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healthy families, young minds and developing brains:

enabling all children to reach their potential

CHARLES WALDEGRAVE
KASIA WALDEGRAVE

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EXECUTIVE SUMMARY

This study provides a critical overview of recent research into how minds and brains in young children develop, and some of its implications for families in New Zealand. It particularly focuses on factors that enable children to reach their potential or prevent them from doing so, as they interact with each other and with their parents and caregivers. It also discusses the new appreciation of the importance of pre-school years, which is due to growing knowledge of the interaction between genetic endowment and experience in the development of a child's mind and brain. An overview of the current debates and application of this knowledge in early childhood education and parenting programmes in New Zealand is presented, along with research data that indicate the groups of children who are most likely to be at risk. The study concludes that while the *neurodevelopment* and *cognitive development* of most New Zealand children proceeds quite normally, there is likely to be a substantial minority of families where children are 'at risk' of impaired development.

The first chapter begins by briefly outlining the events during the 1990s that were influential in bringing the claims of neuroscientists, and their implications for education and welfare policies, into the arena of public debate. The terms *neurodevelopment* and *cognitive development* are distinguished and briefly discussed. A summarised description of current knowledge on how the brain develops in young children is introduced, focusing on the growth of neurons, and the production and elimination of synapses and brain wiring as they emerge and interact with the environment. The importance of pleasurable and loving experiences for the maturing orbitofrontal cortex and the development of the social brain and emotional intelligence, as children learn to regulate their emotions and engage in increasingly complex interactions, is also highlighted.

Chapter 2 summarises and evaluates the criticism often levelled at proponents of critical periods for brain development during the first three years of life, and the consequent call to provide enhanced environments to maximise children's neurodevelopmental growth. Recent studies that provide evidence of some of the ways environmental factors interact with and influence neural development are reviewed. The current state of our knowledge is such that the jury is still out regarding the impact of enriched environments on the neurodevelopment of children in normally loving and stable homes. Cognitive development, motivation, perseverance and educational attainment, however, can all be improved. There are many implications for families. The importance of the development of foundational capabilities during the early years, so that later growth in linguistic, cognitive, emotional, social, regulatory and moral development can progress, is stressed. However, it is thought that such growth is not limited to the early years, but continues into adulthood. Experiences of sustained neglect, stress or trauma seriously impair children's growth, leading to the release of stress hormones that can thwart higher functioning and impair both neurodevelopment and cognitive development.

The third chapter focuses on the critical factors that enhance or hinder optimal cognitive development and neurodevelopment, and their implications for families and young children. The domains selected for closer examination are visual development, self-regulation, the acquisition of language and number and the impact of neglect. Important research findings in these fields illustrate the types of experiences and stimulation that ensure healthy development and those that impair it. The interaction of genetic endowment and the environment, particularly the family environment, in the development of the child is well known, and is documented here. The research presented in this chapter demonstrates the critical role of parents and caregivers in mediating the interaction of the child with the environment, whether for good or ill. It is contended that trauma in children leads to delayed or abnormal mind and brain development, which results in impaired intellectual, emotional and social functioning, whereas the active and loving engagement of the caregiver in the child's exploration of their environment will assist their development, even if earlier growth was damaged.

Chapter 4 addresses the relationship between low socio-economic status, poverty and healthy development. The associations of poor family living conditions with ill health, low educational attainment and crime can create stress, depression and a sense of hopelessness. Some parents who live in such conditions struggle to get the resources to live comfortably without stress and provide a stimulating environment for their children. The risk factors are substantial, and require vigorous, high-quality social policy and public health responses. The results of a

number of longitudinal evaluative research studies of early childhood education programmes with children from largely impoverished backgrounds are presented. The enhanced environments at the heart of these programmes correlated significantly with positive outcomes in later life – particularly educational attainment, employment and earnings – and reduced crime, emphasising the importance of cognitive and neural stimulation in the early years, particularly for children from disadvantaged backgrounds.

Chapter 5 explores the extent to which the recent findings in cognitive development and neurodevelopmental research have been taken up in New Zealand early childhood education (ECE) and parenting programmes. The *Te Whāriki* ECE curriculum, which all chartered early childhood services are required to comply with, has developed in step with the growth in knowledge of children's needs and potential, as expressed in cognitive development and neurodevelopmental research. The Education Review Office has created a set of evaluation indicators to assess the application of the *Te Whāriki* curriculum goals. Their evaluations are individualised to ECE centres, however, and do not provide an overall perspective. Parenting programmes are largely, though not entirely, delivered to medium- to high-risk or disadvantaged families. They offer skills, networks, safety and stability which can clearly aid the development of disadvantaged children. Unfortunately, the evaluations of the main parenting programmes in New Zealand are inconclusive and uneven, though parents usually speak well of them.

Chapter 6 notes that children who experience abusive, neglectful or stressful family environments are most likely to have impaired neurological or cognitive development. The populations most likely to be at risk in New Zealand are determined through studies that include data on child deaths; safety; Child, Youth and Family notifications of children at risk, and those where further action was required; poverty; three significant New Zealand longitudinal studies; and studies that examine educational inequality. The studies demonstrate the extent of the problems in New Zealand families and children. On balance it is suggested that there are too many at risk and too many persistently at risk from early childhood.

The report ends with a conclusion and discussion chapter, which draws together and summarises the implications of the research in the other six chapters. While some parents and caregivers are knowledgeable about the recent research on neuroscience and cognitive development in children, many, and particularly many in disadvantaged families, are probably unaware of the implications for their children's development. It is recommended that:

1. Accessible information on the importance of healthy neural and cognitive development in children and the risks of developmental impairment be produced in popular formats, firstly aimed at a target group of families who are at risk of abusing or neglecting their children and the key groups that work with them, and secondly at the population as a whole.
2. Access to high-quality ECE continues to be increased, particularly where children are at risk of violence, abuse or neglect.
3. Policies that focus investment on lifting children and families out of poverty be extended to ensure adequate income, decent housing and affordable access to healthcare for all New Zealand families.
4. Further research be commissioned to track:
   - the effects of impaired development in children so targeted policies can be implemented
   - the numbers of children at risk
   - the effectiveness of enhanced environments in restoring potential development for those whose development has been impaired
   - the effectiveness of public education programmes in preventing children from becoming 'at risk' and promoting safe, secure and loving family and educational environments.

A glossary of terms is set out in Appendix 1.

1. THE DEVELOPING BRAIN IN YOUNG CHILDREN

1.1 Introduction

Social policy in OECD countries is increasingly focusing investment and interventions on young children and their families before the children enter school – that is, before the age of five. In knowledge economies, the interrelationship of cognitive, linguistic, social and emotional skills is very important.

> A person's ability to understand, interpret and productively utilise information is a sine qua non in knowledge economies where technologies and skill requirements are apt to change rapidly (Esping-Andersen, 2003, p.142).

The school system has a very significant role to play, but increasingly ECE and parenting programmes are being viewed by policymakers and educationalists alike as helpful for providing an early foundation that enables children to have a strong cognitive and social capacity, and that can be developed to the level of their potential. Decades of educational reform in the school system and remedial programmes to maximise each child's potential, particularly in disadvantaged neighbourhoods, have attempted to eliminate the impact of parents' social status on outcomes in later life. While the impact has been reduced, the effects of socio-economic standing have not been extinguished. Social inheritance continues to remain the best predictor of outcomes in adulthood (Esping-Andersen, 2003; Wylie, Ferral, Hogden, & Thompson, 2006).

The convergence of two bodies of knowledge has led to a new appreciation of the importance of the pre-school years. The first concerns the significance of the interaction between genetic endowment and experience in the development of the young child's brain, and the differing effects that support and security bring when contrasted with stress and dysfunction in the child's environment. The second springs from outcome evaluations that have demonstrated substantial net benefits from ECE, (that includes parental support), in the acquisition of life skills and results in productivity in adulthood.

A number of rigorous, evaluative, controlled longitudinal studies have demonstrated that high-quality ECE and parenting programmes can contribute substantially to school-readiness, improved educational performance and increased economic success in adulthood (Heckman, 2006a; Karoly, Kilburn, & Cannon, 2005; Schulman & Barnett, 2006). Most of the research has concentrated on programmes provided for disadvantaged children. IQ gains were attained, though they tended to fade with time, but emotional, behavioural and educational improvements persisted. Furthermore, the economic returns from these programmes have been substantial. The Perry Preschool Study, the Abecedarian Study and the Chicago Longitudinal Study of Child-Parent Centers all found strong positive benefit-cost ratios in adulthood. These studies (which are looked at in greater detail in Chapter 4) have sparked a renewed interest in ECE and the policy settings around it. Nobel laureate James Heckman has argued from these studies that:

> The best evidence suggests learning begets learning. Early investments in learning are effective (Heckman & Lochner, 2000, Conclusion, p.75).

The neurobiological, behavioural and social science research in child development has taken place over much the same time as the longitudinal studies on ECE programmes. The interest in both has begun to converge as policymakers have endeavoured to address the persistence of inequalities in social outcomes, and have sought to educate children to produce the flexibility and resilience necessary for the fluid labour markets of modern knowledge economies.

1.2 Disputed claims concerning brain development in young children during the 1990s

As the work of neuroscience became more well known to social and behavioural scientists, particularly in North America, some began to note implications for education, family and welfare policies. They encouraged investment in young children as an effective strategy for overcoming many of the social and behavioural deficits in society. Controversial claims were made about:

- brain development in young children, and particularly the importance of the first three years of a child's life

- the significance of critical development periods for stimulation
- the value for children of an enriched environment
- the negative effects of stress and threats.

The early enthusiastic and somewhat triumphal embrace of these claims has since become the subject of considerable criticism, which is detailed in the following chapter. Today, it is generally accepted, as the evidence in this publication will show, that while the human brain is most sensitive to change during the earliest years of a child's life, malleability, development and learning continue through into adolescence and much later in life. Strict critical periods for brain development are considered to be restricted to only a few neural systems, such as the visual system. Furthermore, the evidence to date has not provided incontravertible proof that normal human brain development can be enhanced by enriched stimulation beyond that provided by a normally loving, stable and predictable family environment. Despite these caveats, there is considerable agreement today that the growing years of infancy and early childhood are very important for the developing brain.

One of the earliest documents making the controversial claims was the Carnegie Corporation's *Starting Points: Meeting the needs of our youngest children* (1994). It singled out the first three years of life as a crucial starting point in which a good beginning would promote further learning, or an adverse one could impair brain development and broader behavioural and social competence. The early environmental influence on brain development was considered to have longlasting effects, not only on the number of brain cells and connections, but also on the way the connections were wired. Healthy brain development was considered as important as healthy nutrition, good parenting and positive family interaction.

An influential conference that promoted these ideas was on Early Childhood Development and Learning at the White House in Washington DC. It was called by the Clintons during April 1997. The document *Rethinking the Brain* (Shore, 1997) was released at the conference. It stated that human development essentially involved the interplay between nature and nurture. It challenged previous assumptions that people were dependent upon their genes for the way their brain developed, and that experience before the age of three would have limited impact on their brain development. Brain development was, in this earlier approach, viewed as being linear, and the capacity to learn was assumed to grow steadily through childhood to adulthood. This was aided by a secure relationship with a primary caregiver. A child's brain was considered to be much less active than a university student's.

Rethinking the Brain stated that new research had exploded most of those ideas. Brain development, it was claimed, was now understood as part of a complex interplay of genes and life experience. Early life experiences were thought to have a decisive impact on the architecture of the brain and, as a consequence, on capacities in adulthood. Early interactions and experiences directly affect the way the brain is wired. Brain development is non-linear, and there are critical times for acquiring different kinds of knowledge and skills. A three-year-old's brain was now considered to be twice as active as that of an adult.

At the heart of this new approach was an understanding that in order for the brain to develop, brain cells (neurons) need to be active and connect with other cells through synapses. In children's brains, the synapses grow at a staggering rate, and are very dense at age three. In later years there is a gradual decline in density as 'pruning' selectively removes excess synapses. Experience plays an important role in determining which synapses will be pruned.

> When some kind of stimulus activates a neural pathway, all the synapses from that pathway receive and store a chemical signal. When the signal reaches a threshold level something extraordinary happens to that synapse. It becomes exempt from elimination – and retains its protected status into adulthood (Shore, 1997, p.20).

Shore emphasised the importance of the early years by describing brain development as a "use it or lose it process", stating that synapses that were not used frequently in earlier years tend to be extinguished.

At that same White House conference, the Rob Reiner Foundation's 'I Am Your Child' campaign, a national public education early child development push, was launched. The campaign drew on both the *Starting Points* and *Rethinking the Brain* documents, concluding that:

> How children function from the preschool years to adolescence, and even adulthood, hinges in large part on their experiences before the age of three (Head Start Bulletin, 1997, p.1).

The media also became involved in the promotion of these ideas. Sharon Begley, a well-known science writer, penned an article in *Newsweek* on the brain development issue, entitled *Your Child's Brain* (Begley, 1996). It stated that the connections, pathways and networks that are formed in the brain enable children to develop the full range of their abilities, such as vision, language, emotion and even the early development of maths and logic. There are critical periods, she noted, for forming pathways that stimulate the wiring of the neurons. With sight, for example, if stimulation is not available during the critical period, deficits occur that are not correctable during later stages of development. She described this process as follows:

> Once wired, there are limits to the brain's ability to create itself. Time limits. Called 'critical periods,' they are windows of opportunity that nature flings open, starting before birth, and then slams shut, one by one, with every additional candle on the child's birthday cake (Begley, 1996, p.2).

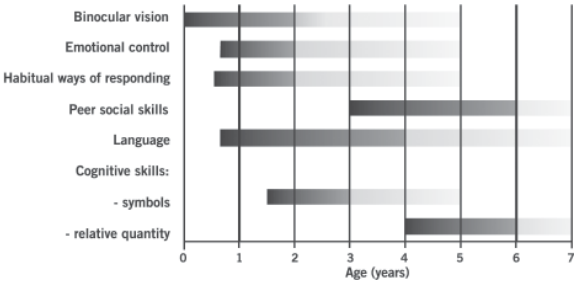
Begley's article also referred to the negative effects of fear and constant threats, which can rewire the developing brain. The amygdala scans sensory input, such as incoming sights and sounds, for emotional content before they reach the rational neocortex. If the experience has proved to be painful in the past, the amygdala floods the circuits with neurochemicals which keep the brain 'on alert', before the higher brain knows what is happening. She referred to Perry's work (1997) that says when circuits stay on high alert for days, the cortex has difficulty absorbing complex information like language.

Doherty (1997), in an extended research paper the following year, adapted the suggested timings, in Begley's *Newsweek* article, into the diagram in Figure 1, and noted:

> …different circuits are most sensitive to experience and most receptive to new learning at different ages. As noted earlier, critical periods appear to have two stages. The first stage involves an age range during which the neurons are maximally sensitive to the presence or absence of required stimulation. This is followed by an age range during which the sensitivity gradually wanes (Doherty, 1997, p.55).

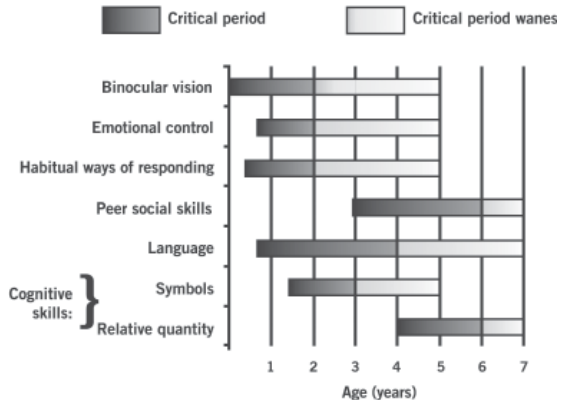
This assertion of such specific critical periods has become the source of considerable debate, and is seldom stated so strictly today. It is interesting that a diagram that originated in a popular media magazine like *Newsweek* found its way into the scientific literature. Two years later McCain and Mustard (1999) further developed the diagram from Doherty and boldly re-titled it *Critical Periods for Some Aspects of Brain Development and Function*, as set out in Figure 2. Interestingly, Doherty's diagram has been reproduced again with an even bolder title: *Brain Plasticity: Critical period for brain development* (Trefler, 2004), as yet another author has strengthened the emphasis on critical periods for brain development in young children.

FIGURE 1: Critical periods for some components of school-readiness



Source: Doherty (1997, pp.58-59). Adapted from Begley (1996).

FIGURE 2: Critical periods for some aspects of brain development and function



Source: McCain and Mustard (1999, p.31). Adapted from Doherty (1997).

These early claims indicate the excitement engendered as the data from neuroscience became increasingly available to behavioural and social scientists. They

were controversial, and indeed still are. In recent years they have been subject to considerable criticism, and the balance of scientific opinion has moderated the more rigid claims. As the next chapter outlines, the strict emphasis on critical periods, which, if missed, are fatal for particular developments, is not supported by the evidence. The 'use it or lose it' view and the focus on the first three years is considered now, by most scholars, to be an exaggeration. The increasing use of critical periods from Begley through Doherty to McCain and Mustard and then to Trefler, as illustrated diagrammatically above, indicates how a given perspective can build in emphasis from one writer to another without any new evidence being produced.

The picture painted during the 1990s was in essence a reasonable application of new and emerging knowledge. The fundamental understanding of the importance of early life experience; the significance of the interaction between genetics and the environment in brain development; the powerful impact of early relationships as a source of encouragement and adaptation or risk and unpredictability; and the negative consequences of sustained stress and threat, are all generally accepted today. It was the claims beyond these that created the intense debate, and they are discussed later.

An important aspect that has not helped the debate is the failure of many of the social science authors, when referring to brain development, to distinguish between *neurodevelopment* and *cognitive development*. Neurodevelopment refers to the growth and development of the physical tissues of the brain which consist of billions of neurons. Cognitive development refers to the growth of neural capacities by which children, in particular, learn to more accurately understand their environment and relate logically to it. While neurodevelopment is necessary for cognitive development, growth in cognitive activity and ability is not normally directly correlated with measurable tissue growth in the brain. The precise relationship between neural and cognitive development is still being explored. However, the social science literature in this field often refers to brain development when it is discussing cognitive development in children in much the same way as when it refers to the growth of neurons that make up the physical tissue of the brain. This can be confusing and has led to controversy, as will be shown further on in the report.

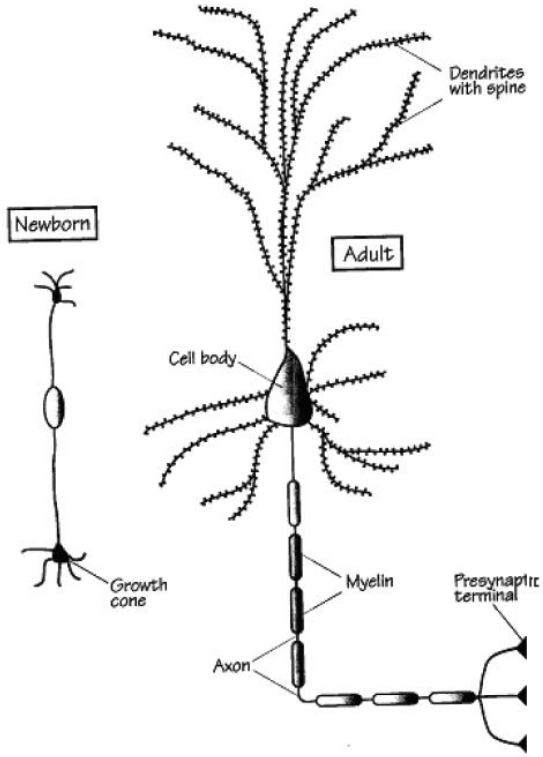
In order to better understand this distinction, the rest of this chapter will provide an overview of the relevant aspects of neurodevelopmental and neurobiological research into brain development in young children. It has two parts: the growth of neurons and brain wiring; and the developing social brain.

1.3 The growth of neurons and brain wiring

The human brain is made up of billions of nerve cells, or neurons. As shown in Figure 3, each neuron is shaped like a tree and, as they mature, they develop extensive 'root systems' called dendrites, which receive inputs from other neurons. Neurons also develop trunks, known as axons, which can become very long (as long as 91 cm in children (Petersen, 2000)). The axons pass on information to the next neurons in their circuit.

In between the two branched systems is the cell body (soma), which carries the nucleus and oversees the cell's basic metabolic functions. Information within neurons is transmitted electrically by impulses. However, when impulses reach the end of an axon, the information must cross a gap, known as the synapse, to the next neuron in the circuit. The presynaptic terminal of the axon releases a chemical messenger, or neurotransmitter, which spreads across the synapse and binds to receptors on the postsynaptic neuron's dendrites. This in turn sets off an electrical response in the receiving neuron. This sequence of electrical and chemical transmission is repeated through every cell and synapse of the circuit. A typical mature brain cell is connected to about a thousand other neurons.

