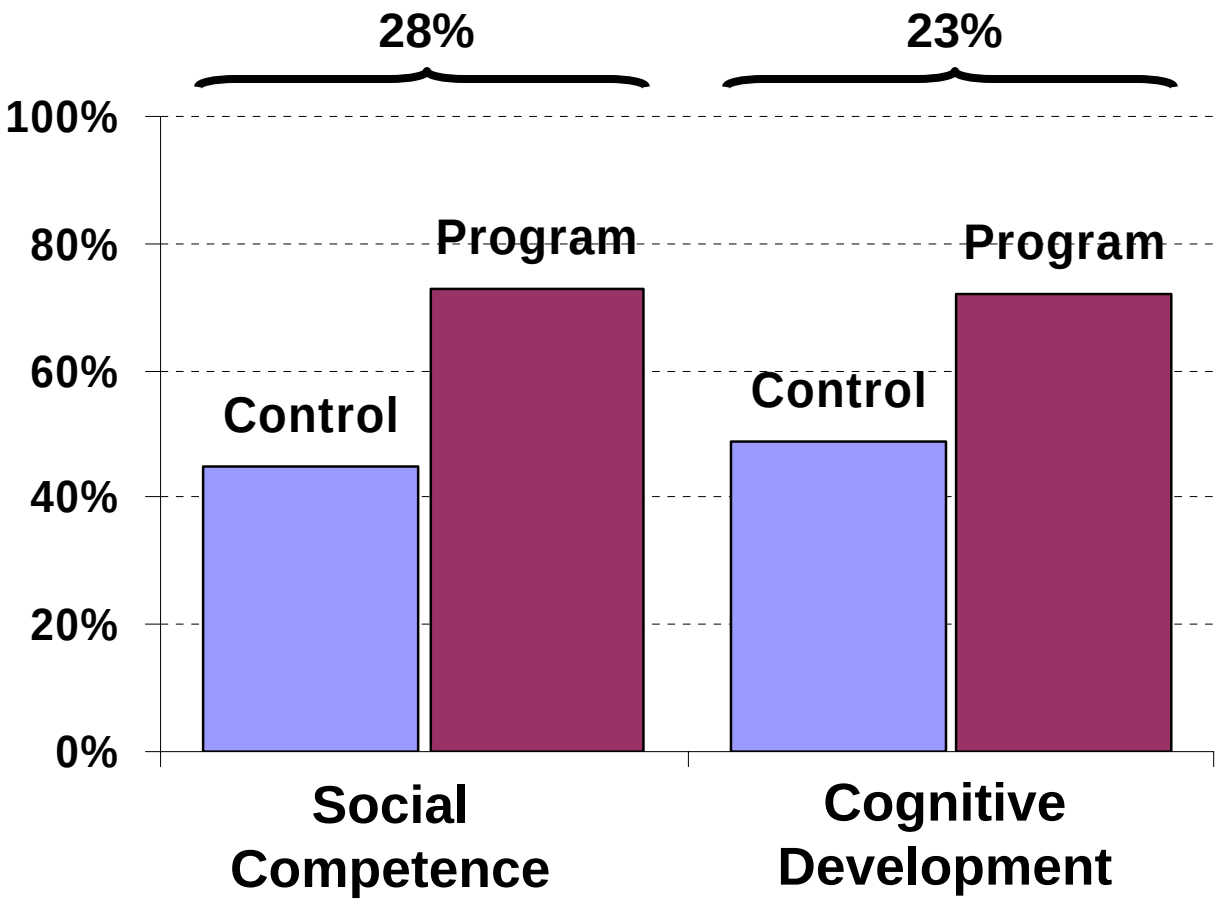
members of the treated group were 17 percent more likely to have graduated from high school, 23 percent more likely to be homeowners, and 28 percent less likely to have been arrested five or more times. Here the snowball effect was a positive one, producing higher educational attainments, higher income and greater life-style stability. (Although I initially accepted the educational benefits without hesitation, until recently I have been more skeptical about the crime statistics. As we shall see, they are consistent with the conclusions of a new medical literature on the topic.)

As a Torontonian, I was interested in looking at a local program. Toronto has 55 Parenting and Family Literacy Centres in neighbourhoods with a high proportion of children considered at risk for developmental problems. These Centres are essentially parent-tot programs that focus on teaching a particular set of parenting skills to improve the child's "readiness to learn" in the year before entry to Junior Kindergarten. More than 200 of these children were tested upon beginning Junior Kindergarten in 2000. They scored 28 percent higher on social competence and 23 percent higher on cognitive development than comparable at-risk children who did not participate in the Centres.[5] (Figure Five)

The significance of the snowball effect, when it comes to boosting the numbers of our teenagers who attend university, is that success will depend less on tweaking tuition subsidies than on ensuring that children from poor families have enriched early childhood experiences.

[5] See Hon. Margaret Norrie McCain and J. Fraser Mustard, *The Early Years Study Three Years Later*, August, 2002 and Magdalena Janus and Dan Offord, "Readiness to Learn at School," *ISUMA*, Vol. 1(2), Autumn 2000. The program was set up by Mary Gordon in 1981. The Atkinson Foundation funded the 1999 research. Readiness to learn is measured by the Early Development Instrument that was developed by Magdalena Janus and Dan Offord at McMaster University's Canadian Centre for Studies of Children at Risk.

Figure 5: "Readiness to Learn" Program in Toronto



Source: See text. A child that scores low on social competence is a child with regular serious problems in more than one area of getting along with other children, following class routines, respect for adults and children, self-confidence, and/or tolerance.

The most cost-effective way to raise university enrolment while maintaining and even enhancing student quality is to invest in our children.

Evidence from the Laboratory

As I noted earlier, I have been somewhat skeptical of the studies I just reviewed. It was only the scientific discoveries of recent years that convinced me of the direct link between early childhood experiences and outcomes in adulthood. There has been a real outpouring of research at the molecular and cellular levels relating early environmental stimuli to biological processes in adulthood, so now a causal mechanism can be demonstrated. Of all the areas of research, three might be of particular interest for our purposes: brain "plasticity", the HPA axis (or stress system), and serotonin metabolism.

1. Brain Plasticity

In the months leading up to birth, the body cranks up the production of neurons (brain cells) and synapses (connections between brain cells). The process peaks quickly so that by the age of about 18 months the brain has 50 percent more synapses than it will ever have again.[6] It was long believed that this process was entirely guided by genes, and that external influences played no role. There can be no doubt that genes are important. After all, the main structures of the brain are identical in all people, regardless of childhood experiences. The devil, however, is in the details, in the way our neurons communicate with one another. External environmental influences at a very young age play a key role in determining which neuron 'talks' to which

[6] Peter R. Huttenlocher, "Synaptic Density in Human Frontal Cortex – Developmental Changes and Effects of Aging," *Brain Research*, March 16, 1979, 163(2):195-205.

other neurons, and whether the talk will elicit a response. Environmental stimuli such as sight, sound, and touch sculpt these neural communication systems.

From a distance, the developmental process is simple. By the age of three the body will kill off roughly one third of its neurons in a process known as neural pruning[7] and will dramatically increase the number of synapses in a process known as synaptogenesis.[8] The two processes, first conjectured by Canadian psychologist Donald Hebb, are related.

Suppose that at birth, neurons A and B can send messages to neuron C. Each time A sends a message that manages to excite C (to communicate a sensation of touch, for example), C releases chemicals called neurotrophins that A can absorb, but B can't. Neurotrophins are an elixir of life that allows neuron A to sprout new synapses and to live longer. As a result, new synapses grow along the neural pathway that is used (the A-C pathway), thereby raising the probability that C will respond when A "talks". Since neurons die more quickly along neural pathways that go unused, there is neural pruning on the B-C pathway. Environmental stimulus of a neural pathway thus exempts it from neural pruning and, by increasing the number of synapses, makes the pathway more sensitive to subsequent environmental stimuli.

Businessmen will appreciate this system. In the marketplace where neurons do their business, competition is focused on securing the scarcest of all commodities: neurotrophins. Success leads to long life and many connections. To push the analogy, neurons often make greenfield investments outside their core competencies. Such investments explain why the blind often have a better sense of hearing; their "hearing neurons" spread to sites in the brain normally

[7] Max S. Cynader and Barrie J. Frost, "Mechanisms of Brain Development: Neural Scultping by the Physical and Social Environment," in *Developmental Health and the Wealth of Nations: Social, Biological, and Educational Dynamics* edited by Daniel P. Keating and Clyde Hertzman, 1999.

