



Visual voodoo: the biological impact of watching TV

While controversy continues to surround the way the content of screen media affects our thoughts and behaviour, a growing body of empirical evidence is indicating that watching television causes physiological changes, and not for the better. Most of these effects occur irrespective of the type of programme people watch – whether it is sex and violence or the Teletubbies. It is the medium, not the message.

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Title image: Young child engrossed in a television programme. Photo: Oscar Burriel/ Science Photo Library

Watching television is now the industrialised world's main pastime, taking up more of our time than any other single activity except work and sleep. According to the Broadcasters' Audience Research Board (BARB) in January 2004, by the age of 75 the average Briton will have spent more than twelve

years of 24 hour-days watching television. 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. Children aged 11 to 15 now spend 55% of their waking lives – 53 hours a week, seven and a half hours a day – watching TV and

computers, an increase of 40% in a decade (BMRB, 2004). More than half of three-year-olds now have a TV set in their bedrooms. (Rideout *et al*, 2003)

However, the biological sciences are fast becoming the new arena for examining the effects of society's favourite pastime. And in industrialised societies, the findings are set to re-cast the role of the television screen as the greatest unacknowledged public health issue of our time.

Attention and cognition

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 5% of children now exhibit attention deficit hyperactivity disorder (ADHD), and its incidence appears to be increasing. 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 9% increase in attentional problems. The authors suggest that their findings may actually be an understatement of the effects on children.

Yet attention is not merely confined to everyday descriptions such as concentration or attention span. 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. If early exposure to television does affect

aspects of attention later on, what mechanisms may be involved?

Television 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 television is apparent almost from birth: infants, when lying on their backs on the floor, will crane their necks around 180 degrees to watch (Kubey and Csikszentmihalyi, 2004). Twenty years ago, studies began to look at whether the medium of television alone – the stylistic techniques of cuts, edits, zooms, pans, sudden noises, *not* the content of the programme – activates this orienting response. By watching how electroencephalogram (EEG) responses were affected, Reeves *et al* found that these stylistic techniques can indeed trigger involuntary physiological responses of detecting and attending to movement – dynamic stimuli – something television has in abundance. These techniques also cause us to continue to pay attention to the screen. Most of our stares at a television screen are highly prone to termination, lasting less than three seconds. But as we continue to stare, our stare becomes progressively less fragile gaining a powerful attentional inertia after about 15 seconds. By increasing the rate of edits – camera changes in the same visual scene – one can increase the subject's physiological arousal along with attention to the screen.

Modern television has increased the use of these stylistic techniques. 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. 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% longer than in a commercially produced show. 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 – an attention deficit culture. Could it be the form, not



Figure 1. The all-conquering world of television – even stronger than Communism. Lenin Square, Khabarovsk, Far Eastern Siberia. Photo: A Sigman.

the content, of television that is unique?

Television 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 portrays life with the fast-forward button fully pressed. Rapidly changing images, scenery and events, and high-fidelity sounds are highly stimulating and extremely interesting. Television is the flavour enhancer of the audiovisual world, providing unnatural levels of sensory stimulation. Little in real life is comparable to this. Television may overpay the child for paying attention to it, and in so doing it may physically corrupt the reward system underpinning his ability to pay attention when the TV is off.

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. Screen entertainment causes our brain to release dopamine. 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 do not 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.

More research is needed into the extent to which this reward system involving dopamine (and other neurotransmitters) is set in childhood by exposure to electronic media such as television.

Early exposure to television is now implicated in another childhood condition. The very latest research from Cornell University strongly suggests that early childhood television viewing may be an important trigger for autism, the incidence of which appears to be increasing (Waldman *et al*, 2006).

At the other end of the age spectrum, a new study (Lindstrom *et al*, 2005) addressing the relationships between how much television we watch during our middle years (20-60 yrs) and the development of Alzheimer's disease are concluding that for each additional daily hour of middle-adulthood television viewing, the associated risk of Alzheimer's disease development increases. Watching television was described by the neuroscientists as a non-intellectually stimulating activity for brain function. A study examining the association between soap operas, talk shows and poorer cognition in older women found clinically significant cognitive impairment in all measures, including attention, memory and psychomotor speed (Fogel and Carlson, 2006).

While playing computer games are thought to be more stimulating than passively watching a soap opera, evidence indicates that even this 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 ...”

Television viewing among children under three years of age is found to have deleterious effects on mathematical 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. A 26-year study, tracking children from birth, has recently concluded that television viewing in childhood and adolescence is associated with poor educational achievement by 26 years of age (Hancox *et al*, 2005). 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.

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 television and sleeping difficulties in different age groups ranging from infants to adults.

A study by Thompson and Christakis (2005) of 2068 children found that television viewing among infants and toddlers was 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. 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 two 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). A study at Columbia University found that young adolescents who watched three or more hours of television a day ended up at a significantly increased risk for frequent sleep problems as adults. Remember that this amount of screen time is actually less than the average. On the other hand, those adolescents who reduced their television viewing from one hour or longer to less than one hour per day experienced a significant reduction in risk for subsequent sleep problems (Johnson *et al*, 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 Spiegel, 2003). Melatonin is also sleep-promoting. As it grows dark melatonin levels rise and help facilitate sleep. Researchers have recently reported (Salti *et al*, 2006) that when children aged 6-12 were deprived of their TV sets, computers and video games, their melatonin production increased by an average 30%. Exposure to a television screen was associated with lower urinary melatonin levels, particularly affecting younger children at a pubertal stage when important changes in melatonin's role 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. Animal studies have shown that low melatonin levels have an important role in promoting an early onset of puberty.

