DOES NOT COMPUTE

Screen Technology in Early Years Education

Aric Sigman

Central Government and local education authorities are placing increasing emphasis on the use of screen technology (e.g. computers, 'educational' DVDs) in the classroom, and promoting 'visual literacy' and 'media literacy' as part of the educational curriculum. This trend has been accompanied by assertions that information presented by computers and DVDs - especially moving images - is more engaging and thereby engenders greater learning in children (Marsh et al., 2005). When referring to these new screen technologies in education, there has been an increasing use of the term 'interactive', which by default gives the impression that existing methods of teaching and learning are not, or are less so.

The Department for Children Schools and Families (DCSF) Primary National Strategy states, *"we see the 'box teaching the book' in the very widest sense imaginable*". The growing acceptance of screens in education is further reflected in statements by the Department which considers *"… mainstream policymakers have - perhaps erroneously - seen curriculum subject areas revolving around literacy…"* and posit *"… a curriculum where noun, verb and adjective sit alongside other types of 'grammatical' vocabulary such as pan, zoom and edit"*(DCSF, 2008). And some British state schools are showing DVDs of animated Hollywood films and teaching "*Shrek Units 1, 2 and 3"* (London Grid for Learning, 2007). Lancashire education authority in their Primary Strategy: Literacy, reports pupils' responses to the animated film Stuart Little as, *"The children responded enthusiastically in all cases with comments like:* ***'You get the picture instead of just thinking'*** (Lancashire Grid for Learning, 2006).
The London Education Authority of Hackney states: "*Visual images are fast becoming the most predominant form of communication with the ratio of image to text increasing."* (London Grid for Learning, 2007). Schools are increasingly showing animated Hollywood films as part of the school day and referring to this activity with descriptions such as 'Golden Time'.

However, this trend toward screen technology in education is now being directed at children from the age of 22 months. The Department for Children, Schools and Families now refer to children using, Information and Communications Technology (ICT) in terms of being “legal requirements” for “learning and development” (DfCSF, 2007).

As part of the EFYS (Early Years Foundation Stage), from the early age of 22 months, ICT is now formally considered by the Department as a “development matter”. Children should “*Show an interest in ICT. Seek to acquire basic skills in turning on and operating some ICT equipment*"

From 30 months schools should "*Draw young children's attention to pieces of ICT apparatus they see or they use with adult supervision*".

From 40 months children should "*Complete a simple program on a Computer. Use ICT to perform simple functions such as selecting a channel on the TV remote control. Use a mouse and keyboard to interact with age-appropriate computer software. Teachers should “Teach and encourage children to click on different icons to cause things to happen in a computer program. Provide a range of programmable toys, as well as equipment involving ICT, such as computers.*"
(DfCSF, 2007)

‘Educational’ vs. ‘Non-educational’ Screen Time

There has been a concerted effort to distance and differentiate so-called ‘educational television’ and ‘educational DVDs’ from entertainment television and DVDs. A similar distinction is being made between ‘educational computer games’ and those that are merely entertaining. While the Internet, is increasingly seen as offering phenomenal educational benefits to children. The British Government has established the ‘Home Access Task Force’ to provide every child with home internet access and is encouraging companies such as BT, Sky, Virgin and Microsoft and RM to provide cheaper internet access and computer technology (BETT, 2008). Children are certainly enthusiastic about this ‘home access’ but not in the way envisaged by the Government. A new report

describes an enormous increase in 'social networking' sites (e.g.Bebo) among younger children which "*has overtaken fun (online games) as the main reason to use the Internet and* ***study is now far behind***" (Childwise Monitor, 2008).

'Quality Time'

The advocates of introducing young children to screen technology contend that it is the 'quality' of what the children see on the screen – the content - that is critical. It is suggested that provided what the toddler or young child sees on the screen is 'educational' and 'age-appropriate' there are cognitive and intellectual advantages and educational benefits forthcoming. And there is an implicit message that *not* exposing toddlers and young children to this screen material puts them at a developmental and educational disadvantage. Presumably this is why it is now a legal requirement as stated in the EYFS.