[8] Joseph LeDoux, *Synaptic Self: How Our Brains Become Who We Are*, 2002. LeDoux is an expert in the field and his book provides a very detailed discussion for those interested in the large number of biological details.

occupied by the optical nerve. In fact, research into this topic was stimulated by Canadian Nobel Prize winner David Hubel's attempts to understand the eye.

Cataract surgery is a simple process that involves altering the eye's lens to allow in more light. It is a common surgical procedure in adults but is wholly ineffective in children under the age of three.[9] To investigate, Hubel placed an opaque contact lens in the eye of a young cat. Several weeks later, when contact lens was removed, the cat was blind in that eye. Yet placing an opaque contact lens in the eye of an adult cat had no effect. Why?

Thanks to research done in part by Max Cynader of the University of British Columbia (UBC) and the Canadian Institute for Advanced Research (CIAR), we now know that the lack of environmental stimulus to the shut eye leads to the pruning of the neural pathway linking the eye through the optical nerve to the visual cortex. This pruning appears to be partly directed by neurotrophins released by specialized neurons that disappear in adulthood.[10]

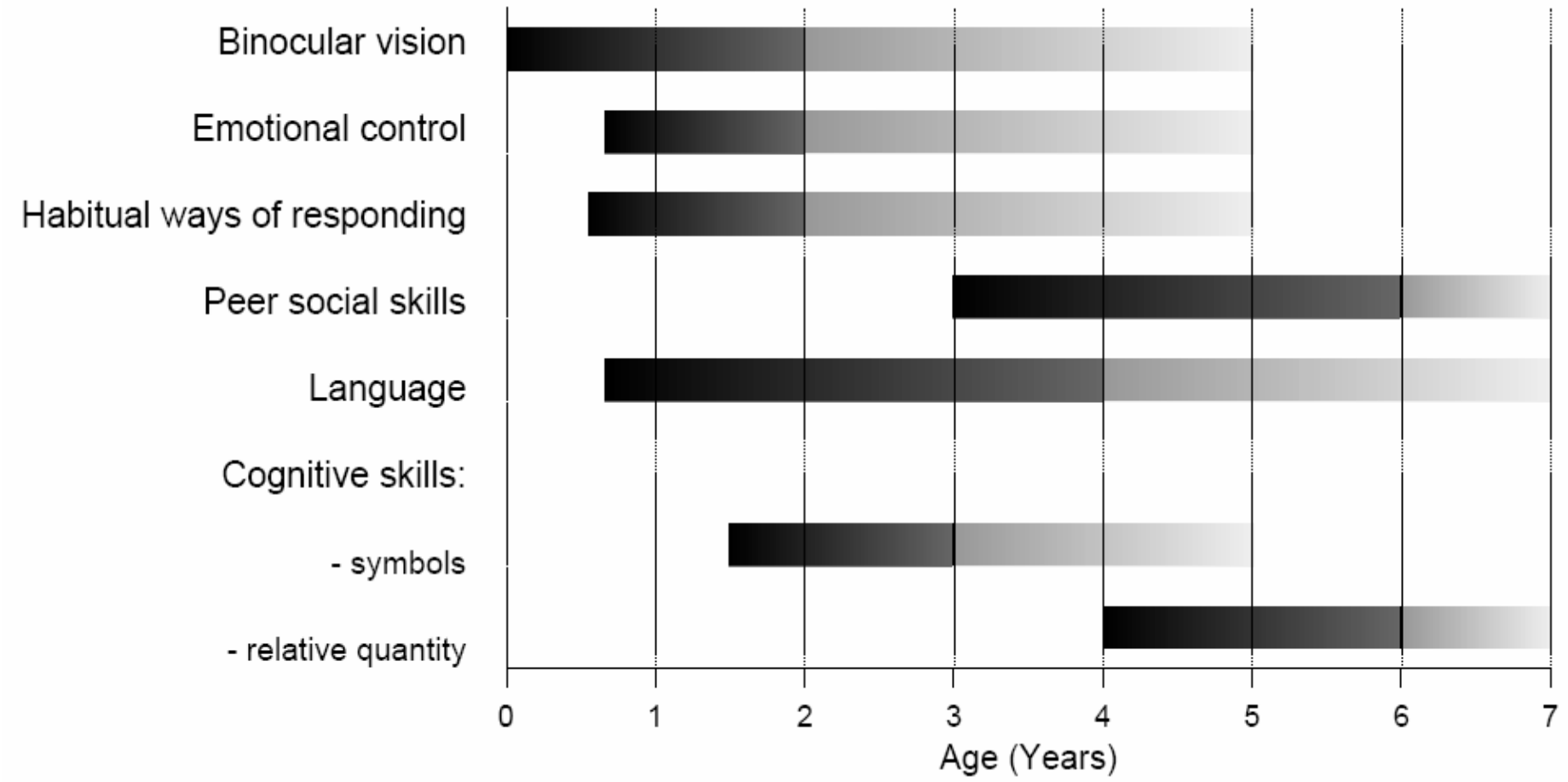
Neural pruning and synaptogenesis occur throughout the course of life in response to environmental stimuli. The two processes are particularly active before the age of six, however. It turns out that the critical periods of plasticity for many brain functions occur before the age of six. These include emotional control, habitual ways of responding (such as optimism versus pessimism), peer social skills (aggressive behaviour, for example), language, and certain cognitive skills. See Figure Six.

Several caveats are in order. First, the existing research is not yet at the point where we can think of designing specific educational curricula timed precisely to the rhythms of the

[9] Steven Hyman, "Susceptibility and 'Second Hits'," in *States of Mind: New Discoveries about How Our Brains Make Us Who We Are*, edited by Roberta Conlan, John Wiley & Sons: New York, 1999. By the way, cataract day surgery was made possible by laser surgery, a technique developed and patented by an African-Canadian woman name Patricia Bath.

[10] Patrick O. Kanold, Prakash Kara, R. Clay Reid and Carla J. Shatz, "Role of Subplate Neurons in Functional Maturation of Visual Cortical Columns," *Science*, July 25 2003, 301(5623):521-525.

Figure 6. Brain Plasticity: Critical Periods for Brain Development



Source: Gillian Doherty, *Zero to Six: The Basis for School Readiness*, Applied Research Branch, Strategic Policy, Human Resources Development Canada, R-97-8E, May 1997

developing brain.[11] Second, the critical periods for many higher order functions come during the teen years. Third, many of the brain functions relevant to workplace productivity are partially plastic throughout life, so (expensive) adult remediation is always possible.

On should not make too much of these oft-heard caveats about the benefits of early childhood interventions. They largely miss the point. Brain development is subject to negative and positive feedbacks that *amplify* the developmental deficits and strengths of early life into the pronounced deficits and strengths of adulthood. For example, success in Grade One builds the confidence needed to succeed in Grade Two, which in turn has an effect on Grade Three, and so on throughout the schooling years. An extraordinary discovery of the last decade or so is that these feedbacks and the behaviours they produce in adulthood operate at the neural and synaptic levels.