FIGURE 3: Structure of the cerebral neurons in a newborn and an adult



Source: Eliot (1999, p. 24).

Axon development appears to be genetically programmed. There does not need to be any activity to start the process, as it can happen in a dish outside the body. For example, when the eye is sending out its nerve cells into the brain, it sends out some inappropriate connections, but many axons do connect to the parts of the brain concerned with vision. Then an activity-dependent stage occurs, when neurons begin to send electrochemical activity 'down the wires' while the eyes are still not seeing. Finally, there is a stage during which patterned activity is needed to make brain connections. The eye has to be sending appropriate messages to the brain to ensure the final wiring is precise. The brain has to be receiving appropriate signals from the eye for this final environmentally driven stage.

> The visual system knows that it's going to have two eyes and that they are going to focus on objects, and it wires itself appropriately. We think that experience expectant prewiring goes on in all sorts of brain parts. It is as if the brain is ready for certain kinds of information at different times (Petersen, 2000, p.69).

Once the neurons make connections, the brain surrounds and insulates the nerve cells with myelin, a fat, which increases the speed of conduction. Different parts of the brain myelinate at different times of life.

The implication is that until a child's brain has reached certain stages of physical development, certain behavioural expectations may not be appropriate. Although children may experience an onset of abilities at about the same age, there is no fixed time when a child will be capable of a specific behaviour. It might be six months, 18 months or three years.

It is considered that at around the age of three children peak in the number of synaptic connections. Billions of neurons and around a quadrillion (US) synapses are produced.[1] Many more synapses are grown than are needed, and unnecessary ones are pruned away because they don't carry information that is useful for the growing child. The brain sends out a whole cluster of possible synapses, and the ones that are in frequent use are retained, as they allow us to do things well according to the needs of our environment. There is a balance between the production of more synapses and their withdrawal.

> The elimination of stray synapses and the strengthening of survivors is what makes our mental processes more streamlined and coherent as we mature. On the other hand, it may also explain why our mental processes become less flexible and creative as we mature. Although the brain continues to exhibit certain more subtle forms of plasticity in adulthood … it is never as malleable as in childhood (Eliot, 1999, p.32).

This has led some researchers to claim, as we have already noted, that once a brain region has reached refinement, the critical or sensitive stage for learning has ended (Doherty, 1997; Eliot, 1999; McCain & Mustard, 1999). These authors argue strongly for quite strict critical periods for development. They consider that they *all* begin in the first three or four years of life. However, they note that the critical period for basic

[1] Shepherd (1998, p.6) states the total number of synapses in an adult's cerebral cortex is 60 trillion. However, Koch (1999, p.87) lists the total synapses in the cerebral cortex at 240 trillion.

sensory abilities, like vision and hearing, is completed much earlier than those for more complex skills like language and emotion. Others (Bruer, 1999; Pinker, 2002; Shonkoff & Phillips, 2000) consider there is no compelling evidence for critical stages and cite examples (some of which are addressed in the following chapter in the context of the broader debate) of contradictory phenomena. It is important to note that the debate is not about the growth and pruning of synapses, but about the deduction from that information that there are *finite critical periods* for learning.

1.4 The developing brain and social interaction

The term *social brain* is defined by its function as:

> …a body organ that mediates social interactions while also serving as the repository of those interactions… The brain is the organ most influenced on the cellular level by social factors across development; in turn, the expression of brain function determines and structures an individual's personal and social experience (Bakker et al, 2002, p.1).

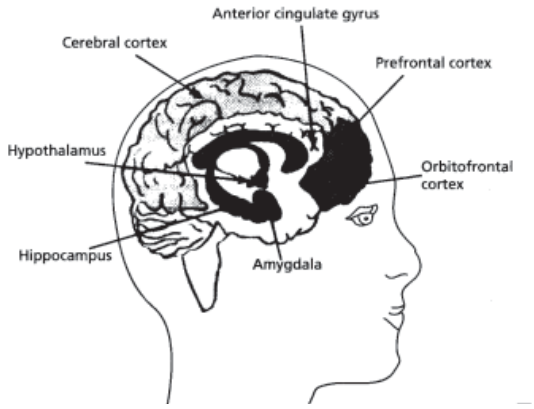
Emotional connection among humans usually involves sharing experiences and co-ordinating with each others' feelings. We link with each other and empathise – we participate in the other's state of mind in order to understand them. In moments of closeness the same types of neurons in the same area of the brain are activated in our own brains (Gerhardt, 2004). As social beings, we monitor the internal states of others as well as ourselves, which helps us maintain the relationships on which we depend.

Babies are sensitive to facial expressions and voice tones, and parents and children can often be observed in mutually responsive interaction. All of these things affect the developing child. Babies who see happy behaviour have been shown to have activation in their left frontal brains, and those who see threatening behaviour have been shown to have activation in their right frontal brains (Davidson & Fox, 1992).

The brain can be described as having layers, each more sophisticated and complex than the last. At the base of the brain are the most basic functions of life, such as the fight/flight response, and above that, those that are more complex, including emotional reaction systems. The basic fear response, for example, is one of the first aspects that matures in the brain. It is concerned with going towards things or retreating from them. One acts first and thinks later (LeDoux, 1998a). The amygdala can send impulses denoting fear or threat to the hypothalamus – approach or avoid; live or die. Beyond and around those systems is the prefrontal cortex and cingulate gyrus, as seen in Figure 4, which form the thinking part of the emotional brain. It possesses a reflective capacity, enabling emotional experience to be held fast, and alternative courses of action to be considered (Morrison, 1999).

The orbitofrontal lobe in the prefrontal cortex has an important role in emotional life. In fact, it has a key role in coding and retrieval of emotional associations (Damasio, 1994; Damsio et al, 2000). As with all regions of the brain, neuroscientists have been able to understand its functions through studies of damage. It has been referred to as the centre for 'emotional intelligence' (Goleman, 1996). Through the orbitofrontal cortex's connections to the more primitive brain systems, it can inhibit rage reactions, switch off fear and generally apply brakes to feelings that arise in the amygdala and hypothalamus subcortical areas. It is capable of holding back "the fast and the dirty" (Damasio, 1994; LeDoux, 1998a) emotional responses and enabling more thoughtful and complex motivations to come through. The basis of human willpower, self-control, empathy and the capacity to modify immediate impulses stems from the orbitofrontal cortex.

FIGURE 4: The human brain



Source: Gerhardt (2004, p.35).

The orbitofrontal cortex develops almost entirely post-natally and does not begin to mature until toddlerhood. A baby's brain grows through experiences, particularly

with those close to them. It is experience-dependent, and there are probably good evolutionary reasons for this – for example, to ensure each person is adapted to the environment in which they live. Thus the social brain capacities develop in response to ongoing social experiences.

A baby is dependent on at least one person for the development of its orbitofrontal cortex. It requires a loving and trusting relationship, at least between the primary caregiver (usually the mother) and the child. When the interaction between the young child and close family adults is happy and positive, the prefrontal cortex develops its capacities for self-regulation and complex social interactions (Cozolino, 2006).

When pleasurable experiences are absent for periods of time – for example, as a result of stress, threat or neglect – normal development can be arrested. Intimate social experience with at least one caring adult is almost certainly necessary for the baby's orbitofrontal cortex to develop. Chugani's (2001) work applying neuroimaging techniques with post-institutionalised Romanian orphans demonstrated the significant deleterious effects of isolation to brain development.

Under normal circumstances, one-off or low-level negative experiences are simply overridden. If, however, young children experience ongoing, seriously arousing fear or threat, they can be exposed to high levels of the stress hormone cortisol as the amygdala and hypothalamus are provoked into an automatic fight/flight response which the cortex will be unable to override. A continuous lack of positive social experiences will reduce the capacity of the orbitofrontal cortex to override the primitive responses that occur.

High levels of the stress hormone cortisol can be damaging to very young children. Being so young, they need stress to be managed for them by an adult. They are simply not equipped to manage their cortisol levels in the way an older child or adult is. In a caring environment where they are touched, stroked, fed and rocked, cortisol levels tend to remain low. However, if they are not being responded to, cortisol levels can escalate (Gunnar & Donzella, 2002) and damage developing neurotransmitter systems.

Finally, eyes also play an increasingly important part in social interaction as babies gain vision control. Eye contact becomes a key source of information about other people's feelings and intentions as they are displayed on their faces (Turner, 2000). This is often referred to as *social referencing*. Infants use visual communication at a distance to assess how best to react, and parents' facial expressions are a key source of information. In fact, Schore (2003) states that positive looks are the most vital stimulus to the growth of the social, emotionally intelligent brain.

2. THE DEBATE ON BRAIN DEVELOPMENT IN YOUNG CHILDREN

2.1 Critiquing the controversial claims

The most concerted attack on the more controversial claims concerning brain development in young children – the importance of the first three years of a child's life in terms of critical development periods requiring mode-specific stimulation; the added value for children of an enriched environment; and the negative effects of stress and threats – has come from John Bruer in his book, aptly entitled *The Myth of the First Three Years* (1999). He sets out the historical development of the claims and refers to the documents noted earlier in this paper, including *Starting Points, Rethinking the Brain* and "Your Child's Brain" in *Newsweek*. He notes the significance of the White House conference and the advocacy of the "I Am Your Child" campaign. He also catalogues various media headlines that carry the claims.

Bruer (1999) discusses three consistent neurobiological strands in these documents. The first is the growth and change in a child's brain following birth and during the early years. Significant in that growth is the production of a very large number of synapses – trillions more, in fact, than are found in an adult's brain. The rate of synapse formation during this early period far exceeds the rate of synapses that are extinguished. Some connections form and provide a foundation for the rest of the child's life, while others are needed in early childhood, but become redundant as the child gains autonomy and independence. For example, in infancy, if a child gets something over its face, it will cry to attract help. As it grows, it can move its head or remove the cover for itself, and therefore no longer needs to cry for help, so the synapses of that particular neural network become redundant. This period of development, it is claimed, generally takes place over the first three years of life.

The second neurobiological strand is the timing of development or critical periods in brain growth. These are times when the brain will develop normally if it receives the right kinds of stimulation. If the wrong kind of stimulation or no stimulation at all takes place, then the brain will develop abnormally. Once the period has finished it becomes very difficult, or in the stricter sense, impossible, to wire certain neural pathways.

The third strand that Bruer notes as prominent in this genre of brain development and early childhood literature is that enriched or complex environments increase brain development and produce more synapses. The validation for this claim usually comes from animal studies.

Bruer summarises these neurodevelopmental arguments before challenging them. He says these authors consistently state the following:

> The first three years in life are important because that is when synapse formation that connects nerve cells into functioning circuits takes place, and as such it is a critical time for brain development. The brain continues to develop after this time, but after three years synapses are pruned more rigorously.

> It is during this critical period that enriched environments and increased stimulation can have the greatest effect on brain development. The critical periods are function-specific; for example, during the critical period for language acquisition, the child needs to be exposed to language-related stimuli (speech, singing, music, language pragmatics) so that the areas of the brain related to language develop properly. If they are not so exposed, they may develop some rudimentary language, but they will never, even with intense speech therapy, achieve normal levels of language functioning.

It follows for these authors, says Bruer, that the first three years offer parents, caregivers and policymakers a biologically time-limited period to provide the right experiences and early childhood programmes to help children build better brains.

Regarding the first claim (increased synapse formation during the first three years), Bruer says its significance has been misunderstood. It suggests that more synapses equals more brainpower. Synaptic densities follow an inverted-U pattern, but our intellectual competencies and ability to learn do not. Despite the fact that at birth and in early adulthood synaptic densities are approximately the same, adults are capable of much more complex tasks and activities

than zero to three-year-olds. Furthermore, the periods of rapid synaptic loss during late adolescence and early adulthood do not usually lead to a drop in brainpower.

Bruer claims this literature carries a false impression that early stimulation will create synapse formation. However, the neuroscientific evidence suggests synapses form in the absence of stimulation (Carlson, 1984). The process does not appear to be driven environmentally, but rather genetically (Diamond & Goldman-Rakic, 1989; Goldman-Rakic, 1997). Bruer concludes that the rate of synapse formation and synaptic density are not influenced by the quantity of stimulation.

Regarding the second claim (that once the critical period is finished it becomes very difficult or impossible to wire certain neural pathways), Bruer says there are some critical period constraints, but only for specific kinds of learning and development. He refers to the distinction between *experience-expectant* and *experience-dependent* brain plasticity (Greenough, Black, & Wallace, 1987). Critical periods tend to exist for sensory skills, motor skills and language. This requires experience-expectant brain plasticity that will enable the acquisition of species-typical traits that have their origins in evolutionary history. Experience-dependent brain plasticity, in contrast, is for traits and behaviours that are relevant to individuals, social groups or cultures, as opposed to species. They are not time-limited, but can involve learning during any period of a lifetime. There is a critical period for vision, for example, but not for learning to make sushi (Bruer, 1999, p.109).

There are differences even within senses. In sight, for example, the ability to perceive visual stimuli (have the sensory input register in the occipital cortex) is experience-expectant, but the ability to make sense of what you see is largely experience-dependent.

As with the first claim, he states that neuroscientists do not think that a greater quantity of experience or stimulation during a critical period will enhance brain development. Critical periods are complex, with differing phases and intricacies. Both language and vision acquisition, for example, have these complexities and extend over long periods of time. It follows from this that critical periods do not fit neatly into the first three years of life.

The third claim is largely addressed in his previous arguments. If one accepts that there is a time of rapid synaptic growth and high synaptic density that takes place during a critical period, and that it can be enhanced by appropriate stimulation, then it necessarily follows that a particularly enriched environment with the said stimulations will help enhance greater levels of brain development. There is no need to repeat the earlier rebuttals. Bruer does, however, refer to the enriched environments that have been developed in the US Infant Health and Development (IHDP) Program and the Abecedarian Project.[2] He refers to the IQ results in the longitudinal follow-up research as the measure of brain development improvement. He accepts that they have improved in both environments, but the improvements in relation to the control groups reduced over time and are thus of minimal consequence.

Bruer has raised some timely and important criticisms of the familiar claims of a number of proponents concerning the importance of the first three years. They have been salutary and well argued, and have exposed some creeping ideology that had found its way into the scientific discussion. However, Bruer's focus on exposing the *myths*, as he refers to the claims, can obscure the importance of the significant new understanding we now have of the way the brain develops in young children, and the sorts of family and early childhood environments we need to encourage and discourage. While Bruer rightly exposed a number of unsubstantiated claims, one could be forgiven for thinking that he asserts that the first three years have no greater significance for brain development than any other period in a child's life.

His critique of the misunderstanding of synapse production and elimination is substantial. However, he states emphatically that synapse production is genetically, rather than environmentally, driven when our knowledge of this area is still in the process of discovery and being debated. Furthermore, he strongly underplays the emphasis on human environmental adaptation in the retention and pruning of synapses. Greenough, who Bruer refers to extensively, and Black (Black & Greenough, 1986; Greenough & Black, 1992) state with regard to experience-dependent development that new and continuous experiences lead to more plentiful connections among neurons, and

[2] The IHDP Program and the Abecedarian Project provide exceptional help to disadvantaged children, particularly ECE, and include longitudinal follow-up evaluation research of the participants' progress. Details of the Abecedarian Project are addressed in chapter 4, along with two other similar early childhood educational projects.

that individual differences in brain development are in part the result of idiosyncratic experiences across the life span. As the next chapter illustrates, there is good evidence to show that parents and caregivers can at the very least stimulate cognitive development, even if the jury is out on neurodevelopment. Inadequate or abusive care does, however, damage healthy neural growth, both during and after the early foundational years of development.

The second critique on critical periods corrects an overly rigid emphasis by some writers noted in the previous chapter. Bruer distinguishes between critical periods for species-typical traits, and other, culturally useful traits, which can be acquired over the life course. He usefully dismisses the 'use it or lose it' claim, showing that neural development continues to take place well after the first three years of life.

His final criticism of the impact of enriched environments is suspect, though. As noted above, differing environmental experiences are associated with different patterns of neural activity. At this stage of our scientific knowledge, we cannot say whether or not enriched environments can enhance the growth of brain tissue in normally developing children, but we can note that it can enhance cognitive development. Furthermore, we know that very negative environments can produce abnormal brain growth in children, which, with an improved environment, can recover at least partly (Chugani, 2001; Perry, 2002).

Bruer refers to the improvements in the IQ results in the IHDP and the Abecedarian Project longitudinal studies reducing over time and thus being unconvincing. However, increases in IQ scores offer at least some evidence of the positive effect of enriched environments, and those same programmes continue to show modest IQ gains in the latest data collection since Bruer's book (IHDP age eight and Abecedarian age 21; Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; Karoly, 2006). Heckman (2006a) makes the point, though, that the non-cognitive skills which are also measured, such as motivation, perseverance and educational attainment, are also very important outcomes, and gains in those areas have been more substantial.

2.2 The balance of expert opinion

Perhaps the most interesting publication in this field is Shonkoff and Phillips' book *From Neurons to Neighborhoods: The science of early childhood development* (2000). It is the result of two-and-a-half years of work by an eminent group of 17 academics and scientists who were members of the Committee on Integrating the Science of Early Childhood Development of the Board on Children, Youth and Families for the United States National Research Council and Institute of Medicine. Their task was to evaluate and integrate the current science on early childhood development. They presented their conclusions and recommendations affirming four themes. These were:

> All children are wired for feelings and ready to learn.

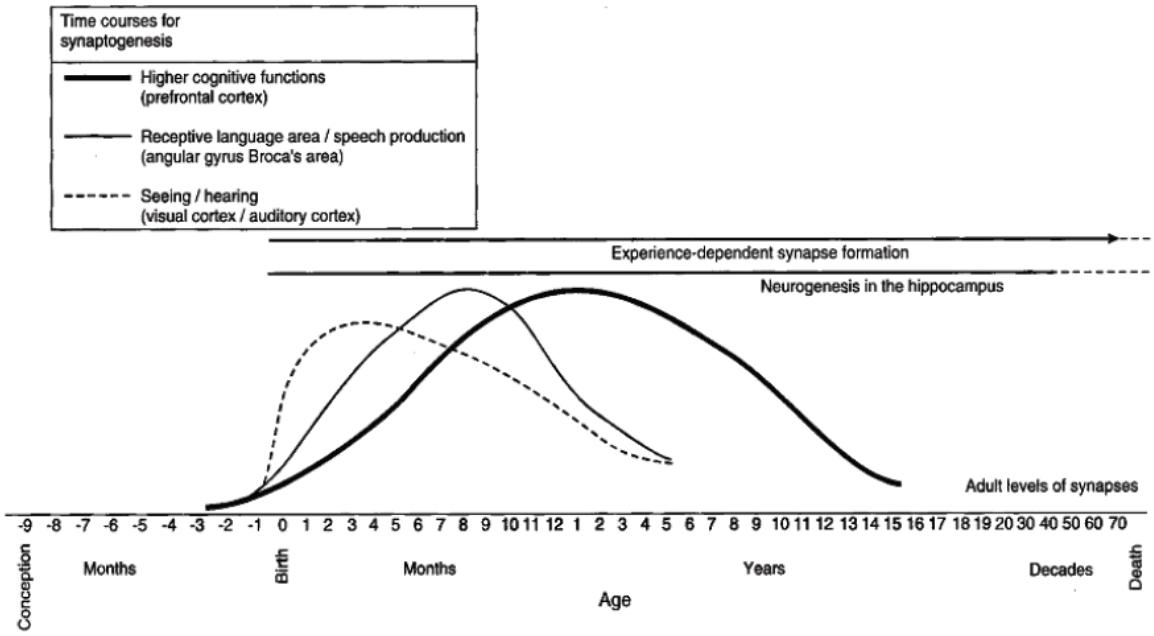
> Early environments matter and nurturing relationships are essential.

> Society is changing and the needs of young children are not in some cases being addressed.

> Interactions among early childhood science and policy are problematic and demand rethinking (Shonkoff & Phillips, 2000, p.4).

In their discussion of synaptic overproduction and loss, they note that Huttenlocher (1979; Huttenlocher & Dabholkar, 1997) was the first to show this pattern of synaptogenesis in the human cortex and its exuberance in the first years of life. As Figure 5 demonstrates, this process takes place for different functions in different brain regions on quite different time courses. Huttenlocher suggested that the high point for synaptogenesis in the visual cortex, for example, occurs at around six months, slowing down over the pre-school period. For higher-level cognition in the prefrontal cortex, however, it occurs at one year of age and continues through to mid-adolescence.

FIGURE 5: Human brain development



Source: C. A. Nelson, reprinted in Shonkoff and Phillips (2000, p.188).

