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EARLY CHILD DEVELOPMENT

THE BASE FOR A LEARNING SOCIETY

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The emerging understanding of how social and physical environments in the early years of human development influence physical and mental health problems, as well as learning and behaviour in adult life, has led to increased interest that investments in mothers and children will reduce inequalities in development and health in adult life. Much of this evidence comes from work in the natural and social sciences involving historical studies, biological studies, genetics, longitudinal studies of birth cohorts, population epidemiology, cross-sectional studies and randomized trials of the effects of improved support for early child development on the later stages of life. It is the integration of this knowledge that sets the framework of understanding as to why early child development is important for a learning society.

The challenge for societies is to integrate knowledge from the natural sciences and the social sciences. Edward Wilson (1998), in his book *Consilience*, sets out the difficulties of integrating knowledge from the natural and social sciences in respect to humans when this involves the beliefs and values of a society and the different intellectual frameworks, beliefs, and culture of intellectual disciplines. In this paper, I will attempt to look at the subject of early child development as a base for a learning society from the perspectives of a number of disciplines involving the natural and social sciences.

HISTORICAL

One of the striking changes in Western countries has been the effect of the Industrial Revolution on their prosperity and the health of their populations. Robert Fogel (2000), Thomas McKeown (1976) and others (Floud, Wachter and Gregory, 1990) have tried to assess what caused the remarkable decline in mortality following the start of the industrial revolution.

Fogel, in a broad and deep assessment of a number of Western countries, concluded that better nutrition, largely as a consequence of the Industrial Revolution and improved prosperity, was the main factor causing the fall in mortality rates. In his analysis he found that as the mean heights of populations improved so did life expectancy. Since nutrition during early childhood (including in utero) has a major effect on adult height,

he concluded that the increase in life expectancy was related to improved conditions for early childhood. He speculated that conditions during early childhood affected the risks for health problems in adult life.

This historical evidence shows a relationship between economic growth and health that is not due to health care and is only partially explained by conventional public health interventions but is linked to improved outcomes for children associated with more prosperous societies.

He also concluded that a large part of the economic growth in developed countries in association with the Industrial Revolution was a consequence of the better quality of the population. He estimated that the improved quality of the population might account for as much as 50% of the economic growth in the United Kingdom following the start of the Industrial Revolution. This historical evidence shows a relationship between technological innovation, economic prosperity, changes in the social environment and the health and well-being of populations and the effects of improved human development on economic growth. Fogel has set out in his recent book how new knowledge and technological innovation today is producing major economic and social changes in societies and the potential effects of these changes on populations.

An unresolved question from the historical evidence is how early life affects competence and coping skills and the risk for physical and mental health problems in adult life. What biological pathways are involved and how do the conditions of early child development affect these pathways?

BRAIN DEVELOPMENT IN THE EARLY YEARS OF LIFE AND ITS EFFECTS ON LEARNING, BEHAVIOUR, AND HEALTH IN LATER LIFE

New knowledge about how the brain develops in early life and affects all aspects of body function through pathways that involve the endocrine systems, the immune system, and mental processes is providing clues about the biological pathways (Keating and Hertzman, 1999). The weight of the biological evidence is compatible with the hypothesis that brain development in early childhood is a factor influencing health, learning and behaviour throughout the life cycle.

Biological Pathways: Our understanding of the hypothalamus - pituitary - adrenal gland (HPA) system and the autonomic nervous system and stress has grown exponentially since the work of Hans Selye (1976). We now better understand factors influencing the development of these pathways in early life and the effects on brain function and other important pathways in the endocrine system [psychoneuroendocrinology], and the immune system [psychoneuroimmunology] throughout life. Basically, sensory stimuli to the brain, external or internal, in early life can, through the corticosteroid releasing

hormone CRH-HPA system, set pathways that can, following stimulation, lead to increased production of corticosteroids (sterols) and activation of the autonomic nervous system throughout life. The sterols released into the blood following stimulation of the CRH-HPA pathway affect all body systems and organs including the brain (McEwen, 1998). Elevated blood sterol levels of a long duration are not good. The brain regulates sterol levels in the blood through a feedback system that involves the hypothalamus, the hippocampus, and the release of corticotropin releasing hormone. The regulation of the release of the corticotropin releasing hormone [CRH] from the hypothalamus not only affects the HPA pathway and sterol levels in the blood, but other pathways involved in the brain's limbic system. A critical question is how the regulation of the corticotropin releasing hormone [CRH] pathway is set.

The hippocampus and hypothalamus have steroid receptors that are important in a number of aspects of brain function that influence, among other things, behaviour, loss of cognitive function and memory loss with aging, substance abuse and suicide (Meaney, 1996; Gunnar and Thornton, 1998). There is evidence from animal studies in new born rat pups that external and internal stimuli during early life can set the sensitivity and regulation of the CRH-HPA system. (Meaney, 1996; Francis et al, 1999; Sapolsky, 1992). Some of the regulation appears to be mediated by the effects of stimuli including sterols in activating specific genes in the neurons in the hippocampus and hypothalamus which is part of the mechanism for the differentiation of these neurons for their function.

