



TRANSCRIPT OF THE KEYNOTE SEMINAR OF THE ALL-PARTY GROUP ON SCIENTIFIC RESEARCH IN LEARNING AND EDUCATION

‘What is the potential impact of technology, such as computer gaming, on the brain?’

Committee Room 2, House of Lords

17/03/2010

The Group heard from Baroness Susan Greenfield, a Neuroscientist and Director of the Institute for the Future of the Mind, at the University of Oxford and Dr Vaughan Bell, a Neuropsychologist at the University of Antioquia, Colombia and a visiting research fellow at King’s College London. The meeting was chaired by Lord Sutherland of Houndwood

Transcript

The All-Party Parliamentary Group on Scientific Research in
Learning and Education seminar

‘What is the potential impact of technology, such as computer gaming, on the brain?’

House of Lords (Committee Room 2) 17 March 2010
5:15-7:15pm

1. Welcome and Introduction by Lord Sutherland of Houndwood

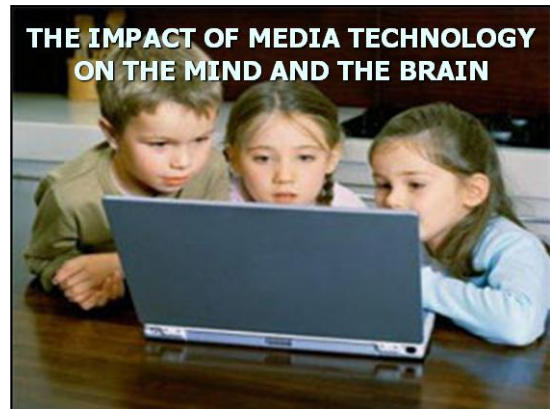
Welcome. Particularly, it is the All-Party Parliamentary Group on Scientific Research in Learning and Education, a seminar to which you have been invited and I am delighted to see such a good turn out. There are many different All-Party Parliamentary Groups. They go from playing bridge right through to high interest/high intellectual context such as this. I hope you have come to the right one!

The topic today ‘What is the potential impact of technology, such as computer gaming, on the brain?’ is clearly very important and we are very fortunate for having two speakers of exceptional high calibre who have been researching in this area. I am reliably informed that they will disagree which is the point of a seminar. Equally, I am reliably informed that they will stick to time very well. The general intention is that we should have 20 minutes from each speaker and that will allow a good time for discussion and probably will finish up at about 7 o’clock. So that is the programme plan for the rest of today.

Of course I must say no one needs introduction to Susan Greenfield. She is actually one of a group of very distinguished scientists who sit on the crossbenches of the House of Lords and who lend their expertise in a variety of ways to work at the house and to equally lend their expertise to various committees in the house. Sometimes formal ones and I am involved in the Select Committee of Science and Technology and also sometimes the All-Party Parliamentary Groups of which I think this is a very good example. Selecting a particular area of interest across both houses and equally the wider community. I am delighted that Susan set this seminar up and I now invite her to make her presentation.

2. The impact of media technology on the mind and brain: the neuroscience perspective - Baroness Professor Susan Greenfield, Professor of synaptic pharmacology at Oxford University

Thank you. I am sure that although it may have been advertised that we are going to disagree and people might be expecting furs to fly. It may be after all, as it is with many things, that not so much that we disagree but we are talking in a complimentary way about an area which is a concern to everyone, otherwise, we would not have such a good turn out. Perhaps at some stage we could have a chance to network and exchange information and background because what is particularly fun about this



group is that it does invite neuroscientists, educationists, teachers and parents and a whole range of different people, who would not normally have the chance to talk and meet each other. So I do hope you have the chance to get to know each other a bit and indeed come to further ones.

So what I would like to do is set the scene really and really give my perspective absolutely. I put my hand up guilty as charged, I am not an educationist and I am not even a parent, but I am a neuroscientist. As a neuroscientist I am asking various questions because really the point about science is to look at disparate bits of information, disparate scenarios and try and see links and from those formulate a hypothesis. So that's what I am going to do. I am not going to say that there is evidence or there isn't evidence. What I want to do is to give you some background as to why we should seek evidence.

Ok so what we are going to look at is what makes you so special first of all. I often like to say that I like to compare being born a human being with being born a goldfish, where goldfish don't have great personalities or any individual traits whereas, of course we pride ourselves on that. If your kids had a goldfish and it died you could rapidly and easily exchange the goldfish and your kids wouldn't know any difference but you couldn't do that with their pet cats or dogs and you certainly couldn't do

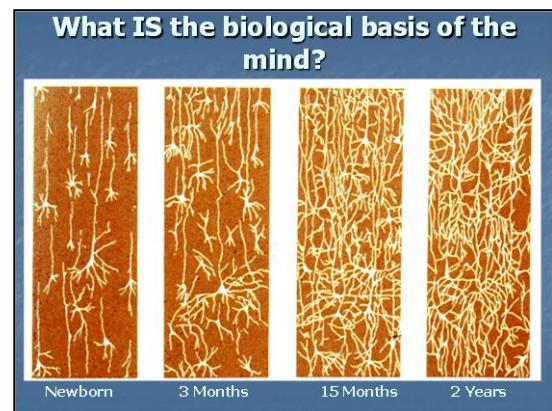


it, they might want you to, with their brothers or sisters. That is because in evolution as we become more sophisticated, so the shift occurs just from the tyranny of our genes, the narrow range of instincts that enable a goldfish for example to live out their goldfishy life's, in favour of living a highly individual life. That is why we occupy many more ecological niches than any other on the planet. We don't run particularly fast, we're not particularly strong, we don't see particularly well, but what we do fantastically is we adapt and we learn. It is this ability to learn from our particular environment, the world in which we happen to be born, that enables

you to have individual experiences and as we will see, if you have individual experiences, guess what you become an individual. So even if you are a clone, an identical twin, you are going to be unique. There has never been anyone like you for the hundred thousand years humans have stormed this planet, nor will there ever be again. Indeed you won't be like you half an hour ago.

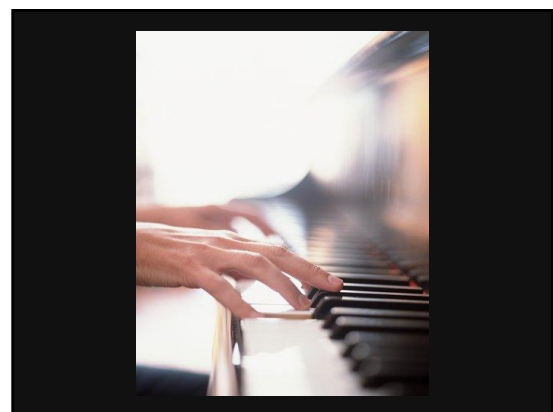
So what is it about our brains that enables us to actually turn them in to minds, turn them into unique perspectives that we treasure more than anything else, whereas we can have our hearts and our lungs and our kidneys transplanted with increasing facility nowadays. Obviously, even if you could technically do it you would think twice about having a brain transplant because this is what you are and this is why incidentally we fear Alzheimer's as although cancer and heart disease our terrible diseases they are not the specter of fear that Alzheimer's is because we know that what is being targeted there is the essence of you.

So what is the essence of you? Well here you see the first two years of life and for the people who are not neuroscientists here, the blobby bits are the brain cells and the stringy bits are the connections. You can see that over the first two years of life it is the astonishing growth in the connections not the proliferation of neurons themselves, well the main part, which accounts for the growth of the brain postnatally. So this means that even if you are a clone, that is to say an identical twin, you're

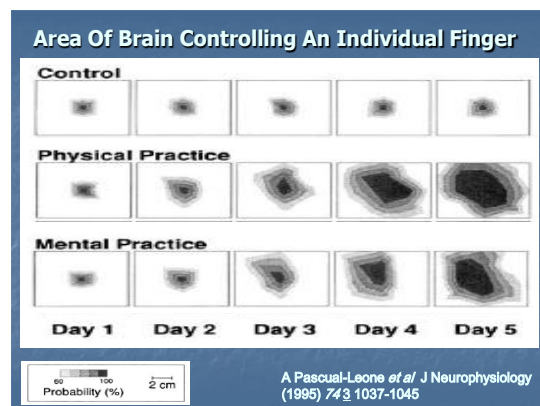


going to have a unique pattern of brain cell connections because given that you are interacting with the environment, you're having inputs, those inputs are literally going to leave their mark on your brain.

