Young Brains

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In the last twenty-five years, technological advances have enabled scientific researchers to make new discoveries about the development of the human brain: its formation, growth and cognitive activity, for example (see Nelson and Bloom 1997). However, a number of researchers have argued that the evidence should be regarded with some scepticism because some of it is old, some from studies of diseased brains and some from studies of rats, rather than humans (Aubrey 2002; Blakemore 2002; Bruer 1999).

Meanwhile, Catherwood (1999) outlined these technological advances in the context of their relevance to developmental psychology and early education, and concluded that new research has begun to indicate that Piaget's characterisations of infant development 'vastly underestimate infant cognitive development' (Catherwood 1999: 28). Mark Johnson (1999), a cognitive neuroscientist at Birkbeck College in London, has claimed it is curious that Piaget, despite his biological approach to human cognitive development and belief in an activity-dependent nature of development, was typical in neglecting brain functions, perhaps because at the time of Piaget's writing there was little information about the brain and certainly not the imaging and computer equipment available today. In spite of the sophistication of today's equipment, Greenfield (in Moyles 2002) claims that the non-invasive techniques are still not refined enough to examine connectors in the brain.

Meade (2001) reviews the evidence available about brain research in relation to early childhood, and helpfully summarises the advantages and disadvantages for researchers and practitioners of neuro-imaging procedures. Neuro-imaging technologies, such as PET scans (Positron Emission Tomography) not only have allowed neuroscientists to study brain activity, but have also led to new or revised perspectives about early childhood development.

For example, it is now known that the nature versus nurture debate is not productive in the quest to better understand the ways in which biological (genetic) and environmental factors impact upon each individual child's development (see Chapter 1). Barnet and Barnet (1998) describe development as 'a lifelong dialogue between inherited tendencies and our life history' and this view is central to their discussions of children's intellectual, moral and emotional development from neurological and psychological perspectives. Shonkoff and Philipps (2000) also concur that neuroscientific evidence has led to a clearer understanding of the ways in which 'genetic and environmental influences work together in dynamic ways over the course of development' and that they are mutually influential. Johnson and Mareschal (2001) provide evidence from research into infants' perceptual development (vision and attention, action and space, social cognition, and speech perception) which has used, among other technologies, neuro-imaging to help reveal the ways in which nature and nurture interact.

There are conflicting views about the extent to which environmental influences and stimulation shape early brain development and subsequently impact upon one's later physical and emotional well-being. There are opposing views about whether 'missed (or neglected) opportunities' during early brain development can be regained later in life. Shore (1997), for example, drew together insights on early development gathered largely from a 1996 conference in the USA of 'the nation's leading brain scientists, experts in child development and early education…' which stated that 'early experiences – positive or negative – have a decisive impact upon how the brain is wired' and that the timing of such experiences is crucial. Furthermore, Shore warns that research has indicated that the emotional neglect or abandonment of children very early in life can often lead to the impairment of brain-mediated functions such as empathy, attachment, and the regulation of the emotions (See Gunnar 1996). The claims that the first three years of life are critical to brain development led not only to a proliferation of articles aimed at parents, carers and educators, but also to a critical response from Bruer (1999). In his review of neurological and psychological evidence, Bruer refuted the view that windows of opportunity for brain development close down after the first three years of life (with the exception of vision). Instead, he argues, neuroscientific findings have sometimes been stretched to form tenuous claims about early brain development to fit the aims of research or policy. While acknowledging that there are critical periods in brain development, Bruer added that the brain's plasticity allows lifelong learning. For example, he tells readers that vocabulary growth and, possibly, Verbal IQ measures is linked to experience – exposure to new words and ideas – and that at any time in life humans can benefit from such exposure (Bruer 1999).

Further support for this plasticity in the human brain is found, as stated in chapter 1, in the fact that Romanian children who were adopted after a period of serious early deprivation made up their physical and psychological losses.

