

EARLY YEARS LEARNING



POST 140

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The House of Commons Education and Employment Select Committee is currently holding an inquiry into Early Years Education. This report was prepared as background briefing for the inquiry. It summarises the scientific research on the development of the brain and the psychological development of children, and studies that have compared the outcomes of different types of pre-school education, and discusses the implications of this research for early years education policy.

INTRODUCTION

The Education Sub-committee is currently undertaking an inquiry into aspects of early years education. It will examine:

- the appropriate content of early years education, taking into account the Qualifications and Curriculum Early Learning Goals (see **Box 1**)
- the way in which it should be taught
- the kind of teaching staff that are needed and the qualifications they should have
- the way quality of teaching and learning in the early years is assessed
- at what age formal schooling should start.

BACKGROUND

The 1870 Education Act first established five as the school starting age in Britain. Increasingly, primary schools have been admitting children at the beginning of the year in which they become five. This is earlier than in most other European countries where children do not start school until the age of six or seven. The age range of children in other European classes also tends to be wider than in British classes, which normally contain children born within the same academic year. This is because school-starting policies in other European countries tend to be more flexible than in the UK, allowing children to spend additional time in pre-school if considered beneficial. In these countries, children spend a longer time in pre-school than children in the UK.

The government has recently introduced a Curriculum for the Foundation Stage for the education of children aged three to the end of their reception year, as outlined in Box 1. This describes the expectations for nursery age children to develop social, physical and intellectual skills before the end of their reception year.

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BOX 1 EARLY LEARNING GOALS

The Early Learning Goals (QCA, 1999) establishes targets for children to reach by the end of the foundation stage (age three to the end of their reception year). Six areas are identified:

- personal, social and emotional development
- communication, language and literacy
- mathematical development
- knowledge and understanding of the world
- physical development
- creative development.

It is recommended that these are developed through play and learning, with teachers and parents. The Early Learning Goals have been superseded by the Curriculum Guidance for the Foundation Stage, which comes into effect from September 2000.

Each child undergoes a Baseline Assessment at the beginning of the reception year, which determines his/her level of attainment in these skills.

For further information see:

The Curriculum Guidance for the Foundation Stage, Qualifications and Curriculum Authority (QCA). May 2000. www.qca.org.uk

Several recent high-profile reports in the British media, for example a recent Channel 4 *Dispatches* documentary¹, have argued that the relatively early school starting age in the UK, together with the introduction of Early Learning Goals for nursery age children, is inappropriate and might be damaging to the social development and educational attainment of British children.

This report gives an overview of research that is relevant to these issues:

- First, research on the development of the brain and its relevance to early years education is discussed.
- Next, research on the development of sensory, cognitive and emotional skills in children is summarised and possible implications for early years education are examined.
- In the final section, studies that have compared the outcomes of different types of pre-school education are briefly reviewed to assess the type of early years experiences that best suit the developing child's needs.

¹ Mills, C. & Mills, D. (1998). *Britain's Early Years*. London: Channel 4 Television.

BRAIN DEVELOPMENT

The Neuroscience and Education Debate

Educators often cite scientific research on brain development when arguing for particular early years educational practices. For example, there are suggestions that children should begin the study of languages, advanced mathematics, logic, and music as early as possible^{2,3}.

Such arguments are based on three well-established findings in developmental neurobiology:

- First, starting in infancy and continuing into later childhood, there is a dramatic increase in the number of connections (synapses) between brain cells (neurons). This 'synaptic proliferation' is followed by a period of synaptic elimination, or 'pruning' in which frequently used connections are strengthened and infrequently used connections are eliminated.
- Second, there are 'critical periods' when the development of sensory and motor systems in the brain depends on experience.
- Third, in rats at least, complex, or enriched, environments cause new synapses to form.

However, many neuroscientists believe that not enough is presently known about brain development to link that understanding directly to instruction and educational practice⁴.

Synaptogenesis and synaptic elimination

An adult brain has about 100 billion neurons; at birth the brain has slightly fewer neurons. However, during development many changes take place in the brain. Neurons grow, which accounts for some of the change, but the 'wiring', the intricate network of connections between cells called *synapses*, sees the most significant change. Early in postnatal development, the brain begins to form new synapses, so that the synaptic density (the number of synapses per unit volume of brain tissue) greatly exceeds adult levels. This process of synaptic proliferation, called *synaptogenesis*, lasts up to several months, depending on the species of animal. It is followed by a period of synaptic elimination (or pruning) in which frequently used connections are

strengthened and infrequently used connections are eliminated (**Box 2**). This experience-dependent process, which occurs over a period of years, reduces the overall synaptic density to adult levels, usually by the time of sexual maturity.

BOX 2 SYNAPTOGENESIS

Most of what we know about how the brain develops comes from animal research. The first demonstration of synaptogenesis was in 1975, when it was found that in the cat visual system the number of synapses per neuron first increases rapidly and then gradually decreases to mature levels (Cragg, 1975). Further research carried out in rhesus monkeys (Rakic, 1995) demonstrated that synaptic densities reach maximal levels two to four months after birth, after which time pruning begins. Synaptic densities gradually decline to adult levels at around three years of age, around the time monkeys reach sexual maturity.

Cragg, B. G. (1975). The development of synapses in the visual system of the cat. *Journal of Comparative Neurology*, 160: 147-166.

Rakic, P. (1995). Corticogenesis in human and nonhuman primates. In M. S. Gazzaniga (Ed.), *The Cognitive Neurosciences* (pp. 127-145). Cambridge MA: MIT Press.

Educational literature often suggests that the crucial phase of brain development in humans occurs as early as from birth to three years and that during this time children should be exposed to all sorts of learning experiences⁵. However, this claim makes two assumptions:

- First, it assumes that the time course of synaptogenesis is the same for humans as it is for rhesus monkeys.
- Second, it assumes that the period of synaptogenesis and synaptic pruning corresponds to the development of certain capacities and skills.