So this is a particularly nice example, just one of many that neuroscientists call plasticity. It doesn't mean to say that the brain is plastic of course but rather from the Greek 'plastikos'. In fact I love this experiment, we could have a whole All-Party Group debating this one slide possibly. In this experiment there were three groups of adult volunteers. None of them could play the piano and if you ever get to do an experiment like this, let me give you a word of advice, don't volunteer for the control group because they just had to stare at a piano for five days. There was however a second group and they had a more interesting time, they learnt five finger piano exercises and there is a third group but I am going to keep them as a surprise.

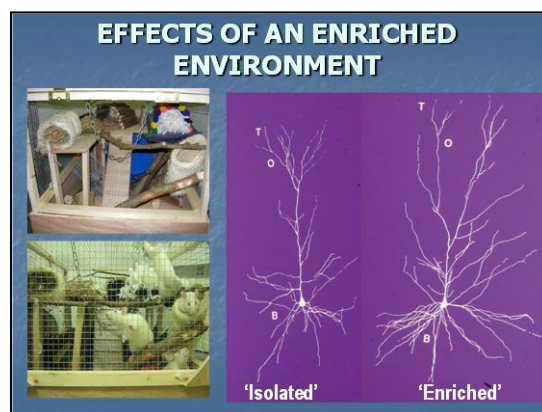


So now let's look at brain scans over five days and see what happens. If you focus first on the top you will see that the control group over five days, the scans here show that the brain is literally unimpressed by this. However, those learning the piano exercise show an astonishing change, there in the brain territory relating to the digits showing that even over five days what you doing is leaving its mark on the brain. However, the most exciting group are the third group because these



people didn't play the piano but they were told to imagine to play the piano. So you can see that with physical and mental practice, in terms of the brain scans there is relatively little difference and yet there was a difference in that one was playing and one wasn't, showing that the contraction of muscle is probably less relevant and that it is the thought that precedes it. That is exciting. That is why I said one could stare at this slide and ask lots and lots of questions about it. It does shoot down that tired old distinction between mental and physical, between mind and brain, as if what the Philosophers' do and I can be rude about them given that there is only one here on my left, is work on the exotic, cognitive, emotional, abstract, airy, things of moi or vous, whereas people like me traffic in the squalor of the chemistry. But you can see that you can't do that anymore. That everything you think, even just a thought is literally changing your brain. How it does it is obviously a completely separate issue, you might like to read the book I have written called "Private Life of the Brain" but that's another story.

So let's look then at how the environment can indeed do this. How were the piano players able to show such as change just by thinking about playing the piano? How could this happen? Well in order to answers those questions and this is one of the issues that we might debate later on, in terms of with humans how much you can ask them to give you evidence. You can do brain scans for sure, but if you want to know what is happening at the level of individual neurons and the mechanisms of the brain you can't do that. In order to do that you have to turn to rodents and here you see rats that are highly exploratory creatures of course, in a paradigm that we actually use ourselves in the lab that is increasingly used now in neuroscience experiments, which is a so-called enriched environment. An enriched environment for rodents does not mean to say that it comes to the House of Lords and has All-Party Group meetings and if they're lucky get invited to the bar! What happens is that they are in an interactive environment compared to their standard caged controls where they climb little ladders, wheels and branches and so on. Now if you look at a brain cell from each of these animals, this is the brain cell from an isolated animal and I know you not familiar



necessarily with brain cells but if you look at the blobby bit then you will see that there are branches coming out of it. It is the branches that I would like you to focus on if we compare a brain cell from the enriched group and you can see that in otherwise identical animals where only the environment has been different that in the enriched group the branches are much more extensive. So what does this mean? Well it means that when you are interacting with an environment you are making brain cells work hard, as you saw with the piano playing and you'll know from when you exercise that if you work muscles hard they grow and they strengthen. Now what happens with brain cells is a similar principle but they don't just grow like a muscle does. What happens to them is the branches grow, as you can see. Now why would that be particularly exciting or interesting? Well by growing the branches you're increasing the surface area of the brain cell and that means you are more available as a target to other brain cells that want to make connections with you. So let's trace that through, a stimulating and interactive environment will make brain cells work hard in certain parts of the brain depending on which area you're exercising, that in turn causes the growth of branches, which in turn will enable connections to be formed.

So imagine you're born in the words of the great William James into a "booming, buzzing, confusion" and bearing in mind what we are looking at here are humans compared to rats. So from what you've seen in a rat think how much more the potential might be for a human brain. So you're born into this "booming, buzzing, confusion" and when you are a small baby you have no choice, you evaluate the world in purely sensory terms. You'll see a visual pattern, you have colours and smells and textures and sounds but



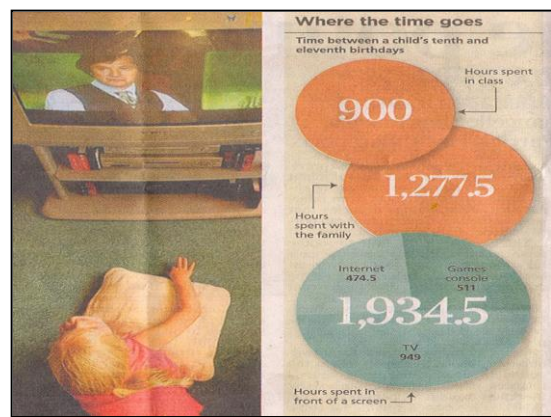
gradually if they repeat and repeat and repeat over and over again then you will start to go from what we call a sensory world of raw sensations through to a cognitive one. Where instead of seeing something just as a conglomeration or feeling something as a conglomeration of senses it will now be meaningful, it might be your mother say. So on the bottom right here and those of you from Oxford might recognise some of these figures, but the whole point is that these are generic middle-aged men in suits and ties and all of us mix and interact with such individuals. You might therefore, see them as generic blokes whereas these are friends and colleagues of mine and they each have an individual history and narrative and they mean something to me. The main point which is that this is how you personalise your brain.

So you are born with your brain like a one-way street where the senses come in as raw sensations but gradually as we've seen, as the brain cells are working hard they will grow the branches, form connections so you will start to see something in the light of previous things. Instead of being a one-way street where we are just a passive recipient of senses you will start to evaluate things in terms of what has happened before and indeed, what will happen at that moment will change what is happening subsequently. So I would like to suggest to you that far from being some high minded literally alternative to the physical brain, the biological

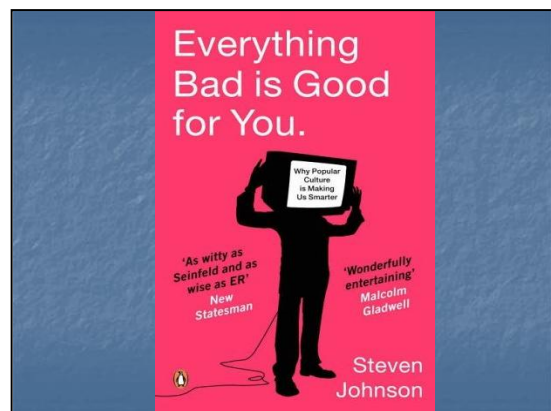
basis of the mind is the personalisation of the brain through unique dynamic configurations of neuronal connections and as we have just seen can be driven by unique experiences. So that's my way of preamble. Now whether that counts as evidence or not evidence I think I have been misquoted by the likes of Ben Goldacre who say I don't have evidence but depending on what you mean by evidence and this is certainly background evidence, that the brain is sensitive to the environment. I don't think that anyone would contest that plasticity doesn't exist in the brain.

