



**Thirteenth
Annual Lecture**
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Technology and Education

**How safe are
our children?**

Dr Sarah Starkey



National Education Union
(ATL Section)
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Introduction

The annual ATL (now NEU) lecture in Northern Ireland was instituted in 2006. The Lecture has become, in a short space of time, an important part of the educational calendar, a place where educationalists can meet, discuss, debate and share views in a *milieu* that is both intellectual and pragmatic, that stimulates and challenges in equal measure. Long may it continue.



This year, we were honoured to host Dr Sarah Starkey.

Dr Sarah Starkey has been studying the scientific evidence for possible biological effects of wireless technologies for the past eleven years.

Her background is in Neuroscience research, with a Master's degree in Neuropharmacology from the University of Bristol (where she studied mechanisms underlying learning and memory) and a Neuroscience PhD from Queen Mary's University in London.

She worked in Neuroscience research within the pharmaceutical industry, working on a range of projects, including serotonin and depression, circadian rhythms, the hormone melatonin and epilepsy. More recently she has published papers on wireless technologies and young people, biological effects of electromagnetic fields and has assessed and challenged official advice on the safety of wireless signals. She is particularly interested in the possible effects that the current widespread use of wireless devices by children may be having on their health, development or wellbeing. She has submitted evidence to the Westminster Parliamentary Science and Technology Committee on the effects of wireless technologies and has supported parents and schools on this issue.

Those in attendance were treated to a thought provoking, passionate and motivational lecture which will remain in the memory for some time. For those not present, we are pleased to allow you to share in our Lecture through this edited published version.

A stylized, handwritten signature in black ink.

Mark Langhammer

Regional Secretary, NEU (ATL Section) Northern Ireland

NEU (ATL)

Lecture: List of past speakers

2006 Baroness May Blood

2007 Duchess Abercorn, and the Minister for Education Caitríona Ruane,

2008 Ken Mayhew (Oxford University and SKOPE), and the Minister for Employment and Learning, Sir Reg Empey

2009 Dr Philip O'Connor

2010 Paul Sweeney, Permanent Secretary, Department of Education

2011 Ken Cunningham CBE (School Leaders, Scotland) and the Minister for Education, John O'Dowd

2012 Professor Bob Fryer

2013 Dr Carmel Gallagher

2014 Baroness Susan Greenfield

2015 Professor Alan Smith, UNESCO Chair, School of Education, Ulster University

2016 Jim Curran

2017 David Gavaghan, CBI

2018 Dr Sarah Starkey

Technology and Education: How safe are our children?

Thirteenth Annual ATL Lecture – Dr Sarah Starkey

I would really like to thank you for inviting me to your conference today. It is a great honour to be here and to have the opportunity to speak to you on such an important subject.

Technology can be useful, particularly when combined with great teaching and is balanced with a wide range of other activities. It is important for children to have access to computers and to be able to benefit from the information, skills and intellectual challenges which they can provide. But the usefulness and innovation of technology is not the whole picture.

My Father was a Craft Design and Technology teacher, and as children, my siblings and I were given design challenges to test around the tea table. It was important that any ideas we came up with managed to fulfil the purpose for which the object was intended. If possible, we also tried to make it beautiful. But it also needed to be safe.

I find that this being safe aspect is too often being missed in society today. Innovation and getting to market quickly is the exciting side of product design, and is celebrated. Making sure something is safe can add delays, increase costs and be viewed as inconvenient and negative. But without taking safety into account, a designer has failed in an important aspect of the design process. We know from the example of asbestos that a product can fulfil its function extremely well, but not be adequately tested for safety.

I worked for many years in neuroscience research within the Pharmaceutical Industry. Here, safety is an extremely important consideration and a new medicine can fall down at many steps along the way before being licenced for use. Many never make it, and those that do have possible side effects carefully documented and restrictions introduced where necessary.

I would like to focus today on wireless communication technologies. These are technologies which emit microwave,

radiofrequency radiation in order to communicate. We are all familiar with them, they range from tablet computers such as iPads or Learn-Pads, smart phones and Wi-Fi, to wireless security systems, wireless virtual reality headsets, 'smart' meters and phone mast antennas.

Virtually all schools throughout the UK and around the world are now using wireless technologies. Some provide tablet computers in the classroom, others require parents to provide them as part of a 'Bring your own device to school' policy, and many teachers ask pupils to use their phones in the classroom to look something up or to take pictures of the whiteboard.