Shonkoff and Phillips (2000) highlight the fact that most measures of synaptic production are based on density measures, and we cannot yet accurately determine the levels of overproduction and pruning. The process, though, leaves the neural system with a precisely organised pattern. Like Bruer, they find Greenough et al's (1987) description of *experience-expectant* and *experience-dependent* mechanisms guiding brain development very useful. The former is genetically programmed, and requires environmental exposure during certain periods of time, as in the case of the visual cortex requiring exposure to light. Deprivation can lead to behavioural malfunctioning. The experience-dependent synaptogenesis, by contrast, takes place throughout life in a manner that enhances new brain development and pattern refinement in the process of an individual's adaptation to their environment. This mechanism is more individual and idiosyncratic. It is a source of enduring adaptability to the flux of everyday life. The more 'used' a neural pathway is (the more repeated and relearned an experience), the more it is likely that the series of synaptic connections will become a permanent one, and more resistant to pruning.

On sensitive periods in cognitive development, Shonkoff and Phillips state that there is no evidence for critical or sensitive periods for cognitive functions. They make it clear they are not suggesting they do not exist, but that science has not yet determined whether they do exist. In fact, they say generally that scientists have not even studied sensitive periods of cognitive development. This highlights the difficulty in this broad field of research, where developmental social scientists can easily work from assumptions they deduce from neuroscience, which may or may not reflect the understandings of neuroscientists themselves. They are of the view that important cognitive developments occur over childhood and adulthood, which raises some questions about sensitive or critical periods. They cite Kliegel, Smith, Heckhausen, & Baltes' 1987 study of adults being trained in the recall of single digit numbers as an example of substantially increased memory capacity later in life.

In their conclusion and recommendations they state:

> Despite a small number of examples, we know remarkably little about the role of experience and the existence (or lack thereof) of time-limited sensitive periods during which specific experiences

> are obligatory for normal human brain development. The evidence to either support or refute claims about critical or sensitive periods in humans simply does not exist. It does appear, however, that development of the neural systems supporting cognitive, social, and emotional competencies remains open to experience at least through adolescence. In fact the brain's ongoing plasticity enables it to continually resculpt and reshape itself in response to new environmental demands well into adulthood (Shonkoff & Phillips, 2000, p.391).

The authors refer to the 'explosion of research' in the neurobiological, behavioural and social sciences that enables us to understand the influences that help children to start life well or hinder them. They consider that recent research has generated a much deeper understanding of the significance of early life experiences, and it is indisputable that what happens during the early months and years of life matters, because it sets either a robust or a precarious base for what follows.

> From birth to age five, children rapidly develop foundational capabilities on which subsequent development builds. In addition to their remarkable linguistic and cognitive gains, they exhibit dramatic progress in their emotional, social, regulatory and moral capacities. All of these critical dimensions of early development are intertwined, and each requires focused attention (Shonkoff & Phillips, 2000, p.386).

Shonkoff and Phillips highlight the central role of early relationships in providing support and adaptation or risking dysfunction. It is during the earliest years that capabilities, complex emotions and social skills develop, and it is important that planned interventions are employed to favour good outcomes. They also contextualised their remarks by listing the constraints on families as a result of changing circumstances in the US, including:

- the amount of work engaged in by parents of young children and the problems of work/life balance
- the continuing levels of economic hardship despite educational increases, unemployment decreases and a strong economy
- increasing cultural diversity and the persistence of racial and ethnic disparities in health and developmental outcomes
- the growing numbers of children and infants spending large amounts of time in childcare settings of variable quality
- the high levels of serious family problems and adverse community conditions that are detrimental to children.

The publication makes it clear that we know a considerable amount about conditions, particularly in family environments, that pose dangers for the developing brain. By contrast, we know virtually nothing about what may enhance or accelerate brain development. As noted earlier in this report, abusive or neglectful care in families is damaging. So, too, are dangerous conditions. Neuroscientific data from animal research increasingly provide evidence that experiences of sustained neglect, stress or trauma within a caregiving environment are damaging to development. They go on to observe that disruptions that create stress in parents, and particularly mothers, or fear-inducing circumstances, negatively affect children as stress hormones are released and modulated.

By contrast, supportive and nurturing homes and other caregiving environments protect children from this type of damage. Furthermore, the evidence suggests that normal child development does not require particularly special experiences or conditions to thrive, because it is remarkably adaptable in normal non-hostile circumstances, and the 'normal' environment is naturally rich for most children. It takes place as children experience and adapt in their particular worlds. Specific experiences or stimulations may or may not further enhance development in children who are being cared for in non-stressful environments. Science simply has not yet reached a point where that question can be answered. The authors also highlight the need to ensure children with disabilities such as visual impairment or auditory processing or major perceptual-motor delays, can have the range of experiences they need for healthy development. There is a danger they could be denied the range of experiences other children have and need for the healthy development of their minds and brains.

Finally, the report highlights the potential of the intersection of child development research, neuroscience and molecular and behavioural genetics to discover how genetics and environmental factors

interact to influence developmental pathways. They list the following as critical:

> Understanding how experience is incorporated into the developing nervous system and how the boundaries are determined that differentiate deprivation from sufficiency and sufficiency from enrichment.

> Understanding how biological processes, including neurochemical and neuroendocrine factors, interact with environmental influences to affect the development of complex behaviours, including self-regulatory capacities, prosocial or antisocial tendencies, planning and sustained attention, and adaptive responses to stress.

> Describing the dynamics of the gene-environment interactions that underlie the development of behaviour and contribute to differential susceptibility to risk and capacity for resilience.

> Elucidating the mechanisms that underlie non-optimal birth outcomes and developmental disabilities (Shonkoff & Phillips, 2000, pp.13-14).

2.3 Environmental factors and brain development

Sir Michael Rutter, one of the foremost British researchers in the field, states:

> One of the most exciting and important findings in recent years has been the growing body of evidence that specific environments have major effects on the expression of specific genes in specific body tissues, including specific parts of the brain (Rutter, 2006, p.182).

He refers to four reasons for expecting gene-environment interactions. Firstly, there is the underlying evolutionary concept of natural selection which considers that genes are involved in the adaptation of organisms to their environment. Secondly, biological development at the individual level involves adaptation to environmental conditions that prevail in the earliest years of development. Thirdly, both human and animal studies consistently display a variability of responses to environmental hazards. Fourthly, differences in genotype lead to different responses from people undergoing the same treatments for similar problems.

Among a number of research programmes Rutter refers to to illustrate his assessment are some of the findings in the Dunedin Multidisciplinary Health and Development Study (DMHDS),[3] which has pioneered important research in our understanding of child development. While investigating the experiences of trauma that result from abuse, stress and neglect, they have demonstrated that the development of the brain is regulated by genes, which interact profoundly with life experiences, particularly early childhood experiences. In cases where there is chronic stress or abuse, 'hyperarousal' occurs in some areas of the brain, and this may result in hyperactivity, sleep disturbances and anxiety, as well as increased vulnerability to post-traumatic stress disorder, conduct disorder and learning and memory difficulties (Dallam, 2001).

Caspi et al (2002) point out that there is a social behavioural effect linked to a MAOA[4] gene allele (a DNA sequence that codes for a gene)[5] and childhood maltreatment. Maltreated children, for example, with a genotype conferring high levels of MAOA expression, were less likely to develop antisocial problems. Those with lower levels, on the other hand, were more likely to develop these problems. Interestingly, certain genes can help determine how people deal with their environment. The authors state that these findings offer epidemiological evidence that genotypes can moderate the impact of harmful environmental factors on children. The interaction between genetic predisposition and environment helps explain why interventions to improve outcomes have a varied success rate among their participants.

The DMHDS researchers note that currently the genetic basis of social traits is poorly understood, and these traits also tend to have a high environmental component.

> For example, a common 5-HTT gene variant or allele (a serotonin transporter) that plays a role in depression is only an influence, not a determinant, if the carrier has had many stressful life events or has been abused. Two copies of the predisposing allele were shown to have a stronger effect than one. If the carrier had a happy childhood, then it has no significant role in the development of depression (Caspi et al, 2003, p.386)

Rutter refers to this type of interaction between environment and genes as clearly biological, involving

[3] Dunedin Multidisciplinary Health and Development Study – A longitudinal investigation of health and behaviour. Dunedin, University of Otago, New Zealand.

[4] Monoamine oxidase A (MAOA), an enzyme that metabolises the brain chemicals serotonin, dopamine and norepinephrine.

[5] Allele – one member of a pair or series of genes that occupies a specific position on a specific chromosome. Also called allelomorph.

individual genes in specific parts of the brain, but terms it epigenetic rather than genetic. He considers the environment affects gene expression rather than alters them. These effects are not concerned with specific allelic variations and they do not affect the genomic sequence.

Recent developments in neuroimaging approaches, including magnetic resonance imaging (MRI), functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI), are providing a more sophisticated understanding of the relationship between environmental factors and brain development. Casey, Galvan, & Hare (2005) have applied this technology in the field of human developmental neuroscience to track brain development and study learning. One of their interests has been to understand the relationship between neural and cognitive development.

fMRI studies can reveal regions of the brain that are associated with cognitive control. Such control demonstrates an ability to filter and suppress irrelevant information, thoughts and action in favour of relevant ones. Various cognitive control tasks are applied in order to determine the pattern of brain activity. Casey and colleagues (Amso & Casey, 2006; Casey, Gledd & Thomas, 2000; Durston & Casey, 2006), using the various neuroimaging approaches, have shown changes in neural effects during the course of learning that highlight increased activity in cognitive task-relevant regions and a corresponding decrease in task-irrelevant regions.

> Studies show that children recruit larger, more diffuse prefrontal regions when performing these cognitive control tasks than adults do. The pattern of activity within the brain regions central to such task performance becomes more focal and fine-tuned with increased activity, whereas brain regions not correlated with such task performance decrease in activity with age (Casey et al, 2005, pp.240-241).

These advances in neuroimaging challenge previous simple and linear claims of causality between coincidental changes in brain development and behavioural development. The DTI, MRI and fMRI methods enable researchers to distinguish between age-related and performance-related changes in brain development.

> Imaging has helped to move the field of cognitive development beyond questions of what develops and when, to how these changes may occur (Amso & Casey, 2006 p.24).

The studies in this section are endeavouring to reveal more precisely the nature of the relationship between genes and environment and neural and cognitive development. The interplay is complex and there is still much we do not understand. While they show that environmental factors interact with and influence some neural development in various ways, they do not (at least at this point) provide evidence for a line of causality that enriched environments enhance brain development in normally healthy children.

It is not surprising that this field has attracted considerable controversy as various disciplines, researchers, educationalists and policymakers seek to draw implications for their particular fields. Quartz and Sejnowski (1997), after reviewing a large body of evidence, suggested a neural constructivist approach to explain brain growth that:

> points to the interaction between cognitive and neural processes in development, suggesting that cognitive and neural levels of description will need to be integrated into a single explanatory framework (p.555).

Interestingly, Maguire et al's (2000) study of experienced London taxi drivers demonstrated, through structural MRI techniques, that they had enlarged posterior hippocampal grey matter when compared with the control group. We know experience results in learning, but as yet cannot be sure of an association with hippocampal development even though the results accord with the notion that the posterior hippocampus stores a spatial representation of the environment and can expand in people who have a high dependence on navigational skills. The jury is still out as to whether gains in cognitive activity are directly associated with measurable tissue change in the brain.

2.4 Some concluding reflections

There is much interest in research into early childhood development because of the outcome studies referred to at the beginning of this report, and because of advances in the neurobiological, behavioural and social sciences. Parents are anxious to know if there are things they can do to enhance their children's capacities to learn and succeed. Policymakers and educators want to know which interventions will

produce the best outcomes for most children over time. There is much at stake.

This summarised review of the research on the science of early childhood development indicates that, although there is a growing body of research in this area, we are just at the early stages of understanding the nature of brain development in young children and its implications. The new bedfellows from a range of disciplines are still in the process of familiarising themselves with each other and learning to speak a common language. Beyond them are well-intentioned advocates, who, in a liberal democracy, take up arguments to support their cause. The pressure is on.

It is clear from this review that, for some, the temptation to claim early research as though it was proven fact has proved too beguiling to resist. It is important, though, to distinguish between over-claim at the margins and the substance at the heart of the research. It is possible to highlight the need for investment and intervention in family and early childhood policies, without minimising the needs of other age groups and claiming suggestive data as fact.

It is reasonable to state from this overview of the literature that there is an exciting body of research in brain development in children and its implications, which is deepening our understanding. This research has highlighted the critical foundational experiences children undergo as they acquire language, progress emotionally and socially and develop their regulatory and moral capacities, particularly in their family environment.

The literature is unequivocal in stating the need to provide loving, safe and secure environments of care for developing children at home and elsewhere, including childcare settings. There is persuasive evidence that where babies and young children are placed in danger or are subject to ongoing fear and stress, development is likely to at least be constrained and at worst be substantially impaired. Neglectful environments can be damaging to children and arrest development. This may well have significant implications for social outcomes and contribute to the persistent 'tail' in New Zealand's social indicators. This knowledge should help us to design more effective interventions by focusing on improving the child's environment, as well as the interactions between the child and the caregiver.

The notion of sensitive or critical periods of development found support in the literature for programmed genetic brain development that is species-typical, such as the acquisition of sensory skills, motor skills and language, but even parts of this development continue well beyond childhood. However, the other aspects of brain development are largely experience-dependent, and though important foundational structures are developed during the early years, they take place throughout life, and enable the individual to adapt to their daily environment. It follows from this that the 'use it or lose it during the first three years' notion of brain development is exaggerated. The early years provide extremely important foundational learning, but that should not lead to a view that interventions should be only focused on the early childhood years.

The literature does not really offer a clear answer as to whether enriched environments stimulate greater neurodevelopment in children who live in normally safe, secure and loving environments. Our neuroscientific knowledge in this complex area of gene-environment interplay is still developing, despite clamorous claims to the contrary. While research shows that environmental factors interact with and influence some neural development in various ways, it does not (at least at this point) provide evidence for a line of causality that enriched environments enhance brain development in normally healthy children.

The cognitive development of children, as distinct from their neurodevelopment, in normal safe and healthy environments, on the other hand, can be expected to benefit from particularly targeted stimulation. Other positive outcomes and life skills can also be enhanced by particular stimulation, such as educational achievement, emotional and social development. Children in neglected, stressful and in other ways deleterious environments, whose neural development has been impaired, can be expected to benefit from a more enriched environment that provides their genetic potential with the safe and loving surroundings in which to flourish.

Finally, this field of study is rich with potential. With luck, the debates in the literature will help the differing research and policy communities to be more reflective and tread more warily.

3. FACTORS THAT ENHANCE OR HINDER OPTIMAL DEVELOPMENT

This chapter focuses on a selection of developmental domains in young children in order to explore some of the factors that enhance or hinder optimal growth. The domains selected for closer examination are visual development, self-regulation, the acquisition of language and number and the implications of neglect and developmental trauma[6] for development. They include both experience-expectant and experience-dependent types of neural development. Mention is made of important research findings that throw light on the types of experiences and stimulation that ensure healthy development in young children, and those that do not. They also show that early trauma leads to impaired or abnormal development, which can result in impaired intellectual, emotional and social functioning.

3.1 Visual development in children

While the basic 'wiring' for visual development is innate, the development of the visual system requires the experience of the visual world (Maurer & Lewis, 2001). It is therefore an experience-expectant type of development with critical stages. There are two important requirements for proper early visual experience, and they are firstly that the eyes form clear images (Gwiazda, Bauer, & Held, 1989) and secondly that both eyes are stably aligned so that they send non-conflicting images to the brain (Tychsen, 2001).

From clinical studies of infants with cataracts, it is known that the most serious damage to acute vision results from persistent, continual deprivation of clear images during the earliest phase of rapid development (Maurer & Lewis, 2001). The cataract acts as a filter, stopping sharp, detailed images while transmitting only the blurriest images. If the deprivation caused by a cataract in one eye is corrected by a combination of surgery, optical correction and patching therapy by the age of seven weeks, the child is likely to develop good to excellent acuity of vision. If the therapy is delayed beyond this interval into late infancy, the best acuity attained is no better than the level of legal blindness (Tychsen, 2001).

Infant depth perception, where both eyes are synchronised, also has a similar critical period.

> Three-dimensional vision (3-D vision) (ie steriopsis) is not present at birth. It develops abruptly in typical infants between ages three and five months as it reaches adult-like levels of performance (Tychsen, 2001, p.69).

Full depth perception depends on binocular discrepancy – a slight difference between what two eyes see gives the sensation of seeing in three dimensions. If misalignment is constant and persists beyond 60 days during the first nine months, then restoration of robust 3-D perception is unlikely, even though motor alignment of the eyes is corrected (Wright, Edelman, McVey, Terry, & Lin, 1994).

It is clear from these two examples that the genetic potential in children for normal visual capability requires constant visual interaction with the child's environment within a finite time period. Where there are physical problems that dilute that interaction, the problems need to be attended to speedily if the child's development is not to be impaired.

The newborn infant is not very responsive to visual events, though their gaze may be attracted by slow-moving objects. The major communication by the infant to the caregiver is crying or distress, which the caregiver can be expected to alleviate. The newborn interacts in the demanding cycle of distress-soothe-sleep-distress. The normal two-to-three month-old seems to actively seek stimulation, often smiling in response to it. At this age interactions have moved from the sequence of distress-soothe-sleep-distress to longer waking and alert periods, along with interest and pleasure in the caregiver and the environment (Posner & Rothbart, 2007). By four months, infants look from place to place to explore their visual environment. In this way they learn about their physical world and develop their ability to orient to sensory events.

If, however, the child's needs are not reliably met in a timely fashion, and the child is not soothed, stress levels in the child rise and other maladaptive cycles begin to be established. As noted in the previous section, the amygdala will respond automatically, overriding the cortex by flooding the young child's brain with cortisol. Prolonged stress can escalate cortisol

[6] The term *trauma* in this context, refers to the subjective psychological experience of neglect, and other events, or series of events that impair neural and cognitive development. These events include neglect as well as stress and abuse. Low-level stress and neglect have effects which are not often recognised in public policy. This paper uses the term *trauma* to cover all of these influences.

levels to a threshold where they damage the developing neurotransmitter systems (Gunnar & Donzella, 2002). It follows, then, that this phase in the establishment of responsive relationships between parent and child is very important.

As the world comes into focus, vision plays an increasingly important part in relationships. During the first few years of life, infants and toddlers gain control of their behaviour and mental state through their senses and their relationships with others. They look to seek approval from their prime carers, and this continues into toddlerhood and later childhood. Infants seek to please their prime carers and thus, like older children and adults, they gain a degree of regulation over their emotions, thoughts and actions (Cozolino, 2006; Gerhardt, 2004).

The system through which this control is exercised is the *attention system*. It is developed through the interaction between infant and caregiver, and leads to the impressive self-control needed for schooling (Posner & Rothbart, 2007). Attention networks are central to children's ability to regulate their emotions and behaviour. The basic mechanisms of attention are developed from three to six months, and preference for novel objects seems to arise along with visual pathway development related to object recognition, which occurs at about four months. Over time this develops, so that by 18 months the young child becomes adept at using the attention of the caregiver for his or her own education, and learns to associate new words with objects in combination with the speaker's attention (Baldwin, 1991). Maturation is advanced by the presence of the primary carer.

In adults the attention system has been explored by neuroimaging techniques. It includes several distinct networks of brain areas that perform the functions of acquiring the alert state (alerting network), orienting to sensory events (orienting network) and maintaining continuity of behaviour when distraction could be called for (executive network) (Posner & Rothbart, 2007). This last network provides the basis for voluntary behaviour, which in turn is closely related to socialisation and school success.

The preference for novel objects and locations in the visual field means that attention is drawn away from those that are already familiar. This particular bias is referred to as *inhibition of return* (IOR) (Harman, Posner, Rothbart, & Thomas-Thrapp, 1994). In adult studies, when subjects were asked to orient their attention to stimuli arising in one visual field, blood flow in the areas of the visual system processing this event increased, and scalp electrical activity was also enhanced about 100 milliseconds after the target was presented. When asked to attend to the colour, form or motion of the stimulus, only those areas of the brain that process these aspects showed blood-flow swell (Corbetta & Shulman, 2002).

> Novel objects have three distinct effects on attention. First, they lead to faster and more reliable orienting. Second, they activate alerting systems that lead to increased alertness via the norepinephrine system, and third, they lead to an effort to develop a new object file that will code the novel event (Posner, Rothbart, & Di Girolama, 1999, p.68).

However, if the same stimulus is presented for a long period or introduced repeatedly, there is a reduction in sustained orienting and *habituation* results (Spelke, 2004).