THE BIOLOGICAL BASIS OF THE MIND IS THE PERSONALISATION OF THE BRAIN THROUGH UNIQUE DYNAMIC CONFIGURATIONS OF NEURONAL CONNECTIONS, DRIVEN BY UNIQUE EXPERIENCES

So if that is the case then we turn to the environment. And this is one particular set of statistics, there are others, more evidence, about how a children from the twenty first century will spend their time. You can see here that between a child's tenth and eleventh birthday they're spending roughly nine hundred hours in class, just under thirteen hundred hours with their family and just about two thousand hours in front of a screen.



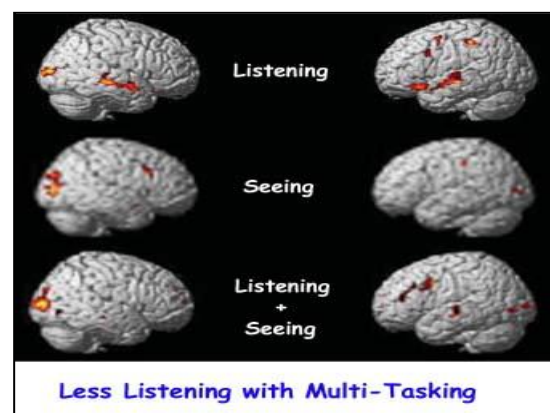
So what I would like to explorer with you and it is an exploration as that's how science starts, we start by asking questions. Is that given the sensitivity of the brain to the environment, if the brain is changing this way might it be changing the mind and the mindset of the next generation? Again, just to show contrary to my press that I am not a complete Luddite, I thought I would include this slide and actually a recommendation of this book by Steven Johnson "Everything Bad is Good for You" which is very well written and it argues very persuasively for good things when people can engage with screen activities. One of the things in particular he highlights for example, as a possible reason for the elevated IQ that seems to be occurring as a quite global trend because after all, the kind of skills that are required in a IQ test are the same as arguably like those that you might rehearse in a computer game. So when you see patterns your exercising your mental agility and therefore one could say this is a good thing perhaps if you spend a lot of time on the screen you'll have a higher IQ. And again that is something that I want to put a marker down, I am sure there are lots of things that perhaps one might site that you can show an improvement in but it does not automatically follow that just because you become better at one thing that you are universally better at everything. And as Steven Johnson himself points out that just because you're



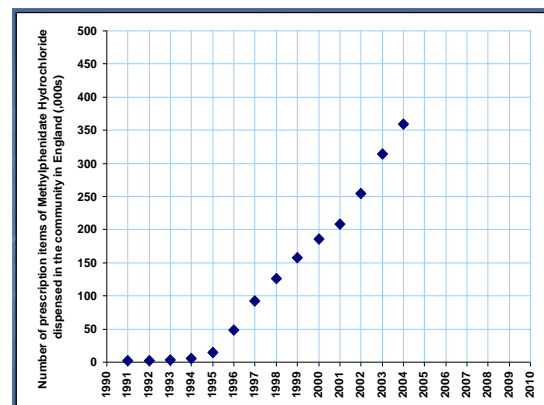
good at an IQ test doesn't give you an insight into economics or history or language or literature or understanding. I don't think there has been an exponential rise in symphony writing going along the rise in IQ for example.

So we have to think of different skills and one of the things that we can debate is what kinds of skills do we put a premium on, it might well be an elevated IQ. So I am not trying to adopt a value judgement here, I am just trying to put before you as neuroscientist with this background evidence the kinds of questions that we ought to be asking a healthy and productive society and the kinds of questions that we should be debating rather than assuming we know the answer to.

So one of the ideas that is often volunteered as good is multi-tasking. This seems to be a premium given everyone seems to be worried about speed nowadays and doing things quickly whether that be speed dating or speed cooking. Then if you could do things in parallel that's an advantage, but is it such an advantage? This is an interesting little scan of comparing listening and seeing with when you listen and see at the same time, and as you can see and perhaps the parents will know this already, there appears to be less listening with more multi-tasking in this particular study.

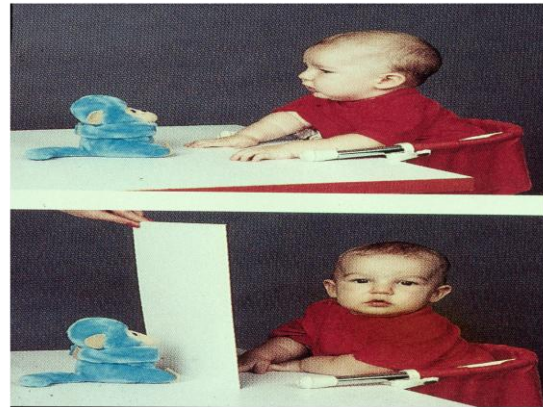


Another issue, of which Ellie at the front is an expert on, is again the sort of evidence you want to look at and question, that is that of the methylphenidate prescriptions. You will know methylphenidate more commonly as Ritalin, it is given for Attention Deficit Disorder and you can see here the escalation in prescriptions over the last fifteen years. Now it could be that people are more sensitive to diagnosing ADHD, it could be that the threshold for prescribing Ritalin has changed or it could be that perhaps



the environment has caused more people to have attention problems. Now these things are not mutually exclusive and it is very hard to vigorously prove that, but all that I am saying is that the brain is sensitive to the environment and we have this interesting increase in ADHD. If you use the prescriptions as an indication, then could we have therefore one of the things on our list that we might want to talk about –shorter attention span and a highly strongly sensory world.

We know that kids, as shown here, are easily distractible and when you are small you live in the moment. So if a small child is eating an ice-cream and drops the ice-cream and starts to cry, a trick I used to use with my brother was say look at the bird and suddenly the ice-cream is forgotten in favour of bird. If you have a depressed adult crying and you say look at the bird, it's not going to be very successful. That is because they are living in a cognitive world not a sensory one. A small child because they haven't had the history of making connections, they will see the world as purely sensory and it will therefore be less meaningful because the connections are not there.



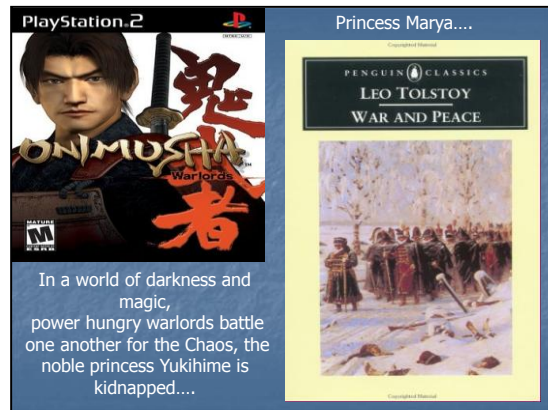
So could it be therefore, that if you are in the strong sensory world and what you see is what you get then another issue that we ought to think about is metaphor and abstract concepts. Again, using my small brother as an example, when he was three, I was sixteen, and I used to torture him therefore, like sixteen-year-old sisters do. The torture took the form of learning Shakespeare and he had to learn and he still knows it, Macbeths' soliloquy "tomorrow tomorrow/Creeps in this petty pace" and had I said to him at the time what does it mean "out, out, brief candle!/ Life is like a poor player" of course he wouldn't of understood that. He knew what a candle was, what the snuffing out of a candle was but the notion that the snuffing out of a candle could stand for death of course is a completely separate issue and a very sophisticated link that you do not make when you are three years old. So that is the issue, that if you are constantly living in a literal world will you graduate to making that link if you don't have the opportunity to do so.

Similarly, what is honour? Here we are, abstract concepts. I thought I would Google honour. Say you had to explain to someone what honour was I wonder how you would do that. If you Google honour this is what you get. Now when you think how nuance a concept like honour is, just by looking at literal images it is very hard. I know this myself when I do PowerPoint's and you want to express subtle or complex ideas it is very hard to do it just visually, whereas a word can stand for so many different things and concepts simultaneously, it is much more powerful at doing that.