As far as the first assumption is concerned, development is a complex process that differs widely between brain areas. The time course of synaptogenesis is different for different brain areas and different classes of neurons in the same brain region gain and lose synapses at different rates. Moreover, brain development varies between species. Comparatively little research has been carried out on human infants because brain tissue can be studied only at autopsy. The only available data suggest that synaptogenesis in humans follows a different time course from that in animals. In the human visual cortex, there is a rapid increase in the

² Beck, J (1996). A meeting of minds between neuroscientists and educators is first step in improving America's schools. *Chicago Tribune*, Section 1, p.23.

³ U.S. Department of Education (1996) *Building knowledge for a nation of learners: A framework for education research 1997*. Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

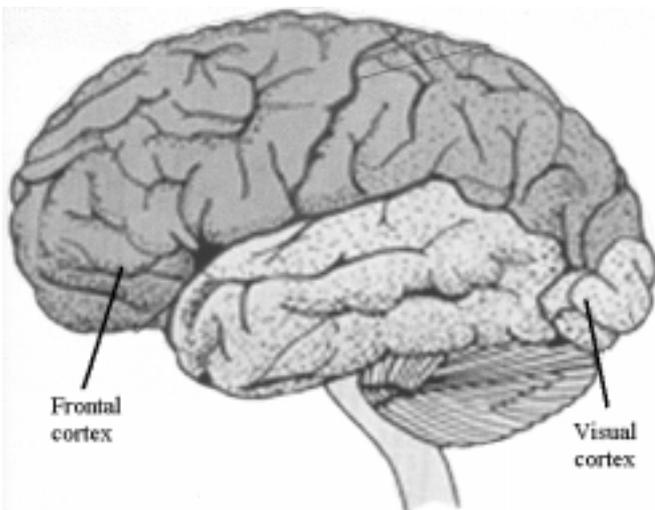
⁴ Bruer, J. T. (1999) Education and the brain: A bridge too far. *Educational Researcher* 26 (8): 4-16.

⁵ Education Commission of the States (1996). *Bridging the gap between neuroscience and education*. Denver, CO: Education Commission of the States.

number of synaptic connections at around two or three months of age, which reaches a peak at eight to 10 months. After that there is a steady decline in synaptic density until it stabilises at around age 10 years and remains at this level throughout adult life⁶.

Different areas of the human brain develop at different rates. In the human frontal cortex (**Figure 1**) - the brain area responsible for planning, integrating information and decision making - synaptogenesis occurs later and the pruning process takes longer than in the visual cortex. In this area, neuronal development continues throughout adolescence - synaptic densities start to decline around mid-adolescence but do not reach adult levels until about age 18.

FIGURE 1 DIAGRAM OF THE HUMAN BRAIN



In summary, while it is true that pre-school children have brains that undergo substantial and rapid changes and are more flexible than adult brains, this increased flexibility remains throughout adolescence in some brain areas.

Psychological studies have been carried out with human infants to test the second assumption (explained on the previous page) by examining the behavioural and cognitive processes that occur at the same time as synaptogenesis, as illustrated in **Box 3**. Increases in synaptic density are correlated with the initial emergence of some skills and capacities, but these continue to improve after synaptic densities begin to regress to adult levels - humans are clearly able to learn new skills well into adulthood and old

age. Thus, synaptogenesis may be necessary for the initial emergence of some abilities, but it cannot account entirely for their continued refinement.

BOX 3 VISUAL DEVELOPMENT

When synaptogenesis begins in the visual cortex, at around 2 months of age, human infants start to lose their innate, infantile reflexes. At age 3 months, when synaptogenesis is well under way in the visual cortex, infants can reach for an object while visually fixating on it. At 4 to 5 months, infants' visual capacities increase. At 8 months, infants first show the ability to perform visual memory tasks, such as delayed-response tasks. In these an object is hidden from the infant's view and after a certain time delay the infant is allowed to reach for the object. Children's memory for hidden objects improves steadily between eight and 12 months. Although the emergence of these capacities coincides with synaptogenesis in visual cortex, they are not necessarily *causally* linked.

Goldman-Rakic, P. S. (1987). Development of cortical circuitry and cognitive function. *Child Development*, 58, 601-622.

Most of what is known about brain development corresponds to the emergence of or changes in visual, movement and memory functions, which are acquired in almost any environment throughout the world at approximately the same age, well before children enter formal education. How synaptogenesis relates to later educational learning or to the acquisition of knowledge and skills such as reading, writing and numeracy is unknown.

Critical Periods

Researchers has known for the past 30 years that an animal requires certain kinds of environmental stimulation at specific times during its development if the brain's sensory and motor systems are to develop normally (**Box 4**).

BOX 4 CRITICAL PERIODS

To investigate developmental 'plasticity', Wiesel & Hubel (1965) temporarily covered one eye of new-born kittens. After about three months, the eye was uncovered and the researchers studied the connections between the two eyes and the brain. They found that this early visual deprivation led to a severe deterioration of neuronal connections in the visual areas of the brain and to virtual blindness. This is because the brain had received no stimulation from the deprived eye and it had wired itself to receive information only from the other, open eye. The kittens remained blind in the initially deprived eye. By comparison, the same or longer periods of complete visual deprivation had no such effects on the visual system of adult cats, nor on their ability to use the deprived eye to guide their behaviour when it was subsequently uncovered.

Wiesel, T. N., & Hubel, D. H. (1965). Extent of recovery from the effects of visual deprivation in kittens. *Journal of Neurophysiology*, 28: 1060-1072

⁶ Huttenlocher, P. (1990). Morphometric studies of human cerebral cortex development. *Neuropsychologia* 28(6): 517-527.

The irreversible consequences of early visual deprivation, as described in Box 4, are often cited as evidence for the importance of early childhood education. However, subsequent research has suggested that some recovery of function is possible depending on the specific period of deprivation and the circumstances following deprivation. The shorter the period of deprivation the more recovery of function is possible. In addition, if the animal is trained to use the initially deprived eye after it is uncovered there is some recovery of vision^{7,8}.

Most neuroscientists now believe that critical periods are not rigid and inflexible. Rather, most interpret them as 'sensitive' periods comprising subtle changes in the brain's ability to be shaped and changed by experiences that occur over a lifetime. For some functions to develop normally, the animal must receive appropriate sensory input from the environment at some stage during development. However, this input tends to be very general in nature, including patterned visual stimuli, the ability to move and manipulate objects, noises, and speech sounds for humans. Such stimuli are available in almost all environments. Higher cognitive capacities, such as language, have several critical periods, many of which continue into adulthood (see section on cognitive development).