It is also implied that if children do not 'get used to' screen technology early on, they will in some way be intimidated by it, or be less competent at using it later. However, new research has found that even Rhesus monkeys are comfortable with, and capable of using, the same screen technology that children are exposed to (Deadwyler et al, 2008). Monkeys are even willing to forego their food and drink in exchange for the opportunity to look at screen images of the dominant, 'celebrity' monkeys of their pack. And there is 'monkey porn'. Sexual imagery on screens works on male monkeys who are also willing to 'pay' (with their food) to see images of female monkeys' hind quarters (Deaner et al., 2005). The Dallas Zoo reports that their gorillas each have their favourite television shows. They all like Disney cartoons; The Little Mermaid, The Lion King and Beauty and the Beast are their favourites. One teenage gorilla 'Patrick' has a penchant for public television and National Geographic specials but is bored by sports. The zoo explained that '*They don't follow the story of course, they like the music, the color and the movement*.' (Dallas Zoo, 2004)

While this trend in introducing screen technology in early years education is gathering strength, a growing body of empirical evidence – most of it from beyond the domains of

media studies, education and psychology - is providing a very different account of how exposure to screen technology affects children now and in the long-term future. There seems to be a direct conflict between the advocates of ICT in early years education and the warnings arising from studies in paediatric medicine and biology.

The Video Deficit

ICT production interests from both the state and private sectors have cultivated a belief that almost from birth, so-called 'age-appropriate, educational' television and DVDs will provide children with cognitive/intellectual advantages including improved language acquisition. Yet for example, recent studies find, "*When learning from videos is assessed in comparison to equivalent live presentations, there is usually substantially less learning from videos*." (Anderson & Pempek, 2005) And a phenomenon called the *video deficit* is being used to describe the observation that toddlers who have no trouble understanding a task demonstrated in real life often stumble when the same task is shown onscreen. They need repeated viewings to learn it. The young children's 'educational' television and DVD market has allowed some to believe that learning and experiencing via a screen, rivals, and often exceeds, the process of learning via real-life interactions.

Language Acquisition

Screen-based education is found to be less effective and in some cases deleterious. For example, despite claims that educational DVDs and videos are beneficial to young children, a recent study published in the medical *Journal of Pediatrics* found that the use of such productions might actually *retard* their language development. Furthermore even 'educational' television programmes, DVDs and videos showed no positive effects on children age 2 and under. And there were **no** benefits whether the children watched 'educational' or 'non-educational' media or adult television programs such as *The Simpsons*, *Oprah*, and sports programming. Whether parents sat and watched the screen with the children also made **no** difference to the outcome.

In particular, the scientists found that for every hour per day spent watching specially developed baby DVDs and videos such as *Baby Einstein* and *Brainy Baby*, children under

16 months understood an average of six to eight fewer words than children who did not watch them. One of the authors stated," *The evidence is mounting that they are of no value and may in fact be harmful. Given what we now know, I believe the onus is on the manufacturers to prove their claims that watching these programs can positively impact children's cognitive development. The bottom line is the more a child watches baby DVDs and videos the bigger the effect. The amount of viewing does matter*." (Zimmerman et al., 2007a)

'Educational' Computers

Enthusiasm for the advantages offered by screen technology is more pronounced when considering computer use in schools. However, a recent study of 15-year-old students in 31 countries concluded that those using computers at school several times a week performed "***sizeably and statistically significantly worse***" in both maths and reading than those who used them less often (Fuchs & Woessmann, 2004). The idea that children leaving primary school are becoming more and more intelligent and competent is also called into question by new findings. Using a standard test of perceptions of volume and weight, considered a fairly robust indicator of cognitive development, researchers concluded… "*An 11-year-old today is performing at the level an 8- or 9-year-old was performing at 30 years ago…*" The decline was attributed in part to the growing use of computer games. Children, especially boys, are playing more in virtual worlds instead of "*outdoors, with tools and things …*" (Shayer, 2006).

Redefining 'Interactive'

A major study by London University's Institute of Education has also raised doubts about the growing use of "interactive whiteboards". Moss et al, (2007) reported, "*Although the newness of the technology was initially welcomed by pupils, any boost in motivation seems short-lived. … "Statistical analysis showed no impact on pupil performance in the first year in which departments were fully equipped.*" Many pupils were relegated to that of "spectators" as teachers used this ICT to create faster and more complicated lessons. It was reported that some children became distracted by the technology and the pace of some classes slowed as teachers sought to give each child "turns" at using the board. "*For*

instance, the focus on interactivity as a technical process can lead to some relatively mundane activities being over-valued …". "*In lower ability groups it could actually slow the pace of whole-class learning as individual pupils took turns at the board.*"

Brain Function and Computer Use

While playing computer games are thought to be more stimulating than watching television or DVDs, evidence indicates that even this so-called 'interactive media' is associated with limited neurological activity. For example, a study looking at differences in cerebral blood flow between children playing computer games and children doing very simple repetitive arithmetic adding single digit numbers found that computer games only stimulated activity in those parts of the brain associated with vision and movement as compared to arithmetic-stimulated brain activity (Kawashima, 2001). Adding single digit numbers activated areas throughout the left and right frontal lobes. Playing computer games did not. The findings were described by the World Federation of Neurology as "*alarming …computer games stunted the developing mind …*"