This brings us then to process versus content or meaning. I mentioned earlier the notion of rescuing the princess say when playing a computer game. I would like to suggest to you that when we say something means

something it is because we can see one thing in terms of something else. So the snuffing out of a candle meant dying, as you can see one thing in the terms of something else. If you literally have a fact it doesn't mean anything. Meaning only comes when you can imbed it in a conceptual frame. So when you play a computer game to rescue the princess as say here, you may be becoming very agile at your mental processes, but do you really care about princess Yukihiime? Do you care about what she is thinking or feeling? Do you care about what is going to happen to her after she has been rescued? Do you care what career she is going to take up? Is she going to marry a prince? Do you care about the princess compared to when



you have been told a story for example, and you have princess Marya? So the difference here, there both valid I am not saying that one is superior to the other because we do need agile mental processes, there good things of course and I wouldn't be the first to promote agile thought. On the other hand, is it enough and is that all we want and are we losing a notion of understanding or significance if we concentrate on just one thing rather than both things. If we do price things having a concept or a conceptual frame work how can we go from information to knowledge because that is really what it is. Information, as with information technology, are facts but facts on there own are very boring hence, we derived pub quizzes or trivial pursuits because if someone said I am going to tell you facts tonight and I am going to come to your house and sit you next to someone who will tell you facts all evening. Many women will know that that's what happens at dinner parties anyway, people telling you facts. But it is only when you link the facts so that they become an idea that they become interesting. We see one thing in terms of something else; it changes how you see something. So again, I am not in anyway disparaging acquiring facts or accessing facts or being fast at doing it. Fine. But then what do you do? This Rose report that wanted three year olds to learn Google I just wonder why they are supposed to of learned Google. What are they going to do? What questions are they going to ask? How will they understand or evaluate the answers they get?

EFFECTS OF SCREEN CULTURE?


- Shorter attention span
- Strongly sensory
- Lack metaphor / abstract concepts
- Process vs Content / Meaning?
- Reduced empathy

If we go on to process and content and we think is that going to effect what this means to you? Bearing in mind when you play a computer game it doesn't have to mean anything because you can just play the game again and if actions don't have consequences it might not be to good a lesson to learn about life. What about therefore, reduced empathy and why would one query that? Well look at these



two little boys here. Both in the thrill of the moment having an exciting time. But we know when you communicate normally in life only ten percent of the impact comes from words; a lot comes from eye contact, as we all know. We all know how scary it is sometimes to look someone in the eye, they just stare at you and after a while you start to get a bit uncomfortable. It is a skill to learn and if they don't look you in the eye at all then you feel uncomfortable as well. Similarly, body language combined with eye contact is fifty-five percent of how you come across to someone and I don't know if anyone has evaluated but there is also voice, thirty-five percent, pheromones those sneaky chemicals and physical contact. I have deliberately chosen a business scenario here, where there patting each other on the arm, shaking hands where it's much more. I will suggest that none of those things can happen in social networking. How are you going to hug someone, look them in the eye, pick up on their pheromones and so on? If you are not rehearsing those skills, and we have seen the brain will do what ever it rehearses, then if you are not rehearsing those things you might want a premium on the things you can experience which literally has to be more sensationalist. I am concerned that if you are not rehearsing those skills and I know that some people on the social networking sites have a rich renaissance portfolio outside the physical screen, but I am worried about those that do not. Might we end up with people as it was suggested recently, where people don't have empathy? So that recent case of the two little boys who almost killed two boys of a similar age and crowed about the vividness of the pictures on their mobile, could this and this is again a question, could this be due to a lack of empathy? Because they have been in a world that hasn't got the meaning that three dimensional living with other people and interacting with them may have helped them with their brain.

COMMUNICATIONS IN THREE DIMENSIONS



- Eye contact
- Body language: 55% of impact
- Voice (tone/rate/volume): 35% of impact
- Pheromones ?
- Physical contact ?

Words: 10% of total impact

That brings us on to second life. Again, I am sure that everyone here is too sophisticated to be on second life. While Avatar of course, everyone knows what Avatar is now because of the film, as you know you can be the dragon slayer or something if you prefer as an alternative life if you prefer to you first life. What is very interesting is that Autistic people and I will remind you that Autistic people have a problem with empathising with others and attributing thoughts and feelings to others, they are particularly comfortable and happy on second life, which caters for them. So if you have a reduced empathy for others and you are living in a two dimensional world a lot of the time, let me push this further and ask what does this mean to how you see yourself? What is your identity? Now this might seem like such a stupid question to ask because we know who we are, of course we know who we are, but you don't know who you are when you are very small, you're not self-conscious. I would like to suggest that identity

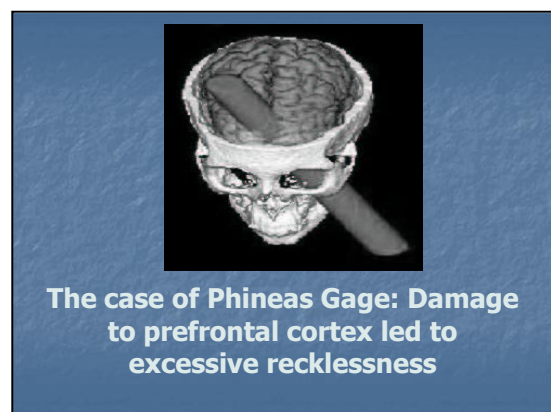
REDUCED EMPATHY?



comes with interacting and developing empathy for others as opposed to your self. So that you know you are a separate entity and more over, it comes from having a past and a future because that gives you a continuity that survives the mere press of the moment, where things do have consequences, do have meaning because they have a clear permanence. So a lot of our identity comes because we have this narrative, this story that is our life of a past, a present and a future and a fantasy and so on. So if that is the case what happens when you have a synthetic identity? Let's look at the history of blogging, which I think might be quite telling. Here we are "1999: So just have to tell someone about the thing my cat did today...". "Oh My God!" 2004 flickr "Cat pictures!" YouTube 2005: "Moving cat picture!" And here we have the pinnacle of civilisation, twitter 2007 "1pm My cat just sneezed! 1:02pm Cat sneezed again!, 1:04pm Cat hasn't sneezed recently. Getting worried". I am going to really stick my neck out and say doesn't this remind you slightly of really small children "look mummy I've put one sock on, look I've done this, look at me" and they're relatively boring things, or perhaps to you as parents there fascinating things but certainly comparable with a lot of the boring stuff you read that people are putting out on twitter about themselves, the self-centred. It is not so much selfish as self-centred because that is the only frame of reference you have. If you don't have a conceptual framework, you don't have empathy with others, what else do you have things to relate things to other than what you're feeling or what you doing? My worry is that some people might be here in some sort of existential crisis and that is why you need constant feedback reassurance that you are there So that might say that identity is much more blurred than previous generations if your living a passive existence of the senses.



Finally recklessness. It affects us as a society and Obama said it was greed and recklessness that accounted for the current financial problems. This is someone called Phineas Gage, very famous in the neuroscience world and beyond because he got this big bar through his prefrontal cortex when he was putting down dynamite and it went off prematurely and drove the bar through his head. Why am I telling you this gory story? He actually survived and not only that he seemed perfectly 'normal' in inverted commas. He went back to work but had to leave because he became so unpleasant to work with and in the words of the physician at the time, he was child-like and capricious. If you interested in what happened to him he ended up as a fair ground freak showing off his wound and could afford to become an alcoholic and died of alcohol poisoning. That is Phineas Gage's story.



We here are interested in the prefrontal cortex, which in humans occupies thirty-three percent of the brain compare to only seventeen percent in our nearest relatives the chimps. Now why am I suddenly talking about the prefrontal cortex, well it seems that is linked when damaged, with being reckless. Interesting enough other groups of people without damage there show similar pattern of under activity of the prefrontal cortex and higher risk taking.

One interesting group are obese people. Again, I am showing you evidence here or be it indirect. These people are reckless in gambling tasks. Similarly, people who have a high body mass index, not necessarily obese but it does include obese people, those that are very heavy compared to their height they have less activity in the prefrontal cortex.