Sterols regulate gene expression by several pathways involving activation of specific genes and also via the regulation of RNA transcription (Meaney, 1996). Studies have shown that the gene expression of the hippocampus, hypothalamus pathways is influenced and set by stimuli in early life and that this sets the sensitivity of the CRH-HPA system throughout the life cycle.

McEwen (1994) has summarized this dynamic interaction and the effects of early experiences that affect the CRH-HPA pathway. "All this means that, while the brain evokes hormones and their multitude of effects, the tide of hormones affects the brain too. The implications are profound: individual differences in experience are translated into differences in brain function, even brain structure. That is what makes the situation so complex, so difficult to resolve into such tidy simplicities as nature vs nurture. Early life experiences and the hormone exposures that are determined by the brain's reactions to those experiences provide cues that will change the way the brain responds to new experiences in the future."

There is now a body of evidence that relates early life experience to physical and mental health problems later in the life cycle. The exceptional work of Barker (1992, 1997, 1998) and his colleagues, relating birth weight and length of gestation to health in adult

life, has shown the long reach of conditions in utero and early life to such conditions as coronary heart disease, high blood pressure, non-insulin dependent diabetes, reduced immune function and obesity in later stages of the life cycle. Recently Barker's group has found that plasma sterol levels in 64 year old men were inversely related to their birth weight (Barker, 1998). The higher plasma sterol levels found in men with a low birth weight in relation to gestational age were associated with higher blood pressure, elevated plasma glucose levels and insulin resistance. They conclude, as has Meaney and his group, that there can be intrauterine programming of the CRH-HPA axis (Smythe and Meaney, 1994, Francis et al, 1999). Thus, the development and regulation of the CRH-HPA pathway in early life resulting from the kind of stimuli [endogenous and exogenous] received in utero and in the period after birth influences gene expression and the function of this pathway through the life cycle. Since the CRH-HPA pathway can affect memory, cognition behaviour, metabolic pathways, the immune system, and the cardiovascular system throughout life, the development of the brain function in early life is important. Although more difficult to study, there is evidence that the response of the autonomic nervous system is also influenced by the conditions of early life probably related in part through its effects on the development of the limbic HPA system.

Another set of brain pathways that are influenced by the conditions in early life is the wiring and sculpting of the regions of the cortex that connect to our sensing systems [vision, sound, touch, smell, etc.] by which we perceive the world around us. The neurons in the different sensing parts of the brain cortex that differentiate in response to the signals received in early life influence how well we recognize the world around us and respond to the inputs from the sensing organs. The ground breaking work on vision (Hubel and Weisel, 1962; Cynader and Frost, 1999) has shown that there is a sensitive period during the early stages of development, when the vision neurons in the occipital cortex of the brain are most sensitive to the wiring and sculpting of the neurons brought on by the signals from the eye. As in the CRH-HPA story, there is a sensitive period in early development when the stimulus from the retina of the eye switch on the genetic machinery in the neurons in the occipital cortex to enable them to differentiate for their function in vision. It appears to be difficult to turn on the genetic mechanism if the sensitive period is missed. Despite some different interpretations of this work by non specialists, one of the neuroscientists (Cynader, 2000) who works in the vision field has recently made a clear statement about the implications of the vision research. "Studies of the plasticity of the visual cortex during the critical period of postnatal development are particularly germane in light of recent controversies about the importance of early childhood experience in determining cortical competency in adults. These controversies – which have profound implications for early childhood education, parenting and childcare – have been characterized more by polemics than by neuroscience research (Bruer, 1999). The visual cortex represents the best model that we have for understanding how sensory stimulation of the early brain influences brain circuitry and

function throughout life. Its study should increase our knowledge of the ways in which early sensory inputs determine the long term capabilities of the brain”.

We now know that this relationship holds for other sensory pathways such as sound and touch (Cynader and Frost, 1999; Hyman, 1999). One of the important points from all of this work is that if development of the brain’s sensing system does not occur during the optimum period, it is difficult to substantially improve the relevant wiring and sculpting for the sensing pathways later on. There is now growing evidence about how sensing pathways such as vision interconnect with other key centres in the brain (LeDoux, 1999). Although we know relatively less about the development of neural pathways to other parts of the brain that influence arousal, emotions, behaviour, language and mathematical skills, some neuroscientists speculate that the wiring and sculpting of these pathways develop in a similar manner to the visual sensory systems. (Cynader and Frost, 1999; Ledoux, 1999; Hubel, 1996).

The evidence from studies in animals and humans is consistent with the conclusion that the wiring and sculpting of the brain is most dynamic during the early years of life and that this is substantially affected by the quality of nurturing or stimuli received during this period of development. This is not an all or nothing story, at least, as judged by vision. However, the longer the period before signals from the eye reach the visual cortex in a young child, the poorer the visual acuity in adult life (Cynader and Frost, 1999).

Recently, non-invasive studies of human brain development have demonstrated that some structures develop earlier than others and that brain development is most active in the early years of life. By the second decade, this activity declines to approximate the values in adult life. Thus, some developments will be early [e.g. sensing pathways such as vision, sound, touch and the CRH-HPA pathways] and some later, but build on and are influenced by the earlier base [e.g. language and mathematics]. Some are complex, such as behaviour, emotion and arousal. Fortunately, the hippocampus, a key structure for memory, remains plastic throughout life and can generate new neurons (Kandel, 1999). However, the evidence from studies of the effect of early life on the development and regulation of the CRH-HPA pathway and cortisol levels, indicate that poor early experience can lead to poor regulation of cortisol and that this can have, among other things, a negative effect on the development and function of the hippocampus (memory) throughout the life cycle.