There are, however, aspects of the evidence on brain development about which Bruer and Shore agree. Namely, that it is during the first three years of life that the human brain *makes trillions of new* (synaptic) connections, and that environmental influences are known to impact upon these connections. Bruer (1999) noted that neuroscience has led to the discovery that early in their development, both humans and other animals experience a rapid flowering of synapse formation, that is, in brain connectivity. Furthermore, environmental influences on the brain's early formation and 'wiring' can be both positive and negative and can take place even before a child is born. Nelson,C. (1999) also argues that neuroscientific work has shown that 'neural plasticity…the subtle but orchestrated dance that occurs between the brain and the environment' may lead to reconceptualisation of ideas about intervention, competence and resilience. He stresses that it is important to dispense with nature versus nurture arguments in favour of a new approach to understanding how experience can modify the brain, and how knowledge derived from such an approach can better identify intervention procedures, for example.

Thus the implications for children with special needs are that intervention programmes should be fine-tuned to ensure maximum stimulation for those aspects, sensory, physical or intellectual, to enable the synapses to form/ connect.

Babies' brains develop at an astonishing pace in the early years. Brains are genetically wired at birth, but the complex circuitry that permits mature thought processes to occur only begins to develop in early childhood, and connections continue to be made throughout life, and are shaped by experience.

The human brain begins its lifelong, developmental journey in the womb; by the end of the first month the human foetus already has a primitive brain which, by nine months' gestation has formed virtually all of the neurons that it is ever likely to have (Greenfield 1997).

It is now known that a baby's brain is not fully developed at birth, although it arrives in the world with most, if not all, of its neurons in place and with some connections between them (synapses) that have permitted basic foetal movement in the womb, and which subsequently allow vital and reflex functions to occur neonatally. While a newborn, or neonate's, brain still has a long way to go on its developmental journey, it is not 'empty' or inactive. At birth, the process of wiring up synaptic connections (called synaptogenesis) continues and accelerates. Webb,S. et al's (2001) review in neurological detail the process of postnatal neuroanatomical change and its implications for behaviour, and they emphasise that brain development is characterised by two main periods, the first beginning at conception, and the second during gestation (the latter continuing for up to two decades). They observe that many researchers (such as Goldman-Racik 1987; Katz and Shatz 1997 cited in Webb, S. et al 2001*)* have proposed that early brain development involves a huge overproduction of synaptic connections; some of these connections will become redundant and are subsequently 'pruned' away. Connections that have been repeatedly used tend to be retained, and those that have not been used often are shed. Pruning in the brain, much as in the garden, not only eliminates circuits that are surplus to requirements, but also allows the remaining circuits to grow bigger and stronger.

The metaphor of plant growth was used by Diamond and Hopkins (1998) in their synthesis of early brain research and information on children's playful activity, *Magic Trees of the Mind*. A detailed explanation of the processes of synaptogenesis, synaptic pruning, can be found in Bruer (1997), where he also discusses the 'windows of opportunity', otherwise known as 'critical periods' in brain development. Greenough et al (1987) have described these periods, saying that it appears that through the process of evolution, neural systems have been developed which expect to find particular types of stimuli in the environment, stimuli which are capable of fine-tuning their performance.

The *'Brainwonders' website* defines critical periods as developmental phases that are dependent upon environmental input; it adds that there are differing critical periods for 'the presence of certain nutrients … for certain types of sensory stimuli (such as vision and speech sounds), and for certain emotional and cognitive experiences (attachment, language exposure)'. On the other hand, it is also made clear that 'there are mental skills, such as reading, vocabulary size, and the ability to see colour, which do not appear to pass through tight critical periods in their development.' However, yet again there have been disagreements about the possible existence of such periods in human development, Blakemore (2002: 28) writes that 'Most neuroscientists now believe that critical periods are not rigid and inflexible. Rather, most interpret them as 'sensitive' periods.' Those who believed in the existence of critical periods set in motion what Johnson (2002) refers to as a plethora of materials, such as videos, claiming to 'boost' your baby's brain, and implying that these will result in long-term beneficial effects. He stresses, though, that such claims currently have little support from neuroscience and that they should be treated with caution. This does not mean we should treat babies as if they have no brain, nor young children as if they cannot benefit from education (in its broadest sense – not formal schooling) until they are admitted to school, as one Times editorial appeared to argue not long ago, suggesting that the purpose of nursery provision is simply to prepare children, so that 'the reception class can begin the proper process of education.' (The Times 1995: 17).