There is also another group, that is people with schizophrenia who have an underactive prefrontal cortex and what do we know about schizophrenia? Well we know that, and you can probably tell where this is headed now, that they have a domination of the sensory over the cognitive. They see the world in grain colours often giving rise to God-like delusions. Like children, they cannot interpret proverbs. If you say people in glass houses mustn't throw stones, they'll say what this means if you live in a glass house and you throw a stone the house will break, which of course it does mean that but it means rather like my brother with the candle, the ability to extrapolate beyond the literal to a more abstract notion. We know also with children, the prefrontal cortex doesn't mature until late teens early twenties.

So what we say about children, about people that eat a lot, people that gamble and people with schizophrenia is that, well look at the schizophrenic paintings. This is a famous series of paintings where you start top left with a fairly recognisable cat whereas bottom right in psychiatric terms the patient has deteriorated, I think artistically it is probably

(I) DECISION-MAKING IN OBESITY: A STUDY USING THE GAMBLING

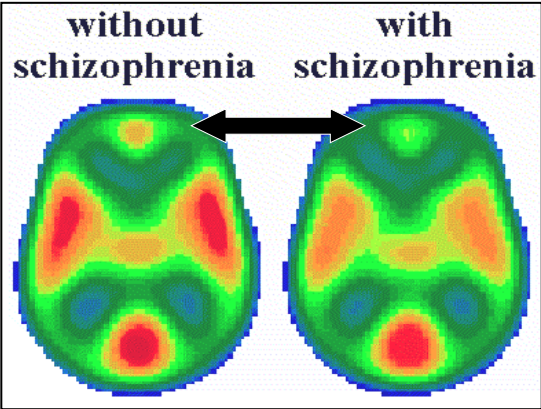
Pignatti R, Bertella L, Albani G, Mauro A, Molinari E, Semenza C.

Eat Weight Disord. (2006) 11 pp126-132.

(II) INVERSE ASSOCIATION BETWEEN BMI AND PREFRONTAL METABOLIC ACTIVITY IN HEALTHY ADULTS.

Volkow ND, Wang GJ, Telang F, Fowler JS, Goldstein RZ, Alia-Klein N, Logan J, Wong C, Thanos PK, Ma Y, Pradhan K.

Obesity (2009) 17 pp 60-65.



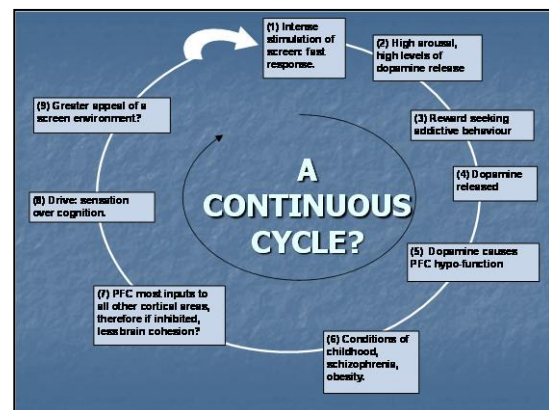
A COMMON FACTOR: THE PRESS OF THE SENSES?

an improvement.! But no one shown the bottom right would recognise that as a cat would they? It's sensory as opposed to cognitive. So could it be that there is something linking here with the underactive prefrontal cortex. Anyone who eats knows the thrill of eating but they also know the consequences but some people do it, they let the sensation trump the cognitive. Anyone who gambles knows the consequence of gambling and again they let the sensation trump the consequence of going bankrupt. So could it be that you could associate an underactive prefrontal cortex with the press of the senses trumping the cognitive.

So basically underlying all these things is an excess amount of dopamine, which we know, underlies arousal, addiction and reward in the common dopamine pathways in the brain. We know that dopamine in the brain can be associated with an underactive prefrontal cortex as shown here and we can see a profile, which I don't have time to detail but which, actually would shine with the kinds of profile we were looking at, that I was suggesting could occur with excessive use of screen technologies. We know that in fact dopamine has inhibitory effect on the prefrontal cortex and therefore I would like to suggest a cycle where intense stimulation requires fast responses, that's a fact. We know that if you are aroused high levels of dopamine release, that's a fact. We know that underlies reward seeking addictive behaviour, that's a fact. If dopamine is released it can cause hypo-function of the prefrontal cortex and simulate additions of childhood conditions of schizophrenia and obesity. We know that the prefrontal cortex inputs to all other areas more than any other of the brain does, so you will have fragmentation in the so-called higher centres with an inhibited prefrontal cortex. Therefore you mandate sensation over cognition, which will drive you to seek out experiences that give you sensations rather than meaning i.e. screen technology. So that is my suggested link all of which as I say, have got indirect evidence, but we are working to try and validate that concept. So one should see and I want to end here, that we do have prove of concept , there is some, there is indirect evidence, there is evidence of addiction but perhaps Vaughan will contradict this, but I think there is quite a lot where the jury is very much out but we still need more. We need to identify the addictive elements of screen experiences and above all I think we should try to develop novel software where neuroscientists and parents sit down to work out and deliver things that we do see as desirable

TWO BASIC MODES FOR THE HUMAN BRAIN?

<p>Prefrontal under-function?</p> <ul style="list-style-type: none"> ■ Strong feelings ■ Sensory ■ Here-and-now ■ External environment dominates ■ Little 'meaning' ■ Reduced sense of self ■ No time-space ■ Infants and children ■ More Dopamine 	<p>Prefrontal activation?</p> <ul style="list-style-type: none"> ■ Thinking dominates ■ Cognitive ■ Past / present / fantasy ■ Internal perceptions dominate ■ Personalised 'meaning' ■ Strong sense of self ■ Clear time-space reference ■ Older children and adults ■ Less Dopamine
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EDUCATION RELATED RESEARCH PROJECTS?

- Proof of concept
- Identification of the addictive elements
- Development of novel software

and there not there in the twenty-first century. I just want to conclude and I am aware that I had to rush the last bit as I have a very fierce chairmen, that I don't think there is an issue of is there evidence. Fine if there's not then it does not exist, evidence of absence is not absence of evidence but rather we should be open minded, we should concede yes indeed that screen technology can be shown to do some good things. They may or may not do things that we consider undesirable but we have to debate to consider whether we see them as desirable or not. Above all, it is not the type of issue that we can complacently say all is well, all is fine. I think we would be doing a disservice to the next generation if we assumed that because there was no evidence we didn't have to do anything about it. I think we need to be sure where we are going and we have to deliver to young people the fullest and most individual life that they can possibly have. Thank you.

Lord Surtherland:

Thank you very much indeed. I am delighted now to invite Vaughan Bell a neuropsychologist at the University of Antioquia in Colombia and also a Visiting Research Fellow at the Institute of Psychiatry, King's College London. Back especially for this event, which is much appreciated. Over to you.

3. The impact of media technology on the mind and brain: scientific evidence and media scares - Dr Vaughan Bell, a neuropsychologist at the University of Antioquia

Hello everyone. I want you to imagine for a second that we are having a debate about Afghanistan, about the war in Afghanistan. We hear not a single fact about Afghanistan with military conflict in that country. In fact, we hear about what might happen in Turkey and we hear about someone's friend who went to Marrakesh last year, but we don't hear a single fact about what has happened in Afghanistan, despite the fact that there is a huge amount of information out there. We have heard that an absence

of evidence is not evidence of absence. So on the screen you can see PubMed. PubMed is the international publically available database of medical research that is available to anybody on the internet. I have just searched PubMed for all academic articles that discuss video games or computer games and there are 1569 academic articles in the medical literature that directly discuss the effect of video games and computer games. That directly address many of the questions that Professor Greenfield has proposed. It is essentially important that we talk about the research which is directly relevant to the point in hand, which is what is the effect of technology on the mind and brain of young people and adolescence and there is a great deal of that research that is directly aimed to answer that question. I am going to discuss some of that today.

The Impact of Media Technology on the Mind and Brain:

Scientific Evidence and Media Scares

Vaughan Bell

Departamento de Psiquiatría, Universidad de Antioquia
Institute of Psychiatry, King's College London

So firstly, I am just going to talk about the current media climate in which we discuss the concerns about these young people and concerns about technology. I am going to have a brief look at some of the historical context, about concerns about new technology. Then I am going to look scientific evidence for effect on the brain and then scientific evidence on health and social risks.