According to Ofcom in 2016, 44% of 5-15-year olds owned their own tablet and 62% used a mobile phone. These are quite high percentages, but the reality is that nearly all children in schools are using mobile devices. Schools are playing an influential role in giving the message to parents that the technologies are safe. Parents are not asked for their consent and possible risks are not mentioned. If families would like a non-wireless learning environment, at the moment this means having to give up their child's human right to an education at school, because there is nowhere else for them to go to. With such involuntary exposures, the technologies have to be absolutely safe.

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So why wouldn't they be safe? Well, we absorb some of the wireless signals into our bodies and these might have biological effects. Babies, children and young people are particularly at risk because they are still developing and can absorb wireless signals into their bodies more easily than adults. When switched on, Wi-Fi access points (as used in classrooms) are giving off signals all of the time, even when the devices are not being used. Apps on 'smart' phones are regularly updating and communicating information such as location, which is relevant when they are carried next to the body, because some signals may be absorbed.

There is a large body of scientific research and I would like to very briefly mention some of the evidence, focusing on the brain, fertility, pregnancy and cancer. Please bear with me for this part of the talk, it is necessary, because any concerns need to be based on evidence.

Further information on the science, and references, can be found in my submission to the Westminster Science and Technology Committee for their Early Years Inquiry, which can be found at the link included in your conference pack¹

The brain: Mobile phone and Wi-Fi signals can alter the normal electrical activity in the human brain. Electrical signals are part of how neurones communicate with each other and are an important influence in brain development. Studies in animals have also shown a wide range of other changes in the brain, such as the concentrations of signalling chemicals known as neurotransmitters, increased damage to DNA, altered enzyme activity, increased cell death, decreased numbers of neurones in some brain regions and altered expression of some genes. With so many changes we shouldn't be surprised that some effects have been reported on brain development, cognition and behaviour.

For example, a Spanish study of 9-11-year-old boys (Calvente *et al* 2016) found that when background radiofrequency exposures outside their home were above average (at median values or above; ≥ 1.02 V/m at highest point), there was a significant association with anxious or depressed behaviours, social problems, rule breaking, aggressive behaviour, conduct problems and attention deficit hyperactivity disorder, or ADHD. They also had poorer verbal expression, comprehension and

Mobile-phone use has also been reported to significantly increase the risk of headaches in humans (Wang *et al* 2017).

a lower IQ score. A study of 12-17-year olds in Switzerland investigated a possible link between wireless exposures and memory performance. Figural memory (remembering symbols) was significantly worse for the 25% of children who used wireless devices the most (Schoeni *et al* 2015). Mobile phone signals decreased accuracy in a working memory test in adolescents (Leung *et al* 2011) and even 5 minutes use of a mobile phone significantly decreased performance in a working memory test in adults (Kalafatakis *et al* 2017). But not all studies have reported damaging effects on cognition or behaviour. Some have found no effects and others reported faster reaction times or improved attention (e.g. Curcio *et al* 2004; Curcio *et al* 2012).

A large number of studies in animals have reported impaired learning and memory following radiofrequency exposures, including from Wi-Fi. Exposures have increased anxiety-like behaviours, decreased learning and increased neurodegeneration in the hippocampus and cerebral cortex of the brain, regions important for cognition (Zhang *et al* 2017; Saikhedkar *et al* 2014). There are hyperactivity behaviours and demyelination of neurones (which is a loss of the cells which surround neurones to increase their speed of communication; Kim *et al* 2017).

Mobile-phone use has also been reported to significantly increase the risk of headaches in humans (Wang *et al* 2017). We are in exam season and young people throughout the UK are taking GCSE, A level or other examinations in halls with Wi-Fi transmitters in them. It would be easy to switch these off, to make sure that no pupils have their cognitive abilities compromised, or suffer headaches during the exams.

We have enough evidence at the moment to be concerned about the effects of wireless signals on behaviour, cognition, brain development and brain function in children and young people and

¹ <http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/science-and-technology-committee/evidencebased-early-years-intervention/written/75325.pdf>



possible longer-term effects, such as increased risk of dementia as a result of cell loss in the brain.