The frontal lobe is the brain's executive control system, responsible for planning, organising and sequencing behaviour for self-control, moral judgment and attention. The frontal lobe continues to develop until the age of about 20. It is imperative that children and young adults do things, which thicken the fibres connecting neurons in this part of the brain, and the more the person is stimulated, the more the fibres will thicken. The study reported by The World Federation of Neurology expresses great concern over the way visual electronic media is affecting children by '*...halting the process of frontal lobe development and affecting their ability to control potentially antisocial elements of their behaviour...the implications are very serious...children should also be encouraged to play outside with other children, interact and communicate with others as much as possible*'. It is suggested that the more work done to thicken the fibres connecting the neurons in this part of the brain, the better the child's ability will be to control their behaviour (Kawashima et al, 2001).

As a point of comparison, real-world cognitive demands – especially early ones -

physically improve and enlarge children's brains. For example, a study published in *Nature* has found that learning a second language literally increases the density of a child's grey matter in the left inferior parietal cortex of the brain (Mechelli et al, 2004). This part of the child's brain is active during both procedural and declarative learning.

Brain Function and Reading

Reading has been observed to increase brain activity in the left hemisphere and to build the neural mechanisms for better reading. And the nature of the words read appears to influence brain structure and function. Reading figurative language - sentences containing irony or metaphor - produces more brain activity than reading factual, literal sentences (Turkeltaub, et al., 2003; Eviatar & Just, 2006). Reading Shakespearean language has been found to cause significant increases brain activity, as the brain is often forced to retrace its thinking process in order to understand some of the unusual use of words (Davis, et al., 2006). It is thought that in reading the printed word, the medium is secondary. The child is required analyse and interpret. Watching a televised account of the same material does not place the same cognitive demands on the child.

Stimulating young children through the early use of screen technology may have an inhibitory effect on their later ability to be engaged by traditional written information as presented in books, or by propositional learning through lessons given by a teacher in a class room (Sigman, 2007a). Early introduction to screen technology may in effect render the real world less arresting and compelling.

Screen Viewing Leads to Less Reading

The media prominence of Harry Potter has caused many to labour under the misapprehension that children are reading more. The opposite is true. Early exposure to, and increasing time spent watching screen technology is strongly linked to a significant continuing decline in time spent reading books as a regular past time (Childwise Monitor, 2008). Pre-school children spend three times longer in front of a television or computer, than they spend reading. And those with a screen in their bedroom are less likely to be able to read by age 6 (Rideout et al, 2003). Even in 1999, British studies were finding

that, "*Fewer homes have books than have television sets. Despite the discrepancy in cost, no more children own books (two thirds in all) than have their own television set.*" (Livingstone & Bovill, 1999)

A recent comparative study of children in 41 countries has found that England has dropped from third to 19th in the international reading literacy league table since 2001 (PIRLS, 2007). More than a third (37%) of 10-year-olds in England play computer games for more than three hours a day, the study found. This represents an increase since 2001 and one of the highest proportions internationally, and researchers found a link between this use of computer games and lower attainment in reading and literacy. Interestingly it was the lower achievement of *better* readers that has had the most influence on the overall decline. The Children's Secretary stated, "*This study shows that our highest achieving children are reading less.*"

The effects are also found in adults. A quarter of US adults say they read no books at all (Associated Press-Ipsos, 2007). While a quarter of Britons say they have not read a book in the past year including almost half of males aged between 16 and 24 (Office of National Statistics 2008). Another global study concludes that '*Britons watch more TV but read less than any other country in Europe.*' (NOP World, 2005)

Educational Achievement

Television viewing among children under three is found to have 'deleterious effects' on mathematics ability, reading recognition and comprehension in later childhood. Along with television viewing displacing educational and play activities, it is suspected this harm may be due to the visual and auditory output from the television actually affecting the child's rapidly developing brain (Zimmerman and Christakis, 2005). A 26-year study, tracking children from birth, has recently concluded "*television viewing in childhood and adolescence is associated with poor educational achievement by 26 years of age. Early exposure to television may have long-lasting adverse consequences for educational achievement and later socioeconomic status and well-being.*" The authors describe a dose-response relationship between the amount of television watched and

declining educational performance, which has 'biological plausibility'. Significant long-term effects occurred even at so-called modest levels of television viewing: between one and two hours per day. They also wrote '*the overall educational value of television viewing was low...These findings offer little support for the hypothesis that a small amount of television is beneficial*'. (Hancox et al., 2005)