So I am just going to run you through a few of the headlines we have had in the last few years. This is from the Guardian “Computer games stunt teen brains. Hi-tech maps of the mind show that computer games are damaging brain development” and so on. This was based on a press release from Education Company. No scientific study was completed, no data was presented, no study was published, and yet this is a headline in the Guardian.

CNN “Emails ‘hurt IQ more than pot’”. Again, no scientific data presented. No scientific paper published.

“Bridgend deaths: Police warn of Bebo ‘internet suicide cult’”. Simply untrue. They never warned that there was a Bebo suicide cult. They simply mentioned that they were going to check people’s online profiles for possible evidence of suicides at Bridgend, as they should do. This was picked up in the media and turned into a suicide cult story.

Outline

- Current Media Climate
- Historical Context
- Scientific Evidence for Effect on the Brain
- Scientific Evidence on Health and Social Risks
- Conclusions



“Twitter and Facebook could harm moral values, scientists warn”. This was actually based on a real scientific study that had nothing to do whatsoever with the internet. It didn't mention the internet, it didn't talk about technology, it just talked about differing speeds of reactions in different parts of the brain to different forms of emotional senses.



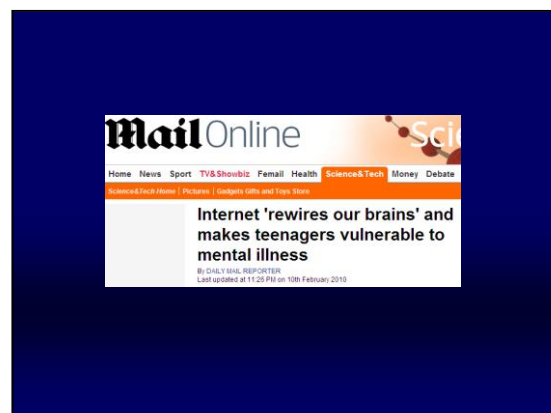
“Facebook and MySpace generation ‘cannot form relationships’”. This was based on the Royal College of Psychiatrists Conference based on no evidence whatsoever and as we will see, studies on this directly show that this is not the case.



The Daily Mail “How using Facebook could raise your risk of cancer”. I think we need to say no more about that.



This is only from three weeks ago. The “Internet ‘rewires our brains’ and makes teenagers vulnerable to mental illness”. This was based on a survey done for a television programme, it didn't mention the brain, I contacted David Nicholas responsible at UCL and there is no way that you can draw any implications from the study about the brain and about the rewiring or making you vulnerable to mental illness.



None of these studies had a scrap of evidence to support them. However, we regularly see scare stories about new technology appearing in the media and they always have a couple of themes. One of them, which is that technology is damaging the mind, the body or social functions - just using the technology is inherently bad. The second is the content of the new technologies is trash compared to the enriching established media. So past media we all grew up with is wholesome, culture enriching things and the new media is full of trash.

Because the technology is new, people assume that this is a new concern. That this is an unprecedented challenge to young people and to society. But this is clearly not the case.

Throughout history we have had technology concerns, technology scares in exactly the same format. Socrates famously warned that acquiring writing would damage memory because people would stop remembering huge sways of text and that immortal allegories would harm young children. They warned parents only to tell their children decent and uplifting allegories.

Conrad Gessner one of the founders of Zoology, one of the most respected scientists of his time set out to write the Bibliotheca Universalis where he listed every single book in publication at that time in the 16th Century. In the preface of that book he warns about the “confusing and harmful abundance of books”, because printing press was producing so many books people could not read them in one lifetime. He called on Kings and Princes of the time to stem the flow of printer pressers of books so people would not be confused and harmed by this abundance of media.

Malesherbes railed against the effects of newspapers in the 18th century claiming readers were “dispersed people” and sat in “sullen silence”. He argued that people usually got their news from the pool pit, which was a group community activity. Newspapers came along and it was damaging the

New Technology, New Danger?

- None of these stories had a scrap of evidence to support them.
- Scare stories centre around several themes:
 - i. The technology itself is damaging the mind, body and / or social function.
 - ii. The content on the new technology is trash compared to enriching established media.

New Technology, New Danger?

- Because the technology is new, commentators tend to assume that their concerns are new.
- But this is clearly not the case.

Scares Through History

Socrates warned that acquiring writing would damage memory and that immoral allegories would harm children.



Conrad Gessner warned in the 16th Century that the printing press was producing a “confusing and harmful abundance of books”.

Scares Through History



Malesherbes railed against the social effects of newspapers in the 18th century, claiming readers were a “dispersed people” in “sullen silence”

Pritchard listed “excessive study” as one of the principal moral causes of insanity in his landmark 1837 book on madness.



fabricates of society because people would sit there reading rather than gathering the news as a communal group.

James Pritchard who wrote one of the most famous books in Psychiatry listed “excessive study” as one of the principal moral causes of insanity, in the book “*A Treatise on Insanity*”. Henry Moorsley, another one of our great Psychiatrists, also wrote exactly the same thing.

When public schools were introduced this caused a huge debate about the damaging effect of schools on the minds and brains of young people. The argument at the time was that children had a natural and wholesome way of developing and schools took children out of that and made them do unnatural mental tasks like concentrating, reading and they were in classrooms all day. This is from a History paper by Duffy and he quotes this article from *The Sanitarian*, 1873: “Foolish parents were immolating

thousands of children under the assumption that education was ‘solely a matter of books and school-rooms.’ ‘Under such delusion,’ the author asserted, ‘they exhaust the children’s brains and nervous systems with complex and multiple studies, and ruin their bodies by protracted imprisonment.’” Schools are an essential part of children’s growth, development, cognitive, education and cultural development and yet there was a huge debate about the damage to children’s minds and brains.

When industrial society struck two famous Neurologists came up with Neuroasthenia, they put down it was caused by the “whirl of the railway, the pelting of telegrams, the strife of business, the hunger for riches, the lust of vulgar minds for coarse and instant pleasures”. Industrialised society was a parody causing this mental illness and damaging people’s minds and brains.

Of course, History repeats itself. We have had exactly the same concerns about each new technology as it has arisen and yet every generation feels that the technology that they grew up with is perfectly reasonable, wholesome, but that new technology unprecedentedly is damaging young people’s behaviour.

The School Book Horror

•Duffy (1968) describes the outcry caused by the newly widespread schools damaging the mind and bodies of young children.

Foolish parents were immolating thousands of children under the assumption that education was “solely a matter of books and school-rooms.” “Under such delusion,” the author asserted, “they exhaust the children’s brains and nervous systems with complex and multiple studies, and ruin their bodies by protracted imprisonment.”

The Sanitarian, 1873

Industrial Neurasthenia

•At this point technology of industrialised society was specifically cited as causing mental illness.

•Neurologists George Beard and Silas Weir Mitchell described the nervous disorder ‘neurasthenia’...

•...caused by the “whirl of the railway, the pelting of telegrams, the strife of business, the hunger for riches, the lust of vulgar minds for coarse and instant pleasures”



History Repeats Itself

•We have seen exactly the same pattern for:

- »Comics
- »Records
- »Radio
- »Television
- »Home videos
- »The internet and so on

Now I have not shown you this list of historical worries because I think it proves or disproves the fact that technology is harmful or safe for young minds. What I am showing is that a general sense of social concern is not a good guide to how harmful or how safe a technology may be. The only way that this can be done is through the scientific evidence and we have heard very little of that today. So I am going to talk about some of that scientific evidence.

How much screen media do children consume? And we saw a thing from the newspaper there and this was based on a report by Childwise. They are a commercial market research company and they estimated that UK children spend an average of 6 hours a day in front of a screen. I have no idea how they came to this figure because this was widely reported in the press and it was in their press release but their actual report costs one and a half thousand pounds to buy. The Kaiser Family Foundation US think tank recently reported that “8-18 year-olds devote an average of 7 hours and 38 minutes to using entertainment media across a typical day” So here, we have the idea that children are spending from 6 to 8 hours stuck behind a screen.