ANIMAL STUDIES

Although there are cultural, philosophical and other factors that make many resist attempts to apply knowledge from animal biological experiments to the brain function and human development, we should always keep in mind that much of the understanding

of human physiology and disease and our technologies for diagnosis and treatment comes from animal studies. Scientists are now in the process of experimenting with the transfer of animal tissue to humans to alleviate health problems including some brain disorders. Some reservation about the relevance of animal studies to humans is sensible, but to ignore the core information is a mistake, partly because you can only begin to understand biological systems through studies in animals of how the various organs of the body such as the brain, interact at the cellular and organ level throughout the life cycle.

There are a number of studies with mice and rats (Greenough et al, 1973; Smythe and Meaney, 1994; Suomi, 1997) looking at the effects of the conditions of early life events on brain development and brain characteristics and function later in life. The rat data shows a number of interesting observations that relate developmental neurobiology to function. There are clear benefits to rat pups given an enriched animal cage [toys to play with] with the involvement of the mother. In contrast to rat pups not given the enriched housing, the animals given the enriched laboratory environment as adults had more neurons, more connections [outcome of brain wiring and sculpting], and performed better in tests of rat competence. Greenough, in this work, points out that adult rats exposed to a similar environment also show new neurons and increased neural connections. However, the changes are faster in young rats and the magnitude is greater.

We also know from other studies that rat pups that are intensively licked by their mothers in early life, set a regulatory control for the HPA axis that provides a more balanced response to stimuli [lower steroid levels to stressful stimuli and better return to lower base line values] (Liu et al, 1997). One of the striking features from these studies is that the well-licked rat pups have better memories as they age. The loss of hippocampal neurons was less in these rats as they aged (Liu et al, 1997). Thus, rat pups with lots of touch [licking from their mother] have a better regulated CRH-HPA pathway and retain a better memory and cognitive function as they age. One of the interesting studies in rats was to cross foster pups from mothers who groomed and licked intensely with pups from mothers with a low licking and grooming characteristic (Francis et al, 1999). The results showed that pups, regardless of biological mother, placed with the good mothers developed CRH-HPA pathways similar to the rats from and reared by the good grooming mothers. The female pups from the poor mothers, raised by the good mothers, had the same biological and mothering characteristics as the mothers that raised them.

There have been extensive studies of early life and the development of monkeys (Suomi, 1997). In one set of studies, the animals were grouped into genetically vulnerable and resistant strains. The genetically vulnerable strain can be characterized as hyper reactors to stress or challenge. This strain of Rhesus monkey, if a nurturing mother does not

raise them, develops a CRH-HPA system with exaggerated cortisol responses and poor return to resting levels. These vulnerable animals, poorly nurtured when young, show in their development, avoidance of novel stimuli as well as anxious and depressive reactions to maternal separation. As adults, they show increased anxiety and depressive behaviour, excessive alcohol consumption if given access to alcohol, impulse aggression and violent behaviour, high circulating sterol levels and the females tend to be poor mothers. They have been able to do detailed biological pathway studies in these animals. They show high sterol levels to mild stress and high resting levels, low brain serotonin levels and a disrupted circadian rhythm for sterols. They have been able to cross foster offspring from poor mothers in the vulnerable strain with highly nurturant mothers (Suomi, 1997). In this case, the high risk infants become secure and precocious in their exploratory patterns. As adults, they rise to the top of social hierarchy, have a robust immune response, a better regulated sterol pathway, normal brain serotonin levels and the females become very nurturant mothers.

They have found in the vulnerable monkeys a genetic characteristic related to serotonin metabolism. The animals with the short allele will, if poorly nurtured, have excess sterol responses to stimuli and low brain serotonin levels. If they are well nurtured, this does not occur. This is a good example of the effect of environment on gene expression.

One of the important effects of the CRH-HPA system is on the immune system. Excess activity of this system with increased sterol levels in early life can produce permanent and marked reductions in immune competence. Infant monkeys raised in a deprived environment were found to have changes in antibody function that can increase the risk of autoimmune disorders and conditions such as asthma. The effect of sterols on the immune system is complex. For example, with an acute illness, a strong CRH-HPA response can be beneficial in bringing the illness under control.

The evidence from these and other studies shows that the circumstances of early life influence brain development and that this early development affects behaviour, learning, health, and memory in later life.

HUMAN STUDIES

When measures of health and cognition and behaviour for individuals in populations in developed countries are plotted against socioeconomic status [SES] the relationship turns out to be a gradient. Those at the bottom of the SES index have the poorest performance and as you go up the SES scale, the performance of the respective population groups improves. There are several points arising from these population based epidemiological studies that show the social partitioning of health, learning, and behaviour in the developed world. The gradients for health, learning, and behaviour tend to be linear, meaning there is no poverty threshold. The gradient cannot be explained solely by genetics and there is a clear effect of the social environment. Some

countries have high performance, shallow gradients. The other point that comes from the studies in the developed world is that the greatest number of children not achieving their full potential in countries like Canada, are in the middle class.