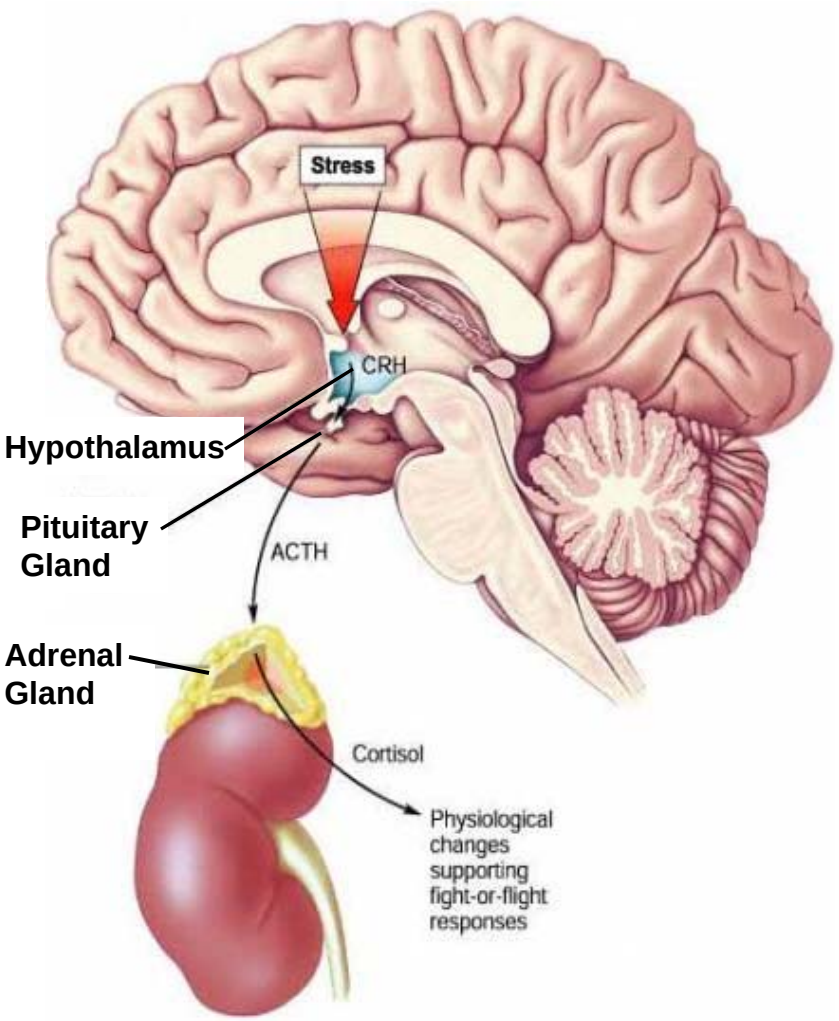
2. Taming the stress system

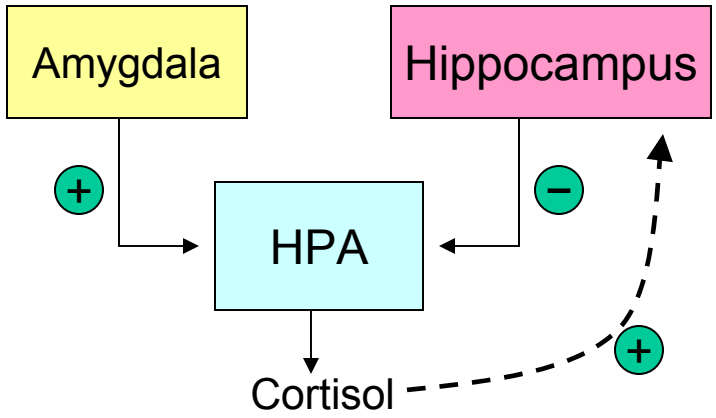
A tiger has just stepped out of the jungle and decided that you will be its next meal. The hair on your neck rises and you stand stock still, wholly focused on the tiger. Within about 15 seconds your fight-or-flight reaction kicks into full gear. In response to this extreme stress your hypothalamus-pituitary-adrenal (HPA) axis initiates the release of cortisol into the bloodstream. (Figure Seven)

Among other things, the cortisol regulates a number of immune responses, such as swelling at the site of any tiger-inflicted injuries. But your body wants to return cortisol levels to normal quickly because sustained high levels cause all sorts of serious stress-related diseases, so

[11] John Bruer, *The Myth of the First Three Years*, Free Press, 2002.

Figure 7. The Stress System: Coping With Challenges





Source: Left panel adapted from http://www.neurophys.wisc.edu/index.asp

cortisol is reduced by a negative feedback system: High cortisol levels are detected by sensors called cortisol receptors that are located in the neurons of the hippocampus (the part of the brain responsible for contextual memory and learning). When the hippocampus detects elevated cortisol levels, it signals the HPA axis to stop releasing cortisol.

Scientists believed until recently that the operation of the HPA axis was not sensitive to such external influences as early childhood nurturing. But now we know that, just as Pavlov trained his dogs, early childhood experiences ”train” the hippocampal response to elevated cortisol levels, thereby affecting a person’s lifelong ability to effectively handle stress. This astounding discovery came as quite a surprise.

In the 1980s, the Stanford neuroscientist Robert Sapolsky was interested in the mechanism through which prolonged stress affects memory and learning in the aging brain. In his most famous experiment, he divided a large number of baby rats into two groups. The treatment group was handled for 15 minutes a day for three weeks. Such handling induces the mother rat to lick the rat pups more frequently and to feed them more actively. The remaining newborn rats were left unhandled. At the end of six months the rats were exposed to an extremely stressful situation. Each was left to swim in a maze filled with opaque water. To escape, each rat had to locate a submerged platform. The experiment was repeated many times in order to assess how quickly each rat learned to find the submerged platform. At the age of six months, both the handled and non-handled rats averaged about four to five metres of swimming before locating the platform. By the end of their natural lifespan of 24 months, however, the handled rats still swam an average of five metres while the non-handled rats swam three times

further. That is, early experiences fundamentally affected memory and learning in adulthood.[12] (Figure Eight)

Sapolsky conjectured that the rat performance was the result of a lifelong snowball effect, whereby frequent stressful events in early life led to repeated periods of elevated cortisol. He knew from previous work that excessive cortisol exposure affects hippocampal neurons, reducing the number of neurons and the number of cortisol receptors per neuron, thus lessening their sensitivity to cortisol. This allows the HPA axis to raise cortisol to very high levels before being told by the hippocampus to stop. The end result is a vicious positive-feedback loop: high cortisol levels, a weakened hippocampus, hippocampal insensitivity to cortisol, and even higher levels of cortisol.

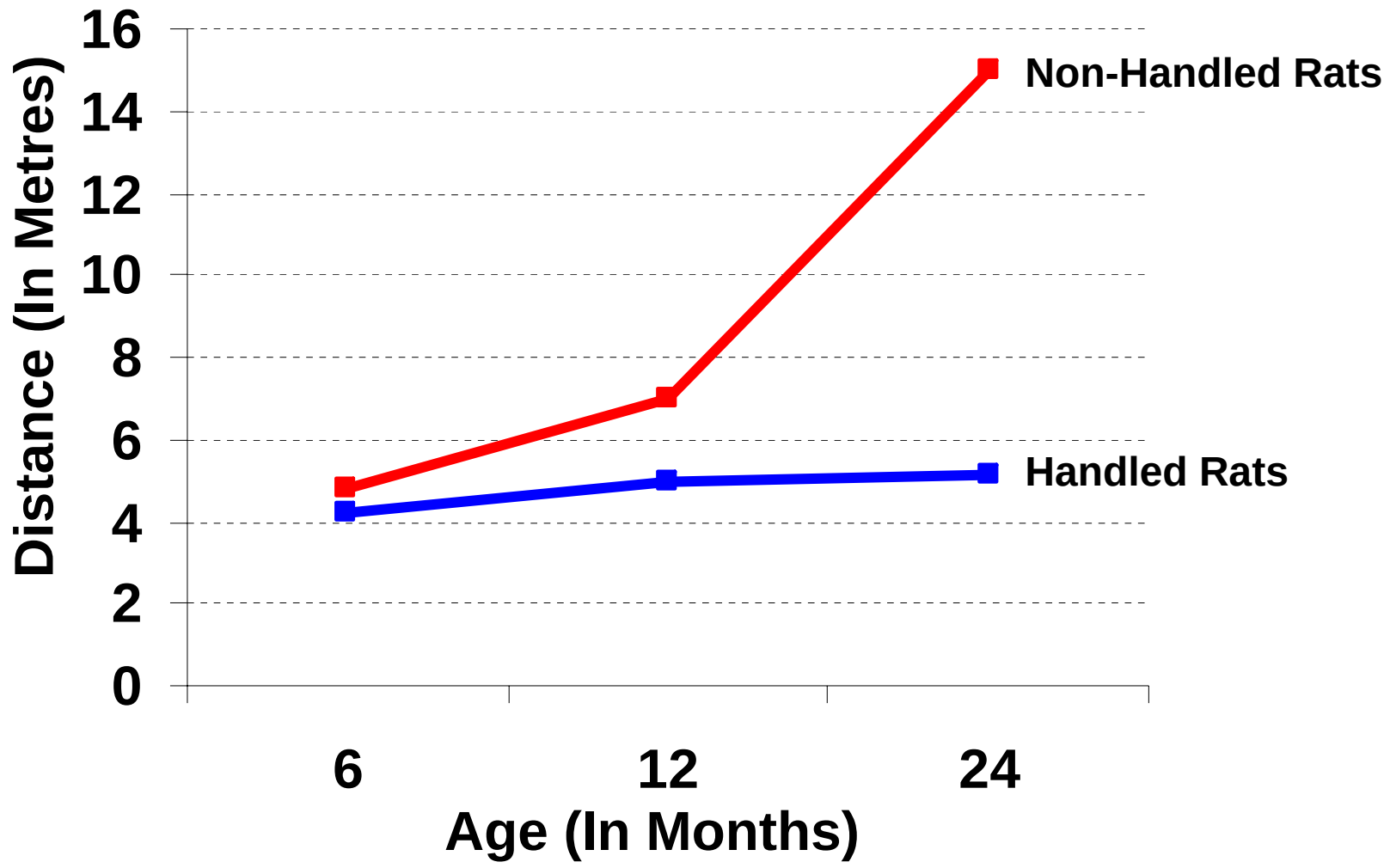
When Sapolsky examined cortisol levels in his rats he did indeed find excessive cortisol levels in the non-handled rats. More importantly, when he dissected the hippocampus of the adult rats he found that the handled rats had denser neural development (more neurons) and more cortisol receptors per neuron. Sapolsky's lifetime snowball hypothesis was borne out: a causal link between early nurturing experiences and adult memory and learning had been discovered.[13]