In contrast, the scientific literature gives markedly smaller figures. So this was a systematic review of ninety studies across the world, largely based in Europe and North America, including two large World Health Organisation Studies from 1996 and 2000. It found that youth watch an average of 1.8–2.8 hours of television a day and this amount had not changed for 50 years. Boys and girls spend approximately 60 and 23 minutes a day on computer games and computers account for an additional 30 minutes a day.

So this is the result of scientific evidence on directly this issue and it shows that children are spending between 2 and 4 hours a day in front of screens. So it is important that we base our concern on reasonable estimates of exactly what children do.

Media Scores

- Almost every new technology or social innovation has been faced with similar worries.
- This **does not** show that new technology is risk free or harmless.
- But it does demonstrate that ‘social unease’ or ‘personal disquiet’ are not a reliable guide to risks associated with technology.
- Those risks can only be demonstrated through scientific studies, which we shall now review.

How Much Screen Media?

- Surveys from commercial or independent organisations give far higher figures than scientific studies. e.g.
 - » Childwise (2009) – a press released commercial marketing report (£1350 + VAT) estimated an average of 6 hours a day screen time for UK children.
 - » Kaiser Family Foundation (2010), US think tank: “8-18 year-olds devote an average of 7 hours and 38 minutes to using entertainment media across a typical day”

How Much Screen Media?

- In contrast, Marshall et al. (2006) systematic review of 90 scientific studies on media use in young people.
 - » Largely from Europe / North America, including two large World Health Organisation studies.
 - » Youth watch an average of 1.8–2.8h TV a day. No change for 50 years.
 - » Boys and girls spend approx 60 and 23 min day on computer games.
 - » Computers account for an additional 30 min day

So let's think about the effects of computer games on the brain. There is not an absence of evidence on this topic, we have a great deal of studies looking at the neuropsychological effect of computer games on the brain of young people. This is both naturalistic studies, where we take people who play lots of games compared to those that play few games and compare them, as well as experimental studies, where we get a group of young people and we randomly assign them to play games or

not play games. There are hundreds of these studies looking at a whole range of things from the effect of violence to reaction times. These are the ones that are particularly at the neuropsychological effect, the effect on the brain processes of playing on these games. This was subject to a recent meta-analysis, if you are not familiar with meta-analysis it is a mathematical aggregation of all the results of previous studies and these studies have been in publication from 1986 to 2009. The unambiguous result of these studies was that action computer games, fast moving computer games, cause reduced reaction time in attention tasks not at the expense of accuracy. So people were not making any more errors, with no increase in impulsivity. They were not responding without thinking and the benefits generalised. So the people were not just getting better at those computer games, they generalise across a wide range of neuropsychological tasks which test the whole aspect of the mind and brain, which we know is related to reward and addiction.

This is one of the most important studies, which has addressed exactly this issue, which has come out recently. This was a randomised controlled trial and it was what is the effect of giving video game consoles to young boys from the age of 6-9 years who don't have a video game console, on education achievement on neuropsychological function. So a group of young people, they are randomly divided into 2 groups, half were given a video console half were not, they were tested before and tested afterwards.

It was found that console ownership was related to slowed academic performance 4 months later. So was this due to neuropsychological problems, damage to the brain or changing the fundamental mechanisms? No, it was not. We know that because they looked at behavioural problems, one of the earliest indicators of neuropsychological problems and attention, a cognitive task, there was no difference between those 2 groups. The diary study showed this was entirely related to the amount of displacement of after school academic activity and this is the main theme that comes through this research. If people play video games and they displace other important activities of course they will perhaps get worse in health, get worse in education because there not doing so much of those things.

Computer Games and the Brain

- All evidence points to beneficial effects for action video games on neuropsychological function.

- Recent meta-analysis, Dye et al. (2009), 89 experimental conditions, nine neuropsychological tasks, studies from 1986 – 2009:

- » Reduced reaction time in attention tasks.
- » Not at the expense of accuracy.
- » With no increased impulsivity.
- » The benefits generalise and are not specific to playing computer games.

Weis and Cerankosky (2010)

- Randomised controlled trial, giving video game consoles to adolescent boys, 6 – 9 years of age.
- Console ownership was related to slowed academic performance.
- Was this due to neuropsychological problems? No.
 - » No difference in attention or behaviour.
 - » Diary study showed slowed academic performance was due to displacement of educational after school activities.

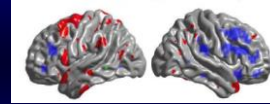
We have several neuroimaging studies, which have directly addressed the effect of computer games on the brain. For example, children and adults show improved cortical efficiency, improved performance and reduced metabolic load. In other words, there getting better while using less energy to do the same thing on Tetris. If you are not familiar with Tetris, it is a kind of puzzle game. This study was completed using PET and fMRI, two forms of functional brain scanning, which look at brain activity while people are doing tasks. It also found an increase in grey matter in task relevant areas in adolescents and this again was a randomised control trial so this is very good evidence. So we are seeing an increase in cortical efficiency and an increase in grey matter and the important processing aspect of the brain. There are also some imaging studies using infrared spectroscopy. This is where infrared light is beamed through the skull and oxygenated areas of the brain have more red blood and

deoxygenated areas which have used their energy, have less blood and the amount of infrared light reflected gives us a measure of brain activity. Actually, all this concludes is that the other studies are a little bit suspicious because they found so much variability between people. Some people increased activation, some people decreased activation. This is because they probably just sat people down asked them to play and of course we all work things out in different ways. A study in press just published online, found that experienced video gamers showed no difference in action coordination so there was no difference in what they were doing, but a difference in balance of brain activity on a non-game task. So in other words, when you become skilled at a task you do things in a slightly different way and indeed, the point of this study is that they are directly comparing it to studies on musicians because musicians show exactly the same effects as people on computer games. When you become better at a task you need less brain energy to do that and indeed we see the lovely grey matter increases. Studies of people juggling as well, if you teach people to juggle their grey matter increases in relevant areas and of course because they are practising these skills.

So video gaming is reliably associated with improvement in attention and perceptual processing, without causing additional cognitive problems. We have this evidence. There are many studies to the point that we have a meta-analysis that collate the results from all these studies. This is reflected in increased cortical efficiency and grey matter increases. So we know there is no physical brain damage

Neuroimaging Studies

- Children and adults show improved cortical efficiency (improved performance, reduced metabolic load) on Tetris after a practice period (PET: Haier et al., 1992; fMRI: Haier et al., 2009).
- An increase in grey matter in task relevant areas in adolescents (MRI: Haier et al., 2009).



Grey matter increases in red, metabolism changes blue, after practice. From Haier et al. (2009).

Neuroimaging Studies

- Infrared spectroscopy shows variable results: increases and decreases differ in frontal areas between individuals during play (Matsuda and Hiraki, 2006; Nagamitsu et al., 2006).
- Granek et al. (in press) experienced video gamers showed no differences in action coordination but a difference in balance of brain activity on a non-game task.
- As noted by Granek et al, the studies on video games reflect similar findings in learning and well practiced individuals (e.g. musicians, jugglers etc).

Summary

- Video gaming is reliably associated with improvement in attention and perceptual processing, without causing additional cognitive problems.
- This is reflected in increased cortical efficiency and grey matter increases.
- Exactly as we would expect from other studies on task learning and practice.

and this has been well shown in a number of imaging studies on exactly this. Exactly what we would expect from other studies with task learning and practice. So if you read these studies on computer games they make direct references to the large literature on learning new tasks.

Another theme that comes through on this literature is not playing games per se, which causes a problem. One of the big issues apart from displacement of activities is the content of those games. I think that we have good evidence now to say that violent computer games cause a small but significant increase in aggression, in aggressive thoughts, in aggressive behaviour and though the evidence is slightly weaker a reduction in prosocial behaviour, that's helpful behaviour and empathy. This is

due to content not the games per se. It is not because people don't see the actions of their consequences because these studies compare neutral non-violent computer games to violent computer games and non-violent ones do not cause this effect. A study recently published looked at games involving helping and cooperation and found exactly the reverse. That these actually improve empathy and improve helpful behaviour. So it is not gaming per se, it is the content of those games that we should be concerned about.