Whether critical periods exist for culturally transmitted knowledge systems, such as those responsible for reading and arithmetic, is currently unknown. Research findings on critical periods do have one implication for early childhood care: it is important that parents and teachers rapidly identify and, if possible, treat children's sensory problems, such as visual and hearing difficulties, so that the children can regain normal function.

Enriched Environments and Synaptic Growth

Neurobiological research involving rats is often cited as evidence for the importance of enriched, stimulating early childhood environments (see Box 5). However, in the cited experiments, the 'enriched' environment in the laboratory was actually more like the normal environment of a rat in the wild. So, rather than showing that extra stimulation leads to

an increase in synaptic connections, it might be more accurate to say that a more 'normal' environment leads to more synaptic connections than a deprived environment. In terms of human babies, the research does not imply that parents should provide special 'enriching' experiences to children beyond those that they experience in everyday life. It is unlikely that children brought up in any 'normal' environment could be deprived of sensory input. Research on animals, and recent research on humans, does however suggest that an extremely deprived environment could harm a baby's brain (Box 5).

BOX 5 ENRICHED ENVIRONMENTS

Animal studies

Early studies showed that laboratory rats raised in an 'enriched' environment, with wheels to spin, ladders to climb on, and other rats to play with, have up to 25% more synapses per neuron in brain areas involved in sensory perception than 'deprived' rats, raised alone in a lab cage with no 'playmates' or toys. Furthermore, the rats raised in complex environments perform learning tasks better than deprived rats. In subsequent studies, Greenough and his colleagues showed that the brains of adult rats form new synapses in response to new experiences and toys (Greenough *et al.*, 1987).

Human studies

Recent studies have demonstrated that Romanian babies reared in severely deprived conditions, with no sensory or social stimulation, are more likely to have delayed development of skills such as walking and talking, and impaired social, emotional and cognitive development (O'Connor *et al.*, 1999).

Greenough, W. T., Black, J. E., & Wallace, C. S. (1987). Experience and brain development. *Child Development*, 58: 539-559.

O'Connor, TG, Bredenkamp, D & Rutter, M (1999). Attachment disturbances and disorders in children exposed to early severe deprivation. *Infant Mental Health Journal* 20(10): 10-29.

As noted in Box 5, research on rats suggests that experience can also shape the *adult* brain. Therefore, unlike critical-period phenomena, the ability to create synapses in response to new experiences seems to persist throughout life. So, although the effects of complex environments occur more readily in younger animals, they endure throughout life.

Overall, the research does not support the argument for a selective educational focus specifically on children's earliest years.

Plasticity in the adult brain

Many studies have demonstrated that the adult human brain retains a certain level of plasticity and is capable of changing depending on how it is used. Much of this research has employed modern brain

⁷ Chow, K.L. & Stewart, D. L. (1972). Reversal of structural and functional effects of long-term visual deprivation in cats. *Experimental Neurology*, 34: 409-433.

⁸ Mitchell, D.E. (1989). Normal and abnormal visual development in kittens: insights into the mechanisms that underlie visual perceptual development in humans. *Canadian Journal of Psychology* 43(2):141-64. Review.

imaging techniques such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET), which measure activity in the brain as humans perform a certain task. Recent examples of such studies are described in **Box 6**.

BOX 6 PLASTICITY IN THE ADULT BRAIN

The case of London taxi drivers

Recent studies have shown that the area of the brain responsible for spatial memory (remembering where things are) - the hippocampus - is enlarged and more active in London taxi drivers than in non-taxi drivers. Hippocampus size was related to the time a person had been driving taxis, suggesting that the size changes according to how much the taxi drivers have used their spatial memory (Maguire *et al.*, 2000).

Increased auditory cortex representation in musicians

The part of the brain that processes sound (the auditory cortex) in highly skilled musicians is enlarged by about 25% compared with control subjects who have never played an instrument. Enlargement was correlated with the age at which musicians began to practice, suggesting that the reorganisation of the auditory cortex is use-dependent (Pantev *et al.*, 1998).

Learning to play the piano

Non-piano playing adults learned a five-finger exercise on the piano for two hours a day over the course of five days. The area of the brain responsible for finger movements enlarged and become more active in these subjects compared with control subjects who had not learned the piano exercise. This demonstrates that in just five days the adult brain can adapt according to how it is used (Pascual-Leone *et al.*, 1995).

Maguire E.A., Gadian D.G., Johnsrude I.S., Good C.D., Ashburner J., Frackowiak R.S. & Frith C.D. (2000). Navigation-related structural change in the hippocampi of taxi drivers. *Proceedings of the National Academy of Science U.S.A.* 97(8): 4398-403.

Pantev C., Oostenveld R., Engelien A., Ross B., Roberts L.E. & Hoke M. (1998). Increased auditory cortical representation in musicians. *Nature* 392: 811-4.

Pascual-Leone A., Nguyet D., Cohen L.G., Brasil-Neto J.P., Cammarota A. & Hallett M. (1995). Modulation of muscle responses evoked by transcranial magnetic stimulation during the acquisition of new fine motor skills. *Journal of Neurophysiology* 74(3): 1037-45.

Summary

The young brain is very flexible, sensitive and plastic, and is influenced and shaped by events in the outside world. Sensory areas of the brain seem to develop optimally when the environment contains a variety of sensory stimuli - visual stimuli, textures and sounds. Although babies' brains undergo a large amount of change in the first few years of life, parts of the human brain continue to develop well into adolescence and beyond. Even the adult brain is capable of change. It is therefore difficult to make direct links from the neuroscientific evidence to specific early childhood environments, experiences and early child-care policies.

COGNITIVE DEVELOPMENT OF PRE-SCHOOL CHILDREN

Background

The psychological development of children has seen extensive scientific study over the past 40 years. This has demonstrated the importance of child-initiated play, exploration and peer and sibling interaction, and the role of parents and other adults in the learning process^{9,10}. This report focuses on the following main areas:

- Sensory development
- Understanding the physical world
- Understanding emotions and beliefs
- Development of language
- Learning to read and write
- Development of numeracy.