What are the implications of this process in human beings? The adult's ability to cope with stress depends critically on how good the hippocampus is at regulating the HPA axis. Because early childhood experiences "train" the regulatory response, frequent stress in early life

[12] See Robert M. Sapolsky, *Stress, The Aging Brain, and the Mechanisms of Neuron Death*, MIT Press: Cambridge, 1992. The exact experiment described here appears in Michael J. Meaney, David H. Aitken, Chayann Van Berkel, Seema Bhatnagar, and Robert M. Sapolsky, "Effect of Neonatal Handling on Age-Related Impairments associated with the Hippocampus," *Science*, February 12, 1988, 239(4841):766-768 and Dong Liu, Josie Diorio, Beth Tannenbaum, Christian Caldji, Darlene Francis, Alison Freedman, Shakti Sharma, Deborah Pearson, Paul M. Plotsky, and Michael J. Meaney, "Maternal Care, Hippocampal Glucocorticoid Receptors, and Hypothalamic-Pituitary-Adrenal Responses to Stress," *Science*, September 12, 1997, 277, 1659-1662. These papers were funded by the Medical Research Council of Canada and Meaney, a neuroscientist at McGill University, continues to work in this area.

[13] Robert M. Sapolsky, *Stress, The Aging Brain, and the Mechanisms of Neuron Death*, MIT Press: Cambridge, 1992.

Figure 8. Mean Swimming Distance to the Platform



Source: Robert M. Sapolsky, *Stress, The Aging Brain, and the Mechanisms of Neuron Death*, 1992, figure 12.8

leads in adulthood to an unhealthy regulatory response, the exact physiological counterpart to what is meant by poor coping skills. In contrast, early nurturing experiences keep cortisol at healthy levels, thereby short-circuiting the negative snowball effect and improving the opportunities for acquiring strong coping skills.

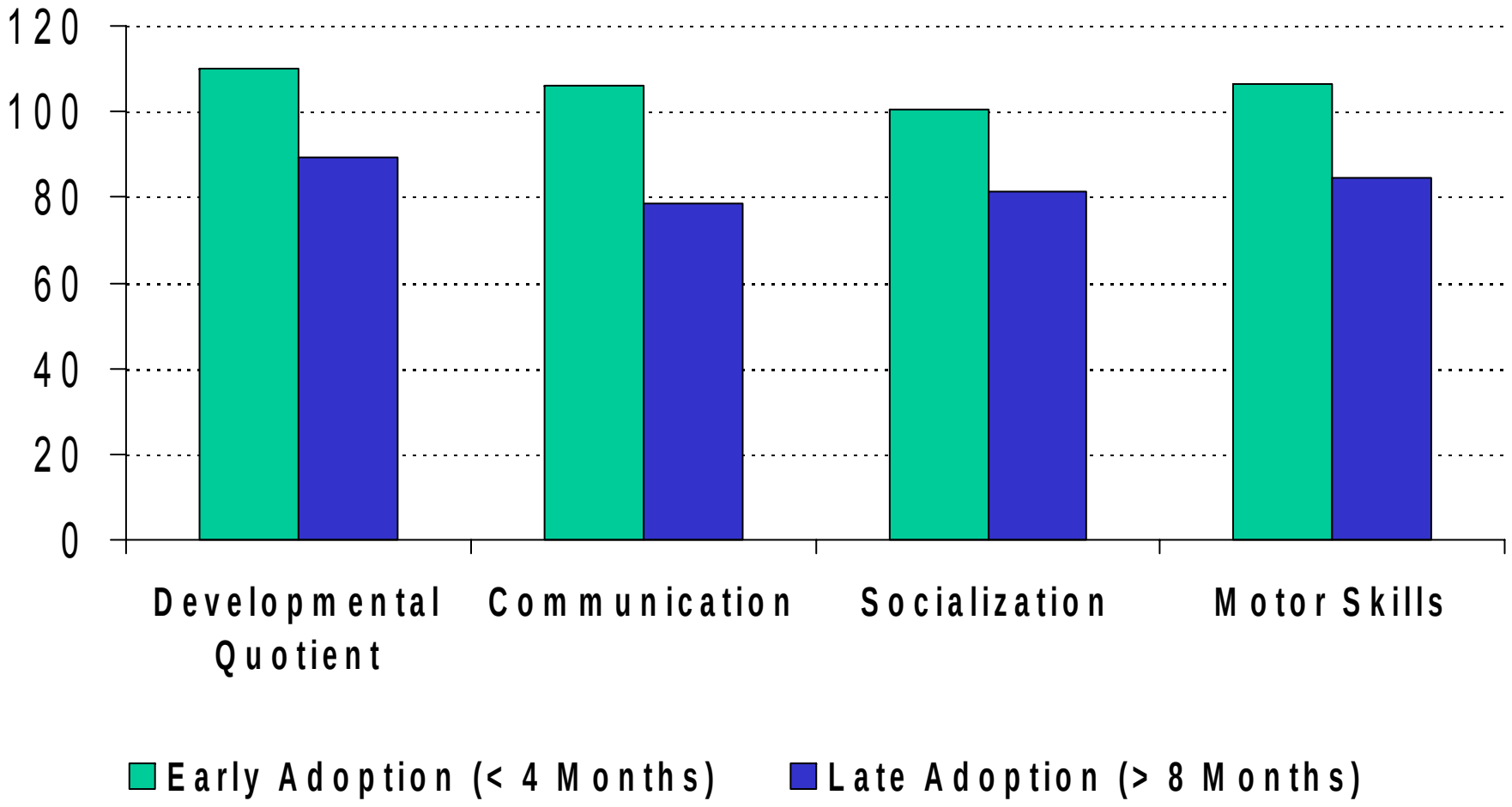
Experimenting on children using water mazes and other artificially stressful situations is thankfully deemed unethical by health researchers. Unfortunately, human barbarism offers scientists numerous natural experiments. One of these occurred in 1990 when Romania was in the midst of an economic and social meltdown. One result was a horrible deterioration of care in orphanages: Infants were deprived of nurturing and stimulation. Babies spent 20 hours a day in their cribs with nothing to look at and little to hear.[14] Many of those orphans were eventually adopted into Canadian homes, some at a younger age than others. Those who arrived before the age of six months – that is, those who had much richer and more nurturing early childhood experiences – did remarkably better later on in standardized tests than those adopted after the age of six months. Poor early experiences resulted in an extremely low developmental quotient. These late adoptees also had reduced communication and socialization skills. Sapolsky's snowball mechanism is very much in evidence. This is summarized in Figure Nine.[15]

Similar problems with HPA regulation and coping skills appear in adults who have experienced sexual and physical abuse as children. These adults have not only abnormal cortisol profiles but also an increased risk of mental health problems, including depression, antisocial behaviour, drug abuse, and learning difficulties. Recent research extends Sapolsky's snowball

[14] Elinor W. Ames, Kim Chisholm, Lianne Fisher, Sara J. Morison, Susan Thompson, Henry Mainemer, Margaret Carter, Hayden Ebbern, Ann-Louise Ellwood, Mark Ferrari, Lorraine Gilman, Sarah Lukie, and Lynn A. Savoie, *The Development of Romanian Orphanage Children Adopted to Canada*, Human Resources Development Canada, January 1997.

[15] I am indebted to Clyde Hertzman for this slide, which summarizes the huge literature on the topic.