These same effects are seen in infants of four months. The genetic plan for development of the visual system includes a critical role for exposure to the visual world. It is very important for the normal maturation of the visual system that the infant comes into contact with both familiar and novel visual events.

3.2 Developing self-regulation

The early life of the infant is concerned with the regulation of their emotional state, including distress. During their first year of life, considerable attention is given to developing this form of control. At the same time, infants also develop self-soothing mechanisms such as relying on a cuddly blanket or toy.

During the first three months, holding and rocking are generally the preferred method of soothing an infant. Parents often try distraction as a regulating technique from this time. The infant also actively solicits the attention of the adult and, as time progresses, control of regulation activity passes from the adult to the infant. Mischel and his colleagues (Sethi, Mischel, Aber, Shoda, & Rodrigues, 2000) found that toddlers' use of distraction strategies in an arousing situation was positively related to their later delay of gratification at age five.

Caregivers play an important role in helping infants learn to moderate and regulate their emotions

and cognition through simple eye movements and distraction strategies, for example, to which the child responds. Where the caregiver fails to be involved in teaching the moderation and regulation of emotions in a reliable and timely fashion, the child misses the development of a deeply ingrained pathway to self-discipline (Izard, 1991; Thompson, 1998).

The child's ability to resist attempts at control from their carers gives rise to our feeling that toddlers, unlike infants, have a mind of their own. The second year of life ushers in a period of development that is critical for the child's ability to participate in the school experience. They develop executive attention processes, such as selection and inhibitory control, which can be applied to learning the complex skills taught in school. They learn to anticipate when looking, and to resolve conflict between what they appear to see and what they anticipated. This is part of the development of the anterior cingulate and the executive attention system (Berger, Tzur, & Posner, 2007).

If attachments are jeopardised in early childhood, or if the child is not helped to reduce stress through a comforting caregiver, they can become vulnerable to various psychopathologies which can impact on their lives during childhood and into adulthood (Cozolino, 2006). Their reduced capacity to regulate their emotions and cognition means their likelihood of finding dysfunctional solutions to emotional dilemmas is increased. When an individual's capacity to manage their own feelings has been impaired by having poorly developed emotional systems, they become vulnerable to behaviours and responses which are self-harming or damaging to relationships with others (Anderson, Bechara, Damsio, Tranel, & Damiso, 1999; Mazza & Reynolds 1998).

Emotional intelligence is learnt with others and from others. Goldberg, Muir, & Kerr's (1995) work on insecurely attached children found that around 35 percent of children were insecure in a variety of cultures. They had difficulty in managing feelings well. It can be inferred that adults who have responsibility for children need to be aware that children are dependent to a very large extent on their input to help them learn to moderate and direct their emotional responses.

Paradoxically, people need to have a satisfying experience of dependency before they can become truly independent and self-regulating. The 'fight or flight' response to threat is at the basis of this development. A baby can do very little to regulate itself other than to cry louder (fight) for attention or withdraw mentally (flight). Both fight and flight are accompanied by the stress hormone cortisol (Gerhardt, 2004). In time, under normal circumstances, they develop executive attention processes which enable greater self-regulation on the one hand, and early experiences of self-determination on the other.

Feelings are both biologically and socially determined. As feelings happen and are experienced as thoughts, psychological changes take place in the person's nervous system, endocrine system and other systems. If a child articulates those feelings and they are then pushed away, an important source of regulatory feedback is lost and the opportunity to gain some control over the duration and intensity of feelings disappears. There is good evidence that the parenting environment influences the developing patterns of neural connections that underlie infant behaviour in this manner (Dawson, 1994).

Whereas the orienting network develops most strongly in infancy, the executive attention network develops from two to seven years of age. Training studies suggest the possibility of improving the network before the child is seven (Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005). At four and six years of age, five days of training produced more adult-like performance than was found in the control group.[7]

Experience can shape the neural networks underlying the brain's attention system and modify the efficiency of network performance. As with training following brain injury, attention in children can be taught. Effective devices for the youngest children in Hungarian kindergartens were observed by Mills and Mills (2000). The most common were eye-contact exercises and 'stop-go' games in which children, when pursuing different activities, must listen for specific signals (such as a drum beat) and stop the activity. All sorts of listening and auditory games were observed for slightly older children.

Adults who attend to the needs of children at home are in effect training them by the repetition of regular patterns in daily life. Repetition and regularity play a very big role in learning, so that the effect of novelty is

[7] Encephalogram recording data also indicated that activity in the anterior cingulate of the executive network was altered by the training.

reduced, and recovery occurs when something new, but related, happens. For example, a child who notices a flower in a vase a number of times, upon seeing one growing in a garden, recalls the first one.

Posner and Rothbart have underlined the importance of the nature of attention for children's development:

> Even if psychological science has shown that most learning is domain-specific, the unique nature of attention as a critical aspect in all domains of explicit learning supports its use as a preparation for schooling. We believe a strong national priority should be given to adopting the best and most appropriate methods to assist all children in the important goal of self-regulation (2007 pp.118,119).

3.3 Learning language and the acquisition of number

Infants come into the world with the capability to discriminate among phonemes[8] in all of the world's languages. If one phoneme is sounded over and over again its novelty effects are reduced, and recovery occurs when a different phoneme is heard. This is evidence of auditory discrimination. However, this ability to discriminate unfamiliar sound units from familiar ones begins to disappear when the sounds to which the infant is exposed solidify around prototypical phonemes in the language (Werker & Yeung, 2005). Children learn the phonemes to which they are exposed, and between six to 10 months there is considerable shaping of the phonemic structure (Kuhl, 2000).

Infants raised in one language, for example, can maintain their ability to discriminate phonemes in a foreign language, if exposed to a speaker of those sounds during this six to 10-month period. However, this discrimination does not occur if the child is exposed to a video rather than an actual person (Kuhl, Tsao, & Liu, 2003). These experiments show that the infant's auditory system is being trained by the speech patterns of their community. Studies with infants have demonstrated the effectiveness of this training by measuring and recording changes in scalp-recorded event-related potentials (ERPs)[9] that take place after a change from a frequent to an infrequent phoneme (Cheour et al, 1997; Guttorm et al, 2005).

The effectiveness of caregivers in establishing for children the phonemic structure of their native and additional languages has also been examined. It is possible to predict later difficulties in spoken language and in reading from these recordings. Furthermore, through these methods of electrical recording, it is possible to check for the development of a strong or weak phonemic structure.

However, it should not be assumed that the learning of all skills will be the same. The acquisition of number, for example, tells a different story about skill development during early childhood. Children begin to learn to count in a primitive way about the same time as their language explosion, at about two years of age. The earliest abilities for addition and subtraction can be found even in infants of a few months, who have long and surprised looks when their expectation of object number in a hiding game is not fulfilled (Wynn, 1992).

Recent studies have examined the understanding of number through the ability of humans and other organisms to know something about quantity, even without verbalised counting. Objects are automatically evaluated for location, identity and emotional power and sets of objects at separate locations give rise to an impression of quantity or number. This primitive understanding of quantity is present in infants. It has been found that infant brains, like those of adults, showed strongly increased activity over frontal electrodes when the answer was wrong. It is the same area of the brain that self-regulates in adults, which supports the notion that a violation of expectation is involved for the infant as for the adult (Berger et al, 2007).

There have been empirical efforts to train number comparison in low socio-economic status children at risk of failure in primary school arithmetic (Griffin, Case, & Siegler, 1995). In the Right Start Program the idea was to train the concept of quantity as part of learning to play a variety of games. Evaluative studies suggest that this learning allowed children at risk to succeed in elementary school arithmetic and perform about as well as children of high socio-economic status, who were likely to have had more parental tuition.

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[8] Phoneme: any of the units of sound in a specified language that distinguish one word from another.

[9] An event-related potential (ERP) is any stereotyped electrophysiological response to an internal or external stimulus. More simply, it is any measured brain response that is directly the result of a thought or perception.

3.4 Neglect

The research covered in this section so far has pointed to significant behavioural interactions that enhance the developing young child and enable him or her to gain visual, regulatory, linguistic and numerical control. Absence or neglect of these types of behavioural interaction will hinder or retard such development. Neglect in this sense can be malicious, but it can also be, and probably most often is, the result of other stresses and demands in a parent's life, or of disarray or ignorance (Dubowitz, Black, Starr, & Zuravin, 1993). In many situations, the lack of adequate childrearing information, skills or resources contributes to neglectful situations. It is not confined to any particular socio-economic group. The extent of damage caused by inadequate nurture and neglect rests in the fact that cognition is directly affected by social emotional and physical events.

> Neglectful parents may not be aware that their actions (or lack of actions) are of a sufficient degree to potentially result in harm to the child (Perry, Colwell, & Schick, 2002, p.193).

It is quite clear that any severe social isolation will have negative effects. There are many historic examples of this from institutional care (one example of which is referred to later in this chapter) and, on a continuum from neglectful to adequate care, all different degrees of harm may occur. This raises the issue of how we define and study neglect.

De Bellis notes that "child neglect is the most prevalent, but least empirically studied, form of child maltreatment" (2005, p.150). According to Perry et al it is the least studied and most poorly characterised form of child maltreatment. This, he says, is due to multiple factors, including the difficulty in defining and documenting neglect of children. In a broad definition, neglect is any failure to provide for the basic needs of the child. For example, the child's ability to link feelings and words does not come automatically, but relies on the initial relationship between baby and parent, and later social relationships (such as staff at childcare), to build connections between the separate neural networks dedicated to language and emotional disposition.

Hart, Binggeli, & Brassard (1998) say that neglect is a form of maltreatment that involves acts of omission as distinct from acts of commission. Kairys, Johnson, & Committee on Child Abuse and Neglect (2002) refer to it as failing to provide for the emotional, behavioural, physical or educational needs or problems of children. They state that with other forms of maltreatment, it can have adverse effects on emotional health, including low self-esteem, anxiety and depression; social skills; learning; and physical health.

Developmental traumatology is a relatively new area of study that looks at the psychiatric and psychobiological impact of adversity on the developing child. It synthesises knowledge from developmental psychopathology, developmental neuroscience and stress and trauma research. We are still at an early stage of disentangling the influence of neglect from other factors, influencing the regulation of biological stress systems and brain development.

Psychobiological studies of child neglect are only just emerging (De Bellis, 2005). Functional MRI studies of anxiety circuits in neglected children may help our understanding of the neuromechanisms of anxiety-driven aggression in neglected children, who express fearful behaviours in tandem with increased heart rate, blood pressure and cortisol levels (LeDoux, 1998b).

However, in relationships where the needs of the child are continually ignored, the developmental damage can be severe, chronic and irreversible (Perry et al, 2002). At the same time, the child may be learning that their role in the family group is tenuous, their existence is unnecessary and their future survival is in question. For this reason, to be ignored is possibly worse than to be abused in other ways. In this sense, neglect is abuse.

Neglect in the earliest period of life may lead to severe or chronic damage. When a child is neglected, their development is disrupted. Without remedial interventions, the deficit stays with the child into the next stages of development and negatively influences subsequent growth. As a result, problems can multiply. The foundations for later healthy growth and development can be damaged (Perry et al, 2002).

It is not an easy task to separate out the influence of neglect factors on development from the other forms of maltreatment; consequently, there are few published cross-sectional studies that examine the neurodevelopmental consequences of neglect. There are ethical issues as well. For example, it would be unacceptable to seek out a sample of neglected children and keep some of them as a control group while others are assisted.

Cultural norms about neglectful behaviour vary from society to society, or within a given society, and change over time. In Laotian, Cambodian and many Pacific societies, for example, leaving an infant in the daylong care of seven- or eight-year-old siblings would be expected rather than considered neglectful, whereas in contemporary industrialised society, both the infant and the seven- or eight-year-old caregiver child would be judged as neglected (Korbin & Spilsbury, 1999). These culturally specified norms for neglect tend to be based on the society's experiences of risk to the physical safety of the child in their communities, and does not consider any impact of these behaviours on development.

McKenzie and Trocmé (2003) have analysed the ratio of reported cases of neglect in Canada to those which are investigated and no further action taken. This occurs when the child protection service investigates but does not intervene because the damage done is below a specified threshold. They noted a low number of neglect cases were reported, and among cases that were reported, the percentage reporting serious harm was also low. Public investment in these families who were consequently perceived to be at less risk of serious harm was low, and as a result a blind eye was turned to the damage to these children. Many of the categories of neglect already noted are likely to fall into this 'lower-level group'. They suggest that:

> A shift requires both a new public role for child welfare services, and a continuum of services that place more emphasis on both earlier forms of intervention and networking with other formal and informal community services (p.69).

The outcomes of neglect depend upon the timing, nature and duration of the neglect and of the remedial and enrichment experiences provided to address the deficits (Evans, 2002; Perry, 2004). The recent tragic examples of severe neglect and deprivation in many Eastern European orphanages add to our understanding of the crucial need for adequate emotional, physical and cognitive stimulation during childhood. To take one well-known example, one half of a group of 111 Romanian children were adopted before they were six months old and half were adopted between the ages of six months and two years. All the children came from very emotionally and physically deprived institutional settings and they all had significant developmental delays. Four years after being placed in enriching and secure environments the children were re-evaluated and, while both groups improved, the younger adoptees had significantly greater improvements in all areas examined (Rutter & the English and Romanian Adoptees Study Team, 1998).

No adopted children were found to be unattached to their adoptive parents, despite drawn-out residence in the state-run orphanages. It was found, though, that the quality of the attachment varied depending on the length of their orphanage stay. For those adopted after their first birthday or later, one-third of the attachments were insecure, and, although the children were capable of warmth, they were often characterised by disorganised insecurity. Parents of these children reported greater levels of parental stress, with less ability to create a warm and responsive environment in their home. The study showed that the duration of institutional deprivation was a predictor of the children's psychosocial difficulties (Thompson, 2001).

Perry and Pollard (1997; Perry, 2002) also found substantial improvements in children who had been removed from severely neglectful environments and then placed in foster care. The frontal-occipital circumference (FOC) (considered to be a reasonable measure of brain size in children) of the neglected children was measured at the time of removal and again a year later and compared with the norms for the same age. At the time they were moved, their measured FOC showed the group mean to be below the fifth percentile. After a year, they demonstrated a recovery of function and percentile increases in their FOC measures. As with the Romanian orphans, the recovery was more robust the less time they spent in a sensory deprived environment. The group mean for those removed in their first year moved up to the 27th percentile, those removed in their second year to the 22nd percentile, while those removed in their fourth year just reached the sixth percentile.

Chugani (2001) applied neuroimaging fMRI techniques in another study with neglected Romanian orphans. They demonstrated decreased metabolic activity in the orbital frontal gyrus, the infralimbic prefrontal cortex, the amygdala and head of the hippocampus, the lateral temporal cortex and the brainstem. These findings suggested functional abnormalities in cognitive, emotional, behavioural and social functioning.

These studies and similar studies are stark reminders of the life-long impact of deprivation in the earliest years, but are also a powerful illustration of the beneficial effects of early intervention in cases of serious neglect.

Sometimes other, more indirect types of behaviour and stress that expose children to harm done to others are referred to as neglect. Chamberland et al (2003) state that:

> Domestic violence, or spousal abuse, is an indirect form of psychological maltreatment of the child, because it can compromise the child's feeling of physical and psychological security (instability of emotional surroundings). Exposure to violence against a loved one can thus be a form of indirect terrorization (p.65).

Onyskiw (2002) found that children exposed to family violence had lower health status, and more conditions or health problems which limited their participation in normal age-related activities, than children in non-violent families. In addition, more child witnesses of family violence used prescription medication than children not exposed to violence at home. This is a form of emotional neglect or abuse.

Events that pose an actual or perceived threat to the individual activate a stress response, as in the case of children witnessing the abuse of a parent. During the traumatic event, the child is forced to mediate the adaptive responses – emotional, behavioural, cognitive and psychological changes – necessary for survival (Perry & Pollard, 1998). In some cases, if the situation is repeated, the stress-response systems do not return to the pre-event homeostasis. In these cases, the symptoms become so serious and disruptive that they reach the level of clinical disorder. Perry includes among these cases of post-traumatic stress disorder (PTSD), seen in children exposed to chronic neurodevelopmental trauma.

It is important to recognise when addressing these issues that attachment is an essential precondition for healing, and the strong emotional bond between the child and the primary caregiver (usually, though not necessarily, the mother) during childhood has a crucial impact on the child's capacity to form and maintain healthy emotional relationships. If the caregiver had attachment problems with their own parents, she or he is more likely to parent poorly (Perry, 2004). For the cycle to be arrested, it is necessary to provide enriching and nurturing early experiences and interventions to help those who are currently neglected, and education and support for the parents and caregivers to reduce the likelihood of neglect in the future.

There is a moral distinction between a caregiver's ability to meet the financial aspects of care where there is poverty involved, and calculated reluctance or refusal to give care. However, all neglect, intentional or unavoidable, has consequences. This raises important public policy issues because wherever the emotional, educational, psychological and vocational achievement of young people is hampered, their *contribution* to the functioning of society is hampered also, and they are more likely to call on public resources in the future. Social development, educational, health and judicial policies play a significant role in enhancing or hindering both unintentional and deliberate neglect.

The foregoing studies have stressed the importance of the quality of the relationship and interactions between parents or other primary caregivers and the child for healthy growth and development. In a secure, predictable and loving environment, the young child lives in a responsive set of relationships that help stimulate, regulate and order learning and socialisation. In this type of family environment, a multiplicity of factors encourage and enhance positive development. Where families are unhappy as a result of abuse, stress or neglect (or even seriously inconsistent interactions), elements of children's development and learning can be either missed or slowed down.

4. SOCIO-ECONOMIC STATUS AND EARLY CHILDHOOD EDUCATION (ECE) STUDIES

Low socio-economic status and poverty can be a cause of the sorts of inadequate conditions that create obstacles for children's development, as the associations of low socio-economic status (SES) with poor health, low educational attainment and crime attest (Acheson, 1998; National Health Committee, 1998; Crampton, Salmond, & Kirkpatrick, 2000; Dunn, Hayes, Hulchanski, Hwang, & Potvin, 2004; Kawachi & Kennedy, 2002; Kawachi & Berkman, 2003; Waldegrave, King & Stephens, 2004). The levels of stress, depression and hopelessness families experience as they struggle to get themselves the necessary resources to live reasonably can mean that they cannot afford, materially or in terms of time, a richly stimulating environment for their children. The levels of stress may be such that parents cannot give their children the regular, consistent attention that most enhances brain development. This is not to imply that low-income parents are unable to adequately parent their children, but the pressures they experience are more likely to create significant stress than the pressures on those with greater resources. Parents benefit from support that enables them to balance demands – the needs of their children and the circumstances of their own lives.

The impact of economic distress on parents' lives can shape children's lives. Low-income parents are at greater risk of depression and other forms of psychological distress, because they experience more negative life events and have fewer resources with which to cope (McLeod & Kessler, 1990). The connection between economic hardship and mental health is important because poor mental health can be related to unintentional harsh, inconsistent and detached parenting.

The link between poverty and diminished outcomes is well illustrated by a stressful life event, such as a premature birth. The premature infant born to a lower-income mother with few resources who receives poor prenatal care is likely to have a much more difficult neonatal course, and therefore be at higher developmental risk, than an infant of the same gestational age born to a mother who received better prenatal care and has more resources (Saigal, Szatmari, Rosenbaum, Campbell, & King, 1991).

The interface of work, income and the care of children in low-income neighbourhoods is very challenging. It poses some of the most complex problems of contemporary society.

> Many of the well-documented risk factors that can impair early brain development are embedded in the experiences of poverty and malnutrition, illiteracy, violence, toxic exposures, and substance abuse ... it requires a vigorous public health approach (Shonkoff & Phillips, 2000, p.400).

A dramatic illustration of the impact of parental SES is provided by a study of children adopted between four and six years of age into families that varied widely in SES (Duyme, Dumaret, & Tomkiewicz,1999). This study directly addressed the question of the extent to which the environment (defined by the SES of adoptive families, as measured by the father's occupation) can alter the cognitive development of children who tested in the very low range before adoption (IQ between 60 and 86). All children demonstrated higher IQs after adoption, whether they were adopted by high-, middle- or low-SES parents. However, the children adopted by higher-SES families had statistically significant larger gains in IQ. This study illustrates the powerful role the quality of the environment plays in children's growth and development. Clearly, moving children from their parents because they are poor is not an acceptable public policy response. Policies designed to reduce poverty are.