Sensory development

Babies are born with basic sensory capacities, for example vision and hearing, which are refined and developed throughout childhood. At birth babies can distinguish between different visual forms - new-born babies get bored and look away when they have been shown the same visual stimulus for some time, and only look again if a new visual stimulus is presented. Within a few days of birth babies learn to recognise their mother's face - they will look at a picture of their mother's face longer than a picture of a stranger's face¹¹. Similarly, young babies will listen to their mother's voice longer than a stranger's voice. There is even evidence that babies recognise their mother's voice at birth, from hearing the muted but still audible sounds in the womb¹². Although basic sensory capacities are present at birth, babies require continual sensory stimulation throughout the first few years of life for their sensory systems to develop normally.

Understanding the physical world

Jean Piaget, who pioneered developmental psychology research in Switzerland in the 1930s, believed that babies are born with no capacities beyond simple reflexes. All children, he argued, go through a series of fixed stages of development, and

⁹ Gopnik, A., Meltzoff, A. & Kuhl, P. (2000). *How babies think*. Weidenfeld & Nicolson, London, U.K.

¹⁰ Karmiloff-Smith A. (1995). Annotation: the extraordinary cognitive journey from foetus through infancy. *Journal of Child Psychology and Psychiatry* 36(8): 1293-313.

¹¹ Field, T.M., Cohen, D., Garcia, R. & Greenberg, R. (1984). Mother-stranger face discrimination by the newborn. *Infant Behaviour and Development* 7: 19-25.

¹² DeCasper, A.J. & Fifer, W.P. (1980). Of human bonding: newborns prefer their mother's voice. *Science* 208: 1174-1176.

use innate learning mechanisms to construct ideas about the world. One of his main areas of research was on children's understanding of physical objects, as summarised in **Box 7**. Although Piaget's work on cognitive development was important, most psychologists now believe that babies are born with much more than simple reflexes.

BOX 7 CHILDREN'S UNDERSTANDING OF OBJECTS

Piaget found that babies younger than nine months do not realise objects they cannot see continue to exist. By nine months, babies will start to search for a hidden object. But even at 15 months babies become confused if an object is moved from one place to another place hidden from view and tend to look in the first place the object was hidden. By 18 months babies are able to search for objects correctly and understand the ways in which objects influence each other, for example that one ball can cause another ball to move by colliding with it.

Piaget, J. (1954). *The construction of reality in the child*. New York: Basic Books.

How do children learn about the physical world?

Most of what children learn about the physical world is acquired naturally by exploring, playing with and observing the relations between objects. Young babies, even new-borns, naturally imitate other people's gestures, facial expressions and actions, and imitation seems to play an important role in learning how the world works - for example, children learn to use tools by copying adults¹³.

Understanding emotions

Understanding people's emotions, desires and beliefs plays an important role in social interaction. Within the first nine months babies develop a basic understanding of emotion. For instance they can tell the difference between facial expressions of happiness, sadness and anger and recognise that these are associated with different emotions. Babies begin to show signs of empathy by about 18 months and realise that people can have different points of view, emotions and desires from their own¹⁴. This understanding of other people's emotions continues to develop throughout the first few years of life¹⁵.

¹³Meltzoff, A.N. (1999). Persons and representation: why infant imitation is important for theories of human development. In *Imitation in infancy*. Ed. J. Nadel & G. Butterworth, 9-35, Cambridge: Cambridge University Press.

¹⁴Repacholi, B.M. & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month-olds. *Developmental Psychology* 28: 406-13.

¹⁵Harris, P. (1989). *Children and emotion*. Blackwell, UK.

Understanding beliefs

As soon as they can talk, children talk about their minds and those of other people. At first they concentrate on desires, perceptions and emotions: what they see, feel and want rather than what they think or know. At around 18 months, children start to develop pretend play. This requires an understanding of knowledge and belief - knowing what is real and what is not - and is one of the first instances of creativity. At around three, children start to talk about beliefs (e.g. "I *think* the sweets are in the cupboard"). Only at the age of about four or five do children start to realise that people can have different beliefs from their own and that they themselves can have different beliefs at different times. This is referred to as having a 'Theory of Mind' (**Box 8**).

BOX 8 THEORY OF MIND

The *Sally-Anne false belief task* tests children's 'Theory of Mind'. In the task, children are shown two dolls, Sally and Anne, in a room containing a basket and a box (see Figure 2). Sally has a marble, which she puts in the basket, and then she leaves the room. While Sally is out of the room, Anne removes the marble from the basket and hides it in the box. The children are asked where Sally will look for the marble when she returns. Three year olds fail this task - they say that Sally will look where they know the marble is hidden, in the box. By four or five children give the correct answer (the basket) - by this age they have developed a 'theory of mind' and understand that people can have false beliefs, which differ from their own. Children with Autism often have difficulties understanding other people's beliefs and most fail the Sally-Anne test well above age five. It has been suggested that the trouble Autistic children have forming social relationships might be related to their difficulties in understanding other people's beliefs (Frith, 1992).

Frith, U. (1992). *Autism: Explaining the enigma*. Blackwell UK.

The relevance of Theory of Mind to education

To benefit from formal education children need to be able to do more than just learn and know, they have to be able to know about knowledge and learn how learning works. Knowing what one does not know is a prerequisite for the kind of systematic instruction children receive in school. At three, children do not understand the difference between what they do and do not know. By five most children understand this, enabling them to be instructed in a formal way.

How do children learn about other people's beliefs?

Teaching children explicitly about beliefs can improve their performance on belief tests such as the Sally-Anne task (Box 8). However an understanding of the mind develops naturally in most children, without any explicit teaching, through peer and sibling interaction, as shown in **Figure 3**.