A challenge is to try and understand the pathways by which the social environment can affect health, learning, and behaviour. The evidence from longitudinal studies is compatible with brain development in the early years being a contributing factor, setting in place pathways that will influence learning, behaviour, and physical and mental health throughout the life cycle. Hertzman in Keating and Hertzman (1999) refers to this as biological embedding which will influence outcomes in health and well-being throughout the life cycle. This concept involves genetics but is related, as discussed in the animal studies, to how the environment of early life switches on the expression of genes in neurons. It is a nature nurture interaction.

The longitudinal studies of cohorts of children from birth to adult life shows that there are similar SES gradient effects for health, behaviour, and learning (Power and Hertzman in Keating and Hertzman 1999). Figure 1 shows the gradients for academic achievement at age 22 for the children from the 1958 British birth cohort in relation to social class at birth. For each step upward in the social class at birth, the education performance of the children is better. Figure 2 shows the gradients in health measured for the 1958 birth cohort at age 33. There is a gradient in mental health problems at age 33 which is most striking for females. There is also a gradient in self rated health at age 33 [a good predictor of physical and mental health problems in later life]. These data are compatible with the findings from the work of Barker and his colleagues that many of the chronic health problems in adult life can be related to the conditions during pregnancy and the early years of life. What the cohort data show is whatever the factors in the environment are that affect health, behaviour, and learning in early life, children in all social classes are affected - the farther down the families are in the social class scale, the greater the proportion of children affected. These observations do not, of course, provide evidence about the effect of events during the life course up to age 23 and 33. Power and Hertzman (1997) have made an assessment of this. They concluded that a poor early start compounded by a poor life course had the greatest effect. This subject is reviewed in the book by Keating and Hertzman (1999).

There are other sets of data that show a clear relationship between the early years and competence, coping skills, and health in the later years come from other longitudinal studies in other countries (reviewed in McCain and Mustard, 1999, and Keating and Hertzman, 1999). A Swedish study (Andersson, 1992) following a sample of children from low and middle income urban households, born in 1975, found that children in good early child development centres, involving parents before age one, had the best social skills and cognitive abilities at age 13. Male children entering the Swedish school system with poor verbal skills tended to be functionally illiterate as teenagers and a

significant number ended up in the justice system. Studies of the children in the French Ecoles Maternelle program (Bergmann, 1996) has shown that these programs enhance performance in the school system for children from all social classes. The earlier the children entered the preschool program, the better the outcome. A study in the United Kingdom (Osborn and Milbank, 1987) showed that children in good half day preschool programs had better cognitive development and academic achievement compared to children who were not in such programs. Children from disadvantaged backgrounds gained more than children from advantaged circumstances.

One of the striking observations from the longitudinal studies is that the children brought up in dysfunctional families without external support in the early years are at increased risk for behaviour and mental health problems in later life.

Effects of Improvement in Conditions for Early Child Development: There have been a number of studies in the developed and developing world looking at the effects of programs for enhancing early child development on learning, behaviour, and health later in life. Randomized trials of social interventions are, for obvious reasons, far more difficult to do than randomized trials with drugs for use in medical care and tend to be small in numbers involved. One test of the results from these studies is their consistency with what we now know from the biological and animal studies and from population-based epidemiological and longitudinal studies.

Grantham-McGregor (1991) and her colleagues examined in Jamaica the effects of good nourishment and nurturing on the development of stunted children at birth in relation to a normal control group. The study group was randomized into four groups: no enhanced support in nutrition and nurturing; improved nutrition; enhanced nurturing or stimulation; and a group given both improved nutrition and nurturing. Over the two year period, the group given no support showed poor development; the groups given either improved nutrition or stimulation improved about equally and achieved about 50% of the development of the control group. The group given both nurturing and nutrition, equaled the development of the control group at two years. This study shows the value of both nutrition and nurturing on development in the early years for infants who are clearly at a disadvantage at birth.

The Carolina or Abecedarian project shows an effect of an early child development initiative in a poor African-American population in which the mothers had low IQs. (Ramey, 1990; Campbell and Ramey, 1994) The children were randomized into two groups: one group was placed in an early child development program involving the parents and home visits covering the whole year starting shortly after birth continuing until the children entered school; and the other, a control group, were not given the program.

The program was a strong early child development initiative with one qualified early childhood educator for three infants and toddlers until age three. After age three, the staffing was one early childhood educator for six children. Parents were involved and there were home visits. The program would have to be considered a strong early child development and parenting program. The importance of the early years support was brought out by the observation that special programs for the control group when they entered the school system did not lead to the same improvement in performance in the school system as for the children given the strong support shortly after birth.

This study showed gains in cognition [including IQ], in education performance, and improved behaviour that were still evident at age 21 in comparison to the control group of children. The effect on IQ is of interest since a recent review of this subject concluded that the circumstances of the first years of life do appear to affect IQ. This program also produced a significant gain in mathematics performance during the school years. At age 21, more than four times as many children who were in the preschool program, were enrolled in four year degree programs than children who were in the control group. This directly demonstrates the relationship between investment in the early years and life long learning.