Autism

Early exposure to screen technology including computers, television and DVDs is now implicated in another childhood condition. Research from Cornell University strongly suggests that for children under 3 years of age, screen viewing may be "*an important trigger for autism*", the incidence of which appears to be increasing. Researchers estimated that just fewer than 40 per cent of autism diagnoses studied were linked to watching screens below the age of 3 (Waldman et al., 2006). While it is not clear how watching screens could trigger autism, it is possible the lack of social interaction could make children prone to autism more withdrawn. And if screen technology is involved, the damage must be done early in life, as most cases of autism are diagnosed by age three. In discussing the findings the lead researcher commented, "*we have evidence that is awfully suggestive of a link between watching TV and autism.*"

'Videophilia'

Regular contact with greenery is associated with improvements in attention, behaviour and school performance (Sigman 2007a, 2007c). For a growing number of children, screen technology makes the real world appear less interesting. This effect is showing up in a wide range of areas. For example a 16-year study recently found that Americans are less interested in spending time in natural surroundings … because they are spending more time watching television, playing video games and surfing the Internet. After a 50-year steady increase in visits to the countryside, a significant decline started as of 1988 "*coincident with the rise in electronic entertainment media...*"

Researchers tested more than two dozen possible explanations for the trend and found that 98 percent of the drop in countryside visits was explained by video games, movie

rentals, going out to movies, Internet use and rising fuel prices. Other possible explanations such as family income or the aging population were ruled out. They identified "*a fundamental shift away from an appreciation of nature –'biophilia' – to 'videophilia', the new human tendency to focus on sedentary activities involving electronic media*." (Pergams & Zaradic, 2006). In Britain, the Department for Environment, Food and Rural Affairs has reported a significant decline in people's contact with the countryside (Defra, 2006).

MECHANISMS AFFECTING LEARNING

If early exposure to screen technology compromises learning, the mechanism may be alterations in the child's developing attentional system.

In August 1999, the American Academy of Pediatrics (AAP) issued guidelines recommending that children under the age of two watch no television or any screen entertainment at all because television '*can negatively affect early brain development*' and that children of all ages should not have a television in their bedroom. This announcement has more recently been followed by a study of 2,500 children (Christakis et al, 2004) published in their journal, *Pediatrics*, looking at whether early exposure to television during critical periods of synaptic development would be associated with subsequent attentional problems.

About five per cent of children now exhibit attention deficit hyperactivity disorder (ADHD), and the incidence of this neurological disorder (Castellanos, et al., 2002) appears to be increasing (Schonwald, 2005). Although genetic inheritance accounts for some of the prevalence of ADHD, and despite decades of research, little thought has gone in to the potentially crucial role that early childhood experiences may have on the development of attentional problems.

Christakis and his colleagues wondered if there was an omnipresent environmental agent that is putting some children at risk of developing ADHD. They found that early television exposure was associated with attentional problems at age seven which was

consistent with a diagnosis of ADHD. Children who watched television at ages one and three had a significantly increased risk of developing such attentional problems by the time they were seven. For every hour of television a child watched per day, there was a nine per cent increase in attentional problems. The authors suggest that their findings may actually be an understatement of the effects on children (Christakis et al., 2004).

And a more recent study has found later attention damage in children who watched average amounts of screen time when they were over 5. The study is the first in the world to investigate a possible long-term link between television viewing in childhood between the ages of five and 11, and attention problems in adolescence. Symptoms included short attention span, poor concentration and being easily distracted. The study concluded: "*Childhood television viewing was associated with attention problems in adolescence, independent of early attention problems and other confounders. These results support the hypothesis that childhood television viewing may contribute to the development of attention problems and suggest that the effects may be long-lasting."*(Landhuis et al., 2007)

These findings could not be explained by early-life attention difficulties, socio-economic factors or intelligence. The authors stated that even after all of these factors were taken into account, watching more television was associated with teenage attention problems. "*Although teachers and parents have been concerned that television may be shortening the attention span of children, this is the first time that watching television has been linked to attention problems in adolescence*."