FIGURE 2 SALLY-ANNE FALSE BELIEF TASK

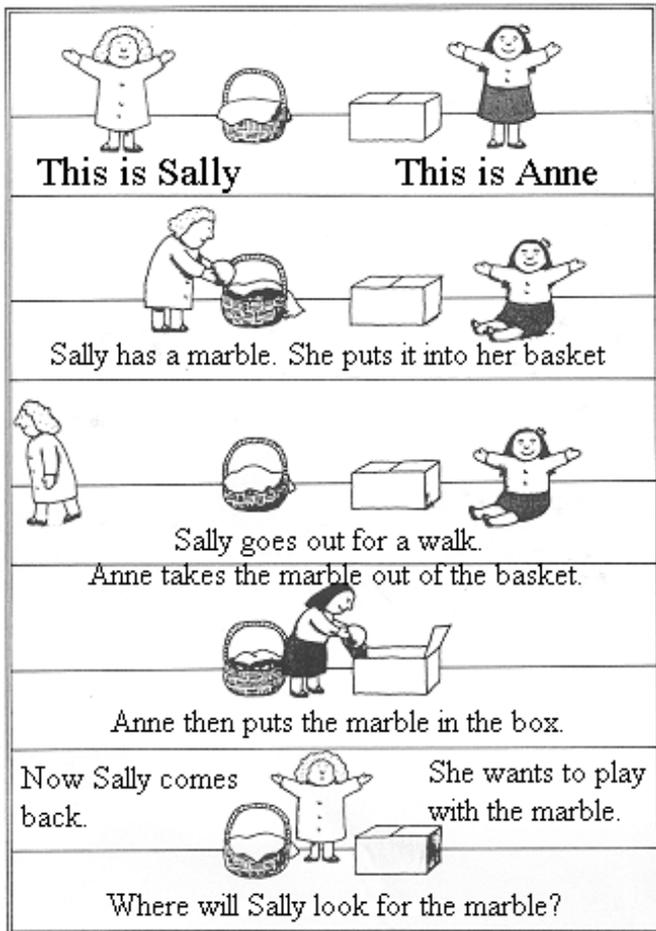


FIGURE 3 DEVELOPMENT IS AIDED BY INTERACTION WITH OTHER CHILDREN

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Development of language

Language and its components - sounds, vocabulary and grammar - are mastered in early childhood using powerful (possibly innate) learning mechanisms that help children to learn a vast

amount by listening to and interacting with adults and siblings (**Box 9**). Because children acquire language without any explicit instruction well before they enter formal education, it has been suggested that humans have a predisposition to learn and generalise the rules of language¹⁶.

BOX 9 LEARNING THE COMPONENTS OF LANGUAGE

Learning sounds

Learning one's own language initially requires categorising the sounds that make up language. New-born babies are able to distinguish between all speech sounds. Sound organisation is determined by the sounds in a baby's environment in the first 12 months of life - by the end of their first year babies lose the ability to distinguish between sounds to which they are not exposed (Kuhl, 1998). There is evidence that learning the sounds of one's own language begins *in utero* - even new-borns can distinguish between sentences spoken in their parents' native language and sentences in another language, presumably on the basis of prenatal experience with maternal speech (Mehler *et al.*, 1988).

Sound categorisation

It is well known that Japanese people cannot distinguish between R and L sounds. However, Japanese babies *can* detect the difference between R and L but only before 10-12 months. The Japanese language does not contain distinct R and L sounds so Japanese babies are not exposed to these sounds and lose the ability to distinguish between them. By one year they can no longer detect the difference between R and L. In contrast babies brought up in the USA at the same age become even better at hearing this distinction because they are exposed to these sounds in their language. Similarly, before about 12 months of age babies brought up in the USA can detect the difference between certain sounds common in the Hindi language, which after 12 months they cannot distinguish.

Learning words

When babies are about one year old they move from sounds to words. In a process called 'fast-mapping', babies begin to map words to objects on the basis of words they hear other people use. From about 18 months to two years, when most children have established a core of around 20 to 50 single words, the speed at which they learn new words accelerates. By the time they are five, most children have a vocabulary of five thousand words or more, and this pace of learning new words continues in the primary years of school. The ability to acquire new vocabulary slows down after adolescence but continues throughout our lifetimes.

Learning grammar

As children's vocabulary increases, they begin to join words together in sequences and establish a basic understanding of grammar. Children are able to develop grammatical rules (e.g. plurals, verb tenses) without explicitly being taught them. At age two, babies tend correctly to say 'children' and 'went' and then only later incorrectly say 'childs' and 'goed'. This suggests that, before two, they copy words they hear adults speak, whereas later they have developed rules about language and generalise these rules, sometimes incorrectly. The period for acquiring grammar and sentence structure continues throughout adolescence and into adulthood.

Kuhl, P.K. (1998). The development of speech and language. In *Mechanistic relationships between development and learning*, ed. T.J. Carew, R. Menzel & CJ Shatz (pp. 53-73). New York: Wiley.

Mehler J., Jusczyk P., Lambertz G., Halsted N., Bertoncini J. & Amiel-Tison C. (1988). A precursor of language acquisition in young infants. *Cognition* 29(2): 143-78.

¹⁶Pinker, S. (1994). *The language instinct*. New York: Morrow.

Young children learn language by listening to adults using words to communicate with them, and imitating what they hear. Adults play an essential role in language development (see **Figure 4**), without making any real effort to do so, for example by using language that is easy for babies to learn (see **Box 10**). This behaviour on the part of adults is almost unintentional - it is as if adults are programmed to behave in a way that aids the development of children¹⁷.

BOX 10 MOTHERESE

Adults often talk to babies in a unique way, which is high-pitched, and contains long, exaggerated vowel sounds - this is called 'Motherese'. Psychologists have found that babies prefer to listen to Motherese sounds than other language sounds, such as those used between adults. Motherese occurs in all cultures and is advantageous because the short and simple sentences and long vowels help children learn the sounds and structure of their language. Motherese is an example of the way adults are designed to help babies learn and therefore play a crucial role in child development (Fernald, 1992).

Fernald, A. (1992). Human maternal vocalizations to infants as biologically relevant signals: An evolutionary perspective. In *The adapted mind: Evolutionary psychology and the generation of culture*, eds. J.H. Barkow, L. Cosmides & J. Tooby. (pp. 391-428). New York: Oxford University Press.

FIGURE 4 ADULTS PLAY AN IMPORTANT ROLE IN DEVELOPMENT

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Photograph by Ed Freeman, courtesy of the National Early Years Network, UK.

Learning to read and write

To understand written words, children must appreciate that an object can be represented by certain sounds and that these can be represented by lines on a surface. Both reading and writing are established most readily on a foundation of good

spoken language. If children have not developed spoken language sufficiently, they might be exposed to written forms of words before they understand the spoken forms.