The well known High Scope Study (Schweinhart, 1993) has provided evidence from a randomized study of children in families in poor socioeconomic circumstances of an early child development initiative starting at age three and continuing until the children entered the school system at age six. This program begins later than the Abecedarian project and operated only during the school year. This program involved parents and one early childhood educator for six children and home visits. At ages 18 to 20, the children given the preschool program showed better school performance, better employment and fewer behaviour problems such as teenage pregnancies and criminal activities. The assessment of these children at age 27 showed some quite striking effects. Fewer women in the intervention group were in programs for "educable mental impairment". This is compatible with the increasing evidence that females in poor environments for good early child development, are at increased risks for mental health problems in adult life. The males in the intervention group showed far fewer arrests by age 27. This study did not have a sustained effect on IQ, perhaps because the program was started after the very early years, which appear to have an effect on IQ. The results are compatible with development occurring over a substantial time period but that for some aspects of brain development it may be difficult to fully overcome the disadvantages of poor development in the very early years later on.

Mathematics ability is an example of an effect occurring in the later preschool period. We now know that programs designed to enhance basic cognitive ability in mathematics around ages four to five have an effect. Case and colleagues (Griffin, Case and Siegler, 1994) examined whether performance in mathematics in school years could be improved through an initiative called Right Start that provided children with experiences about “the cognitive weight of numbers”. Children in a poor socioeconomic neighborhood were randomized into an intervention group and a control group. The children given the special preschool intervention program surpassed at age nine children in a middle class school whereas the children in the control group performed less well than the children in the middle class school. Case has speculated that if this sensitive period of development is missed, it is difficult to do complex mathematics later in life. Case’s work is compatible with the conclusions of Vic Fuchs (Fuchs and Reklis, 1994) looking at early child development and mathematics performance of students in states in the United States. He concluded that if the mathematics performance of U.S. students overall is to be improved, it would require strong preschool programs. These results are also compatible with the findings from the Abecedarian study.

Observational Studies: Observational studies show the benefits of good support in the early years of life. One of the most recent (Ames, 1997), concerns the outcome of children adopted into Canadian British Columbia families from Romania, shortly after birth with those adopted after many months or years in the Romanian orphanages. The description of these orphanages indicates that they were poor environments for good early child development. The children adopted shortly after birth into families in British Columbia show a similar development to Canadian born children in middle class families. Those adopted after many months or years in the orphanages have significant behavioral problems, poor attachment to caregivers and lower IQ’s than the children adopted early. Megan Gunnar, who studies the CRH-HPA axis in children, has found that the children adopted late have significantly higher evening sterol levels. The sterol data are compatible with the animal experiments showing that a poor nurturant environment in early life can lead to an overactive and poorly regulated CRH-HPA system elevated sterol levels, with their effects on cognition, memory, and behaviour throughout the life cycle.

Megan Gunnar (1998) in reviewing the stress sterol pathway and early childhood came to the conclusion that caregivers and parents through the quality of the nurturing have a very powerful effect on the development of this pathway in early life. In respect to the CRH-HPA axis and its development, and the effects on the animal and human data are remarkably congruent.

The study of Korean orphans adopted into American homes is also compatible with all the other studies showing an effect of the quality of the early years of development on development and performance in later life (My Lien, N., Meyer, K., and Winick, M., 1977). The children adopted into American families early after birth all had higher IQ scores than children whom had spent a considerable period of time in the Korean orphanages before adoption. Despite the limitations of the orphanage studies and other possible explanations, the findings are all compatible with the importance of the early years in setting the base for competence and coping skills throughout the life cycle.

OECD-STATISTICS CANADA LITERACY STUDIES

One of the striking observations from many studies is the relationship between verbal skills around age five and literacy in later life. There is reason to consider that SES gradients in literacy are in part a reflection of early child development. Doug Willms, who has been part of the OECD-Statistics Canada studies on literacy in developed countries, has emphasized the importance of early childhood as well as the school system on literacy (Willms in Keating and Hertzman, 1999).

The recent OECD studies on three measures of literacy [prose, writing, and quantitative] in the OECD countries show that in all the countries the level of literacy is a gradient when plotted against SES measures such as parent level of education (OECD, 2000). In some countries, they have a high performance and fairly flat gradient. In other countries there is, by comparison, a fairly steep gradient. Literacy in later life is related to verbal skills at ages four to five (reviewed in McCain and Mustard, 1999). In the United States, population measures of verbal skills in the four to five age group show a fairly steep SES gradient compatible with the fairly steep literacy gradient found in the adult population. About 33% of Canadian youth [ages 16 to 25] are at levels one and two [low] while 55% of American youth are at levels one and two and in Sweden, it is less than 20%.

An important observational study relevant to this point was carried out by the Stanford economist, Vic Fuchs, who looked at the relationship between an index of early child development “Readiness to Learn” for a number of states at the time children enter the school system and the performance of children in mathematics test in grade eight. The correlation was positive with a correlation coefficient greater than 0.8. Math performance in the schools was clearly related to the quality of early child development at the time the children entered the school system. Fuchs concluded that if you wish to substantially improve mathematics outcomes in the United States, investment in the preschool period for all children of equal importance to the investment in schools. This evidence plus the work of Case that has been discussed, along with the epidemiological data, does not

support the naive assumption that only a small number of children could benefit from good early child development programs.