And a new controlled study on children 14 to 22 years concluded, *"Frequent television viewing during adolescence may be associated with risk for development of attention problems, learning difficulties, and adverse long-term educational outcomes. Youths who watched 1 or more hours of television per day at mean age 14 years were at elevated risk for poor homework completion, negative attitudes toward school, poor grades, and long-term academic failure. Youths who watched 3 or more hours of television per day were the most likely to experience these outcomes. In addition, youths who watched 3 or more*

hours of television per day were at elevated risk for subsequent attention problems and were the least likely to receive postsecondary education."
(Johnson et al., 2007)

Yet attention is not merely confined to everyday descriptions such as concentration or attention span (Sigman, Phillips and Clifford, 1985). And new brain-imaging studies are finding that different parts of the brain deal with different types of attention, and so there can be types of attentional damage different from ADHD (Stuss et al., 2002). If early exposure to television does affect aspects of attention later on, what mechanisms may be involved?

Screen technology elicits what Pavlov first described as the orienting response, our instinctive sensitivity to movement and sudden changes in vision or sound. The orienting response to screen stimulation is apparent almost from birth: infants, when lying on their backs on the floor, will crane their necks around 180 degrees to watch (Kubey & Csikszentmihalyi 2004). Computers or 'educational DVDs/TV offer additional stimulation to children in early years education than the world around them, or they would not sit and look at a screen.

And the stimulation has intensified over the past decades. For example in television programmes, there are more zooms, pans and edits. A study of the pace and editing speed of Sesame Street over 26 years observed that the number of editing cuts on this popular 'educational' children's programme actually doubled during this period (Koolstra et al., 2004). Others have compared the attentional demands of children's programmes made in the public and private sectors, i.e. BBC and commercial television. The duration of a typical scene in a public children's show lasted over 70 per cent longer than in a commercially produced show (Hooper & Chang, 1998). Children's television programmes increasingly "*demand constant attentional shifts by their viewers but do not require them to pay prolonged attentional shifts to given events*." Researchers are now asking if it "*is possible that television's conditioning of short attentional span may be related to some school children's attentional deficits in later classroom settings*" and

whether " … *the recent increase of attention deficit disorders in school age children might be a natural reaction to our modern speeded-up culture … we live in an attention deficit culture*. "(Hooper and Chang, 1998; Healy, 2004) Computer programs for children have also become more sophisticated and stimulating. Could it be the form, not the content, of screen media that is unique?

Screen technology is the perfect medium to produce strong rewards for paying attention to something. Compared to the pace with which real life unfolds and is experienced by young children, television, DVDs and computer games portray life with the fast-forward button fully pressed. Rapidly changing images, scenery and events, colours, and high-fidelity sounds are highly stimulating and extremely interesting. Screen technology is the flavour enhancer of the audiovisual world, providing unnatural levels of sensory stimulation. Little in real life is comparable to this. Screen technology may overpay the child to pay attention to it, and in so doing it may physically corrupt the reward system underpinning his ability to pay attention when the screen is off. (Christakis et al., 2004; Healy 2004)

The actual currency used to pay off and corrupt the reward system may come in the form of the neurotransmitter, dopamine. The release of dopamine in the brain is associated with reward. In particular, dopamine is seen as rewarding us for paying attention, especially to things that are novel and stimulating. (Nieoullon, 2002) And computer screen entertainment causes our brain to release dopamine. (Koepp et al., 1998) It is increasingly clear that ADHD is linked to a change in dopamine functioning. Genes necessary for synthesis, uptake and binding have been implicated in ADHD, and dopamine underfunctioning is also found in the Spontaneously Hypertensive Rat animal model of ADHD. This underfunctioning of dopamine may fail to reward the brain's attention systems, so they don't function effectively. (Sagvolden et al., 2005) Interestingly, adults with attention deficit disorder given dopamine-boosting methylphenidate (Ritalin) before doing a maths test find it easier to concentrate. This is partly because the task seems more interesting. (Volkow et al., 2004)

More research is needed that looks at the extent to which this reward system involving dopamine (and other neurotransmitters) is set in childhood by exposure to screen technology.

Brain Development

What humans do better than any other species is to learn, and whatever happens in the environment will leave its mark on the child's brain. Every moment counts in building brain circuits. The story of an individual's life is based on their brain connections. The young brain is a physically sensitive organ. Repeated exposure to any experience will have a powerful impact on the child's mental and emotional development by either building specific brain circuitry in relation to that experience or by simply depriving their brain of other experiences. The types and degrees of stimulation the child receives from his environment affect the actual number and the density of his brain cell connections, and width of blood vessels, which supply the brain. This process of moulding, referred to as *structural neuroplasticity*, affects both the brain structure and function and appears to influence brain cell development and the regulation of the brain's chemical messengers (neurotransmitters). A good example of this is the finding that learning a musical instrument by the age of 12 will actually make a part of a child's brain larger, in particular the left temporal region. This gives them a better verbal memory and vocabulary years later when they become adults. (Chan et al., 1998) Even vague concepts such as a child raised without nurturing or love will determine the size and function of that child's brain. The frontal-temporal part of the brains of Romanian orphans have been found to be underdeveloped and showing little or no activity. The author later commented '*these children appear to have altered brain growth'*. Brain scans showed that neglected three-year-olds actually had smaller heads than children raised in loving families (Perry, 2000).