Farah et al (2006) are involved in a research programme that is looking into how growing up in a low-SES household is associated with reduced cognitive achievement, as revealed in neurocognitive systems of the brain. They administered a battery of tasks designed to test specific neurocognitive systems of a healthy bimodal sample of low- and middle-SES children, who had been pre-screened for medical history and matched for age, gender and ethnicity. They found that higher SES was associated with better performance on tasks, as expected, but the difference was significantly non-uniform across neurocognitive systems. They found pronounced differences in left perisylvian (language) and medial temporal (memory) systems, along with statistically significant differences in lateral/prefrontal/working memory and anterior cingulate (cognitive control). Non-significant differences were found in occipitotemporal (pattern vision) and parietal (spatial) cognition. In short, they found:

> The association between SES and neurocognitive development is highly significant and varies

> significantly in strength across the neurocognitive systems tested. SES disparities in language and memory ability are most pronounced. Working memory ability also differs, along with a weaker trend toward differing cognitive control ability. Visual and spatial cognition were not found to differ significantly in this sample (p.168).

Wilson (2002) argues for an inclusive approach to the discussion around neuroscience and its impact on knowledge relating to brain development in the early years. While accepting the profound impact of growth during infancy and the early years, she criticises an exclusive emphasis on brain development as a cure-all. She argues for an interconnected and multidimensional approach to child health and welfare that alters the environmental factors we know to hinder brain development, including the elimination of poverty, for example. As the studies covered in this report suggest, this approach is well supported by the evidence.

We turn now to studies of enriched early childhood environments, where the aims are to achieve both a broad range of stimulating learning experiences and to create a sustainable route out of poverty. There are obvious ethical limits to experimental studies of groups of children in family and early childhood settings. Experiments can be laden with risk, and it is not acceptable to refuse services to a child in need in order to preserve their 'control group' status. However, there have been a number of robust longitudinal studies that have measured the effects of early ECE programmes. These programmes have been designed specifically to provide robust data on the effects of selected early childhood programmes on cognitive, social and emotional development.

It is important to note that these programmes evaluate the adult outcomes for children who in their pre-school years participated in these targeted programmes. They do not claim to provide information on neurodevelopment, but the learning outcomes are considered by the researchers to be the result of an enhanced learning environment. These improvements, which are noted in the following pages, are considered to be the result of high-quality ECE. As most of the children were in some way 'at risk' because of their intellectual development – low IQ and social development, or low-income households – the care, stimulation, predictability and family links created by these programmes are seen by the researchers to be responsible for the considerable school, career and social achievements of many of the ex-pupils. The ECE environments were all congruent with the directions of the research findings noted in the previous chapters.

There are numbers of such studies, but three stand out because of the high quality, intensity and comprehensive scope of the programmes involved, and the rigorous evaluations that have tracked the progress of the participants into adulthood. The evaluations have examined multiple effects on children, including educational, employment and social impact. The three programmes are the Perry Preschool Program,[10] the Carolina Abecedarian Project[11] and Chicago Child-Parent Centers.[12] Each involved low-income or 'at-risk' children, had intensive learning programmes with low teacher-pupil ratios and involved parents and families in their delivery.

Each programme has undergone rigorous evaluation, involving longitudinal studies, to assess educational and societal effects on the children involved. The Perry Preschool Study is a longitudinal follow-up of a randomised trial of 123 low-income African-American children with IQ scores between 75 and 85 points (according to Stanford Binet, the range for borderline mental impairment) and at high risk of school failure. Beginning at age three, half were randomly assigned to the programme and half were not (58 in the programme, 65 in control group). The groups were matched according to age, IQ, socio-economic status and gender. Children attend the programme for two-and-a-half hours a day, five days a week, from three years of age for a two-year period. The study has followed the children through to age 40. It has a case attrition rate of five percent across all measures. Five successive classes from 1962 to 1965 inclusive entered the programme.

The Abecedarian Study is also a randomised trial with a longitudinal follow-up. It has followed 104 children at risk in terms of intellectual and social development to age 21, from the original 111. The majority of the children were African-American (98 percent). From the total, 57 children were randomly assigned to the centre-based programme group and 54 to the control group. The groups were matched on high risk-index scores, gender and poverty. The typical mother in the programme was young (mean age 20 years),

[10] http://www.highscope.org/Research/PerryProject/perrymain.htm

[11] http://www.fpg.unc.edu/~abc/

[12] http://ideas.repec.org/p/wop/wispod/1126-97.html

unmarried, with less than a high school education, living in a multigenerational household and reported no earned income. Local service agencies and local parental clinics helped find potential participants. Unlike the other programmes, the Abecedarian Projects take in children in infancy as young as four months for six to eight hours a day, five days a week until age five. Four cohorts enrolled between 1972 and 1977 and have been followed since that time. At age 21, the retention rate was 93.7 percent.

The Chicago Longitudinal Study is a quasi-experimental study that compared 1,539 children from low-income areas who attended the Child-Parent Centers (CPC kindergartens) and who would graduate to 26 public elementary schools in Chicago with a control group of 550 children of similar socio-economic backgrounds, randomly selected from similar neighbourhoods, who attended alternative childhood full-day programmes. CPC programmes consisted of half-day pre-school at ages three to four years, half- or full-day kindergarten and school-age services in linked elementary schools at ages six to nine years. African-American children made up 93 percent of the total, and the remaining seven percent were Hispanic. They have been followed through to age 21. At age 20, 83.2 percent of the original sample had been maintained.

The Perry Preschool Program draws on Swiss psychologist Jean Piaget's approach to child development and applies it with practical experience-based learning. The curriculum focuses on skill development and child development. The skills include problem-solving, social co-operation and independent thinking. There is also an emphasis on literacy, maths, initiative and social relationships, creative representation, movement, music and logical thinking. Five learning strategies are employed that are designed to help children learn and develop. These are active learning, adult-child interaction, creating an effective learning environment, maintaining daily routine and providing child-observation assessments. The programme uses a Plan-Do-Review approach, which involves a daily process of children making choices about what they will do, carrying out their ideas and then reflecting on their activities with adults and peers. Teachers carry out child-observation assessments, which they record, and then plan experiences which will encourage the child's growth and development. Regular home visits are made by staff, who also provide parent education on child development and classroom learning reinforcement. This is a critical part of the programme – its purpose is to improve the stimulation available to the child in the home environment, and to combine this with emotionally warm engagement between the child and caregiver.

The Abecedarian Project has two age-based programmes, one for pre-school and one for school-age intervention. The primary goal of the pre-school programme is to create an educational, creative and structural environment to promote growth and learning and enhance school-readiness. The curriculum is designed to encourage cognitive and linguistic development and to provide an enriched language environment that is responsive to the children's needs and interests. The children receive nutritional food supplements, paediatric care and, with their families, supportive social work services that, like Perry Preschool, are designed to lift the stimulation and emotional tone of the home environment. When the children are three years old, they participate in a more structured programme.

The Chicago Child-Parent Centers are operated by Chicago Public Schools. Their curriculum focuses on the major developmental areas in young children: body image; gross motor skills; visual discrimination; perceptual-motor skills; arithmetic; and language. The pre-mathematic activities include colour and shape specification, matching and sorting and completion tasks. The language activities include both expressive oral tasks and receptive communication involving listening and understanding. Children also carry out tasks that involve sound discrimination, sentence-building, story comprehension and verbal problem-solving. Regular assessment of individual children takes place, and the results are used by teachers to develop programmes for children to further advance their development. The centres also run multifaceted parent programmes, supervised by a parent resource teacher, that include participating in parent-room activities, volunteering in the classroom, attending school events and enrolling in educational courses for personal development.

The parent programmes of the three organisations differ in emphasis. In the Perry Preschool Program, teachers visit each child's family for one-and-a-half hours per week. They recruit parents to support their children's development by encouraging their active and independent learning. The teachers encourage parental attachment, parental involvement and parental skills, and aim their interventions at parents as well as children to make them sustainable. The ongoing

home-school involvement enhances the socialisation and participation of parents. Parents also meet with other parents once a month in groups facilitated by programme staff.

The Abecedarian Project views child development as an ongoing process of interactions among the child, caregivers, the home, school, neighbourhood and societal forces. At later school age, the goal is to involve parents in their children's learning. Families are assigned a Home School Resource Teacher (HSRT) who serves as a liaison between the school and home for the first three years the child attends public school. Children also receive nutritional supplements and disposable nappies, along with paediatric care and supportive social work services as needed in both the intervention and control groups.

The Chicago Parent-Child Centers provide comprehensive educational and family support services from ages three to nine. Each parent is expected to dedicate at least one half-day per week to volunteer at the CPC. Their involvement is designed to accommodate parents' daily schedules and needs. A full-time staff member provides outreach services to CPC families. These services include recruiting families from the neighbourhood who are most in need of CPC programming; conducting home visits to families when children enrol and on a continuing as-needed basis; and referring families to community and social services agencies for matters such as employment training, mental health services and welfare. The outreach worker also provides transportation services to families when needed.

Each of the programmes clearly draws upon a comprehensive understanding of growth and cognitive development, which they employ to overcome the disadvantages their pupils begin with. They enrich the child's experience of learning and intellectual and social development with a vast range of intensive activities. They all employ techniques to tie emotionally warm school and home environments to sensory and cognitive stimulation. They also involve the primary caregivers and broader family in the programme to ensure the interventions are both effective and sustainable.

A comparative summary of the main outcomes of these evaluation studies is set out in Table 1. IQ was not measured in the Chicago study, but it was shown to exhibit a statistically significant increase at age five in the other two studies. This result was sustained at age 21 in the Abecedarian but faded in the Perry Preschool Study.

TABLE 1: Outcomes and cost-benefit analyses of the Perry Preschool, Carolina Abecedarian and Chicago Child-Parent Centers Programs[13]

	Perry Preschool	Carolina Abecedarian	Chicago Child-Parent Centers
Outcomes			
Increased short-term IQ	Yes	Yes	Not measured
Increased long-term IQ	No	Yes	Not measured
Increased long-term IQ achievement	Yes	Yes	Yes
Special education	37% v. 50%	25% v. 48%	14% v. 25%
Retained in grade	35% v. 40%	31% v. 55%	23% v. 38%
High school graduation	65% v. 45%	67% v. 51%	50% v. 39%
Arrested by 21	15% v. 25%	45% v. 41%	17% v. 25%
Benefit-cost results			
Cost	$16,264	$36,929	$7,417
Benefit	$277,631	$139,571	$52,936
Benefit/cost ratio	17.07	3.78	7.14

Sources: Barnett (1993, 1998); Masse and Barnett (2002); Reynolds, Temple, Robertson, and Mann (2002); Schweinhart et al (2005).

[13] Barnett and Akerman (2006).

Increased long-term achievement into adulthood proved to be significant in all three studies. Fewer programme participants required special tuition or were held back a year at school than non-participants. Fewer were arrested and more graduated from high school. The investment in these programmes paid substantial dividends, with a cost-benefit ratio ranging from 3.78 to 17.07.

Karoly (2006) summarised four main themes from these studies. The measured outcomes were educational attainment, employment and earnings, social service use and crime. The results are set out in Table 2. The unshaded cells indicate a statistically significant favourable result. The grey cells indicate where a measure did not find a statistically significant effect, and the black cells indicate that no measure of that domain took place for the particular programme.

TABLE 2: Measured outcomes and programme impacts for adult outcomes for targeted ECE programmes

	Adult outcome domain			
Programme (age at last follow-up)	**Educational attainment**	**Employment and earnings**	**Social services used**	**Crime**
Abecedarian (age 21)	Years of completed schooling ever attended 4-year college	Skilled employment		
Perry Preschool (age 40)	High school graduation	Employment Earnings Income	Use of social services	Arrests Arrests for violent crimes Time in prison/jail
Chicago Child-Parent Centers (age 21)	High school graduation Highest grade completed			Arrests Arrests for violent crimes

Source: Adapted from Karoly et al (2005) in Karoly (2006).

Legend

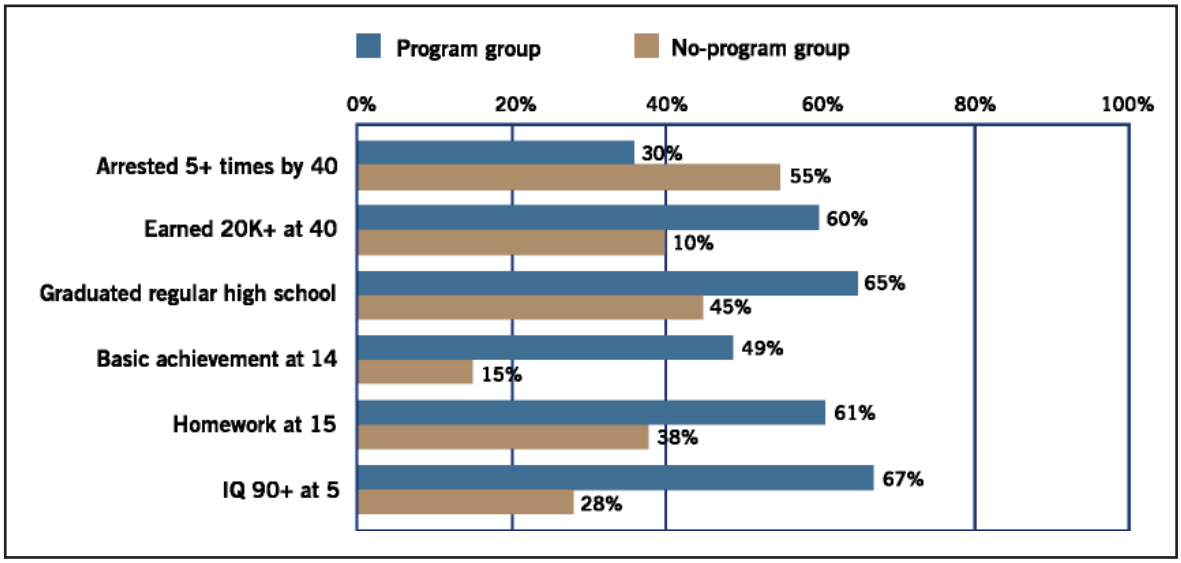
	=	Outcome measured and improvement in the listed indicator was statistically significant at the 0.05 level or better
	=	Outcome was measured but difference was not statistically significant at the 0.05 level or better
	=	Outcome was not measured

All three programmes demonstrated statistically significant results for educational attainment. The two studies that measured the employment and earnings domain found favourable outcomes. The Abecedarian Project showed no statistically significant results for the social service use and crime domains. However, Perry Preschool achieved statistically significant favourable results for all four domains. The Chicago Child-Parent Centers demonstrated a significantly positive result in the crime domain.

Figure 6 illustrates, for Perry Preschool, a range of statistically significant findings over different ages and their comparisons with the control group. The programme group were arrested less often, earned more money, did more homework at school, were more likely to graduate from high school, achieved more and had substantially increased IQ scores at five years.

Further work needs to be done to understand why Perry Preschool shows consistently good functional results, but no long-term increase in IQ (Table 1). It may be, as noted earlier, that IQ tests do not adequately measure social and emotional capacity even though these are often the foundation of good educational, employment and welfare outcomes.

FIGURE 6: Major findings: Perry Preschool Study at 40[14]



The results of these longitudinal studies are indeed interesting. While they do not record measured neurological changes, the findings demonstrate substantial gains in cognitive functioning and social development. They tend to confirm the broad hypotheses of this study that good-quality sensory and cognitive stimulation, combined with attention from reliable and responsive caregivers in families and educational institutions, can be expected to result in substantially improved educational, income and employment outcomes in later life. It is reasonable to infer that such programmes effectively stimulate both social and learning development. Furthermore, they have proved to be effective with low-income and at-risk children, which, on the basis of studies referred to earlier in this report, would tend to suggest there is likely to be some interaction between the improved learning environment and neural activity for the children, which in turn could be enabling recovery of some lost development.

Nobel laureate James Heckman (2006b) linked the research findings on development in young children with the results of these longitudinal studies and said:

> Early family environments are major predictors of cognitive and noncognitive abilities. Research has documented the early (by ages four to six) emergence and persistence of gaps in cognitive and noncognitive skills. Environments that do not stimulate the young and fail to cultivate these skills at early ages place children at an early disadvantage (p.1900).

[14] Schweinhart (2006).

Further support for this perspective can be found in the results of an important British programme of research (Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2004) on the effective provision of pre-school education (EPPE), which investigated the effects on children's development from ages three to seven years. In this longitudinal study, a wide range of information was collected on 3,000 children from 141 pre-school centres at ages three, four or five, six and seven years. The researchers applied standardised assessments and quality rating scales. They also interviewed parents and pre-school centre staff, and led case study interviews and observations. Social and behavioural profiles of the children were completed by pre-school and primary school staff.

The findings showed that the duration of a child's attendance at pre-school was important. It related to their intellectual gains at school entry and again at age seven. An early start, between ages two and three years, was linked to better intellectual attainment and being more sociable with other children. However, an early start in group settings before age two slightly increased behaviour problems for a small group of children at ages three and five years.

Pre-school showed particular benefits for children at risk of developing learning disabilities. At the start of pre-school entry, one in three children were at such risk, but by school entry this had reduced to one in five. The results also suggested specialised support for language and pre-reading skills could help children from disadvantaged backgrounds or for whom English was an additional language. Children from disadvantaged backgrounds did better in settings with other children from different social backgrounds than in settings where most of the children were from disadvantaged families. Pre-school did not eliminate disadvantage, but ameliorated its effects, enabling children to have a better start to school.

The quality of ECE was also important. It was observed and assessed in centres using standardised rating scales. Higher-quality ECE was positively associated with the intellectual and social development of the children. They showed more independence and reduced anti-social and worried behaviour by the time they entered school. Where staff showed warmth and were responsive to the individual needs of children, children made more progress. They also progressed more where staff had higher qualifications. Trained teachers working with children had the greatest impact and this was specifically linked with better outcomes in pre-reading and social development at age five.

Children also demonstrated better outcomes where the curricula in centres were balanced. Children in centres that placed particular emphasis on literacy, maths, science and environment and children's diversity (catering to children's gender, cultural background, abilities and interests) achieved greater subsequent academic attainment, especially in reading and maths at age six.

These findings are in accord with many other international studies. Smith et al (2000), in a substantial review of the literature on ECE, stated that:

> Attendance at early childhood education programmes is associated with cognitive gains and improved performance in school throughout the world.

> Social gains are reported mainly from intervention studies with high-risk children but the experience can help all children develop social competencies (p.3).

Smith et al also noted that *structural quality*, such as high staff-child ratios and staff wages, was associated with better outcomes for children. Likewise, *process quality*, such as good responsive teacher-child interaction and support and sensitivity towards parents, was also associated with better outcomes.

5. APPLICATIONS IN NEW ZEALAND ECE AND PARENTING PROGRAMMES

5.1 Introduction

In the previous chapters, key aspects of recent research on cognitive development and neurodevelopment, and their implications for families and young children's growth and development, have been discussed. The studies stressed the importance of the quality of the relationships and interactions between parents, other primary caregivers, early childhood educators and the child for healthy growth and development. This chapter will identify, to the extent possible, applications of this knowledge in the New Zealand ECE curriculum, the process for evaluating ECE and parenting programmes.

5.2 ECE provision

Though most children begin school around their fifth birthday, education is not obligatory in New Zealand for children under the age of six. In this section we will consider the curriculum framework for the majority of services that are provided for children before they enter primary school.

The number of children attending ECE services in New Zealand has been steadily increasing for children of all ages over the past 15 years. According to Ministry of Education statistics (2005a) the rate of increase has been greatest for children aged one, two and three years. In 2001, there were 171,333 children enrolled in early childhood services. Of Year 1 students in primary school, 91.3 percent had attended an early childhood service. In 2005, there were 185,528 children enrolled and 94.3 percent of Year 1s had attended an early childhood service. Participation had increased for children of all communities, and the increase is greater for children of lower socio-economic backgrounds.

Children can participate in ECE services on an all-day or sessional basis. The largest growth has been in all-day services. In 1998, enrolments in all-day services made up 42 percent of all enrolments; in 2005, this figure had risen to 60 percent. Some difference in SES and ECE participation remains: in 2005, 86 percent of children who attended a school in deciles one and two (from the lowest socio-economic communities) attended an ECE service before starting school, compared with 98 percent attendance by children who attended a school in deciles nine and 10 (Ministry of Education, 2006 pp.10,11).

The changes have probably been influenced by a favourable economic climate for parents who work, and to some extent the new policy developments in ECE, some of which will be noted below. The Government's 10-year strategic plan for early childhood education, *Pathways to the Future: Ngā Huarahi Arataki* (Norquay & Durbridge, 2003, p.8), has been very influential. Strategies have included increasing the knowledge and skill levels of early childhood educators, and developing a comprehensive national curriculum.