Figure 9. The Impact of Early Nurture on Developmental Outcomes – Romanian Orphans



Source: Clyde Hertzman. Children who were adopted early (< 4 months) did much better than children who were adopted late (> 8 months).

mechanism by demonstrating that abused children experience changes in the hippocampus that likely account for these mental health problems.[16] Elevated cortisol levels have also been implicated in inappropriate behaviour of children in poor-quality daycares.[17]

3. Serotonin metabolism and aggressive behaviour

There is no better predictor of school performance than aggressive behaviour. Physical aggression peaks during the "terrible twos", when children's bodies develop faster than their abilities to verbalize wants. Rather than ask a fellow toddler for his toy, why not just push him away? After age two most children steadily learn to replace aggressive behaviour with conflict resolution through communication.[18]

Yet not all children are successfully socialized, and the consequences are dire both for themselves and for society. Richard Tremblay, a pediatrician at the University of Montreal and the CIAR, has been tracking a large group of boys from poor areas of Montreal since they entered kindergarten. Boys who failed to curb aggressive behaviour by the age of 10 are three times more likely to find themselves in remedial or special education classes.

Although expensive, the cost of these classes is just a small part of the billions of tax dollars that will be spent on aggressive children. Statistics show that the aggressive child

[16] Martin H. Teicher, "Scars That Won't Heal: The Neurobiology of Child Abuse," *Scientific American*, March 2002, 286(3):68-75.

[17] Andrea C. Dettling, Megan R. Gunnar, and Bonny Donzella, "Cortisol levels of young children in full-day childcare centers: relations with age and temperament," *Psychoneuroendocrinology* 24 (1999) 519–536 and S.E. Watamura, B. Donzella, J. Alwin, and M.R. Gunnar M.R., "Morning-to-Afternoon Increases in Cortisol Concentrations for Infants and Toddlers at Child Care: Age Differences and Behavioral Correlates," Child Development, July 2003, 74(4), 1006-1020.

[18] See Richard E Tremblay, "When Children's Social Development Fails," in *Developmental Health and the Wealth of Nations: Social, Biological, and Educational Dynamics* edited by Daniel P. Keating and Clyde Hertzman, 1999 and Minne Fekkes, Frans I.M. Pijpers, and S. Pauline Verloove-Vanhorick, "Bullying Behavior and Associations with Psychosomatic Complaints and Depression in Victims," *Journal of Pediatrics*, January, 2004, 144(1):17-22.

reduces the quality of our schools by disrupting classroom activities, creates an epidemic of psychiatric disorders by bullying his classmates, gets an early start with drugs, has early and frequent run-ins with the law, and ends up as a high-school drop-out with poor labour market prospects. Each of these events is a drain on the scarce tax dollars available for education, health, policing and social assistance.

The problem is so severe that it has recently evoked a call for action by Richard Goldbloom, a pediatrician and Chancellor of Dalhousie University.[19] Easier said than done, since aggression in children has a strong genetic basis. So the question is: Can early childhood interventions really put the brakes on genetics? An outpouring of scientific research since 1996 has established a resounding affirmative answer.

At the heart of discussions about genetics and aggression lies serotonin, a neural transmitter (a chemical that makes synapses work). A genetic abnormality that inhibits serotonin metabolism was identified in 1996 and came to be called the "mean gene" because poor serotonin metabolism is associated with aggression in children and violence in adults.[20]

Steve Suomi of the CIAR is a leading expert on the socialization of aggression. Based on his work with Rhesus monkeys he conjectured that a nurturing early childhood environment could actually improve serotonin metabolism in those with the genetic abnormality. That is, nurture can moderate nature. To investigate, Suomi devised a remarkable experiment.

In the wild, monkeys with this genetic abnormality are very aggressive and perform poorly in social settings, so much so that males with the abnormality are typically kicked out of

[19] See Richard Goldbloom, "Children's Inhumanity to Children," *Journal of Pediatrics*, 144(1), January, 2004, pp. 3-4.

[20] A. Heils, A. Teufel, S. Petri, G. Stober, P. Riederer, D. Bengel and K.P. Lesch, "Neurochemistry Allelic Variation of Human Serotonin Transporter Gene Expression," *Journal of Neurochemistry*, June 1996, 66, 2621-2624.

the troop before the age of puberty, perishing soon afterward. Suomi turned his attention to a group of monkeys in his lab, identifying the ones with the genetic abnormality. Half of the group were raised by their biological mothers while the other half were peer-reared, which means that they received far less nurturing. For those monkeys with normal genetics, mother-reared and peer-reared monkeys both displayed low levels of aggression. However, for those monkeys with the genetic abnormality, maternal nurturing entirely eliminated the aggressive behaviour observed in the peer-reared. More remarkable was the physiological response. *The mother-reared monkeys experienced a pronounced life-long improvement in their serotonin metabolism. For monkeys with the 'mean' gene, nurturing at a young age had resolved later aggressive behaviour, in part by "fixing" the abnormal serotonin metabolism.* [21]

What does Suomi's research mean for childhood interventions aimed at reducing aggression? Aggressive children typically suffer from language delays that incline them to get what they want using physical aggression rather than verbal communication. In later life this lack of socialization causes problems. Studies of adult criminals confirm this: criminals have below-average language skills that can be traced back to early childhood language deficits.[22]

The question is whether early nurturing can moderate aggressive behaviour. One possibility is that aggression and verbal communication are both caused by the same underlying genetic factors, in which case there may be little to be done. This turns out not to be the case. First, such a view is inconsistent with Suomi's work on monkeys. Second, a recent twins study by Richard Tremblay and his colleagues establishes causality running from language

[21] See Stephen J. Suomi, "A Biobehavioral Perspective on Developmental Psychopathology: Excessive Aggression and Serotonergic Dysfunction in Monkeys," in *Handbook of Developmental Psychopathology, 2nd Edition*, edited by A.J. Sameroff, M. Lewis, and S. Miller, 2000.

[22] Hakan Stattin and Ingrid Klackenberg-Larsson, "Early Language and Intelligence Development and Their Relationship to Future Criminal Behavior," *Journal of Abnormal Psychology*, August 1993, 102(3):369-378.

development to aggression.[23] Third, language development is highly influenced by early environmental factors. Talking to infants improves their verbal communication.[24] See Figure Ten. In short, an early nurturing environment improves verbal communication skills, thereby leading to lower levels of aggression and improved socialization skills throughout the life course.

Now do the Parry Preschool crime results of Figure Four start to make sense? If you need more evidence, take a look at what Tremblay is doing with his Montreal kids. Using a randomized trial, he has shown that early interventions have long-lasting effects on delinquent behaviour, gang involvement, police arrests, and alcohol and drug use.[25] [26]

A Children's Agenda for Canada's competitiveness

We have looked at just three smoking guns in a large arsenal of neuro-scientific discoveries that confirm the connection between childhood experiences, permanent changes in molecules with long names, and economic and health outcomes in adulthood. It is an arsenal that grows with scientific findings that appear monthly. What this means is that the most cost-effective way of

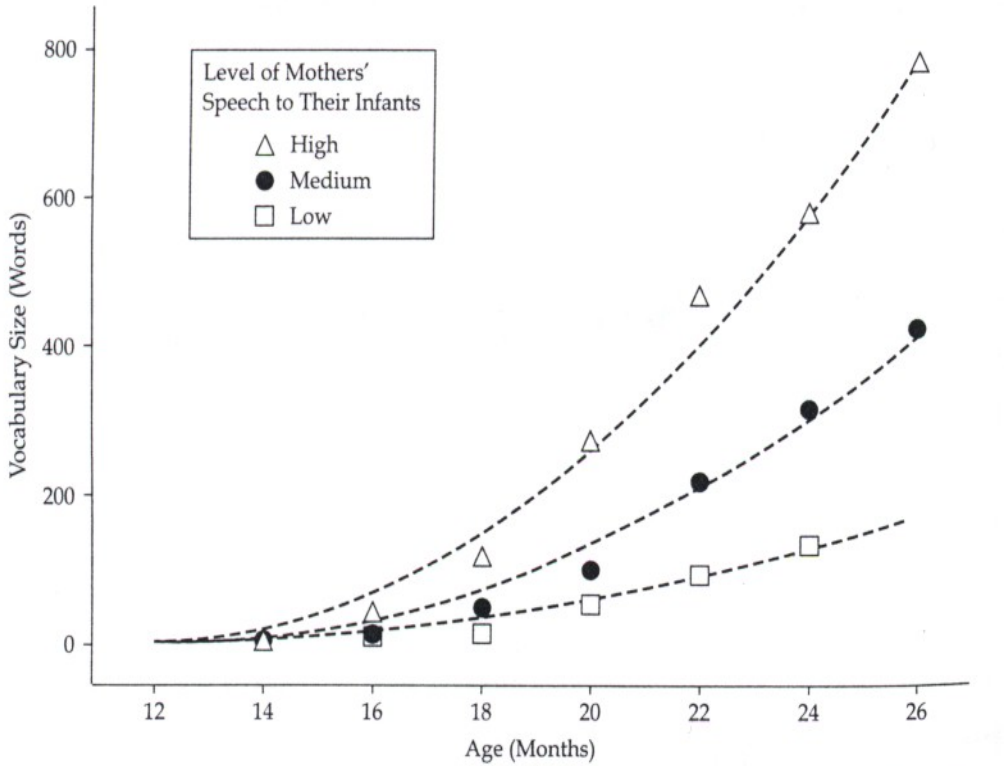
[23] Ginette Dionne, Richard Tremblay, Michel Boivin, David Laplante and Daniel Pérusse, "Physical Aggression and Expressive Vocabulary in 19-Month-Old Twins," *Developmental Psychology*, 2003, 39(2): 261–273.