And contrary to the cultural notion that the child's brain needs constant external stimulation to develop properly, new research finds that the opposite can be true. Restricting stimulation by meditating actually increases the thickness of the brain's cortex in areas involved in attention and sensory processing. The scientist remarked, '*You*

are exercising it while you meditate, and it gets bigger', adding that yogis 'aren't just sitting there doing nothing'. (Lazar et al., 2005)

A child's brain cells are literally 'up for grabs'. Plasticity is political in that there is a constant battle for the child's neurons to quite literally develop in a certain way. Therefore, we need to have a far better understanding of the overwhelming lobbying power of media screen. Irrespective of the content, the medium alone may cause powerful irreversible changes to a child's brain either directly or by displacing other critical experiences, which have sell-by dates on their consumption. The newest and greatest environmental factor in the child's daily life is the screen. And Government EYFS is likely to add to both the early age of exposure and the number of hours per day that children look at a screen.

HOURS OF SCREEN TIME

Irrespective of the educational value of the viewing content, and whether children are looking at screens in or out of a class room, or with or without 'supervision', there is growing concern over the sheer number of hours children now spend looking at a screen. (Sigman, 2007).

In the United States, by 3 months of age 40 percent of infants are regular viewers of television, DVDs or videos, and by the age of 2 this number increases dramatically to 90 percent (Zimmerman et al, 2007b). Even the youngest of children are no exception. Nearly two-thirds of children under 2 spend a couple of hours a day in front of the screen (Rideout et al 2003). The average six-year-old will have already watched more than one full year of their lives. When other screen time is included, the figure is far higher. British children aged 11 to 15 now spend 55 percent of their waking lives - 53 hours a week, seven and a half hours a day – watching TV and computers, an increase of 40 per cent in a decade. (BMRB, 2004). More than half of three-year-olds now have a TV set in their bedrooms. (Winston, 2004). At least two-thirds of young British children watch television before they go to school and even more watch when they return home. (Childwise Monitor, 2008). "*Over the course of childhood, children spend more time*

watching TV than they do in school." (Zimmerman, 2007). Twenty Five per cent of British 5 year-olds own a computer or laptop of their own. (Childwise Monitor, 2008)

These already escalating levels of screen exposure occur in the context of screen viewing in early life leading to higher levels of screen viewing later on. (Vandewater et al., 2005)

BIOLOGICAL CHANGES

And there are an increasing number of empirical studies finding significant links between hours of screen viewing in childhood and physiological changes along with the development of health risks. (Sigman 2007b) These biological changes range from reduction in child resting metabolic rate, increase in body fat, elevated blood cholesterol levels, clinically increased risk of abnormal glucose metabolism and new Type 2 diabetes in adults (Hu et al., 2003), through substantial increases in myopia (Morgan and Rose, 2005), to increases in migration of cutaneous immune system mast cells which also "lost their granular content and the cytoplasm shrunk" (Johansson et al., 2001). Watching screen technology, irrespective of the content, is increasingly associated with unfavourable biological and cognitive changes. These alterations occur at viewing levels far below the population norm.

Sleep

An increasing number of studies have found that children are getting less sleep than previous generations and are experiencing more sleeping difficulties. New research has found a significant relationship between exposure to screen technology and sleeping difficulties in different age groups ranging from infants to adults.

A study by Thompson and Christakis of 2068 children has found that television viewing among infants and toddlers is associated with irregular sleep patterns. The number of hours of television watched per day was independently associated with both irregular naptime schedule and irregular bedtime schedules. (Thompson and Christakis, 2005) Another study of 5-6 year olds found that both active TV viewing and *passive* TV exposure was related to shorter sleep duration, sleeping disorders, and overall sleep

disturbances. Moreover, passive exposure to TV of more than 2 hours per day was strongly related to sleep disturbances. "*TV viewing and particularly passive TV exposure … significantly increase the risk of sleeping difficulties*." (Paavonen et al., 2006) Remember that this amount of screen time is actually less than the average. Lack of sufficient sleep significantly affects learning and development in children (Sadeh et al., 2003; Wiggs, 2004).