It is perhaps because literacy is a measure of brain development and function and brain development affects health that there is a strong correlation between estimates of a country's literacy and life expectancy (OECD, 2000).

PROVINCE of ONTARIO

In 1998 the Honourable Margaret McCain and I were asked to chair a reference group and prepare a report on the early years for the Province of Ontario (McCain and Mustard, 1999). We reported to the Premier and the Minister for Children, Margaret Marland and their government in April 1999. In preparing this report, we were given many anecdotal accounts of children in difficulty in the wealthiest province in Canada and that the problems were increasing. The government of Ontario did not have a database that would allow to confirm whether there was any substance to these claims. Fortunately, the National Longitudinal Survey of Children and Youth [NLSCY] had developed key data on the populations of Ontario and Canada that allowed us to assess, from a population perspective, the early years and child development in Ontario.

We were fortunate to have measures of verbal skills for children at ages four and five for all social classes. There was a clear gradient in this measure for children plotted against their socioeconomic status [Figure 3]. While more children in the poorest circumstances showed poor performance (about 32%), 10% of the children at the affluent end of the SES scale did poorly.

Since verbal skills at age four and five is a predictor of subsequent literacy, it was not surprising to find that the literacy gradients for youth and young adults in Ontario was steeper than for the three Prairie provinces [Alberta, Saskatchewan, and Manitoba] and Quebec (McCain and Mustard, 1999). We found a similar gradient in mathematics performance for Ontario's children. It is important to remember in looking at these data that while a higher portion of the children at the low end of the SES scale are in difficulty, a significant number of children from affluent families are not performing at the desirable levels.

In our assessment of Ontario children [using all measures of performance] against family income, we found that about 32% of the children in families in the bottom quartile of income were not doing well, but that more than 20% of the children in families in the top income quartile were not doing well. We concluded from the full analysis that the greatest number of children in difficulty are in the middle class and that income is not the determining factor. Rather, the quality of parenting and care giving was an important factor in poor early child

development. Thus, we recommended to the government that good early child development and parenting programs should be available for all families with young children in Ontario (Figure 4).

The significance of this work for a country like Canada, that needs to sustain and improve the competence and coping skills of its population for the future, comes in part from the OECD-Statistics Canada Literacy Study(2000). The domains examined in these literacy studies and the levels: domains – prose literacy, document literacy, and quantitative literacy; levels of assessment - level one indicates individuals with very poor skills [difficulty in determining the correct amount of medicine from printed instructions]; level two indicates a better proficiency but still face difficulty meeting new demands and learning new job skills. They can only deal with material that is simple and clearly laid out. Levels four and five are individuals who can effectively cope with higher order information processing. In Canada, more than 30% of the youth and young adults (ages 16 – 25 years) are at levels one and two. In some developed countries, less than 20% are at levels one and two and more than 30% are at levels four and five. An important lesson from all these studies is that to establish a strong base for a learning society, good early child development and parenting programs should be available for all sectors of the population if you wish to have a competent literate populations.

OUTCOME MEASURES

In putting in place a strategy for early child development, it is important to put in place outcome measures. In the United States, a “readiness to learn” measure at the time children enter the school system was found to be a good predictor of mathematics performance in the school system (Fuchs and Reklis, 1994). The introduction of the early development index by members of the CIAR Human Development Program of the Canadian Institute for Advanced Research led by Dan Offord and Magdalena Janus in collaboration with Allan Zeesman and colleagues in Human Resources Canada is a population sensitive measure of early child development. It assess five domains at the time children enter the school system. The five domains [or scales] are: physical health and well-being; social knowledge and competence; emotional maturity; language and cognitive development; and general knowledge and communication skills (isuma, 2000).

Preliminary findings from the application of this population based measure have been reported. The following is a quote from their recent report in isuma (2000). “The following is a simplified example of such an analysis. Two schools, A and B, are located in the same large city of North York. The EDI results in all five domains are widely different, with students in School A having some of the best scores in Toronto, while students in School B, some of the worst. In the absence

of cut-offs for each scale, we chose district-wide percentile boundaries as indicators of poor outcomes. Students whose scores fall in the worst five percent of the whole population are very likely to have problems at clinical levels. Such likelihood is even greater for students who have scores in the worst five percent in two or more domains. In School A, over 90 percent of children had no serious problems, and the remaining had a problem in one domain. In School B, about 73 percent had no problems, and as many as 23 percent had problems in two or more domains. What types of resources are available in the neighbourhoods of these schools? We selected seven with the greatest relevance for early child development: day-care, family resource centres, family support services, parent support/parenting classes, public library, toy library and literacy programs. All of them are available on the spot, or within one kilometer from School A, while only three out of seven are between one and two kilometers from School B.”

Thus, it is possible to assess at the community level early child development and the distribution of resources that influence ECD. Communities can, with this information, mobilize resources to strengthen ECD in areas of need.