We now know that, right from birth, babies are capable of turning their eyes towards what interests them, in particular to faces. But as Johnson (2002) says, sometimes babies' brains have been thought to be passively shaped by their environment, probably because, to the unfamiliar eye, they seem unable to do anything, perhaps since their use of their arms and legs is undeveloped. Johnson's point sums up the traditional English view reflected in the saying 'children should be seen and not heard' and the fact that adults, including young parents, in England who have public conversations with babies are often looked at askance. Perhaps one outcome of the *Birth to Three Matters* project might be the promotion of joyful, public conversation between babies and young children and their carers in shops, streets, everywhere - to push home the message that children have brains and that they are trying to make sense of the world from the moment of birth. It is in sharing these ordinary encounters that brain development is promoted as well as other aspects such as emotional attachment and self-esteem, as we have already discussed.

Neuroscience has started to map out the ways in which young brains make the connections that are the key to each individual child's personality, its mind. It has also provided useful insights into the ways in which environmental influences can impact upon the brain. Eliot (1999) describes the medical research into environmental influences on the prenatal brain. She reports that poor nutrition, substances and chemicals, alcohol, cigarettes, illegal drugs (including marijuana) and maternal emotion and stress can all have detrimental influences upon the developing brain. Caffeine, sweeteners and monosodium glutamate (MSG) were also tested but no ill effects had been found. Research by Drewett et al (2001) with malnourished Ethiopian children also found that early malnutrition does not have a permanent adverse effect on brain development.

By contrast, neuroscience does not offer keys to raising a super-intelligent child; indeed, Bruer (1997) argues that neuroscience has been incorrectly applied to devise cognitive development programmes that claim to boost a young child's intelligence. Discussing critical periods in brain development, he states that, experience-expectant brain plasticity does not make specific demands relating to experiences or environments. Thus, one cannot use this as a guide to the selection of particular toys, nursery provision, or childcare policies. Rather, children develop their fundamental sensory-motor and language skills through the kinds of experiences, which can occur in their everyday environments (Bruer 1997).

What is evident from neuroscience is that 'normal' brain development in early childhood is dependent upon environmental input and, for parents and carers, this means warm and loving, appropriate interaction with children who are living in a safe context, in which they are nourished and nurtured and allowed opportunities to explore. Gopnik et al (1999) summarise evidence from research in philosophy, psychology, neuroscience, linguistics and other disciplines to provide an account of how babies and young children learn about the world around them, about people and relationships, and about language, linking their discussion to what is known about brain development. They assert that we know from science that nature has designed adults to teach babies, just as much as it has designed babies to learn and that it indicates we should talk, play, make funny faces, and pay attention to our babies when we are with them – but that we simply need the time to do this (Gopnik et al 1999).

So it would appear that research from a number of disciplines informs us that babies and young children need to play and interact with their parents and other significant people in their lives, because it is in these enjoyable everyday exchanges and conversations that their brains develop – are 'redesigned' even – as a result of learning. However, in a society where parents (and other family members) may have less time to spend in the home, their children could be losing out on the quality time that can be spent doing just those very simple activities on which their brain development can thrive. Added to this are the pressures of poverty and socio-economic disadvantage, which may give rise to depression in parents. Population studies (Richman 1978; Richman et al 1982) found that as many as 20-40% of British mothers were suffering from depression (although not all sought medical help), and that depressed emotional states adversely impact upon parent-child relationships because mothers are less likely to stimulate their babies and children. (See Goleman 1996; Kendall 2002 for a summary of evidence on the effects of maternal mental health on development in the first twelve months of life.) The research seems to indicate that we need to ensure parents have support when they need it, that they have time to enjoy being with their children, and that they feel assured that when they are at work, their babies and children are still enjoying interactions with other key adults and children. Some of the main messages for parents, early years practitioners, policy makers and researchers about the changes in thinking about early brain development and function can be found in Shore's summary of the differences between 'old thinking' and 'new thinking' about the brain, which has been adapted for Figure 2 below.