The implications may be serious. Stanford University Medical Center has found evidence that a lack of sleep can significantly alter levels of the hormone melatonin, an extremely powerful antioxidant. Reduced amounts of melatonin may result in a greater chance that cell DNA will produce cancer-causing mutations (Sephton and Speigel, 2003).

Premature Puberty

Melatonin is also sleep-promoting. As it grows dark melatonin levels rise and help facilitate sleep. Researchers have recently reported that when children aged 6 -12 were deprived of their TV sets, computers and video games, their melatonin production increased by an average 30 per cent. Exposure to a screen "*was associated with lower urinary melatonin levels, particularly affecting younger children at a pubertal stage when important changes in melatonin's time structure take place*." The lead author speculated that girls are reaching puberty much earlier than in the 1950s. "*One reason is due to their average increase in weight; but another may be due to reduced levels of melatonin*." (Salti et al., 2006) Animal studies have shown that low melatonin levels have an important role in promoting an early onset of puberty and linked to reproductive function in several sexually mature animals (El-Battawy, 2006).

Autistic children have been reported not to produce the normal night time surge of melatonin. And a new study at the Pasteur Institute found significantly reduced melatonin levels in over 250 autistic French children. (Coghill, 2007)

SOCIAL DISENGAGMENT

Childhood is increasingly about 'private space' and sedentary activities, which are directly displacing social interaction or self-generated imagination. Many people now talk of the benefits of 'interactive' media and the Internet because it is used for communication. But even that has damaged family relationships. A detailed classic two-year study of 73 households examined '*the effects of the Internet on social involvement and psychological wellbeing'*. The families used the Internet extensively for communication. Yet the researchers concluded *'Nonetheless, greater use of the Internet was associated with declines in participants' communication with family members in the household, declines in the size of their social circle, and increases in their depression and loneliness*.' They also considered that increasing time in front of the screen, *"causes both social disengagement and worsening of mood...and limited face-to-face social interaction*'. Both the Internet and television were found to cause '*poor quality of life and diminished physical and psychological health. When humans have more social contact, they are happier and healthier, both physically and mentally*'. (Kraut, R. et al, 1998)
The BBC is launching a social networking site MyCBBC enabling children as young as 6 to design online "dens" to reflect their personality and interests. The BBC states "*This is about trying to develop their Internet skills and social networking … It's about media literacy*." (BBC, 2008)

An ongoing study of families by UCLA is finding that social disengagement is now rapidly increasing, as side-by-side and eye-to-eye human connections are being replaced by the eye-to-screen relationship. The impact of multitasking gadgets is one of the most dramatic areas of change, described by the scientists as '*pretty consequential for the structure of the family relationship*.' (Ochs, 2006)

MULTI-TASKING

Scientists are now witnessing compound effects. Children and teenagers are spending an increasing amount of time using 'new media' like computers, the Internet, ipod videos and video games, without cutting back on the time they spend with 'old' media like television. Instead, because of the amount of time they spend using more than one

medium at a time (for example, going online while watching television), they're managing to pack increasing amounts of media content into the same amount of time each day and at younger and younger ages. (Kaiser Family Foundation, 2005; Childwise Monitor, 2008)

As more children either study with a TV on in the room or multi-task by switching their attention between different forms of electronic media or even different programs on the same screen at younger ages, brain imaging now reveals that multi-tasking activates a different brain region (the striatum) to the one used when you learn one thing at a time (medial temporal lobe) and this is a significant hindrance to learning. (Foerde et al, 2006) Studying with a television on makes learning less efficient and makes what you manage to learn less useful. Homework can take 50% longer to complete. Performing two or more related tasks either at the same time or alternating rapidly between them produces many more errors and it takes far longer - often double the time or more - to get the jobs done than if you did them one at a time. The neuroscientists behind this research are describing the benefits of modern multitasking as "*a myth ... The toll in terms of slowdown is extremely large - amazingly so ... you will never, ever be able to overcome the inherent limitations in the brain for processing information during multitasking*." (Myers, 2006)

DISCUSSION

The introduction of screen technology in early years of child development increasingly conflicts with empirical evidence that it may have deleterious effects on learning and development. Paradoxically, the premature introduction of these technologies - which could later be used as tools - may ultimately undermine the cognitive and academic skills they are intended to cultivate in the first place. It appears that the timing of screen exposure is crucial.