Young children's sensitivity to rhyme is correlated with, and therefore might feed into, later reading skills. Awareness of rhyme is acquired informally by children hearing language spoken around them¹⁸. There is also an association between nursery-age children's ability to name and sound letters, which requires teaching, and their reading ability at age seven and 11¹⁹. However the ability to identify letters by age five does not necessarily *cause* better reading at age 11, and teaching children to read early does not necessarily mean that they will be better readers later. Studies have found that children with good reading skills generally have access to books at home and parents who encourage their children to read but do not pressurise them or use systematic formal approaches that are commonly used in schools²⁰.

Children who have competent narrative skills (the ability to give a continuous account of events) learn to read and write more readily than children who have not established these skills. As well as narrative skills, children need to be able to coordinate and control their finger movements to start to write. Fine finger coordination is not usually developed until at least five years and is slower to develop in boys than in girls - aspects of finger movement control continue to develop throughout the primary school years. Forcing handwriting skills upon children before they have the basic coordinative powers might be harmful. Few children will have established the skills involved in writing before the age of five, no matter how good their conversational language or how exposed they are to books and other forms of writing.

Development of numeracy

Usually by about three years, children begin to count, and start to apply number words to objects (e.g. "I have three sweets") and actions ("I climbed four steps"). By this age they can successfully share out toys and sweets and so on. However a deep understanding of numbers and quantities seems to develop later through formal instruction (**Box 11**).

¹⁸Bryant P.E., Bradley L., Maclean M. & Crossland, J. (1989). Nursery rhymes, phonological skills and reading. *Journal of Child Language* 16(2):407-28.

¹⁹Blatchford, P. & Plewis, I. (1990). Pre-school reading-related skills and later reading achievement: further evidence, *British Educational Research Journal*, 16(4): 425-8.

²⁰McQuillan, J. (1998). *The literacy crisis: false claims, real solutions*. Portsmouth, NH: Heinemann.

¹⁷Vygotsky, L.S. (1986). *Thought and language*. Trans. A. Kozulin. Cambridge: MIT Press.

BOX 11 LEARNING ABOUT NUMBERS

Learning to count

Although very young children can count, it is believed that at first they are practising little more than a verbal routine, and a deep understanding of the significance of counting takes years to develop (Piaget, 1965). For example, children under six years old seem to believe that two sets of objects contain an equal number of objects only if the sets are the same size. If one set is more spread out than the other children claim that there are more objects in the wider set than in the narrower set. However, there is evidence that when tested with one set of objects at a time, children as young as two or three have a basic understanding of the principles of counting. For example, they understand that counting occurs in a fixed order and the last number counted represents the value of the set (Gelman & Gallistel, 1978).

Sharing and division

Children as young as two or three are adept at sharing and other everyday mathematical tasks as long as they do not involve mathematical numbers or abstract concepts. Sharing is believed to play an important role in the development of mathematical concepts such as division, and is a useful basis for teaching such concepts because it is familiar to children. However, sharing does not give the child immediate insight into the nature of division - young children who are adept at sharing have little understanding of the mathematical relationships in sharing. These more complicated concepts are rarely learned before about age seven, and require formal instruction (Nunes & Bryant, 1997).

Adding and subtracting

Three and four year old children can do well on tasks that involve simple addition and subtraction, but only if the tasks involve small quantities of familiar objects in familiar contexts (e.g. How many objects are there if I add this toy to these two toys?). Children's performance declines on tasks that are abstract in nature (e.g. How many is two and one more?; Hughes, 1981). Children's early ability to add and subtract objects is based on their experience with objects and might be a precursor to the more formal, abstract type of addition and subtraction learned in school.

Butterworth, B. (1999) *The mathematical brain*. London: Macmillan.

Gelman, R. & Gallistel, C.R (1978). *The child's understanding of number*. Cambridge, MA: Harvard University Press.

Hughes, M. (1981) Can pre-school children add and subtract? *Educational Psychology*, 1: 207-219.

Nunes, T. & Bryant, P. (1997). *learning and teaching mathematics: an international perspective*. Psychology Press, Hove, U.K.

Piaget, J. (1965). *The child's conception of number*. New York: Norton.

A deep knowledge of counting and the use of numbers is largely the result of coaching by adults in the primary school years. However, the ability of pre-school children to count, share, and add and subtract small quantities of objects is more likely derived from their own experiences and no doubt provides a good foundation for learning the more abstract mathematical concepts taught in school.

Summary

Developmental psychology research has demonstrated that children's main sensory and cognitive learning achievements come from their own experiences in the course of activities such as play, exploration, everyday talk and social interaction with peers and siblings.

COMPARATIVE EDUCATION STUDIES**Background**

This section gives a brief overview of some recent studies that have compared different types of early years education in terms of the optimal age to start school and the kind of pre-school programme that best suits the developing child's needs. This review is not exhaustive²¹.

School starting age

Young, summer-born children tend to do better on later tests of academic achievement if their entry to school is delayed. Sharp and Hutchison (1997) studied a random sample of 3288 children in 114 schools in 50 English and Welsh LEAs. They found that those who were oldest in the age-group (autumn-borns) performed best and the youngest (summer-born) children performed least well in their Key Stage 1 assessments²².

Analyses of the relationship between school starting age and academic attainment in different countries have generally shown that an earlier school starting age (four or five) has little advantage in terms of later educational outcome compared with a later starting age (six or seven). Children who start school at seven had largely caught up with the earlier starters by the age of nine²³. In countries where children started school at seven, almost all children go to high-quality kindergarten from the age of about three years until they enter school. The principle of these is to prepare children for education and to develop intellect rather than knowledge. They teach children to regulate their emotions, attention span and social behaviour, which are considered prerequisite skills for effective intellectual development. After such skills are learned, intellectual development focuses on memory, oral language skills and conceptual and mathematical understanding. However, in most European countries children are not taught formal literacy or numeracy in kindergarten.