The economic benefits to society and individuals are very great. As the economic historians have pointed out, a sizable factor in the economic growth of Western countries following the Industrial Revolution was the improvement in the health, competence, and coping skills of their populations. The Dutch economist, Jacques van der Gaag (2000), in his assessment of the value of investment in early child development in his work for the World Bank, has concluded: “Education, health, social capital and equality. All goods in themselves and worth pursuing. ECD programs, if well executed and well targeted, contribute in numerous ways to all of these. In addition, they have all been shown to be important contributors to economic growth. Education, health, social capital, equality, and economic growth. These are the elements of a comprehensive human development framework. The framework can easily be expanded, for instance by bringing in gender issues [which would further strengthen the case for ECD], poverty [in the equality section], or by bringing in human rights issues [but that would go beyond the scope of this note]. The evidence suggests that the benefits of ECD interventions go well beyond those immediately accruing to the young child. Investments in ECD programs truly are investments in the future of a nation. In light of the above, one may wonder whether the overall [global] investments in comprehensive early child development programs are anywhere near sufficient.” (in press, 2000)

If the regions of the world are going to be able to cope with the profound socioeconomic changes that are taking place and the effects of globalization, a significant factor will be the competence and coping skills of populations in all

parts of the world and the culture and values of their societies. The World Bank and the Inter-American Bank have made ECD a high priority for the developing world.

RECOMMENDATIONS for GOVERNMENT of ONTARIO

The recommendations we gave to the government of Ontario were based on our understanding of all the evidence outlined in the report and the changing socioeconomic characteristics of society, and the need for a high performance, competent population for the knowledge based, increasingly globalized society of the future.

Among the points we considered were:

1. The changing nature of the social and economic conditions of society being driven in part by the exponential growth in new knowledge and technology. In the new knowledge-based society being driven by the “chips for neurons revolution”, we are only beginning to appreciate the changes being produced by this revolution which for Western societies, are likely to be as great as the introduction of the printing press and the Industrial Revolution.
2. The increased number of women with young children in the labour force and holding important positions in the new knowledge-based society.
3. The demographic changes with an increasing older population who no longer have children to care for and the decreasing number of families with children. A question raised by some of these individuals is why should I be taxed to invest in other people’s children?
4. The demographic change in developed countries indicates that a smaller portion of the population in the active labour force will have to be very productive in the new knowledge-based society to sustain the standard of living for all sectors of society.
5. The period of early child development is, in our culture, primarily a family or parenting responsibility sensitive to culture, religion, ethnicity and language.
6. Any program for early child development [ECD] and parenting has to be based on the understanding and commitment of all groups in a community [public and private sectors].

RECOMMENDATIONS

1. Establish a network of early child development [ECD] and parenting centres in communities available to all families with young children starting at conception through to school entry.
2. The centres should involve parents to assist in support for the parenting function.
3. The private sector should be given incentives to invest in ECD and parenting programs, particularly for their employees with young children, that are open to the community. We should move towards the goal of family friendly workplaces.
4. Governments should create incentives for communities to establish a network of ECD and parenting centres available to all families with young children.
5. One strategy is for the government to establish a matching grant program based on the resources communities can mobilize from the private sector, charitable foundations, redeployment of public sector resources and including user fees.
6. Government support should be predictable, sustainable and incremental as capacity is established in communities.
7. Establish a community based measure of early child development that can measure ECD in communities and the effects of initiatives to improve ECD. This should be for communities and not governments [the new EDI measurement and the NLSCY longitudinal study are an important base for the outcome measures].
8. It is important for all sectors of society concerned about the learning society for the future to appreciate the importance of tier one [before formal education] in human development.

The detailed recommendations for Ontario are given in McCain and Mustard (1999). The government has endorsed the report and taken steps to implement the recommendations.

GOVERNMENTS of CANADA

The governments in Canada announced at the September 11th meeting of First Ministers set out their vision of early child development in the future of Canada.

They stated, “Canada’s future social vitality and economic prosperity depend on the opportunities that are provided to children today”. They identified four key areas for action:

1. Promote healthy pregnancy, birth and infancy.
2. Improve parenting and family supports.
3. Strengthen early child development, learning and care.
4. Strengthen community supports.

To support the developments in the provinces and communities, the federal government committed \$2.2 billion over the next five years. The governments are committed to a framework of action that reflects the points that have been discussed.

The conclusion of a World Bank report (Young, M. 1997) for countries in the developing world about ECD is also very relevant to the OECD countries. “Because learning begins at birth, and even before, the starting point for involving families in early child development programs must be as early as possible ... Knowledge and understanding of programs is no longer the constraint facing early child development. Rather, transforming this knowledge into action is the major limiting factor in implementing early child development programs and requires the combined support of governments, non-government organizations, the private sector and the media. The challenge to care for society’s youngest members is not just a challenge for a single country or continent; it is a challenge for the entire world community.”