Figure 2: An adaptation of Shore's (1997) chart of 'old' and 'new' thinking about the brain

What we used to believe	***What research seems to indicate***
Brain development depends on the genes you inherit.	Brain development occurs as a result of a complex interweaving of one's genetic potential and experiences.
Experiences before the age of three do not influence later development very much.	Early experiences affect on the 'design' of the brain, and influence the nature and extent of adult capabilities.
A secure relationship with a primary care-giver is what provides a positive context for early development and learning.	Early interactions impact on the way the brain is 'wired' as well as creating the context for development and learning.
Brain development is linear: in other words, knowledge is gained by a process of accretion throughout life.	Brain development is non-linear: at certain times there are 'sensitive' periods at which conditions for particular kinds of learning are optimal.
Young children's brains are much less active than the brains of adolescents and adults.	In the early years children's brains are much more active than are adults' brains, high levels of activity have reduced considerably by adolescence.

Finally, one area of debate about brain development concerns the question of male/ female differences and their implications. As long ago as 1972 Corinne Hutt, in her book *Males and Females*, discussed the action of adrenalin, which she suggested as activated by the presence of male Y chromosomes, in the very early stages of the growth of a foetus. Some of the main effects of this were thought to be (in general) higher levels of aggression and easier arousal to aggression and other risky activity in males compared with females, and more generalised brains in females, with stronger connections between the two hemispheres. Naturally these are issues that need to be addressed and debated, because whether or not a society overlays these reported propensities to maximise or minimise them, has implications for the way the society functions and raises its young.

What is the difference between brain and mind?

Astington's (1994) fundamental interest is in the development of a theory of mind and, in explaining the research that developmental psychologists undertook in this area in the late 1980s and early 1990s, she begins by considering how the mind can be explained and defined. Astington states that the answer lies in 'everyday, commonsense psychology' or 'belief-desire psychology' which refers to the ways in which a person explains and predicts another's actions by thinking about his or her 'beliefs, desires emotions and intentions' (Astington 1994: 2). Astington adds that thoughts and feelings (or states of mind) originate in the brain but she differentiates between the two, saying that the mind and the brain are not one and the same (Astington 1994: 3). She also discusses philosophical ideas about the mind's existence, as does Greenfield (1997) who differentiates between mind and brain and reveals that the 'seemingly individual and unchanged mind is completely at the mercy of the physical brain' (Greenfield 1997: 84). In her concluding thoughts, she adds that the mind may be, 'the evolving personal aspect of the physical brain' and 'consciousness brings the mind alive' (Greenfield 1997: 149).

Gopnik et al (1999: 175) devote considerable attention to the mind / brain synthesis. They argue that it is by studying babies' minds that one studies their brains most productively. However, they devote individual chapters to *Children's Minds* and *Children's Brains* in their highly informative book reviewing research on babies' thinking. They also draw an analogy between the human mind and a computer, and say that little is known about how we feel conscious experiences, but it is known that early in life babies can translate information from the world into rich, complex, abstract, coherent representations. They suggest that because babies are born with brains that are equivalent to computers already set up and running, those representations allow them to find meaning in their experiences and to predict future events (Gopnik et al 1999). Scientists are themselves in different minds about whether there is a difference between brain and mind. Maybe if we use a computer analogy we can, for now, think of the brain as the hardware and the mind as the software.

The brain, attunement and autism

Attachments or emotional bonds formed between children and other people have been shown to be partly 'environment-expectant' (genetically programmed) and 'environment-dependent' (requiring external stimuli) (see chapter 3). This does, of course, have implications for a variety of issues relating to the feeling and expression of emotions. The part of the brain responsible for emotional and social responses is located in the amygdala, which, if damaged, leads to profound emotional changes in a person. Eliot

(1999: 293) reports that 'amygdala damage or dysfunction is one of the leading hypotheses to explain autism'. Trevarthen et al (1998: 82) concur. They state:- 'In nearly every case of autism, when appropriate techniques are available, some abnormality in the brain can be found.' Whereas other children learn to imitate from birth onwards, and through this begin to develop a sense of empathy, autistic children are far less likely to imitate others (Eliot 1999).

Goleman (1996) reports that Stern believed healthy attachments between infants and their mothers are based on a more active contribution to emotional relationships than pure imitation, and are *environment-dependent*. He defined this active participation in exchanges as *attunement* and argued that the prolonged absence of attunement takes a tremendous emotional toll on the child. Children with autism, however, also have a biological deficiency that makes attunement difficult or impossible. Baron-Cohen et al (1985) devised a series of tasks to test autistic children and found that the children not only were unable to recognise the mental state of surprise in another person, but they also were unable to attribute a false belief to another. The compelling evidence suggested that the autistic children appeared not to develop a theory of mind in the ways non-autistic children do. Astington (1994) explains that, are unable to dissemble, to lie to others, they cannot distinguish between reality and 'appearance' – in other words they are very like three year olds in some ways. But, they do not pretend, finding imaginative play impossible to understand, nor can they comprehend the difference between real objects and mental images – in this respect, they are unlike three year olds (Astington 1994).