Prais (1997) compared the mathematical ability of 200 nine- and ten-year-olds pupils in Barking and Dagenham schools and 65 children in Zurich. The

²¹For further information see Sylva, K. (1994) The Impact of early learning on children's later development. In Ball, C. (1994). *Start Right: the importance of early learning*. London: Royal Society for the Encouragement of Arts, Manufactures & Commerce (pp 84-96).

²²Sharp, C. and Hutchison, D. (1997). *How do season of birth and length of schooling affect children's attainment at key stage 1? A question revisited*. Slough: NFER.

²³Elley, W.B. (1992) *How in the world do students read? IEA study of reading literacy*. The Hague: The International Association for the Evaluation of Educational Achievement.

Swiss children performed better even though they were about a year younger and had entered school a year later. One main difference between the English and Swiss reception classes was that the former were more variable in terms of academic ability than the latter²⁴.

These results call into question the efficacy of an early start as a means of ensuring educational standards and suggest that homogeneity in ability enables the class to progress at a faster and more uniform rate. Homogeneity might be achieved, as it is in Switzerland and other European countries, by increasing the flexibility of the school starting age, allowing children to stay an extra year in pre-school if considered beneficial.

Type of pre-school environment

Evidence from the USA

The outcomes of different types of pre-school curriculum have been assessed in the USA. The American project *Head Start* was originally set up in the 1970s with the aim of reducing the cycle of poverty in the USA, as a legacy of Lyndon Johnson's War on Poverty. Head Start provided 'compensatory' provision for young children from deprived backgrounds. One pre-school curriculum employed within Head Start was the *Perry Pre-school Project*, later known as *High/Scope* (see **Box 12**).

BOX 12 THE HIGH/SCOPE CURRICULUM

The *High/Scope* curriculum is a high-quality programme that includes a complex training scheme for staff and considerable parent participation. It includes the following experiences for pre-school children:

- *Creative representation*: e.g. recognising objects, imitation, pretending, role-play and drawing
- *Language and literacy*: e.g. talking with others, describing objects and events, listening to stories and poems, drawing and scribbling
- *Initiative and social relations*: e.g. solving problems encountered in play and friendships, expressing feelings
- *Movement*: e.g. moving with objects, expressing creativity in movement
- *Music*: e.g. exploring and identifying sounds, playing simple musical instruments
- *Classification*: e.g. distinguishing and describing objects and shapes, sorting and matching
- *Seriation*: e.g. arranging objects in series, comparing attributes (bigger/smaller)
- *Number*: e.g. sharing and counting objects
- *Space*: e.g. filling and emptying, fitting objects together and taking them apart
- *Time*: e.g. starting and stopping an action on signal, anticipating, remembering and describing sequences of events.

Head Start and High/Scope have been subjected to careful evaluation for over 30 years and have shown striking results, as outlined in **Boxes 13** and **14**.

BOX 13 HEAD START

Head start trials

- A synthesis of 210 studies evaluating the impact of Head Start showed that it has immediate, but relatively short-term, positive effects on children's cognitive ability, self-esteem, scholastic achievement, motivation and social behaviour (McKey *et al.*, 1985).
- A study by Lee *et al* (1988) compared the outcomes of 969 disadvantaged children who had experienced three different pre-school environments: Head Start, some other pre-school programme and no pre-school. Head Start children showed larger, long-lasting gains on social and cognitive measures compared with children in the other two groups. The largest gains were made by black children who exhibited the greatest cognitive disadvantage at the outset of the Head Start programme.

Lee, V., Brooks-Gunn, J. & Schnur, E. (1988). Does Head-Start work? A 1-year follow up comparison of disadvantaged children attending Head-start, no pre-school and other pre-school programmes. *Developmental Psychology* 2: 210-222.

McKey, H.R., Condelli, L., Ganson, H., Barrett, B., McConkey, C. & Plantz, M. (1985). The impact of Head Start on children, families and communities. The Head Start Bureau, Administration for children, Youth and Families. Office of Human Development Services. Washington DC: CSR Incorporated.

Cost benefit analyses have shown that, in terms of financial investment over the life times of the participants, the High/Scope pre-school programme returns to the public an estimated \$7.16 for every dollar invested. These calculations were based on the financial cost to society of juvenile delinquency, remedial education, income support, and joblessness, and the return to society of taxes from the higher paid pre-school graduates - set against the running costs of the pre-school programme.

These studies provide a powerful justification for high quality pre-school education. The research designs were rigorous, often employed experimental methods with random assignment to pre-school experiences, assessed a wide range of outcome measures and collected information on children up to and including adulthood, allowing the researchers to make strong claims that the pre-school experiences actually cause lasting cost-effective outcomes.

²⁴ Prais, S.J. (1997). *School-readiness, whole-class teaching and pupils' mathematical attainments* (Discussion Paper No.111). London: National Institute of Economic and Social Research.

BOX 14 HIGH/SCOPE TRIALS

High/Scope

- Berrueta-Clement *et al.*, (1984) found large differences in social and educational outcomes between the 65 children who attended the half-day educational programme over two years and the control group of 58 children who had remained at home. For example, approximately twice the number of people who had attended the High/Scope programme graduated from high school, had college or vocational training or were employed than those who remained at home as children. Social factors such as number of arrests and teenage pregnancies were strikingly lower in the group who had attended the programme. Results from a follow-up of the same children replicated these results, and found that pre-school attendance was associated with social and economic advantages at age 27.
- The High/Scope Pre-School Curriculum Comparison Study followed 68 three- and four-year-olds from disadvantaged backgrounds who were randomly assigned to attend one of three pre-school programmes in the USA on a half-day basis for two years (Schweinhart and Weikart, 1998):
- *Direct Instruction* was a teacher-led approach, involving academic lessons with clearly-defined academic goals in terms of reading, arithmetic and language.
- The *High/Scope Curriculum* used a 'plan-do-review' sequence in which teachers worked with children to initiate, carry out and evaluate their own activities. Children had access to a range of experiences intended to promote intellectual, social and physical development through self-initiated play and exploration.
- In the *Nursery School* approach, teachers created classroom themes and children were encouraged to choose their own activities and to engage in free play.