I would like to stress that we know from animal studies that wireless signals can have harmful effects. The animals were not using screens or social media, they were just unknowingly being exposed to radiofrequency signals. It is becoming acceptable to debate whether screen time or social media might be adversely affecting young people, but whether wireless signals might be harmful is largely avoided. **The scientific evidence has shown us that the wireless signals themselves can have harmful effects.** E-safety needs to take the effects of wireless signals into account, it isn't just about staying safe online and addressing screen addiction.

For male fertility: The majority of studies into male fertility and radiofrequency signals have found harmful effects, including from Wi-Fi. These include damage to sperm DNA (which is a problem because it is the genetic material passed on to the next generation), deformed sperm and reduced motility (which is their ability to move), cell death and decreased diameters of the seminiferous tubules in the testes and changes in the concentrations of testosterone. For children, effects on the development of reproductive organs and cell death are a concern if it might damage their future reproductive health.

Female fertility: For female fertility, there is less data. In animal studies, exposing female rats to a mobile phone-like signal has repeatedly and significantly reduced the numbers of follicles in the ovaries, compared to unexposed animals (Gul *et al* 2009; Bakacak *et al* 2015; Tureli *et al* 2016). The ovarian follicles develop to release the eggs, so loss of follicles would significantly reduce the number of eggs which could be released. We don't yet know whether this is occurring in humans. But it is possible that girls who use tablets or carry phones in their skirt or trouser pockets may have loss of ovarian follicles, which may affect their future reproductive health. This urgently needs to be investigated.

For pregnancy: Maternal mobile phone use during pregnancy has been reported to significantly increase the risk of miscarriage in humans (Mahmoudabadi *et al* 2015). It has been reported to increase speech problems in children (Zarei *et al* 2015) and in several studies, increase the risk of behavioural problems in children, including

ADHD, conduct and peer problems (Divan *et al* 2008; Divan *et al* 2012; Birks *et al* 2017). These are supported by animal studies. Exposing pregnant mice to mobile-phone-like signals led to hyperactivity in the offspring, as well as altered brain development and impaired memory (Aldad *et al* 2012). Many other studies in animals have reported that exposures during pregnancy increased damage to DNA and cell death in a range of organs in the offspring, decreased learning and memory retention and increased foetal deaths or reduced numbers of offspring. But not all studies have reported effects. There was no decrease in motor skills or language skills in children at the age of 3 or 5 (Papadopoulou *et al* 2017). But although not all studies find effects, we have enough evidence to know that harmful effects on foetal development can occur, with some adverse effects seen later in childhood. Exposures of pregnant women are an important health and safety consideration and employers have to take reasonable steps to remove health and safety risks for pregnant women in the workplace. I would like to see us working towards all pregnant women having the right to work in a non-wireless environment.

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For Cancer: The WHO (World Health Organization) International Agency for Research on Cancer (IARC) classified all radiofrequency signals as a possible human carcinogen in 2011. This was based on evidence which included increased risks of brain tumours called gliomas and acoustic neuromas (which are tumours of the auditory nerve), associated with mobile or cordless phone use in humans, mainly after 10 years of use.

Since 2011, further reports have strengthened the evidence. The French CERENAT study reported increased risks of gliomas and meningiomas of the brain associated with mobile phone use. These were significant with the equivalent of just 15 minutes or more mobile phone use per day over 10 years, in adults. The small CEFALO study in children aged 7-19, found no overall association between mobile phone use and brain tumours, but did for 2.8 years of use or more. In other studies, by Hardell and Carlberg in Sweden, young people who first used a mobile or cordless phone under the age of 20 had higher risks than adults of developing a tumour.

Risks are not just to the brain and head. Breast cancers have been reported directly underneath where some women had carried a mobile phone in their bra (West *et al* 2013). More recently the US National Toxicology Programme has reported on its study which exposed rats and mice to mobile phone-like signals. The reviewers concluded in March of this year that there was clear evidence of carcinogenic activity in male rats based on increased malignant Schwannomas of the heart. These are tumours in tissues surrounding the nerves.

There was also some evidence of malignant gliomas in the brain, tumours of the adrenal gland and damage to DNA in the brain. Another group, the Ramazzini Institute in Italy also reported recently that mobile phone-like signals had significantly increased tumours in the hearts of rats. Many scientists are now calling for radiofrequency signals to be upgraded to a probable or definite carcinogen.