The claim that these findings do not apply to 'supervised', educational use of 'age-appropriate' DVDs and computer software is unjustified, as it appears that it is the time

spent during a child's early years looking at and relating to the *medium* of the screen that is the central factor. Moreover, in addition to The American Academy of Paediatrics, a growing number of well-conducted studies have concluded that children under two should be kept away from computer and TV screens, and other researchers and clinicians are now recommending drastic reductions in, or abstinence from, screen exposure for children over the age of 2.

The use of screens in early years education must be viewed in the context of a society of children spending increasing amounts of daily time relating to screens. And in the context of financial and political interests encouraging society to see screens in early years as a beneficial component of modern day child development. For example, in only the past year, there has been a substantial increase in screen-based 'toys' for British children aged 0-3 in a market valued at £728,000,000 by the Toy Retailers Association. Jim Silver, editor of the magazine Toy Wishes, states. "*I don't call it the toy business any more. Big companies are in the children's entertainment business. Young kids are now sitting on their parents' laps to use the computer from 18 months old. This is the real world." "I think it's a good thing, kids need to be comfortable with technology*." (Sunday Times, 2007)

Above all there is a systemic problem in the relationship between the ICT industry and academics - who receive research funding directly or indirectly from suppliers of screen technology, software, internet, advertising and television production. Government departments involved in education as well as the educational establishment, increasingly liaise with suppliers of ICT, which again constitutes a conflict of interest when considering policy making on introducing screen technology in early years education.

However, there are those in the ICT industry who have interesting views on introducing ICT in early years education. Michael R. Bloomberg is both the Mayor of New York City and billionaire founder of the high-technology, computer-based financial media empire Bloomberg L.P. including Bloomberg Terminal computer software, and Bloomberg Television. Bloomberg has made several public announcements that putting computers

in primary school classrooms is not the way to prepare children for the future. "*If you want to know how to position your child for the 21st century, get rid of computers, get smaller classes and pay your teachers more. Force them to teach the kids how to read properly, and how to think.*" (Bloomberg, 1996, 2001)

Another interesting perspective comes from the observation that when affluent British private schools have the resources and latitude to use screen technology in teaching, they do not appear to subscribe to it. A highly pronounced cultural difference between state and elite affluent private schools has been observed in their attitude toward television in education, including young age groups. Affluent private educational institutions appear to consider television as an entertaining, but ultimately less effective method of learning. And other screen technology was considered a supplementary tool, introduced and used judiciously at later ages. The public schools examined did not refer to television or 'visual literacy' when presenting their approach to education or describing their teaching methods. Nor did public schools show images of pupils watching a television screen. There were negligible images of pupils looking at computers. Pupils were typically shown reading books, writing by hand and taking part in tutorial discussions. There was a distinctly low-key tone when 'information technology facilities' were mentioned in learning. (Sigman, 2007d)

An Educational Buffer Zone

Until it is demonstrated otherwise we should assume that young children are predisposed - 'hard-wired' - to learn through real-world experiences and interaction with real human beings. If they do not experience this throughout the critical first three to six years of their life their learning and possibly personality will be impeded.

In particular, until their brains are fully formed, children's attentional development appears to need protection. Attention is the prerequisite to what we consider being alive; one has to be able to pay attention to things in order to experience them. Attending to something is the first stage in processing and analysing it and learning and remembering it. Once a child's attention is damaged, then everything that comes from it is

compromised. Learning language, reading, school work, exams, job performance, relationships, and even one's sense of identity can all suffer. It's akin to damaging the focus control on the child's lens that looks out on life. In damaging a developing child's attentional system, one has damaged the prerequisite to experience. It appears that exposing children to screen technology at increasingly earlier ages along with the sheer amount of exposure may be placing unhealthy demands on our children's developing attention, which is undergoing a fragile period of key development.

Legally requiring the introduction of screen technology to 20 – 60 month old children is likely to lead to even higher levels of daily screen viewing. Early introduction to ICT is likely to lead to a greater lifetime dependency on screens.

Therefore parents and the educational establishment should in effect 'cordon off' the early years of education providing a buffer zone where a child's cognitive and social skills can develop without the distortion that may occur through premature use of ICT.

We must all be reminded of the ancient medical imperative "First do no harm"

CONCLUSION

In the light of accumulating evidence that

a) Exposure to screen technology during key stages of child development may have counterproductive effects on cognitive processes and learning.

b) Learning through watching screens neither rivals nor exceeds early years learning through more traditional 'non-virtual' means.

c) These salient issues occur in the context of screen viewing in early life leading to higher levels of screen viewing later on.

d) Even moderate levels of screen viewing are increasingly associated with a wide range of health risks.

Education authorities should reconsider the role of screen technologies in schools.

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