[24] See Janellen Huttenlocher, Wendy Haight, Anthony Bryk, Michael Seltzer, and Thomas Lyons, "Early Vocabulary Growth: Relation to Language Input and Gender," *Developmental Psychology*, 27, March 1991, 236-248 and also Betty Hart and Todd R. Risley, *Meaningful Differences in the Everyday Experience of Young American Children*, Baltimore: Paul H. Brooks, 1995.

[25] For a review of Tremblay's Montreal Longitudinal-Experiment Study see Richard E Tremblay, "When Children's Social Development Fails," in *Developmental Health and the Wealth of Nations: Social, Biological, and Educational Dynamics* edited by Daniel P. Keating and Clyde Hertzman, 1999.

[26] As an aside, there has been remarkable work on humans relating the mean gene to depression. In what *Science* describes as "the biggest fish yet netted for psychiatry" researchers have replicated a form of Suomi's experiment in humans. Child abuse is a well-known risk factor for later depression, but of course not all abused children suffer depression later in life. What explains the variation? The answer is the 'mean' gene. For those individuals without the genetic abnormality, child abuse has no effect on later depression. For those with the abnormality, child abuse (an extreme form of poor nurturing) has a major impact on the incidence of later depression. Avshalom Caspi, Karen Sugden, Terrie E. Moffitt, Alan Taylor, Ian W. Craig, HonaLee Harrington, Joseph McClay, Jonathan Mill, Judy Martin, Antony Braithwaite and Richie Poulton, "Influence of life stress on depression: moderation by a polymorphism in the 5-HTT gene," *Science*, July 18, 2003, 301(5631): 386-89 and Constance Holden, "Getting the short end of the allele," *Science*, July 18, 2003, 301(5631): 291-292.

Figure 10. Talking to Infants Improves Their Verbal Communication Skills



Source: See Janellen Huttenlocher, Wendy Haight, Anthony Bryk, Michael Seltzer, and Thomas Lyons, "Early Vocabulary Growth: Relation to Language Input and Gender," *Developmental Psychology*, 27, March 1991, 236-248.

increasing Canada's competitiveness and prosperity while maintaining our core values of community and caring is to invest in people when they are young. It turns out that investing in people, especially when they are young, is a policy that feeds directly into many of the sources of competitiveness that Canada must promote. As shown in Figure Eleven, these include:

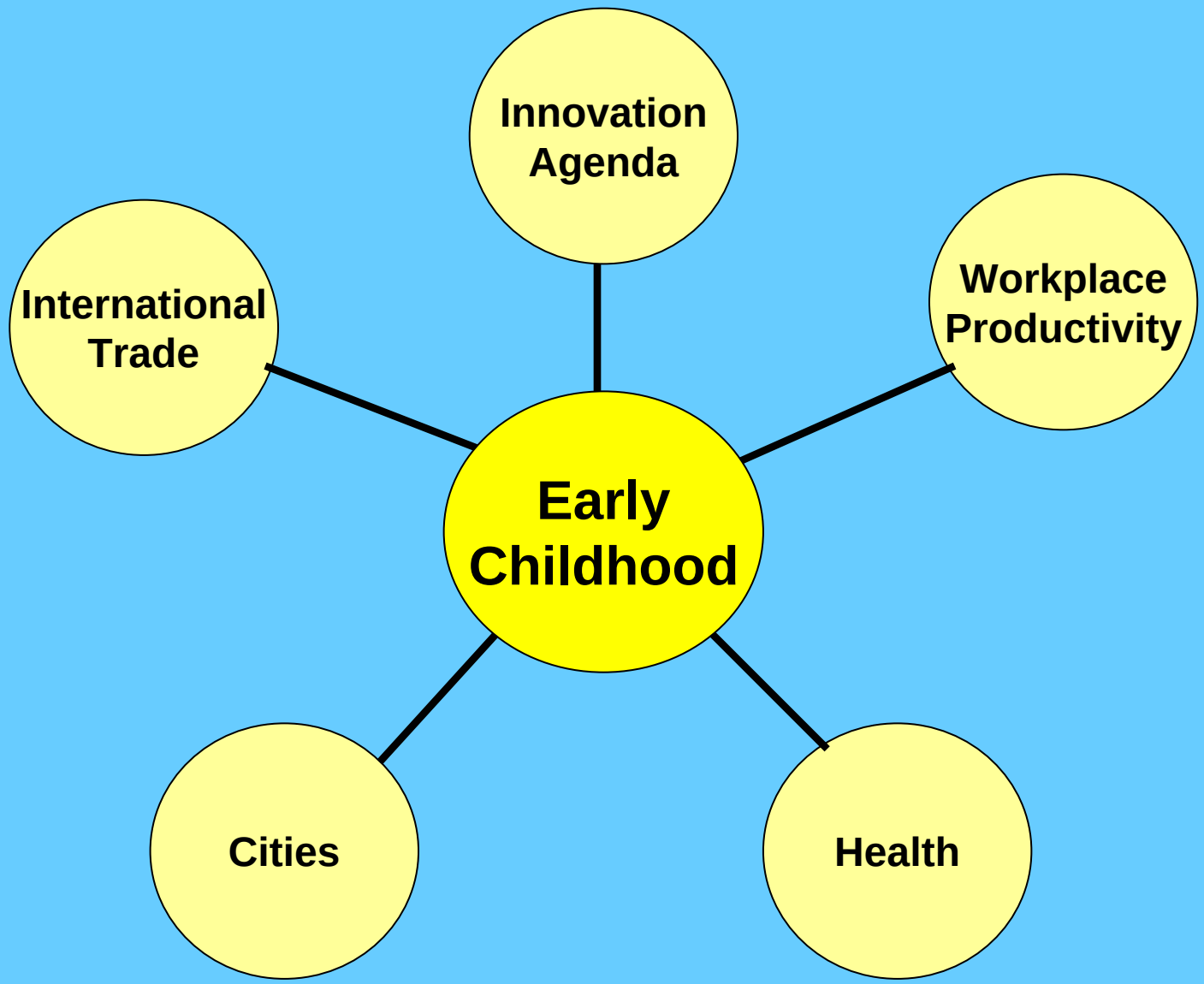
- The Innovation Agenda
- Workplace Productivity
- International Trade
- Cities
- Health

1. The Innovation Agenda

If there is a single unequivocal law in economics it is that continued prosperity depends on productivity growth. Canada's much-touted 'Innovation Agenda' paves the way to continued prosperity precisely because innovation is a source of productivity growth. The Innovation Agenda is carried out by lab-coated scientists and engineers who create innovative breakthroughs in biotechnology, nanotechnology, superconductivity, quantum information processing, and a host of other high-tech fields in which Canada excels. If we want our cities to compete with Boston or San Francisco for high-technology innovation clusters, we will need a long-term strategy for increasing the quantity *and quality* of our lab-coated university graduates.

Unfortunately, the existing long-term government strategy is far too narrow. It relies exclusively on tuition subsidies, assuming that they will provide us with all the high-quality university graduates we could possibly want. It presumes that there is a huge line-up of poor

Figure 11. Overview of How Investments in Children Impact the Economy



superstar teens that are chomping at the bit for a chance to enroll in Canada's most prestigious universities. I wish there were such a line-up, but there isn't. As discussed earlier, the gap in university enrolments is due largely to early childhood experiences and only partly to lack of money. To solve the problem we need to get our children on track for success at every level of education, starting with the ability to cope with new environments at infancy, moving through readiness to learn at the age of four, with a cascade of educational successes culminating in a solid high school diploma and a teen who is confidently ready for higher learning. And this is just one of many ways in which investing in our children would benefit the economy.