It is important to note that exposures from tablets can be the same as from mobile phones. The maximum Specific Absorption Rates (SARs), which are a measure of the amount of radiation we can absorb from each device are similar for iPads and phones. So if mobile phones held next to the body can increase the risk of cancer, then tablets might do as well, close to where they are positioned.

Children in schools use tablets on their laps, close to their reproductive organs, abdomens or chests and their fingers are in contact with the screens. In my view people should no longer be placing a tablet on their lap or close to their chest or abdomen or holding a mobile or cordless phone up to their head. Air tube headsets can be used to keep mobile phones away from the head and phones can be carried in a bag, not in pockets or bras. A lot of children carry their phone in their blazer or trouser pocket whilst at school, which is not a good idea if there are increased risks of tumours of the heart, breast cancers or of reduced fertility. Strapping a wireless virtual reality headset or smart phone onto a child's head, right in front of their eyes and brain, for virtual reality learning or games, is also not a good idea.





So what is the official guidance for schools and other public places? UK Governments, including Northern Ireland, look to Public Health England (PHE). PHE used to be called the Health Protection Agency, but its name was changed in 2013. Their advice for Wi-Fi is that exposures are within internationally-accepted guidelines and they see no reason why schools and other places should not continue to use the technology.

This advice is based on a review of the science carried out by the Advisory Group on Non-ionising Radiation, or AGNIR, and the resulting report which they published in 2012. The report concluded in the executive summary, *"the evidence considered overall has not demonstrated any adverse health effects of RF [radiofrequency] field exposures below internationally accepted guideline levels"*. This is a reassuring conclusion. Most people only read the executive summary from a 348-page report. I published an analysis of it in the journal 'Reviews on Environmental Health' at the end of 2016. It is an Open Access paper, which you can find at the link included in your conference pack² I would encourage you to look at the paper, because the AGNIR 2012 report is what the PHE safety advice to schools is based upon. I found that the conclusions did not accurately reflect the scientific evidence. There were inaccurate, incorrect and misleading statements and many studies and some conclusions were omitted. The AGNIR group has since been disbanded. But their inaccurate and misleading report and advice to schools and other organisations remains.

I would like to give some examples.

The report considered studies which had tested effects of radiofrequency signals on cell membranes and direct effects on proteins. Of the studies included in the report (excluding something called the blood-brain barrier), 97% (32 out of 33), had described significant effects on proteins or cell membranes, but these disappeared in the conclusions. For effects on male fertility, at least 22 studies were omitted, but had they been included, 78% of studies on male fertility (35 out of 45) would have described significant adverse effects. And yet the conclusion was, *"there is no convincing evidence that low level exposure results in adverse outcomes on testicular function"*. Another example is oxidative stress, which is a damaging state where the body produces more harmful free radicals and other reactive oxygen molecules than the body

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can cope with. It's a known cause of cancer and is implicated in a wide range of disorders. At least 40 studies on oxidative stress were omitted. If these had been included, 79% of studies (61 out of 77), would have demonstrated evidence of oxidative stress. But this subject was not even mentioned in the conclusions or executive summary. There are other examples in my review.

The AGNIR report considered evidence for effects below the international guidelines. These are set by a group called ICNIRP, the International Commission on Non-Ionizing Radiation Protection. The Chair of AGNIR and two other members were also part of ICNIRP at the time of writing the report. This introduces a conflict of interest. How can AGNIR report that there is evidence of harmful effects below the current guidelines when several of them are responsible for the guidelines, including the Chair? The group now responsible in the UK is COMARE (the Committee on Medical Aspects of Radiation in the Environment). An author of the inaccurate 2012 AGNIR report, who is also part of ICNIRP, is now responsible for letting COMARE know when they need to look at the evidence. So the conflict of interest, and control, has not yet been removed. We need an honest expert group to regularly assess the evidence, independent of AGNIR, ICNIRP, the wireless communications industry and UK Governments.

When published scientific papers have errors or are factually incorrect, they can be challenged and retracted. But there is no effective mechanism at the moment to do this in the UK for Government documents. I am calling for there to be mechanisms put in place whereby incorrect Government information can be challenged, corrected or retracted. Inaccurate information can lead to poor decisions.