Body fat

Research from as far apart as China and Mexico is increasingly identifying television exposure as an independent factor in obesity. Mexico's health ministry has reported that obesity has risen by 170% in a single decade, with odds ratios of obesity 12% higher for each hour of television watched per day. While in China, a study of 10,000 people found that for each hour of television viewing there was a significant increase in the prevalence of obesity. A study in New Zealand following children from birth to age 15 recently found the amount of television viewing to be a more significant factor in obesity than the effect sizes often reported for nutritional

intake and physical activity. A study of girls aged five and nine found that even in families where neither parent was overweight, television was the only significant predictor of girls' increase in Body Mass Index.

Beyond displacing physical activity, a new study (Cooper et al, 2006) has reported a significant dose-response relationship in which REE [resting metabolic rate] decreased as average weekly hours of TV viewing increased. A recent study looking at the association between television viewing and meal frequency adds to the findings that watching television makes both children and adults eat significantly more, even if they are not physically hungry. One of the mechanisms by which television may induce us to eat more is through causing our brain to monitor external non-food cues – the television screen – as opposed to internal food cues telling us that we have eaten enough and can stop. Experiments (Epstein et al, 1977) have found that when distracted in this way humans continue to salivate unnaturally in response to more and more food when normally they would not. All of these observations occur at a time in our history when 75% of dinners are eaten in front of the television.

A 26-year study of the *Association Between Child and Adolescent Television Viewing and Adult Health* recently published in *The Lancet* (Hancox et al, 2004), involving 1,000 children found that children who watched more than two hours of television a day between the ages of five and 15 developed significant health risks many years later. The study concluded that 15% of cases of raised blood cholesterol, 17% of obesity, 17% of smoking and 15% of reduced cardiovascular fitness were linked to the television viewing that took place years before when the adults were children. This link remained, irrespective of other factors such as social background, body mass index (BMI) at age five, parents' BMI, parental smoking and how physically active the children were by the age of 15.

Other biological changes strongly associated with watching television range from clinically increased risk of abnormal glucose metabolism and new Type 2 diabetes in adults, through substantial increases in myopia, to increases in migration of cutaneous immune system mast cells which also “lost their granular content and the cytoplasm shrunk”.

Conclusion

Watching television, irrespective of the

content, is increasingly associated with unfavourable biological and cognitive changes. These alterations occur at viewing levels far below the population norm. Given the population's sheer exposure time to this environmental factor it is more than puzzling to consider how little awareness and action has resulted.

Perhaps because television is not a dangerous substance or a visibly risky activity, it has eluded the scrutiny that other health issues attract. Additionally, there is little funding and public gratitude in looking for the negative effects of the world's favourite pastime. Conversely, when research is directed at identifying what is termed ‘opportunities in the media-rich home’ and methods to increase so-called ‘media literacy’ or ‘visual literacy’, encouragement and funding appear highly forthcoming. Therefore it is hardly surprising that the incriminating research concerning screen media is coming from beyond the domains of media studies, education and psychology.

An editorial in the American Medical Association's *Archives of Pediatric and Adolescent Medicine* now asks: “Why is it that something that is widely recognised as being so influential and potentially dangerous has resulted in so little effective action? To be sure, there has been some lack of political will to take on the enormously powerful and influential entertainment industry ... [Screen] media need to be recognised as a major public health issue” (Christakis and Zimmerman, 2006). So it is particularly disconcerting to hear some academics urging caution in interpreting these studies and warning of the risk of over-reacting. We must ask them, when considering whether to expose infants and toddlers to television, how exactly can one over-react? What harm could result from preventing very young children from watching television and from reducing the amount of television watched by those over three years of age? Others respond with claims that these findings do not apply to children watching age-appropriate or educational material. Again, this confuses the nature of the message with the effect of the *medium* and is highly misleading. Policy makers and government should consider these questions urgently.

The biological sciences are instrumental in providing an alternative account of the influence of screen media. And by ignoring their findings we may ultimately be responsible for the greatest health scandal of our time.

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Further reading

Sigman A (2007) *Remotely Controlled*. Ebury/Random House, London. This contains extensive referencing of the arguments made in this article.

Dr Aric Sigman is a Member of the IOB and Associate Fellow of the British Psychological Society. He has travelled to various cultures, including Bhutan, Tonga, Myanmar, Iran, Korea, Vietnam, Mali, Bolivia, Burkina Faso and Eastern Siberia to observe the influence of television, and has written a book summarising the empirical literature.

Institute of Biology Members' Evening

Beauty and the beast – surprising uses of toxins

Thursday 8th March 2007 at the Institute of Biology – 6.00pm to 8.30pm

Speaker: Professor Alan Harvey, Strathclyde Institute for Drug Research, University of Strathclyde

£10 – include light refreshments

IOB Members only. There are 35 places available for this event, which may be counted as 5 IOB CPD Points

Medicines have often come from nature, but it is surprising how many have been developed from some of the most toxic substances known. Botox is one example that has caught the public's imagination but there are other recent examples of relevance to areas such as pain relief, diabetes and strokes.

Alan Harvey has a background in neuropharmacology and current interests in the use of natural products for drug discovery. Since 1988, he has led the Strathclyde Institute for Drug Research, a collaborative centre in the University of Strathclyde in Glasgow that encourages interactions between academic researchers and industry. SIDR has worked with 50 companies throughout the world and has attracted more than £20 million in industrial funding. Alan Harvey is also involved in a wide variety of early-stage drug discovery projects from natural products. Along with colleagues from phytochemistry, he has assembled a highly diverse collection of plant extracts that is used in random screening; he coordinates the bioassay development and screening teams. This has led to several patent applications and numerous leads that are currently being followed up in different therapeutic areas.



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