Brain development, memory and the importance of narratives to mental health

The director of the American Center for Human Development, Daniel Siegel (1999), whose work as a paediatrician and psychiatrist focuses on individual, family and community development in the area of human relationships and their links with biological processes, explains how memory develops in early life, with firstly the *implicit memory* being rooted in movement/ behaviour, emotions, and perceptions. Between 12 and 24 months of age, the part of the brain– the hippocampus – which provides for the second form of memory, matures somewhat. Then *explicit memory* develops, enabling recall and a sense of the self that includes knowing about one's past. Siegel claims that narrative, which he sees as essential to healthy emotional development, depends on both types of memory. In constructing autobiographical narratives – stories about ourselves which help us make sense of our lives – we use *autonoetic consciousness*, the ability to 'time travel' in our minds, which Siegel suggests becomes available to children in their third year of life, when the part of the brain known as the orbito-frontal cortex becomes capable of mediation of this process. .

Narratives are thought to rely on memory that is consciously accessible, but they are also influenced by the memories stored implicitly. Perhaps one reason why story telling is so attractive to human beings is that we have the ability to draw on these implicit memories, which have been hidden from us, and they are often emotionally charged. Narratives can have the effect of helping organise the mind, but they can also shape self-regulation because in developing them we seek coherence. Narratives require the involvement of both halves of the brain, the right – said to deal with imagery and the left with 'making sense'/ logic. So in narratives the left hemisphere, which seeks to make sense of cause and effect, interprets and shapes the images conjured by the right hemisphere. According to Siegel (1999) the right hemisphere grows more rapidly and is more active than the left in the earliest years of life. But by age three the two hemispheres have developed sufficiently to allow the transfer of information across the brain and by age four children are well able to use words to tell others about their inner feelings and inclinations. Siegel claims that narratives are a fundamental aspect of integration, our ability to create a coherent internal interpersonal, family and community experience. Narratives are also important because they help us make sense of other minds – after all, that is essentially what narratives/ stories are about. Effective interpersonal relationships and secure attachments depend on emotional attunement, sharing in the construction of narratives, memory talk and dialogue involving reflection and collaboration to repair disrupted interactions. Bilateral integration, the process whereby both hemispheres of the brain engage in information processing to ensure adaptive, coordinated functioning, promotes coherent narratives, which, according to Siegel are a mark of mental health.

Summing up the implications of brain research for ECEC professionals

In summing up her explorations of brain research, Meade (2001) pondered on the role of play for brain development. She suggests that play is important because

- All types of development are practised…it affords appropriate experience for different regions of the brain.
- Play seems to have a relationship with the blooming of synapses.
- Play of the kind where children's interest and motivation are optimal seems to have a relationship with the sculpting of the brain … these sculpting activities occur when children have care-givers who are attuned; activities where the children display most interest may optimise synapse stabilisation …because there is likely to be repetition; selection processes as to play topics …will activate the prefrontal cortex and limbic system and therefore conscious memory; synapses associated with experiences not chosen will begin to wither away…when play is limited, fewer modalities are active and emotions linked to motivation adversely affect brain function – so child-centred, play-based programmes are important.
- Children usually display high levels of motivation in play.

- Play seems to help lay down implicit memories of skills, dispositions and schemas.
- Play in a complex environment affords children lots of opportunities to satisfy novel preferences. (Adapted from Meade 2001: 22-24).

Additionally, Meade draws attention to children's need, among other things, for opportunities which allow them to develop theories about themselves and other people. She advocates that educators should be warm, responsive and capable of fostering young children's brain development through appropriate play activities.

Further key messages from the research are that young brains are exceptionally 'plastic' so they are shaped by experience and the plasticity allows for catching up if development and learning are hampered in anyway. However, they are also incredibly active and thirsty for interactions and activities which will foster further learning and brain development.