² <https://www.degruyter.com/downloadpdf/j/reveh.2016.31.issue-4/reveh-2016-0060/reveh-2016-0060.pdf; Volume 31, issue 4, pages 493-503>

So with schools having been given advice based on inaccurate and misleading information, where does the responsibility lie? The Department for Education in England stated (2018), *"It is for individual schools to decide whether or not to implement Wi-Fi technology in order to meet their needs.... Schools must take reasonable steps to ensure that staff and pupils are not exposed to risks to their health and safety by conducting a risk assessment and, if necessary, putting measures in place to minimise any known risk."*

In Northern Ireland, the Department for Education has also said (2017), *"Schools need to perform risk assessments on the technologies within their school to ensure that they are fully aware of and can mitigate the potential risks involved with their use."*

So schools are responsible and they are expected to carry out a risk assessment before any technologies are introduced and used. I have written an example risk assessment for wireless technologies, which you can find on the website.³

Fortunately, there are safe alternatives and solutions. Schools can use wired computers; devices can be connected to the internet via Ethernet connections or fibre optic cables; Wi-Fi is not the only option. This isn't taking a step backwards, it is updating practices based on biological knowledge and evidence of harm. Pupils can be asked not to use or carry mobile phones on them whilst at school. They may not like it, but they will survive. In fact a study published in 2017 found that when children had no mobile phone on them in the classroom they performed better in a learning test than when they were allowed to use them, or even allowed to keep the phone on them but not use it (Lee et al). We can make sure that children have access to wired phones if they need to phone home whilst at school. Most devices can have wireless functions

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turned off, and better still, manufacturers can make ones which only connect through wires, so that children can't switch it back on in the classroom. As part of addressing anxiety and other mental health issues in young people, we can switch the Wi-Fi off in University student accommodation, boarding schools and for children in care. Wired internet connections can be put into their rooms. We can educate children, young people and parents about the possible serious risks.

The UK Government is not independent. It recently made more than £1.3 billion from auctioning off partial licences for the next generation of communications, 5G, and it made £22.5 billion from 3G licences. They are promoting wireless 'smart' meters, 'smart cities' and the internet of things. **Do not expect them to admit easily that there are any risks at all.** Safety has and is being ignored both in product design and by politicians and decision makers. We are teaching science in schools, but appear to stop valuing scientific information when it becomes inconvenient.

For wireless communication technologies, good product design failed, because despite their usefulness and innovation an enormous body of science has shown that they are not safe. If the evidence of possible harm is acknowledged, then companies can start to design safer and more sustainable technologies for the future.

Unfortunately, concerns and evidence rarely make it into the media. It is difficult to have an article on risks next to a full-page advert for the latest 'smart' phone. But concerns exist. More than 230 scientists who work in this field have called for action to protect the public. This can be found at www.emfscientist.org. The Cyprus National Committee on Environment and Children's Health, Cyprus and Austrian Medical Associations recommended in the Nicosia Declaration (2017) that wireless networks should be prohibited in schools. They stated, *'All children and in particular those with existing neurological or behavioural problems as well as those with chronic diseases must be provided with wired (not wireless) learning, living and sleeping environments'*. The Cyprus Government has produced videos, available on YouTube, to warn pregnant women and to ask parents and schools to reduce their exposures. France has banned Wi-Fi in nurseries and places of care for children under the age of three.

³ www.wirelessriskassessment.org.



Scientists and doctors have called for 5G to be halted (www.5gappeal.eu). If 5G goes ahead, it will lead to a massive increase in wireless signals, for everyone. The UK Chief Medical Officers have recommended that children under the age of 16 use mobile phones for essential purposes only. Unfortunately, almost no one knows about this. Children cannot be protected when no one knows about the information.

Bringing about change is not easy, particularly where conflicts of interest, political pressures and commercial interests dominate. But if responsibility has been delegated to schools, then schools can take action. You can choose to keep children, young people and members of staff safe, based on accurate evidence. You already have excellent child protection policies, safeguarding responsibilities and responsibilities as employers.

We all have a responsibility to safeguard children and young people. Harming children is wrong, no matter how economically inconvenient or how difficult it is to make changes.

Thank you very much for listening.

The UK Chief Medical Officers have recommended that children under the age of 16 use mobile phones for essential purposes only. Unfortunately, almost no one knows about this. Children cannot be protected when no one knows about the information.

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