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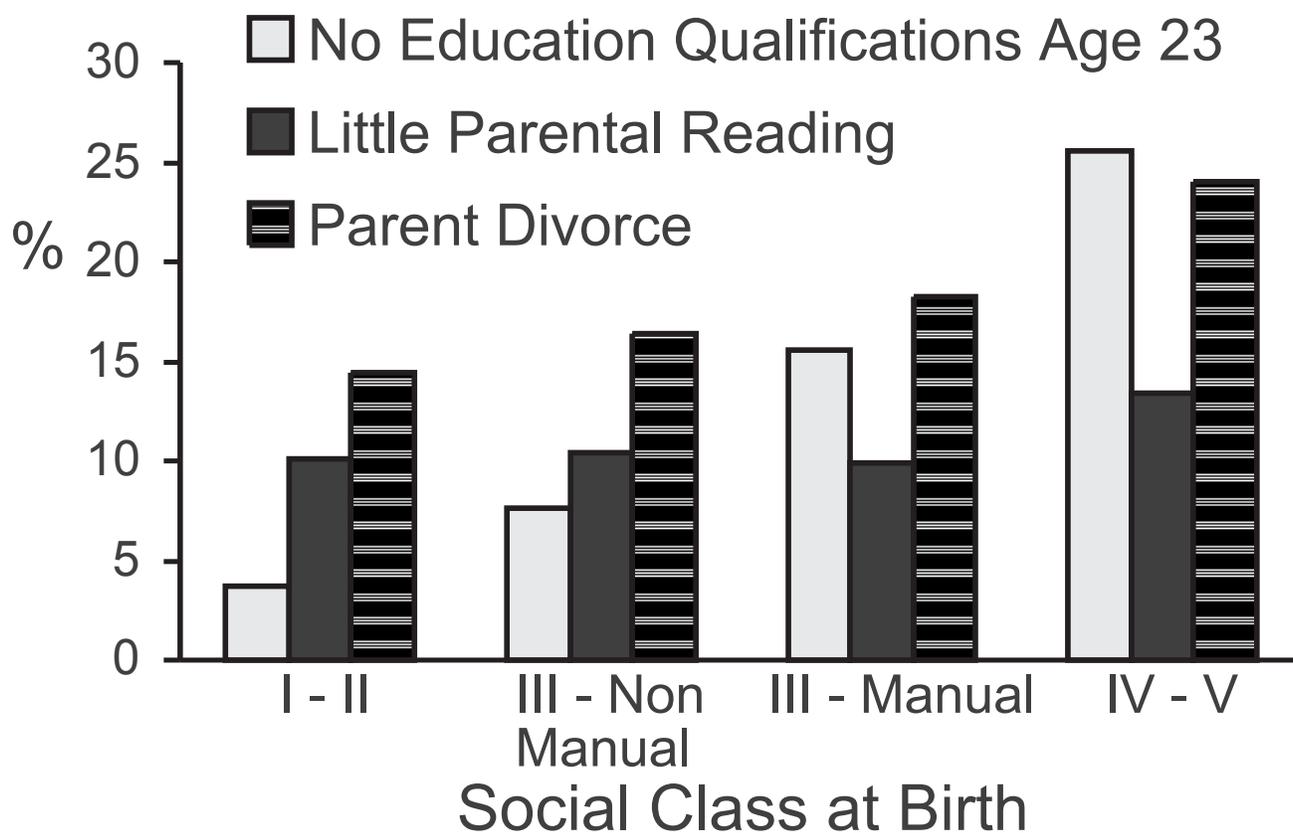
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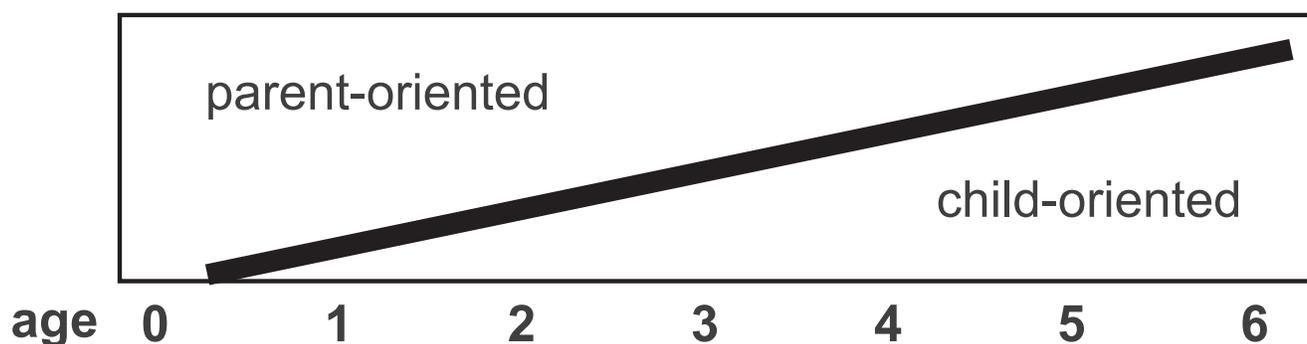
1958 British Birth Cohort - Age 33 Females



1958 British Birth Cohort - Age 33 No Educational Qualifications at Age 23



Source of Brain Stimulation



Components of Early Childhood Development and Parenting Centres:

- parent support (including non-parental care arrangements) & education
 - play-based learning guided by early educators & parents
 - toy & resource libraries, family event,
 - prenatal & postnatal supports
 - nutrition programs & information & referral services
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Socioeconomic Gradients for Low Receptive Vocabulary, Children Aged 4 and 5

National Longitudinal Study of Children and Youth, 1994