2. Incremental innovation in the workplace

Productivity growth may be *the* driver of continued prosperity but high-tech innovations by lab-coated scientists are not the only source of productivity growth. Indeed, *most* productivity growth is the result of incremental workplace improvements to product designs and manufacturing processes.[27] It is hard to think of a successful product or process that was brought fully-formed into the world without the need for significant adjustments to meet the realities of the marketplace. Because of this, leading business strategists such as Harvard Business School guru Michael Porter and Toronto Business School Dean Roger Martin emphasize that every business – high-tech or low-tech – must continually upgrade and innovate if it is to be a world leader.

Incremental productivity improvements can only occur in an environment in which employees are encouraged not only to report problems as they arise, but to find innovative

[27] This view has been forcefully laid out by Nathan Rosenberg, the renowned Stanford professor of economic history and technology. See, for example, *Inside the Black Box: Technology and Economics*, MIT Press: Cambridge, 1982.

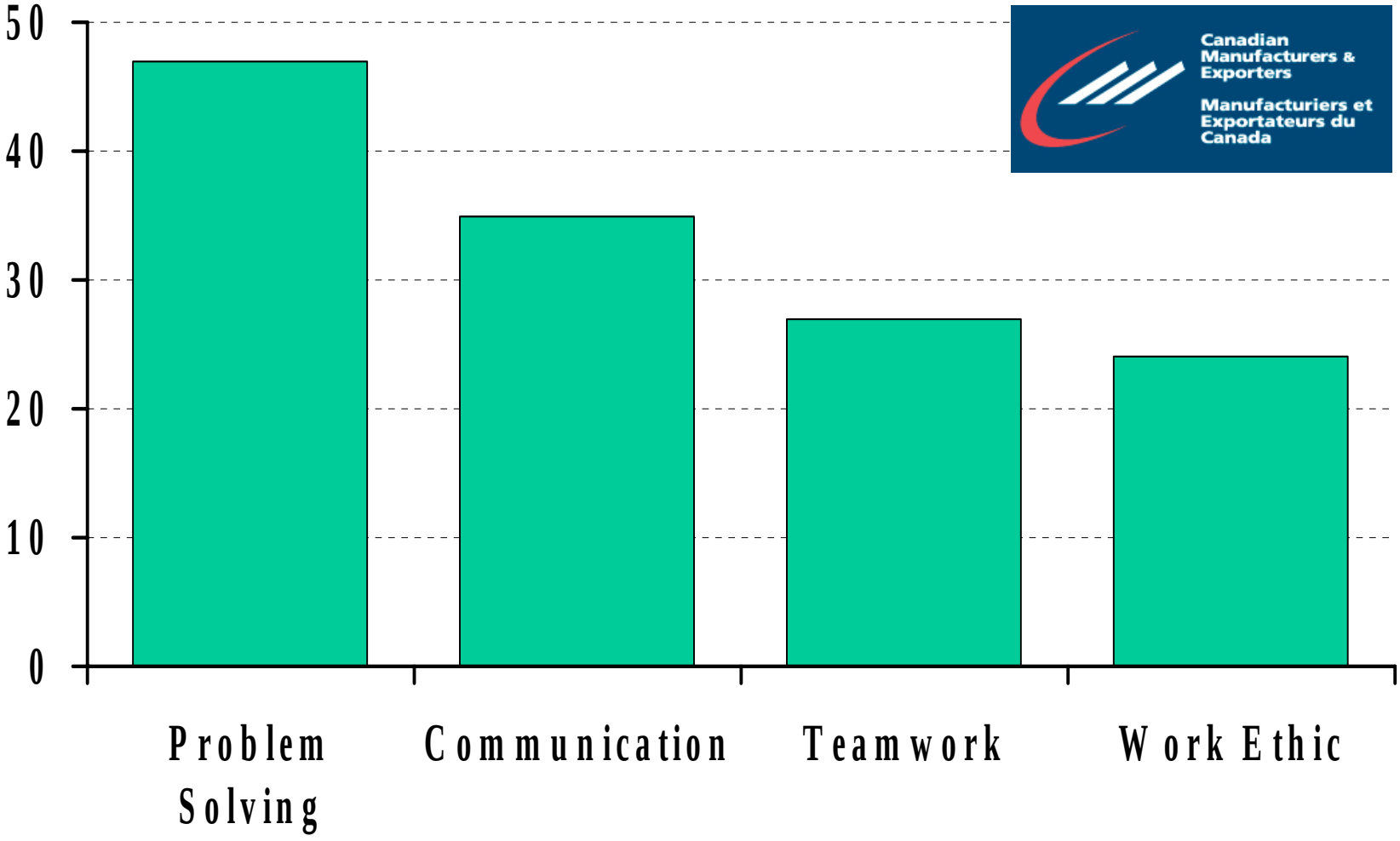
solutions to them. Most of Canada's leading corporations understand this. In describing how it creates low airline operating costs, WestJet Airlines of Calgary emphasizes that it "encourages and empowers people at all levels to find solutions to issues as they arise" and that "communication is highly valued and encouraged between all levels of the organization."[28] Honda's Alliston plant is among the most productive in North America, because of a Total Quality Management program that not only rewards workers who communicate assembly line problems to management, but also provides the workers with the resources needed to solve the problems themselves. Successful companies recognize that the day-to-day communication and problem-solving skills of their employees are a big part of what it means to continually upgrade and innovate.

Is it far-fetched to link all this with children? The Canadian Manufacturers and Exporters Association (CMEA) does not think so. The CMEA has surveyed its membership – which consists of Canada's most successful companies – on what they view as their biggest skill shortages. The result is not a laundry list of traditional occupations from plumbers to programmers, bricklayers to machinists. No, for CMEA's member companies the three biggest skill shortages are the ability to problem-solve, to communicate, and to work in teams! See Figure Twelve. These are the skills that are prerequisites for workplace innovation. They are also the skills that neuroscience tells us are most cost-effectively acquired at a very young age.

When I first saw Figure Twelve I was astonished by its similarity to the Figure Nine description of Romanian orphans. Figure Nine focuses on the development quotient – a test of problems-solving skills. It also focuses on communication and socialization skills – which

[28] WestJet Airlines, *Renewal Annual Information Form, 2002*, May 20, 2003.

Figure 12. Human Resources: Canada's Skill Shortage



Source: *Education and Knowledge: Some Perspectives from 21st Century Manufacturing*, Canadian Manufacturers and Exporters

sounds a lot like the CMEA's communication and teamwork skills. The CMEA wants what late-adopted Romanian orphans do not have.

It shouldn't surprise us. Would you like to work with someone who -- like Sapolsky's rats and Suomi's monkeys -- performs poorly under stress, shows little curiosity, reacts aggressively, communicates poorly, cannot function in teams, and is not particularly bright? If your answer is no, then you are in synch with the human resources departments of our leading companies.

3. International trade

Free trade is crucial for promoting competitiveness. By allowing Canadian companies to penetrate foreign markets, free trade liberates our most competitive companies from the straightjacket of a small domestic market. These competitive companies are exactly the ones we want to promote: they are productive, innovative, and pay great wages.[29] NAFTA has been particularly good at promoting these companies, raising their productivity by an extraordinary 1.9% annually.[30] To see how big this number really is, consider that if all Canadian companies increased their productivity by 1.9 percent annually, we would be the richest country in the world within a decade. You can see why I am such a committed free trader.

Unfortunately, free trade also allows competition from imports that can push domestic companies to the brink. Some companies respond by implementing a new strategy of upgrading and innovation that shelters them from foreign competition. For such companies NAFTA was a

[29] John R. Baldwin and Wulong Gu, "The Effect of Exporting on Productivity Growth in Canadian Manufacturing," Micro Economic Analysis Division, Statistics Canada, October, 2001 and Andrew B. Bernard and J. Bradford Jensen, "Exporters, Skill Upgrading, and the Wage Gap," *Journal of International Economics*, February 1997.
[30] Daniel Trefler, "The Long and Short of the Canada-U.S. Free Trade Agreement," NBER Working Paper No. w8293, May 2001. All subsequent statistics about NAFTA are from this source.

boon to productivity. Other companies were less fortunate, going bankrupt and throwing thousands of people out of work. Under NAFTA, a whopping 12 percent of all workers in import-competing industries had to find work elsewhere.