There has been a rise in the number of qualified ECE teachers. As kindergarten teachers have been required to be registered for some time, most of the unqualified teachers have been located in other parts of the ECE sector, where most of the growth has taken place. Over half of early childhood teachers were registered or qualified in 2007. Since children benefit from participation in high-quality ECE services, improvement in the quality of teachers can be expected to improve outcomes for children. Teaching is an important aspect of this quality, which is the result of *structural quality features* such as the ratio of trained adults to children, the number of children (or group size) and the qualification levels of teachers, and of *process quality features* such as teacher-child interactions and the educators' relationships with families (Smith et al, 2000).

Te Whāriki, copyrighted in 1996, is the curriculum upon which chartered pre-school education is now based (Ministry of Education, 1996). *Te Whāriki* is the bicultural national curriculum statement for the early childhood sector produced by the Ministry of Education. Its purpose is:

> to provide a curriculum framework that will form the basis for consistent curriculum and programmes in chartered early childhood education services (p.10).

It is founded on the aspiration that children:

> grow up as competent and confident learners and communicators, healthy in mind, body, and

spirit, secure in their sense of belonging and in the knowledge that they make a valued contribution to society (p.9).

There are four broad principles:

> Empowerment

> Holistic development

> Family and community

> Relationships.

These principles are interwoven with five strands:

> **Wellbeing – Mana Atua:** The health and wellbeing of the child are protected and nurtured.

> **Belonging – Mana Whenua:** Children and their families feel a sense of belonging.

> **Contribution – Mana Tangata:** Opportunities for learning are equitable and each child's contribution is valued.

> **Communication – Mana Reo:** The languages and symbols of their own and other cultures are promoted and protected.

> **Exploration – Mana Aotūroa:** The child learns through active exploration of the environment.

In its emphasis on wellbeing, belonging and the encouragement of active exploration of the environment, the curriculum is aligned with the essential elements of healthy brain development summarised in the earlier chapters of this report.

5.3 ECE services

Parents elect to involve their child in ECE and, if they live in a larger centre, they may choose from a range of mainly chartered services to suit them and their child best. Services offer different programmes; sessional or full-day programmes; home-based or centre-based programmes; and programmes for differing age ranges. In alphabetical order the main public programmes are:

> **Education and care services** – all-day or sessional services, including Pasifika immersion

> **Home-based services** – eg, Porse, Barnardos

> **Kindergarten** – staffed by a wholly professional teacher body with younger children and older children attending different sessions

> **Kōhanga reo** – a Māori language nest

> **Playcentre** – a parent co-operative operating numbers of sessions each week

> **Play group** – a group in which children play while parents meet regularly (these are not chartered, and are often groups where the mother-tongue is something other than English).

Many of the aspirations in *Te Whāriki* are expressed in the services' chartering requirements. As yet they are not mandatory.

The question arises as to whether the holistic emphasis of *Te Whāriki* supports optimal development in young children. Does it enhance cognitive development, and is it sensitive to the emerging findings from neuroscience about development?

In looking closely at the strands in *Te Whāriki*, one can see how it does contain elements which provide a foundation in the early stages of a young person's development. Strands one, four and five, which are chosen as examples below, particularly focus on areas pertaining to cognitive and emotional development.

Strand One – Wellbeing – Mana Atua. Children experience an environment where: their health is promoted, their emotional well being is nurtured and they are kept safe from harm (p.46).

Strand Four – Communication – Mana Reo. Children experience an environment where they develop non-verbal communication skills for a range of purposes; they develop verbal communication skills; they experience the stories and symbols of their own and other cultures; they discover and develop different ways to be creative and expressive (p.72).

Strand Five – Exploration – Mana Aotūroa. Children experience an environment where their play is valued as meaningful learning and the importance of spontaneous play is recognised; they gain confidence in and control of their bodies; they learn strategies for active exploration, thinking, and reasoning; they develop working theories for making sense of the natural, social, physical and material worlds (p.82).

The strands of the curriculum are designed to promote safety for children and, in a safe environment, encourage and nurture emotional expression. These are the safe and predictable environments that the research already mentioned states are necessary for

healthy development. They encourage the mastery of language as a mode of communication, while at the same time enhancing children's sense of identity and creativity. Exploration, thinking and reasoning all add to a child's confidence and mastery of their environment.

Te Whāriki emphasises the links between home and early childhood services, and between early learning and future learning at school. The introduction states that the document's starting point is the individual child, and goes on to emphasise the importance of the relationships and environments which children experience, and the social context in which learning takes place. In short, it is transactional and relational.

5.4 Evaluating ECE services

The ECE regulatory system articulates government expectations about the level of quality required in licensed ECE services. So, how is the quality of ECE services assessed? Are the ideals of the curriculum reflected in the practice settings, and are the services enhancing children's development?

The Education Review Office (ERO) has published its evaluation indicators and its explanations for them (Education Review Office, 2004). Its statement of belief about the important outcomes of ECE cites the following outcomes as the basis for action:

> confidence and competence as a learner as a result of active exploration

> confidence and competence as a communicator as a result of active exploration

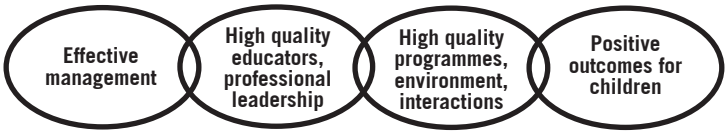
> a sense of continuity and belonging as a result of effective relationships and communication between home and the early childhood service

> a sense of wellbeing and contribution as a result of effective engagement with early childhood education experiences that challenge and stimulate children to learn, think and grow in confidence (p.4).

The ERO uses a metaphor which draws upon the links of a chain as its primary image (p.9). It is set out diagrammatically in Figure 7. The reviewers set about defining positive outcomes for children. They use the indicators to determine beliefs, practices and routines that are likely to support children's learning. They observe actions and interactions that can often be quite difficult to discern. The indicators are not employed as a checklist, but are used to:

> … give greater significance to what reviewers actually see and hear happening, than to the service's administrative and management systems – the focus is on the quality of what children actually experience (p.15).

FIGURE 7: Relationship between the chain of quality and the evaluation indicators



Contributing processes

> early childhood practice and beliefs

> activities of educators, managers, parents that contribute to children's outcomes

(What adults do)

Positive outcomes

> observable behaviour in children

> knowledge, skills, attitudes, dispositions for learning

(What children develop or demonstrate)

Source: Education Review Office (2004, p.9)

By way of example, ERO staff assess the three strands in *Te Whāriki* that emphasise activities pertinent to children's neural and cognitive development as follows:

Regarding wellbeing (Mana Atua), reviewers seek to find out if caregivers and teachers are warm and attentive to the children. They look for continuity of routine and personnel that are familiar to the children, for coherence from day to day and positive relationships between parents and teachers. Other indicators the reviewers seek information on are whether children are expressing happiness and taking pleasure in the company of others, making decisions, asking for things and choosing whether or not to participate. Other indicators are designed to assess if a centre fosters security and confidence in youngsters to take risks and to explore.

Regarding communication (Mana Reo), evaluators are required to be sensitive to the range of ways in which children communicate, and look carefully for the possible reasons when communication does not appear to be happening or is ineffective. They look for signs that communication, verbal and non-verbal, is initiated both ways (child to adult and adult to child), and that adults encourage both styles of communication. They look for dance, singing, dramatic play and painting, which all involve elements of communication. In their assessments, the reviewers also consider what the adults know about the communicative skills that individual children bring to the setting, what languages are spoken in the home and so on.

Regarding exploration (Mana Aotūroa), the evaluators seek the extent to which the early childhood service provides interesting and appropriately challenging learning environments and experiences. They look for skilled adults engaging with children to help shape and co-construct learning, and whether children are spending time in child-initiated play-based activities that help them consolidate prior learning experiences. Reviewers seek to find children having opportunities to theorise, investigate and explore in age-appropriate ways. They also check that teaching support is appropriately geared to a child's need for a lot of help or more autonomy.

Where the quality of a centre meets the approval of reviewers, it can be assumed that children's potential for development is being supported. Where there are concerns about appropriate provision of educational services, the reviewers indicate the sorts of changes they seek before the next scheduled review. These are then checked for progress and improvement. The key features of ERO's approach reflect the principles of participation, rigour and transparency, and in its reviews, ERO focuses on improving the provision of services.

There is no published analysis of the state of ECE in New Zealand as a whole by ERO. Such a survey would be invaluable for making a judgement about the current effectiveness of ECE in New Zealand. The evaluative assessments ERO carries out on early childhood centre and schools are, however, all published and are publicly available on its website. Below are five extracts taken from a range of un-named ERO reports from a variety of ECE settings. They serve to illustrate how the reviews aim to improve the quality of each service, and not merely to rate them. The comments are designed to help services know where to focus attention for future improvement of their educational provision.

> While this has been useful as they are learning the methodology and implementation, it results in the unit of inquiry being driven more by the teachers themselves than by the children's questions and interests.

> While goals from *Te Whāriki* are identified for each child being observed and planned for, these are not yet expressed in terms of children's learning outcomes or specific learning objectives.

> Session evaluations have yet to consistently incorporate what children learnt or achieved. While some note children's skills developed, these documents tend to focus on activities, what adults did or provided and children's involvement or enjoyment.

> Teachers use the resource *Kei Tua o te Pae – Assessment for Learning: Early Childhood Exemplars* as a basis for ongoing discussion and reflection when recording and assessing children's learning in the unstructured programme. Professional development in this approach is planned in 2007. Parents and children have easy access to individual portfolios and assessment files. These documents contain the child's voice, teacher annotations, learning stories, the child's work and parents' viewpoints. The different perspectives assist in building a comprehensive picture of the child as a learner.

> The team holds regular planning and evaluation (P and E) meetings at which each child's documented summary of observations is used to prepare an individual plan that records strengths,

interests, needs, relevant *Te Whāriki* goals and learning outcomes and strategies to meet that child's learning needs. The plan is published, displayed and made known to all parents during the implementation phase. Child experiences and achievements are added to the plan, which is evaluated at the next meeting.

ERO reports on individual settings or services, and the quality they provide, clearly varies. As with any monitoring, some of ERO's judgements are sometimes controversial. They carry out an important role, however, as monitors of the goals set in *Te Whāriki* and the overall quality of New Zealand's chartered ECE services.

5.5 The application of the new knowledge in the *Te Whāriki* curriculum

All chartered early childhood services are required to comply with the *Te Whāriki* curriculum and each provider is subject to an ERO report. *Te Whāriki* is a far-sighted document that has developed in step with the growth of knowledge in children's needs and potential, as expressed in cognitive development and neurodevelopmental research. Its principles of learning and development in early childhood, the strands, goals and learning outcomes are comprehensive, informed and inspirational (*Education Gazette,* 2002; Podmore, 2003). They offer clear, rich directions for anyone moving into the field or wanting to be innovative. They give space for the expression of cultural diversity and they support healthy brain functioning and development. They also have strong public support, and acceptance across the field of ECE providers.

Te Whāriki has been backed by a professional monitoring team in ERO, who have clearly adopted its philosophical underpinnings and developed indicators to ensure their evaluation programme reinforces the curriculum. The quality of delivery of programmes in any particular neighbourhood will vary because of differing staff competencies, access to resources, class size and parental involvement and support. The high level of transparent monitoring provided by the ERO, however, encourages higher standards and provides some considerable insulation from bad practice.

New Zealand continues to lack an overall national assessment of the effectiveness of the different ECE services, so it is not possible to draw robust conclusions about which types of services are most effective in enhancing cognitive development, nor which national features of the current services are most effective. It could be helpful to go beyond individual educational institutions towards some regional and national indicators. This is not to suggest the individual testing of children, but rather some themed analysis of what succeeds across regions and how that success can encourage success elsewhere.

5.6 Parenting education initiatives

This section will look briefly at a number of New Zealand parenting programmes funded or partially funded by the Government to see to what extent recent work in the cognitive development and neurodevelopment fields is incorporated into the programmes. These parenting programmes are largely, though not entirely, focused on medium- to high-risk or disadvantaged families. They have a 'boutique' style, reflecting the unique characteristics of the neighbourhoods in which they operate. A brief description will be given of each, and reports from reviews that refer to the application of research findings concerning healthy development will be outlined. Unfortunately, most of the evaluations tend to be small-scale and inconsistent, and lack rigour. They do, however, offer at least an insight into the sorts of applications of the new knowledge in parenting programmes in New Zealand.

The funded or partially funded programmes include:

> Whānau Toko I Te Ora

> Family Start (uses *Ahuru Mōwai* and *Born to Learn* curriculum)

> Parents as First Teachers (PAFT) (also uses *Ahuru Mōwai* and *Born to Learn* curriculum)

> Home Interaction Programme for Parents and Youngsters (HIPPY)

> Plunket national Parenting Education Programme called PEPE

> Supporting Parents Alongside Children's Education (SPACE)

> Early Start.

5.7 Whānau Toko I Te Ora[15]

Whānau Toko I Te Ora is an initiative delivered under the auspices of the Māori Women's Welfare League. It is developed by Māori and delivered by them to meet the needs of at-risk Māori families with a holistic child-centred focus on the first five years. There are three elements: home visits; education and learning; and group support. The main objectives are to promote and improve:

> positive parenting skills

> confident family functioning

> learning and development opportunities for children.

Local kaitiaki (managers) and kaiāwhina (support staff and role-models) with a good knowledge of the area informally approach the families needing assistance and 'walk beside them'. Medium- to high-need families are the focus of the initiative, and they number approximately 112 to 120 nationally. The programme links parents to others in the community, makes referrals to medical and social services when necessary, and provides support and models for the parents. The Ministry of Education reports that it reaches families who, on entry, present with high-risk indicators and are not linked into other available networks.

A modest evaluation study involving 16 case studies and in-depth interviews was carried out for the Ministry (Livingstone, 2002). Referring to high-need families, the report stated:

> Many caregivers had previously found difficulties in coping with their tamariki, and sometimes children were clingy and displayed signs of whakamā. Factors here were lack of emotional bonding; poor maternal health; overstress leading to depression; marital discord and abuse, with complications arising through absent, estranged or imprisoned partners, plus alcohol and drug addiction; excessive attention-seeking behaviour from disturbed children; and inadequate parental skills resulting in frustration, anger and yelling. For most whānau (at the time of the evaluation) these had begun to recede into the past (p.63).

Five specific features of this programme are considered central to its success. It is broadly based and established on goals negotiated with each individual whānau by the kaiāwhina working with them. It is incremental, so gradual self-motivated changes occur. It is targeted at those in major need. It is flexible, allowing the time of visits to vary and resources to be relocated to specific needs; and it reflects commitment on the part of those who help. They are admired for their dedication and service and they act as role-models for the participants.

The study noted that the living environments of some of the children had improved. For example, some adults ceased smoking. Two-thirds had improved housing, resulting in less crowding. Help with budgeting (a distinctive feature of this programme) meant that better financial management lowered the stress level in some of the families. Half the families had at least one child of pre-school age attending Kōhanga Reo. Marked increases were also recorded in parenting skills and confidence, which is one of the major objectives of the programme.

The evaluation focused primarily on basic survival, living and safety behaviours and choices, rather than the more complex patterns of interaction between parents and children. Nevertheless, progress on such issues increases security for children and encourages developmental processes.

5.8 Family Start[16]

Family Start has achieving better outcomes for at-risk families as its goal. Risks include educational, developmental and employment deficits, such as poor literacy or unemployment; social deficits such as violence or emotional difficulties; and physical or mental health deficits such as low birth-weight and chronic illness. It is a combined education, health and welfare initiative, aimed at the most at-risk families. It is a child-centred, home-based, family-focused early intervention parenting and support programme. The family or whānau worker acts as an advocate and co-ordinator between different agencies to help families access the range of services they need to help them. The main objectives are to:

> improve health, education and social outcomes for children

> improve parents' parenting capability and practice

> improve parents' personal and family circumstances.

15 For description see http://educationcounts.edcentre.govt.nz/publications/maori/whanau-toko.html

16 For description see http://www.familyservices.govt.nz/our-work/strong-families/family-start/about.html

Family Start is aimed at the 15 percent of the population at the highest risk of poor life outcomes, from the birth of a child for up to five years. Priority is given to families with children under the age of 12 months. Of the 843 families entering the programme between January 2001 and June 2002, 61 percent were still in the programme at the end of June 2002 and 38 percent in June 2003. The average length of participation is 13 to 15 months. It tends to be a transient population. The programme has been designed to attract people from all ethnic groups, and it is achieving this aim: of those participating in the programme 2,049 were Māori (56.2 percent), 1,048 were Pākehā (29.3 percent), 259 were from the Pacific Island Nations (7.1 percent) and 29 were Asian (0.7 percent). The remainder were of other ethnic origins.

Ahuru Mōwai and the *Born to Learn* curriculum have a central place in the Family Start programme. *Ahuru Mōwai* recognises and expands on the principles of *Te Whāriki*, the national early childhood curriculum. It is designed to help families and whānau to encourage their children to reach their fullest developmental potential. All Family Start workers receive one week's initial training in the use of the two *Ahuru Mōwai* and *Born to Learn* curriculum manuals. The curriculum contains well-researched information for sharing with parents about healthy brain development, child development, learning, parenting issues, play ideas and extra information on child-focused topics. It is designed for personal visits to families and whānau, where information can be individualised to suit the child and family. Visits can be of varying frequency, depending on the needs of the family.

The fundamental approach for Family Start workers is that the child is central to service delivery. Importantly, this means that while a family may have many concerns, the needs of the child for warm, responsive care and appropriate stimulation cannot wait for crises to pass. The needs of children and how parents are meeting them are the core focus of Family Start.

The March 2005 *Outcomes/impact evaluation of Family Start — Final Report* (Centre for Child and Family Policy Research Auckland UniServices Ltd., 2005) findings for the effectiveness of Family Start were mixed. Some of those interviewed for the evaluation felt that Family Start had been extremely effective in assisting families and supporting change, while others did not believe Family Start had been very effective at all. Some external stakeholders considered that Family Start had effectively increased mothers' confidence, improved parenting skills and elevated the status of children in the family. However, the review found that the focus on children tended to be lost on the adult or family when setting priorities.

Unfortunately, the evaluation had design limitations that meant the efficacy of the programme could not be fully assessed. The evaluation did not focus on the components of child development, but rather on the basic needs of families. However, the findings document a range of outcomes on child health and educational indicators such as immunisation (89 percent), Well Child visits (61 percent), involvement in ECE (22 percent, a further 12 percent in informal childcare) and caregivers participating in educational training programmes since joining Family Start (43 percent). Overall, the evaluation supported the view that Family Start was making progress towards its overall goal of improving outcomes for New Zealand's most at-risk families.

5.9 Parents as First Teachers (PAFT)[17]

Parents as First Teachers (PAFT) is an education and family support programme, operating in New Zealand since 1992, which is targeted at families considered to be at some risk of poor parenting and child outcomes. The Māori dimension of PAFT is *Ahuru Mōwai*, which also contributes to Family Start. In 2005, 45 percent of new enrolments were Māori (Ministry of Education, 2005b). Enrolment is limited to 8,000 families, and in 2003 and 2004 the average size of the roll was 7,637. Around 20 percent do not complete the programme. As with Family Start, this is an indication of the itinerant nature of many of the target families. Initially there was resistance to the programme from some in the community, as take-up was skewed to parents from middle socio-economic groups. The change of focus has positioned it as one of the range of programmes to support children and their families.

> PAFT programme has now definitely become a New Zealand parent education and support initiative (Livingstone, 1998, p.52).

Families usually enter PAFT during pregnancy and up until the infant is four months old, though some do

[17] For description see http://www.ecd.govt.nz/paft/whatispaft.html

enrol later. The aim is to help parents to interact more effectively in their children's early learning. The 'parent educators' establish and maintain a network of other community services and can link families to them when necessary.

Parents are guided to observe their children and learn what can be expected at each stage. PAFT appears to be ahead of other early childhood programmes in making research on early brain development accessible and understandable to all families (Meade, 2000).

Parents who had completed the programme were asked about their satisfaction with, and experiences of, PAFT in a survey which received responses from 400 families on or around their child's third birthday (Farquhar, 2002). The significant reported gains for parents upon completing the PAFT programme were in knowledge about child development and learning, and an improved understanding of their children (69.5 percent of families). The findings also indicated that, of those completing the programme, 88 percent of parents reported that the written materials were useful, and the ideas on play activities, books and toys were very suitable for 98 percent of families. Another aspect of the success of PAFT was in providing links with the community through referrals to health, community and ECE services. By age three, 90 percent of PAFT children had attended an ECE service, including 51 percent who had enrolled in a state kindergarten.

In 2003, an additional small-scale study was carried out (Farquhar, 2003) employing quantitative and qualitative data, including 19 interviews. As with the earlier study, participants found the written material valuable and often shared them with other family members. The service was popular and seen to be supportive and encouraging for those involved. The results of the qualitative data give a better insight into what is actually having an impact on the families involved in the programme with regard to some aspects of neurological brain development.