The researchers followed up the children at various points in their lives. Children from the High/Scope programme and the Direct Instruction curriculum all had higher IQs at school entry than the Nursery school children. At age 15, Nursery and High/Scope attendees were found to engage in half as many delinquent acts as the Direct Instruction group. Thus, raised IQ at school entry does not necessarily indicate later school success. On the most recent occasion the participating children had reached the age of 23. The group who had attended the Direct Instruction programme still appeared to be at a distinct disadvantage to the other two play-based programme groups on a range of personal, emotional and social measures. The results suggest that an emphasis on child-initiated activities develops children's social responsibility and interpersonal skills, and this has a long-lasting influence on personal and social outcomes. In contrast, the lack of opportunities for autonomy and self-direction in the Direct Instruction programme might have contributed to social problems and delinquencies later on in life.

Berrueta-Clement, J.P., Schweinhart, L.J. Barnett, W.S., Epstein, A.S. & Weikart, D.P. (1984). *Changed lives: the effects of the Perry pre-school programme on youths through age 19*. Ypsilanti, Michigan: The High/Scope Press.

Schweinhart, L.J. & Weikart, D.P. (1998). Why curriculum matters in early childhood education. *Educational Leadership* 55 (6): 57-60.

In summary, pre-school programmes that emphasise self-initiated play and exploration provide children with space and toys with which to play, and do not teach academic subjects, seem to be worthwhile to children. Several studies found that the most successful programmes involve a high degree of parental involvement²⁵.

²⁵Woodhead, M. (1989). "School starts at five...or four years old?": the rationale for changing admission policies in England and Wales, *Journal of Education Policy*, 4(1): 1-21.

Evidence from the UK

Children who had attended a Local Education Authority (LEA) nursery and those who had attended poorly resourced playgroups (matched for sex, age, family structure and parental occupation) were assessed in their reception year²⁶. It was found that the nursery children:

- were more likely to engage in more purposeful and complex activities
- chose more 'demanding' educational activities
- spent more time completing workcards and in self-initiated writing
- engaged in more conversation with their peers
- were more persistent and independent than playgroup attendees when they encountered obstacles.

The authors concluded that the children who attended nursery classes were more 'ready' for school than the matched group of playgroup attendees. They argued that playgroups that lack facilities, space and resources may offer limited opportunities for children to initiate their own play and solve their own problems. This has been replicated by several studies, including a recent study that assessed mathematics and reading progress on Performance Indicators in Primary Schools in 1351 pupils attending 38 primary schools in the UK²⁷.

As part of a cross-departmental government review of provision for young children, Oliver *et al* (1998) reviewed research in the UK and other countries on the effectiveness of a variety of early interventions²⁸. The authors concluded that the most effective projects utilise children's instinct for play and allow them to be physically active, and that this is effective because it increases a child's receptivity for learning. They also suggest that building self-esteem is a key element in securing positive long-term outcomes for children and point out that some of the most effective early interventions involve parents in their child's cognitive development, either at home or within a pre-school centre.

²⁶Jowett, S. & Sylva, K. (1986). Does kind of pre-school matter? *Educational Research*, 28(1): 21-31.

²⁷Tymms, P., Merrell, C. & Henderson, B. (1997). The first year at school: a quantitative investigation of the attainment and progress of pupils, *Educational Research and Evaluation*, 3(2): 101-18.

²⁸Oliver, C., Smith, M. & Barker, S. (1998). *Effectiveness of early interventions*. Paper presented at the Cross Departmental Review on Provision for Young Children Ministerial Seminar hosted by Joseph Rowntree Foundation, Institution of Civil Engineers, 11 March.

In 1996 a five year longitudinal study of Effective Provision of Pre-school Education (EPPE) was funded by the UK Department for Education and Employment. It explored the effectiveness of pre-school provision on young children's progress and development from age three to seven years. Approximately 3000 young children entering six different types of pre-school provision are included in the study carried out by Kathy Sylva and her colleagues. In line with earlier studies, the results so far reveal the existence of strong links between parents' educational and occupational backgrounds and their children's cognitive development. It is currently too early to draw conclusions about the effectiveness of pre-school provision, which will be discussed in the final report of the Project in 2001²⁹.

SUMMARY

Studies on brain development are of interest but are more difficult to relate to early years education policy than studies on the development of children and different educational systems.

Certain skills such as walking, talking and emotional understanding, develop naturally in almost all children allowed to play with their siblings and peers and explore their environment. Other skills such as reading, writing and maths require teaching, but there is no convincing evidence that teaching these skills early (before about six) is advantageous. International studies suggest that a later school starting age (age six or seven) might be beneficial, if school is preceded by high-quality pre-school provision.

The comparative education studies support the results of the developmental psychology studies, finding that well-resourced pre-schools that encourage the development of emotional, cognitive, social skills and feelings of self-efficacy through natural activities such as play and exploration result in lasting social and educational benefits, especially for children from deprived backgrounds.

IMPLICATIONS FOR EARLY YEARS EDUCATION

- Play, exploration and discovery are important means of developing cognitive, social and emotional skills, which are prerequisites for other kinds of learning. Most children will naturally pursue these means of learning by exploring their environment and interacting with the objects and people around them.
- Allowing children space and time to play and discover things for themselves is important. There is no convincing evidence that special enriching environments are advantageous to the development of the child.
- The available studies suggest that early reading, writing and maths experiences can be valuable, as long as they are embedded in children's preferred experiences and interests and are not too formal, abstract or disconnected from other activities. There is some evidence that pressurising young children to learn about letters or numbers in too formal a manner might be counter-productive.
- Good language skills are an important prerequisite to reading and writing. Children generally pick up language just by being surrounded by speaking adults and siblings – they rarely require special coaching.
- Research suggests that children under the age of four or five may not have fully developed the social and cognitive skills that facilitate learning from formal instruction. Such research has led some to question the value of formal education at an early age and to suggest that a focus on social interaction, play and exploration might be more valuable.

Further reading

Select Committee for Education and Employment:
www.parliament.uk/commons/selcom/edem/home.htm

Ball, C. (1994). *Start Right: the Importance of Early Learning*. London: Royal Society for the Encouragement of Arts, Manufactures & Commerce.

Gopnik, A., Meltzoff, A. & Kuhl, P. (2000). *How Babies Think*. Weidenfeld & Nicolson, UK.

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²⁹For further information about the EPPE Project, contact Brenda Taggart on (020) 7612 6219