Who are these workers? Almost half of them are high school drop-outs, while a quarter of them did not even make it to high school. These workers are among the most disadvantaged adults in our society. Nor does the story end with NAFTA. Competition from low-wage countries such as China has eliminated half of all jobs available to high school drop-outs and has depressed wages in the remaining jobs by 30 percent.[31]

The new realities of international trade have created a small but tremendously poor and disadvantaged sub-class. I used to think that there was a simple solution to this problem: We could re-train these people and get them back into the workforce. Unfortunately, trade-adjustment assistance programs, which have been in place since the mid-1960s, are an unmitigated disaster. Job-training programs simply do not work for the typical, less-educated worker. This is the unequivocal conclusion of 20 years of thoughtful evaluations of job-training programs.[32]

This will surprise most non-economists. True, it is possible to educate and re-train less-fortunate workers, but it is very expensive. Most trade-displaced, high school drop-outs are even less ready for adult education than they were as teenagers for high school, despite being older

[31] Statistics on educational attainment are from the author's own calculations using Statistics Canada's *Labour Force Survey*. For the statistic on the elimination of half of all jobs see table 2 in Walid Hejazi and Daniel Trefler, "Canada and the Asia Pacific: Views from the Gravity, Monopolistic Competition, and Heckscher-Ohlin Models," in *The Asia-Pacific Region in the Global Economic: A Canadian Perspective,* edited by Richard G. Harris, 1996. For the 30% statistic see table 6-3 in Daniel Trefler, "Immigrants and Natives in General Equilibrium Trade Models," in *The Immigration Debate: Studies on the Economic, Demographic, and Fiscal Effects of Immigration* edited by J.P. Smith and B. Edmonston, National Academy Press, 1998.

[32] For one of many reviews of the literature, see Pedro Carneiro and James Heckman, "Human Capital Policy," NBER working paper #9495, February 2003. There are of course some exceptions as, for example, C.V. writing workshops and childcare programs for single moms. However, these are programs focused not on re-training, but on job search.

and more responsible. For many of them, poor early-childhood experiences left them unprepared for pre-school and/or elementary school. The result was a cascade of bad schooling outcomes that left them unprepared for high school and all subsequent attempts at skills acquisition. Age does not reverse this process; it entrenches it. It's not the result of bad intentions but rather of the snowball deterioration of hippocampal neurons and cortisol receptors.

If re-training programs are a failure, we might be better off just giving these workers cash. In fact, that is exactly Canada's current approach: an income-based safety net for all disadvantaged workers who lose their jobs. While this approach is a compassionate one, it does not put people back to work and so is not a productivity-enhancing one. *Fortunately, the long-term solution is crystal clear: We must reduce the number of Canadian adults whose skills deficits place them at risk from import competition.*

The cost-effective way to do this, if you have not already guessed, is to invest in these people when they are young. Canada needs the rigours of free trade to promote competitiveness and prosperity. However, free trade is only palatable if, by investing in our children, we can mitigate the costs that it imposes on those who are already among our most disadvantaged.

4. Cities

Discussions about improving conditions in our cities tend to focus on two elements, fiscal reform and infrastructure. What is ignored is cities' greatest asset: people. The primary urban infrastructure investments should be human capital investments, and we know that these are most cost-effective when directed at young people. The discussion takes on an added dimension in

light of the fact that, in Canada's increasingly poor urban environments, one child in seven lives in poverty.[33]

As McCain and Mustard emphasize in their *Early Years Report*, early childhood development programs are all about enabling communities. That is, they involve interventions that are targeted at the community level in pre-schools, schools, and community centres. For families with young children, these child-centred institutions are the places where most community interactions take place. As a practical matter then, money invested in children is money invested in communities. Four benefits accrue to cities that make community-based investments in children.

1. They make the community a more desirable place to live, thereby avoiding the pitfalls of U.S. urban decay that are beginning to plague our cities.[34]

2. They provide the long-term benefit of equalizing skills in the population, thereby reducing inequality. To my mind, long-term strategies that alleviate poverty and inequality are left, right, and centre in the battle for the core Canadian values of community and caring.

3. They help combat crime, a key factor that leads to the demise of neighbourhoods. As we have seen, crime often starts off as aggression in young children. It is best dealt with in pre-schools and early elementary grades.

4. They benefit immigrants. It is hard to imagine a more stressful situation than being uprooted from one's home. Language barriers, new workplace stresses (including unemployment), and lack of family support create a stressful environment that children are quick to react to.

[33] This figure is for Ontario. See *Income Trends in Canada*, Statistics Canada, cat. no. 13F0022XCB.
[34] Poverty increased rapidly in urban Canada in the early 1990s. Urban poverty rates grew by 33.8% between 1990 and 1995, 5 times faster than urban growth rates and 2 times faster than rural poverty rates. See Kevin K. Lee, *Urban Poverty in Canada: A Statistical Profile*, Canadian Council on Social Development, April 2000.

Providing immigrant families with opportunities to enrich their children's experiences should therefore be high on our policy priority list. What makes 'targeting' immigrant children a particularly interesting policy is that immigration is a federal jurisdiction. It thus provides the federal government with an opportunity for community-based interventions in Canadian cities. That is, *it allows the Feds to get involved in our cities without having to worry about constitutional battles with the provinces.*

All these investments contribute to the quality of life in our cities. But why is this important for productivity growth? Quality of life matters to business location decisions, especially for the advanced, knowledge-based businesses that Canadian cities need to attract. These businesses are based on people, not places, and so are extremely footloose. They migrate to where the people are, but not just to any city. As Richard Florida and the University of Toronto's Meric Gertler have shown, they need the kind of talent that is attracted to vibrant urban centres.[35]

It is thus not surprising the attention given to the Mercer Human Resources Consulting International *Cities Quality of Life Survey*. In 2003, Canada placed four cities in the top 25: Vancouver (in second place), Toronto (12th), Ottawa (20th), and Montreal (23rd). In contrast, the only U.S. cities in the top 25 were San Francisco and Honolulu. Canadian cities are an important attraction for the talent needed in knowledge-based businesses. Community-based investments in children contribute heavily to the quality of life that this mobile talent pool so highly values.

[35] Meric S. Gertler, Richard Florida, Gary Gates, and Tara Vinodrai, *Competing on Creativity: Placing Ontario's Cities in North American Context*, Institute for Competitiveness and Prosperity, November 2002.

5. Health

The relationship between early childhood experiences and adult health is the most solid fact in the entire scientific literature on early child development. Coronary heart disease, diabetes, immune response deficiencies (such as arthritis and lupus), obesity, depression and suicide have all been tightly linked to poor experience-based brain development in early life.[36]

The costs to society of these poor health outcomes are staggering. For example, depression alone costs the Canadian economy a staggering $6 billon annually. Half of this cost is due directly to the lower workplace productivity of depressed workers.[37]

Healthcare costs in Canada are out of control. We now spend ten cents of every dollar earned on healthcare, and this amount is growing fast. The current approach to healthcare is bankrupt both literally and figuratively. Part of the problem is that our healthcare dollars are eaten up by treatments of existing disease. This is an expensive proposition. The cost-effective approach focuses on prevention, a much cheaper alternative. There are a large number of preventative measures that are best taken in early childhood. Jacques van der Gaag of the World Bank estimates that every dollar invested in children returns three dollars in future health savings. Investing in children must be a part of any healthcare reforms aimed at bringing costs under control.

[36] McCain and Mustard, *Early Years* and Bruce McEwen, *The End of Stress*, Joseph Henry Press: Washington D.C., 2002.

[37] See P.E. Greenberg, L.E. Stiglin, S.N. Finkelstein, and E.R. Berndt, "The Economic Burden of Depression in 1990," Journal of Clinical Psychiatry, November 1993. They arrive at a cost of US$43.7 billion or US$173 per capita. Converting this to Canadian dollars at a 0.78 exchange rate and multiplying by the Canadian population yields CAD$6.6 billion.

The real choice for the future

In the hopes of producing a child of exceptional beauty and intelligence, an attractive woman once asked George Bernard Shaw whether he would father her child. Shaw replied: “But madam, what if the child has my looks and your intelligence?”

We can think of brains as the prosperity agenda and beauty as the core values of community and caring. Traditionally, the United States focuses on prosperity, Europe on core values, while Canadian public policy swings wildly between one and the other. Can we have both beauty and brains? If we try, will we end up with the kind of offspring that Shaw cautioned about, a genetic wrong turn with only disadvantages?

Many polemicists have argued that no successful strategy can reconcile the business and social agendas that have polarized Canadians. They are wrong. Canada can have both, but to do so we must clearly articulate this as the goal and we must set about identifying the policies that will take us there. We need a hard-headed business strategy that promotes both beauty and brains, both caring and prosperity.

The question is *not* about sacrificing our social programs on the altar of competitiveness and prosperity. Rather, it is whether a strategic use of our social programs, especially programs that invest in children, is the best, most cost-effective way to promote productivity growth and prosperity. The answer to this question is a clear and unequivocal “Yes”.