One parent educator, the same year, had this to say:

> I had to work out what would be appropriate to give her today. How much? And, how would I slot in the other bits of important information? Perhaps if we pick one topic for the next three or four visits out of the first four months of information, which is brain development and attachment that can't be left out. She left school in the third form so it is not appropriate to be giving her too much information at once (p.49).

Another said:

> I don't say, 'now the brain development bit today is da de da'. It is all just woven in there, you just pick up, you see things happening. I guess for some parents if you ask them about the brain development stuff they are not aware that it is there or that is a new thing. It is just woven into what we talk about during the visits (p.50).

These statements in the qualitative aspect of the evaluation illustrate how directly PAFT is addressing the issues of healthy development of children in accessible ways.

5.10 Home Interaction Programme for Parents and Youngsters (HIPPY)[18]

HIPPY is a:

> home-based programme that helps parents create experiences for their children that lay the foundation for success in school and later life (Kerslake Hendricks & Balakrishnan, 2005, p.27).

It is targeted at children between three-and-a-half and six years of age, with a significant emphasis on transition to school. Of the 1,040 children at sites funded by the Ministry of Education 48 percent were Māori, 19 percent were Pacific and 33 percent of other ethnicities (Ministry of Education, 2005c).

The programme focuses on the parent-child dyad, with the explicit aim of increasing parents' awareness of their potential and their strengths as home educators. The materials used in the programme are said to produce clearly visible changes in children's comprehension and ability, so that parents will consistently see a high value for their involvement even though it is very structured (Lombard, 1994). Parents, who are tutored by para-professional tutors, work with their children for 15 to 20 minutes daily for 30 weeks over two years. The homes are visited fortnightly by the tutors, and on alternate weeks parents, tutors and a central leader meet for planning, discussion and activities about

[18] For description see http://www.greatpotentials.org.nz/index.php?page=hippy

parenting and child development (Kerslake Hendricks & Balakrishnan, 2005).

The curriculum is primarily cognitive-based, focusing on language development, problem-solving, logical thinking and perceptual skills. Socio-emotional, fine motor and gross motor skills are also addressed. For those aged four, the curriculum has been updated, and activities now have specific links to *Te Whāriki* and the *New Zealand Curriculum Framework*. In an early evaluation of the pilot government-funded HIPPY programmes in New Zealand, it was found that HIPPY children's performance on both reading and maths was at a much higher level than was to be expected from their circumstances (Burgon, 1997).

In 1999, BarHava-Monteith, Harre, & Field used a research approach with multiple informants and multiple measures of numerous outcomes to reach a multidimensional understanding of its effectiveness. Children's skills and behaviour were assessed by their teachers and independent researchers, and archival data of children's success on standardised measures used by their schools were obtained. In addition, primary caregivers of HIPPY children and comparison children were given a questionnaire. In order to conduct a process evaluation, semistructured interviews were carried out with HIPPY caregivers, school personnel and co-ordinators.

BarHava-Monteith et al (1999) found that HIPPY children scored higher than their same-age school peers on a variety of school achievement and adjustment measures, and their academic progress was faster than might have been expected. On three reading tests and children's academic self-esteem the differences were significant. HIPPY caregivers and tutors also scored higher than their non-HIPPY counterparts for positive attitudes, behavioural involvement and self-esteem. Further, HIPPY children's parents were more likely to be involved in teaching activities at school than other parents.

The outcomes support the view that the HIPPY programme's focus on a balance of cognitive, socio-emotional and motor skills enhanced children's development and later school achievement. The particular emphasis on language development, problem-solving, logical thinking and perceptual skills can be expected to have enriched cognitive development.

5.11 Plunket[19]

The Royal New Zealand Plunket Society is centred round the service of nurses dedicated to parents and caregivers from pregnancy through to when their child turns five. They offer independent, expert advice on child health and wellbeing for over 90 percent of babies born in New Zealand and are the largest provider of services for children under five. They supply a comprehensive package of Well Child and parent support services available to promote the development of healthy babies and children.

Plunket runs a national Parenting Education Programme called PEPE, which consists of four short courses designed for new mothers and fathers. Whānau and grandparents are welcomed. The course series is relatively recent, having been inaugurated in 2005. They are run in groups with a set number of hours that can involve different divisions of time according to the groups' needs.

PEPE 1 is intended to run during the antenatal period. It relates to parenting in the first six weeks. As well as focusing on the physical aspects of parenting, it aims to help parents understand how their baby communicates and encourage them to become sensitive and responsive parents. It runs for six hours and promotes the development of positive relationships between adult and child.

PEPE 2 involves parenting from six weeks to one year. It aims to empower mothers and fathers to confidently parent while understanding what is happening to their baby. Alongside physical need topics, the course includes emotional wellbeing and positive parenting. It runs for 12 hours in total.

PEPE 3 is for parents of toddlers aged between ages one and two years. Alongside the physically focused topics, it includes developing positive responses to behaviour and creating an environment for development. It runs for six hours in total.

PEPE 4 is for parents of pre-schoolers aged between two and three years. Alongside some physically focused topics, it fosters self-esteem in the children, giving parents management strategies while enhancing positive parenting choices. Issues of safety are also addressed. It runs for six hours in total.

[19] For description see http://www.plunket.org.nz//AM/Template.cfm?Section=Home

Although an internal review has been completed, no evaluation of the service is publicly available at this stage. The accessible nature of the courses and the topics chosen can be expected to contribute to the healthy development of young children.

5.12 Supporting Parents Alongside Children's Education (SPACE)[20]

SPACE is an initiative springing from the Play Centre Movement. A founding team started working on the concept in 2002.

Drivers for the programme included:

- an apparent need for support for first-time parents, particularly in the first year
- programmes such as PAFT had become targeted, and limited in the number of families they could enrol
- there were few programmes in a group setting that included educational components such as child development information and music for first-time parents.

The Hutt SPACE National team was funded to grow the programme nationally by SKIP (Strategies with Kids Information for Parents),[21] a Ministry of Social Development (MSD) initiative. The team is researching and further developing the programme through the Ministry of Education's Centres of Innovation project.[22]

The SPACE programme has four objectives:

- Children's Education – to increase the participation of children in early childhood education at an early age, provide a high-quality curriculum and maximise children's learning from birth.
- Parenting – to ease the transition to parenthood; support parents in their role as the best and most important educators of their children; and help parents to recognise, support and extend their child's learning and development.
- Support – to provide parents with support and encouragement from one another and experienced facilitators as they share the journey through their child's early months.
- Links – to give parents an opportunity to hear from, and develop links with, a range of community organisations and service providers.

Unlike other parent initiatives, SPACE is carefully targeted at first-time parents, whatever their circumstances. It includes one informational session entitled "The Beauty of the Brain". Other sessions include "Understanding Me" (about crying), "Establishing Attachment", "Heuristic Play" and "Understanding Temperament". All of these would suggest that parents are being encouraged to think about the child's development and their role in it. It is too new an initiative for a review or evaluation to have been carried out.

5.13 Early Start[23]

Early Start is a Christchurch-based service that offers help to families with newborn babies, where their circumstances may put them at risk. The service is home-based and long-term, and is designed to encourage healthy child development and a caring family environment. The family and whānau support workers are professionally qualified and have developed a strength-based programme that operates in a culturally relevant way.

The project was started at the same time as it was established as a research project. In the early 1990s, a consortium of providers including Family Help Trust and the Christchurch Health and Development Study came together to develop a home-based family support programme based on findings from the Christchurch Study. Funding was provided by the Family Start initiative of MSD.

A rigorous evaluation was set up, with 220 families involved in Early Start and 223 families who were not involved in the programme assigned randomly to a control group (Fergusson, Grant, Horwood, & Ridder, 2006). Both sets of families were interviewed at entry; six months; and one, two and three years post-enrolment. At the three-year point, 59 percent of clients were still receiving the programme. Of those who enrolled in the trial, 90 percent were studied for three years.

The researchers found that among those receiving the programme, more children were exposed to ECE. Parenting was more positive and non-punitive. There were lower rates of severe and very severe physical assaults by parents, and the children manifested reduced rates of externalising and internalising behaviour problems. There appeared to be little difference however, between the control and

[20] For description see http://www.space.org.nz/downloads/space.info.sheet.public.pdf

[21] Family and Community Services section of the MSD website: http://www.familyservices.govt.nz/info-for-families/skip/

[22] Information about this innovation in parent education was provided by Sue Pattinson and Leanne Dawson of the Hutt SPACE National Team who can be contacted at space.nz@paradise.net.nz

[23] For description see http://www.earlystart.co.nz/

experimental group in maternal health and wellbeing, family stability, family relationships and violence and family exposure to stress and adversity.

Despite the lack of difference in family functioning, the programme has achieved some success in terms of improved positive parenting, participation in ECE, child health and reduced violence, all of which improve developmental chances.

5.14 Parenting programmes and the problems of evaluation

The Families Commission report *Review of Parenting Programmes* noted that the various reviews have been inconclusive in terms of outcomes for children and parents, although participating parents usually speak well of the programmes (Kerslake Hendricks & Balakrishnan, 2005). The uneven range of evaluations and the lack of rigour in some cases is disappointing.

There are multiple influences on families, many of which are difficult to measure or monitor. Alongside cultural and regional variables, there are clear differences for those working with gangs or families with heavy drug use than for those working with low-income groups that are considerably less antisocial. Sometimes, we are comparing not apples with apples, but apples with karaka berries. These combine to make programme assessments difficult.

Nevertheless, there is a need to design robust evaluations if we are to generate further knowledge to build a stronger evidence base of what works effectively. The randomised trial evaluation design applied to the Early Start programme is much more robust than most of the reviews considered in the foregoing studies. There is also a need for some rigorous qualitative work.

The evaluators may not be the only ones at fault. Good evaluations require good resources. A low investment will inevitably lead to over-simplified and shallow assessments.

As noted previously, parenting programmes in New Zealand are largely, though not entirely, focused on medium- to high-risk or disadvantaged families. They have a 'boutique' style, reflecting the unique characteristics of the neighbourhoods in which they operate. They offer skills, networks, safety and stability. For some children suffering trauma through abuse, stress or neglect, these programmes can help create the conditions that break the cycle. Furthermore, participation in these organisations can help prevent the sorts of domestic environments that are damaging to children's development through the information, support and networks they link parents into. Unfortunately though, with few exceptions, evaluation and monitoring of the programmes is irregular and not always of a high standard. Furthermore, the small scale of the parenting programmes and their ad hoc distribution throughout New Zealand almost certainly means that many families who could be assisted are not receiving help.

It is clear from this description that most of those working in the field would agree with the metaphor employed by Carlina Rinaldi (2003), a leading theorist of young children's learning quoted in an ERO document. In the same spirit as *Te Whāriki*, she describes young philosophers in action:

> The young child is the first great researcher. Children are born searching for and therefore, researching, the meaning of self, the meaning of life in relation to others and to the world. Children are born searching for the meaning of their existence ... the meaning of conventions, customs and habits we have, and of rules and the answers we provide.
>
> Children's questions (such as 'Why are we born?' 'Why do we die?') are precious, as are their answers because they are generative. Children's theories (such as 'The sea is born from the mother wave.' 'When you die, do you go into the belly of death and then get born again?') highlight the strongest characteristic of identity of children and of humankind: searching for and researching meaning, sharing and constructing together the meaning of the world and the events of life. All children are intelligent, different from each other and unpredictable. If we know how to listen to them, children can give back to us the pleasure of amazement, of marvel, of doubt ... the pleasure of the why. Children can give us the strength of doubt and the courage of error (Rinaldi, 2003 p.2&3, quoted in ERO 2004, pp.2&3).

6. CHILDREN AT RISK

As studies cited in this report have shown, children who experience abusive, neglectful or stressful family environments over time are likely to be at risk of impaired or arrested development. Identifying those at risk in this manner is not straightforward because negative environments can be, and often are, hidden from public view. It is possible, though, to recommend measures for populations whose children are more likely to be at risk of impaired development, given the current state of knowledge. The remainder of this section will describe many of the populations and types of families which are most likely to be at risk in New Zealand and the extent of the problem. It should be noted that there are varying degrees of trauma and impairment that children experience depending on the length and severity of the abuse or neglect, and on compensating support persons.

6.1 Violence and abuse

The following studies provide snapshots of the levels of violence, abuse and neglect in New Zealand from differing angles. The picture is not a pretty one, and when considered alongside the information presented in earlier chapters, is quite alarming.

At the most basic level, children must be kept safe if they are to thrive. Infant mortality rates and child health and safety rankings provide (at a crude level) internationally comparable measures of relative safety for children. Two recent international reports (OECD, 2006; UNICEF, 2007) have given New Zealand low rankings because of its high infant mortality rates. At a mortality rate of 5.6 per 1,000 live births, the OECD and UNICEF placed New Zealand above only the USA, Hungary, Poland and the Slovak Republic, whose rates were even higher, among all OECD countries, using 2001 figures.

It is important to note there is some scepticism about this figure because the numbers are very small and can fluctuate. New Zealand also records all live births, regardless of birth weight and gestation, while some countries do not count those at high risk of death at birth. Mortality includes accidents such as swimming pool drowning, and road or driveway accidents as well as intentional abuse.

The UNICEF report ranks New Zealand 24th out of 25 OECD countries for the health and safety of children. The ranking averaged three indicators: health up to age one; preventative health services; and safety. UNICEF measured the first year of health by infant mortality and low birth weight; preventative health services through the percentage of children aged 12 to 23 months immunised against measles, DPT (diphtheria, pertussis and tetanus) and polio; and safety by deaths from accidents and injuries per 100,000 aged 0–19. On low birth weight (percentage of births under 2,500 g), New Zealand ranked a credible 10th but scored last on the safety measure, and on immunisation was third from the bottom. These international comparisons among developed countries are disturbing.

In the five years to 2003, 38 children are known to have died in New Zealand as a result of maltreatment (Ministry of Health, 2004). The rate for young children under five years was 1.7 deaths per 100,000, three times the rate for five- to 14-year-olds (0.5 per 100,000). These figures represent a reduced rate from previous periods.

Notifications about the safety of children to statutory authorities give us another perspective on the number of children at risk of poor outcomes, and again the data are disturbing. Child, Youth and Family (CYF) has received a consistent increase of notifications of children at risk from nearly 27,000 in 2001 to over 66,000 in 2006 (CYF, 2006). The rise in notifications may or may not reflect an increase in child abuse, as it could be argued that improving awareness and disapproval of child abuse may increase these figures. After initial assessment, however, nearly 50,000 of 66,210 notifications required further action. The figures are set out in Table 2.

TABLE 2: Data taken from Department of Child, Youth and Family Services Annual Report for the year ended 30 June 2006

	00/01	01/02	02/03	03/04	04/05	05/06
Notifications received	26,707	27,507	31,781	43,314	53,097	66,210
Further action required	22,868	23,805	27,394	36,066	43,460	49,063

In 2006, CYF held 15,477 Family Group Conferences (FGC). During the same year, 3,442 Family/Whānau Agreements took place and 5,077 children were in care placements (CYF, 2006). These figures indicate that more than 60 percent of the notifications that require further action do not become involved in either a FGC or Family/Whānau Agreement process.

Alongside these statistics, New Zealand has the third highest rate in the OECD for male youth suicides (young people aged 15 to 24) and the highest youth female rate, despite the fact that it is falling from its peak in 1995. In 2003, the rate for 15- to 24-year-olds was 16.5 per 100,000 and included 95 deaths (Ministry of Health, 2006). While these deaths refer to young people rather than children, one can hypothesise that a number of these deaths may stem from deeply unhappy childhoods (Karup, Nielson, Rask, & Petersen, 2007; Shaffer, 2006).

Death is an extreme outcome, of course, but the combination of the violence, health, safety, abuse, neglect and suicide figures suggests that large numbers of families and children in New Zealand experience very unhappy lives. It can be safely assumed that many of these children experienced developmental trauma and impairment.

6.2 Longitudinal studies

Three important longitudinal studies in New Zealand fill out the picture of who is at risk a little further. The Dunedin Multi-disciplinary Health and Development Study has provided important insights into the lasting effects of disruptions during childhood. The study has shown that antisocial behaviour in young men that had its first manifestations during childhood was more persistent than for those whose onset of such behaviour occurred during adolescence (Moffitt, Caspi, Harrington, & Milne, 2002).

The researchers measured antisocial behaviour using the Rutter Child Scales, which were filled in by parents and teachers when the children were five, seven, nine and 11 years old. At ages 15 and 18 a self-report delinquency interview was administered. At age 26 the participants were followed up. Those whose antisocial behaviour rated extreme across childhood and adolescence were assigned to the life-course-persistent (LCP) group. This had 47 members, 10 percent of the 477 males in the study. Those who met the criterion of extreme antisocial behaviour as adolescents, but not as children, were assigned to the adolescent-limited (AL) group. This had 122 members. Three other groups were also formed, consisting of those who exhibited extreme antisocial behaviour during childhood but not during adolescence (40 members); those who had not engaged in antisocial behaviour from five to 18 (25 members); and those who did not meet any of the criteria for the four groups mentioned (243 members).

Earlier waves in this study showed that those whose antisocial behaviour began during childhood, unlike the adolescent onset group, had experienced inadequate parenting, neurocognitive problems, under-controlled temperament, severe hyperactivity, psychopathic personality traits and violent crime. At 26 years:

> the childhood-onset delinquents were the most elevated on psychopathic personality traits, mental-health problems, substance dependence, numbers of children, financial problems, work problems, and drug-related and violent crime, including violence against women and children. The adolescent-onset delinquents at 26 years were less extreme but elevated on impulsive personality traits, mental-health problems, substance dependence, financial problems, and property offences (Moffitt et al, 2002, p.179).

The LCP group were significantly more involved in criminal offending and undesirable behaviour, with negative reactions from courts, employers, women and informants who knew them well. The AL group were still in trouble with the law because of property and drug convictions, but they had better jobs than LCP men, better work histories and higher-skilled occupations. They had average or better scores on factors that predict relationship success, average family relationships, average temperaments and were not rejected by their peers. They also showed close attachments to their parents and social closeness.

The findings confirmed the earlier results that showed AL males have better outcomes than LCP males, because of their experience of pro-social behaviour and basic academic skills in the earlier years. They also highlight the persistence of childhood deficits when fundamental security, safety and self-regulating boundaries are not in place.

The Christchurch Health and Development Study has also examined the links between socio-economic disadvantages and crime, and the pathways and processes of those links (Fergusson, Swain Campbell, & Horwood, 2004). From their longitudinal study, from birth to 21 years, the researchers collected self-reported data on property and violent crime at ages

15–16, 17–18 and 20–21 years. They also accessed official conviction records held by the New Zealand Police. Family socio-economic status was assessed, and a number of possible intervening factors (family, individual, school and peer) were explored.

Family factors were of particular interest. They include:

> the use of physical punishment during childhood in terms of frequency and severity

> maternal care in terms of bonding, perceptions of parenting and care

> changes in parents due to separation, divorce, death, remarriage, etc

> parental attachment in terms of parental communication, trust and alienation

> parental history of criminal offending.

Individual factors included conduct problems.

The study possessed extensive data on family, individual, school and peer factors during childhood and adolescence. Analysis of this data helped isolate the accumulating factors of disadvantage that led to an increased risk of crime later in life. These were:

> Family adversity, including higher rates of physical punishment and child abuse; reduced levels of maternal care; changes in parental figures; low attachment to parents; and parental criminality.

> Childhood adjustment problems, including conduct and attention problems.

> School problems, including truancy; educational underachievement; suspension from school; and low scholastic ability.

> Affiliations with delinquent and substance-using peers (Fergusson et al, 2004, p.963).

Regression analyses on the groups of variables were introduced sequentially. Results pointed to a process of cumulative disadvantage, with increased exposure to the four blocks of factors. Family factors provided the strongest association, while the other three were weaker, but significant.

The results showed that childhood socio-economic disadvantage was associated with higher rates of both self-reported and officially recorded crime, with those born in low socio-economic families demonstrating crime rates over three times higher than those born in higher socio-economic families.

As with the Dunedin study, these findings suggested that adverse life-course processes from childhood increase individual susceptibility to crime. The strongest influence related to parenting factors. The literature that has been repeatedly cited in this paper has shown that parenting factors, such as safety, predictability, consistent care and attachment and responsiveness, support cognitive development through the strengthening of neural pathways and profoundly influence brain development. The foundations for the ability to self-regulate, manage emotions and develop self-discipline are laid for most children in the earliest years.

The Competent Children study (Wylie et al, 2006), which has followed 475 children in the Wellington region from ECE centres to age 14, has reported on competencies and competency development at that age. It, too, illustrates the persistence of childhood disadvantage into later years. The researchers assessed cognitive competencies in reading, comprehension, writing, mathematics and standard progressive matrices involving non-verbal pattern completion tasks. They also assessed attitudinal competencies by asking core subject teachers to rate students on a range of attitudinal dimensions that comprised curiosity, perseverance, self-management, self-efficacy, social skills with peers, social skills with adults and communication.

The study found that attitudinal competencies accounted for a reasonable proportion of the cognitive scores, but cognitive competencies did not account for attitudinal ones. In other words, a high score in mathematics did not predict social skills, for example, but perseverance, communication and curiosity were particular attitudinal behaviours that were associated with higher scores in reading and mathematics.

The study also noted income and educational differences. Although very high and very low competency scores appeared in each social group, the average scores showed that children living in families with higher incomes and higher maternal qualifications had higher average scores in the cognitive competencies at age 14. Though present, the gradient was not as steep for attitudinal competencies. The study also showed that high performance, ie scores in the highest quartile in the early years, was highly predictive of scores in the highest quartile in later years, and that low performance, ie scores in the lowest quartile in the early years, was highly likely to predict scores in the lowest quartile at age 14.

6.3 Disadvantage

This and other studies referred to in the previous chapters have identified the disadvantages children of lower socio-economic status have in terms of school achievement and employment in adulthood. In particular, families below poverty thresholds suffer acute disadvantage. As noted in earlier chapters, the risk factors that can hinder early development, such as poverty, are well documented (Shonkoff & Phillips, 2000). Parents in poverty often experience depression, which can unintentionally lead to high levels of stress and neglect as they struggle to survive in difficult conditions. The combination of family poverty and neighbourhood poverty can entrap them in such conditions.

It is important to note that many poor parents enrich their family's and children's environment very well and that poverty per se need not be a cause of impaired development. The conditions, however, provide greater risks because they create greater levels of stress and depression.

More households with children in New Zealand have been below the poverty threshold than any other household type. Estimates of the proportion of households with children who are living in poverty have varied between a fifth to a third of all households with children, depending on whether a fixed or relative poverty line is employed (Ministry of Social Development, 2006a; Waldegrave, Stephens, & King, 2003). Single-parent households, those dependent on income-tested benefits and ethnic groups other than Pākehā or European were most likely to be on the lowest incomes. The same groups were also most likely to be experiencing hardship with their living standards. In 2004, 34 percent of families with dependent children were categorised in this way (Ministry of Social Development, 2006b). These figures are expected to improve as a result of the implementation of the Working for Families package, which was specifically designed to reduce child poverty.

All of the studies discussed above provide differing snapshots of vulnerable families and children in New Zealand and suggest that a substantial proportion of them live in situations that could place them at risk of impaired development. Another indicator is found in the OECD Programme for International Student Assessment (PISA), in which cross-country comparisons are made among 15-year-olds' reading, mathematical and scientific literacy, and cross-curricula competency in problem-solving (Ministry of Education, 2004). PISA was first administered in 2000 and will be repeated every three years. In 2003, 41 countries participated in the study, involving well over a quarter of a million students. The New Zealand sample consisted of 4,500 students from 173 secondary schools.

New Zealand's mean scores in all four categories were consistently in the second highest achieving group, with countries such as Australia and Canada. Finland was the only country that scored significantly better. The group's scores were all significantly above the OECD average.

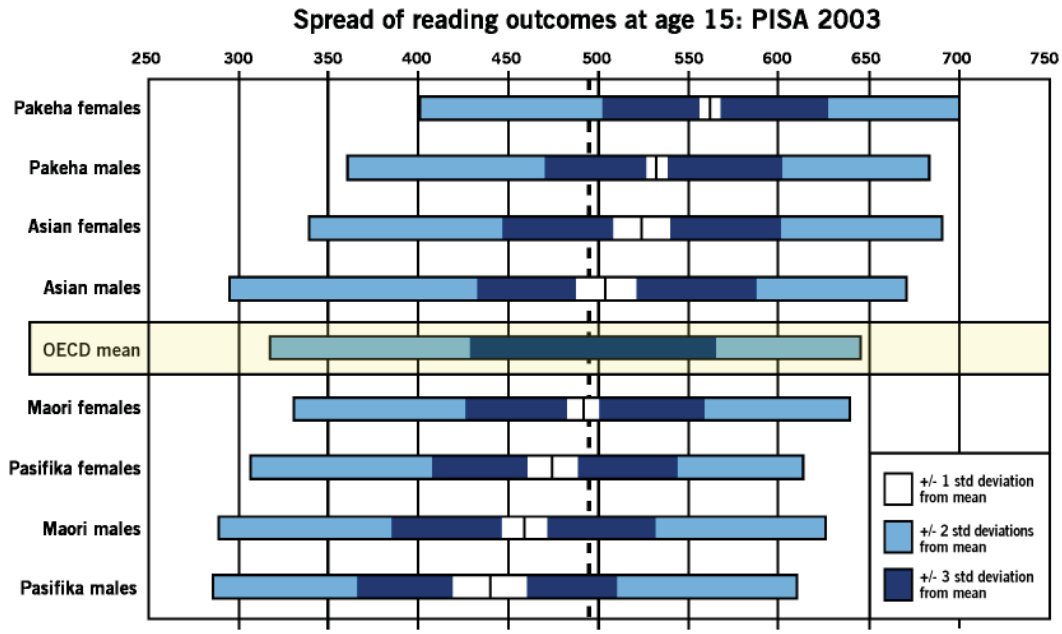
The study also measured the distribution of performance within countries, and in these data New Zealand did not perform so well. The distribution of scores between the highest and lowest performing students provides an indicator of equality of educational outcomes. The gap between the 75th and the 25th percentiles indicates the extent of disparity in educational performance in a country.

New Zealand scores were consistently at the upper end of score dispersion, indicating high levels of inequality. This persistently wide distribution of results was not characteristic of a number of similar countries. Canada, for example, demonstrated a narrow distribution for both reading and mathematical competencies. Canada's results show high average performances can be achieved alongside a low disparity range. The disproportional skew at the lower end of competencies is sometimes referred to as New Zealand's educational 'tail'.

Schools may not be adequately addressing the educational needs of these children at the lower end. A reason for this, in the light of the other studies presented in this paper, could be that developmental damage during childhood among disadvantaged students has not been adequately responded to nor addressed. The impairment thus persists, and those students will be less likely to have the opportunity to reach their developmental potential.

A look at the spread of reading outcomes at age 15 in the New Zealand PISA data shows the ethnic bias referred to in the poverty and living standards statistics noted above. As Table 3 illustrates, a gender skew is evident at age 15. The PISA results also highlighted New Zealand as having a very low rating for enrolment in education at age 17, despite high average reading ability.

TABLE 3: New Zealand reading outcomes 2003



Derived from Ministry of Education PISA 2003 results.

When all the studies noted in this chapter are placed alongside each other, it becomes clear that many New Zealand children could be at risk. The combinations of data show high levels of violence, abuse, suicide – persistent low outcomes that often have their origins in childhood and low socio-economic status. The question has to be asked: is everything being done that should be done for the disadvantaged children of Aotearoa and their families?

A further question, in the light of the foregoing literature, is whether cognitive development and neurodevelopmental impairment through abuse, stress and neglect during childhood is more common than has been assumed in the past. Furthermore, if that is the case, do current social policy settings and practice address it in a manner that helps prevent the damage in the first place, or helps provide the opportunity for restoring what was damaged? It is very difficult to answer these questions with fine-tuned, robust and detailed information. On balance, however, one would be predisposed to say that if New Zealanders seriously care about their children, then there are too many at risk, and too many of those persistently at risk from early childhood.

7. CONCLUSION AND DISCUSSION

The research gathered in this study has underlined the critical significance of the quality of interaction and trust within families, and between caregivers and children, which is necessary for children to develop in a manner that enables them to reach their potential. Our current knowledge of the fields of neuroscience and cognitive development shows that ongoing experience of neglect, stress or trauma can seriously damage development in children.

Families and other caregiving environments that are safe, predictable and loving, by contrast, will protect children against that damage. In ordinary environments, where children experience normal levels of security and love, the brain simply develops, adapting to its environment in a resilient manner. As it does so, children undergo critical foundational experiences that enable them to acquire language, develop increasingly complex cognitive abilities, progress emotionally and socially and develop their regulatory abilities and associated capacities for self-control. Furthermore, such environments can help restore developmental growth that has been lost as a result of the effects of disadvantage and impairment.

Numerous studies have shown the types of experiences that encourage healthy development and are important for healthy family living. The partnership during childhood between a constant caregiver and child provides a pattern of interaction, information and feedback, alarm and comfort, question and answer, exploration, socialisation and learning that enriches the lives of young children, and enables them to adapt successfully to their environment.

The importance of these environments has led some to claim that children's brains during their earliest years will grow more fully in particularly enriched environments of learning, exploration and emotional care. The current state of knowledge indicates that the jury is still out on the impact such environments have on neurodevelopment for normally developing children, but cognitive development, motivation, perseverance and educational attainment can all be improved. Furthermore, an enriched environment can help restore both neurodevelopment and cognitive development in children whose development has been impaired.

The consistent results of robust longitudinal studies have demonstrated that high-quality early ECE contributes to positive educational, employment and social outcomes in later life. While the studies were obviously not designed to measure and record neurological changes, the findings demonstrate substantial gains in cognitive functioning and social development. They have also proved to be effective with low-income and at-risk children, which suggests that there is likely to be some interaction between the improved learning environment and neural activity for the children which enables the recovery of some lost development.

In New Zealand, as with most similar countries, the majority of children grow up in ordinary healthy and responsive homes. Many children and parents are assisted by ECE services and parenting programmes. ECE is now being resourced much more in New Zealand and participation levels have grown significantly. The ECE curriculum *Te Whāriki* is grounded in an understanding of the insights of cognitive development and some of the implications from research in neuroscience. A range of parenting programmes are now in place, and each offers skills, networks, safety and stability in different ways to different targeted groups. These programmes all encourage safe environments and responsive, caring parenting styles.

While this is encouraging, and a tribute to the many people and organisations who have worked to achieve these levels of service and competency, there are indications that many children in New Zealand still suffer trauma as a result of abuse, stress and neglect in families. The levels of recorded violence and abuse of children are high by international standards, and New Zealand longitudinal studies provide sobering evidence of the consequences in adulthood of violent and antisocial environments during childhood. The neuroscientific evidence provided in earlier chapters shows that both cognitive and neurodevelopment can be substantially impaired where children are subject to ongoing abuse, stress or neglect.

Children often experience unintentional and unrecognised stress and neglect as parents struggle to survive in poverty, which is frequently associated with depression, a sense of hopelessness and other forms of ill health. Early disadvantage is persistent, and children who perform at lower levels of competence when they are young tend still to be performing below the average

in their adolescent years. The unequal distribution of New Zealand PISA scores is another strong indication of the types of challenges there are for disadvantaged children to grow up in a healthy way and reach their developmental potential.

Some aspects of the research findings discussed in this report are shared among informed people, and some of them are passed on through ECE and parenting programmes, as has been described. However, it is questionable whether most people are aware of what this research says about the ways children develop and the crucially important aspects of that development, compared with the knowledge they have of good diet and the dangers of smoking cigarettes.

It is the view of the authors that most parents, including those who are disadvantaged, want to help their children, and act to do so, on the basis of the knowledge they have. This is not an uncontested view. Some people consider that adults who sometimes abuse or neglect their children would never respond to the sort of information this report addresses. Having worked alongside families who find themselves in these situations for over three decades, however, we beg to differ. We have seen diet, exercise, smoking and other such messages accepted by people in the same circumstances.

Just as young parents can be unaware of normal development milestones in the lives of babies and young children, they can also be unaware of the substantial impact of the insecurity, unpredictability and aggression (which may not even be directed at the growing child but between parents), for example, on their child's cognitive development and neurodevelopment. Practical and applied information that is woven naturally into leisure and service delivery programmes and that particularly features in ECE parental contact settings could go a long way to communicating this information to groups of parents who are currently unaware of it. The development of an approach that takes into account cultural meaning systems, such as the sacredness of the head in Māoridom, can also enhance understanding and strengthen group commitment.

We recommend four key directions for effective action. Firstly, information needs to be packaged in ways that are familiar, and delivered in the first instance to a target group of those families who are at risk of abusing or neglecting their children and the key groups that work with them, and secondly more generally to the population as a whole. Helpful information could be carefully tailored and passed on through trusted sources in local communities. These might include sports clubs, churches, marae, community-based social service groups and the like. It is very important that parents, extended families and neighbourhoods of children at risk receive the message comfortably so they can act on it confidently. Once a community adopts new knowledge about something as important to them as the wellbeing of their own children, change can be expected to happen for most, though not all, families.

Secondly, it is very important to continue to create access and participation in high-quality ECE for as much of the population as is possible. The high quality of this sector in New Zealand is ideally placed to be a buffer against the negative effects of stress on children at risk and create authentic and natural connections between their parents and extended families, and informed people who can provide support and information. The ongoing quality of ECE in New Zealand will require continuing investment and monitoring.

Thirdly, the policy of focusing investment on young children, and lifting their families out of poverty, needs to continue, and extend its reach into low-income households further. The stress many of these families still experience is often associated with negative outcomes in health and education for children. Stress can sometimes lead to a sense of hopelessness, so that parents cannot give their children the consistent, loving, responsive attention they require. Adequate income, decent housing and affordable access to healthcare are foundation stones for a stable upbringing.

Fourthly, there is a need for further research specific to New Zealand. We require much more information on the impact of impaired development for children so policies and practices can be developed to substantially prevent and reduce it in the future. We need research that can help identify and quantify the incidence in New Zealand, and we need studies that assess the effectiveness of a variety of enhanced family and educational environments to restore the development of those who have been impaired.

Finally, we need research to measure the effectiveness of both targeted and general public education programmes designed to prevent children becoming at risk and to promote safe, secure and loving family and other environments.

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APPENDIX 1: Glossary

Axon: A long and unbranched fibre that carries impulses away from one neuron to the next.

Behavioural genetics: Behavioural genetics is the field of biology that studies the role of genetics in animal behaviour. The field is an overlap of genetics, ethology (the scientific study of animal behaviour considered as a branch of zoology) and psychology (particularly evolutionary psychology). Traditionally, behavioural geneticists have studied the heritability of behavioural traits.

Cell body or soma: The portion of the nerve cell that contains the nucleus but does not incorporate the dendrites and axons.

Cognition: The mental processes involved in gaining knowledge and comprehension, including thinking, knowing, remembering, judging, etc.

Cortex: The outer layer of grey matter that covers the surface of the cerebral hemisphere.

Cortisol: The primary stress hormone. Cortisol is the major natural glucocorticoid (GC) in humans, released to help our bodies deal with threats by breaking down protein stores to use as energy and by suppressing the immune system.

Critical period: A hypothesised time span when a particular part of the brain is most apt to develop and most vulnerable to environmental influences – a limited time in the early stages of a child's life during which it displays a heightened sensitivity to certain environmental stimuli, and develops in particular ways as a result of experiences at this time. If the child does not receive the appropriate stimulus during this 'critical period', some say it may be difficult to develop some functions later in life.

Dendrite: The branched extensions from the cell body of a neuron that receive impulses from nearby neurons through synaptic contacts.

Enriched environments: Settings for animals or human beings that are designed to enhance their achievement in certain fields. For animals it could mean healthy living conditions, good food, toys and social activities. For children in poor areas, it could mean a school providing nutritious food, health care, social services, teacher links with parents and a targeted stimulating learning environment. For a middle-class family wanting to achieve higher educational performance for their children, it could involve targeted educational stimulation such as high-quality music exposure.

Experience-dependent: Describes a form of synaptic formation in response to an individual's adaptation to specific features of the environment. This is illustrated in learning of most kinds.

Experience-expectant: Describes a process wherein synapses form after some minimal experience has taken place. Examples of experience-expectant development can be found in visual development, where eyes have to be properly aligned for stereoscopic vision, or correction cannot take place after five or six years.

Frontal lobe: The part of the brain that is involved in critical thinking, problem-solving, planning and decision-making.

Impoverished environments: Opposite of enriched environments – see above. Can refer to settings for animals or human beings that are inadequate physically, socially, emotionally or recreationally, and involve deprivation for the subject.

Infralimbic cortex: A cortical region in the medial prefrontal cortex which is important in tonic inhibition of subcortical structures and emotional responses, such as fear.

Lateral prefrontal cortex: This part of the cortex seems to help us choose a course of behaviour by letting us assess the various alternatives mentally. It has to do with working memory – the ability to hold the present context or goals of a complex task in mind.

Limbic system: The structures at the base of the cerebrum that control emotions.

Molecular genetics: The field of biology which studies the structure and function of genes at a molecular level. Molecular genetics employs the methods of genetics and molecular biology. It is so called to differentiate it from other subfields of genetics, such as ecological genetics and population genetics.

Neocortex: The 'neo' in neocortex means 'new,' signifying that this area evolved later and is not as primitive as other cortical areas (such as the 'older' hippocampus). It is the top layer of the cerebral hemispheres, 2–4 mm thick, and made up of six layers, labeled I to VI (with VI being the innermost and I being the outermost). It is involved in higher functions such as sensory perception, generation of motor commands,

spatial reasoning, conscious thought, and in humans, language.

Neural networks: A complex system of neurons organised into columns that serve to process a very small part of a brain function and are involved in processing information, making rational decisions and initiating behavioural responses.

Neural pathway: A series of synapses that form a network in the brain.

Neural pruning: The human brain rapidly creates synaptic connections between neurons after birth. Synapses are selectively destroyed or 'pruned', with the most-used synaptic connections remaining and the least-used being removed. In other words, it seems the brain becomes rapidly over-connected but we only keep the useful connections. This has been thought to be loosely analogous to Darwin's 'survival of the fittest' maxim and hence has been labeled 'neural Darwinism'.

Neurobiological: Neurological and biological – neurobiology is the study of the cells of the nervous system and the organisation of these cells into functional circuits that process information and mediate behaviour.

Neurodevelopmental: Drawing on both neuroscience and developmental biology to describe the cellular and molecular mechanisms by which complex nervous systems emerge during embryonic development and throughout life.

Neuron: The basic cell making up the brain and nervous system, consisting of a long fibre called an axon, which transmits impulses, and many short fibres called dendrites, which receive them.

Neuroscience: A field devoted to the scientific study of the nervous system. Such studies may include the structure, function, development, genetics, biochemistry, physiology, pharmacology and pathology of the nervous system. Traditionally it is seen as a branch of biological sciences. However, recently there has been a convergence of interest from many allied disciplines, including psychology, computer science, statistics, physics and medicine. The scope of neuroscience has now broadened to include any systematic scientific experimental and theoretical investigation of the central and peripheral nervous system of biological organisms. It refers to science pertaining to the brain, spinal cord, neurons and the senses.

Neurotransmitters: Small molecules whose function is to transmit nerve signals (impulses) from one nerve cell (neuron) to another. Neurotransmitters are chemical messengers, which neurons use to tell other neurons that they have received an impulse. There are many different neurotransmitters – some trigger the receiving neuron to send an impulse and some stop it from doing so.

Occipital lobe: Part of the brain, located at the rear of the cerebrum, where vision is processed.

Opioids: Opioids are chemicals, such as those found in opium, that produce a feeling of wellbeing (euphoria).

Orbitofrontal cortex: A region of the human brain involved in cognitive processes such as decision-making. This region is named because of its location within the frontal lobes, resting above the orbits of the eyes. Because of its functions in emotion and reward, the orbitofrontal cortex is considered by some to be a part of the limbic system.

Plasticity: The ability of the brain to change or adapt in response to experience.

Postsynaptic neuron: Situated behind or occurring after a synapse, it contains receptor sites for neurotransmitters.

Prefrontal cortex: The prefrontal cortex is known not only to be involved in emotional responses, but also to have numerous connections with other parts of the brain that are responsible for controlling dopamine, norepinephrine and serotonin – three neurotransmitters that are important in mood regulation. There is evidence that the prefrontal cortex may be important for moral behaviour. Adults who suffer damage to the prefrontal cortex develop problems with making decisions and with behaving appropriately in social situations. The two halves of the prefrontal cortex also seem to have specialised functions, with the left half being involved in establishing positive feelings and the right half in establishing negative ones.

Presynaptic terminal: Situated in front of or occurring before a synapse. It contains neurotransmitters, mitochondria and other cell organelles.

Stress: The by-product of our perceived inability to cope with pressures, changes, demands and challenges.

Synapse: The microscopic gap between the axon of one neuron and the dendrite of another.

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This report is available on the Commission's website www.nzfamilies.org.nz or contact the Commission to request copies.

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