One thing that it is not entirely clear is whether other factors might account for this link. For example, a study by Ferguson has found that these big meta-analyses which have just come out actually, there is a big debate in the Psychological Bulletin this month, when however we take into a fact pre-existing emotional difficulties like depression, family problems and lots of the casual effects of computer games this disappears. There is a debate going on about this at the moment and I have to say that I have read the evidence and I come down the side that it is probably causing an increase in aggressive thoughts and behaviour.

Child media use has been linked to a slight reduction in physical activity. Although the effect is stronger for TV than video games. Actually this study by Rey-López found no effect for video games although the overall evidence probably suggests that, as you might expect, if you spend a lot of time doing sedentary behaviour whatever that might be, that includes computer games, your health is going to suffer. However, it is probably worth noting that

Violent Games and Aggression

- Despite disagreement over methods, I think we have good evidence (Anderson et al., 2010) that violent video games cause:
 - »small but reliable increase in aggression
 - »temporary reduction in prosocial behaviour and empathy (evidence less strong)
- This is due to content, not the game per se.
- Neutral games do not show this effect and cooperative games increase prosociality and empathy (Gentile et al. 2009)

Other Variables

- But it is not clear whether other factors might account for this link.
- For example, when pre-existing emotional, family and social problems are accounted for, the aggression increasing effects of video games disappears (e.g. Ferguson et al., 2009)

General Health

- Child media use has been linked to a slight reduction in physical activity (Marshall et al., 2004)
- Although the effect is stronger for TV than video games (Rey-López et al., 2008)
- However, these studies are pre-Nintendo Wii.
- Wii games have been used as clinical interventions to improve fitness, activity levels (e.g. Graf et al., 2009)



these studies are pre-Nintendo Wii. I don't know if you are familiar with a Nintendo Wii but it is a very different games console. Instead of sitting down and pressing buttons, you have to actually be active and it looks where you're moving and so on. The Nintendo Wii came out about 2/3 years ago and is the third best selling games console in history and Wii Fit which is a fitness programme designed to improve your cardiovascular health is the second biggest selling game in history. Wii Sport and Wii Fit are now being used in clinical trials to improve the health of, for example, people with poor balance or people on hospital wards and so on. This is just one of the studies that has recently come out that has shown exactly that on adolescence, in the Journal of Pediatrics from work at the National Psychosis unit at the Bethlem Hospital. They actually had Wii Fit there to help people with problems of metabolism and obesity.

When we look at the studies on the internet and social wellbeing studies in the early 1990s suggested a negative effect of internet use of social connectedness and wellbeing and this in real life as it were. This effect no longer exists in the literature. So now if we look at whether people use the internet or not have better or worse social wellbeing, or better or worse social connectedness, friendships and so on we find that they have better friendships, they have better social support, they have better social wellbeing. This is not simply an effect of sampling or differences in the way we do studies because the original people were found to have negative problems were followed up and in those same people, those effects had disappeared. So the people who were originally reported in the 90's to have less social connectedness through use of the internet, we have now tested those people again and they no longer have those problems. A recent meta-analysis on internet use and psychological wellbeing included 40 studies since 1998, so these are 40 studies published in the medical literature sampling 21,258 participants found that internet use accounted for between 0.001% and 0.003% of our total psychological wellbeing. This is evidence from a huge amount of studies, we have the evidence, it exists and we should pay attention to it.

In terms of social networking sites like Facebook and MySpace and things like this, every single study to date, there are only about six or seven, but every single study to date has found that greater users who use Facebook and young people who use Facebook and MySpace and so on, have better offline social lives. Do they use these things to

Internet and Social Wellbeing

- Studies in the 1990s suggested a negative effect of internet use of social connectedness and well-being (e.g. Kraut et al., 1998)
- This effect no longer exists and internet use is now associated with better social wellbeing, including in adolescents (Valkenburg and Peter, 2009).
- The negative effects have disappeared in the people who were originally found to suffer them (Kraut et al., 2002)

Internet and Social Wellbeing

- A recent meta-analysis on internet use and psychological wellbeing included 40 studies since 1998 representing a total sample of 21,258 participants (Huang, 2009).
- It found internet use accounted for between 0.001% and 0.003% and of our psychological wellbeing.

Social Networking

- So far all studies on sites like Facebook, MySpace have found social benefits:
 - » Facebook used to enhance offline relationships, not replace them (Lampe et al., 2006)
 - » Facebook linked to greater social capital (Ellison et al., 2007)
 - » Better adjusted youth at 13-14 more likely to use social networking at 20-22 (Mikami et al., 2010)
 - » MySpace blogging associated with better social support (Baker et al., 2008)

replace their offline relationships? No, they do not. Facebook is primarily used to enhance offline relationships but not replace them. Facebook is linked to greater social capital and this was found particularly for people who are at college and at a slight distance so use that to maintain their offline relationships. A study recently came out found better adjusted youth at age 13-14 are more likely to use social networking sites at 20-22. People are using it to enhance their relationships. MySpace blogging is associated with better social support.

There is some preliminary evidence that real world social interactions are mirrored on social networking sites so they have not fundamentally changed them. Researcher Nick Yee has done a huge amount of studies into the social psychology of 3D online world and what he has found is that people maintain many of the same social psychological things we have in the offline world. For example, personal distance. So people don't like to be crowded in the online world, which is a bit weird if you

think about it because it's online and completely virtual. But actually we take all of the same assumptions and we behave in very similar ways in these online worlds and Nick Yee's work has demonstrated that. A recent study that looked at how honestly Facebook users present their own personality compared to ideal personality found that their profile was actually a very honest reflection of the personality, flaws and all. This is actually the only study that has ever found a negative effect for sites like Facebook and so on, which found that when people got positive feedback people felt better and when they got negative feedback they felt worst which is exactly as we would expect. When somebody is nasty to you, you feel rotten and when somebody's good to you, you feel great.

So we have this research. We do not need to talk about hypotheses about whether this is affecting empathy. We have the research, it has been done. There are hundreds of studies tackling exactly this. Clearly we always want to continue at looking at new aspects as technology develops but we really need to think about these issues in light of the work that has been done, the scientific studies which are being completed and the evidence which has been gathered. I think we do children and young people a disservice by ignoring said things and basing our decisions on hypotheses that have already been well tackled.

I am just going to conclude by mentioning some of the main points, which the scientific literature suggests. Firstly, that action video games improve attention and perception. Secondly, the risks are associated with content and displacement of other activities and I think this is really important. We should be concerned about the amount of violence in media that our children are consuming. We should be concerned that people are not having proper

Social Networking

- There is some preliminary evidence that real world social interactions are mirrored on social networking sites:

- » Facebook users' honestly represented their personality in their profiles (Back et al., 2010)
- » Positive feedback enhanced self-esteem, although negative reduced it (Valkenburg et al., 2006)
- » Extensive work by Nick Yee on the social psychology of virtual worlds.

Conclusions

- Action video games improve attention and perception.
- The risks are associated with content and displacement of other activities.
- Internet use is not associated with social problems or emotional difficulties.
- In adolescence, internet use promotes social well being.

balances in their lives. This includes spending time out on the streets, spending time playing chess, playing video games, whatever it may be. We want children to have a well-rounded life that gives them the benefit of all the possibilities that the world has to offer, technological and non-technological. Internet use is not associated with social problems or emotional difficulties and in adolescence, internet use promotes social wellbeing. These are all results with scientific evidence and we need to consider those when we are thinking about young people. Thank you.

4. Discussion

Lord Sutherland of Houndwood: Thank you very much indeed. Now I think Susan Greenfield wants to respond briefly.

Baroness Susan Greenfield: I just want to point out one or two quick things. One is that I do find it odd that the picture you paint is one that is quite so rosy, normally with scientific evidence it is much more balanced and there is usually much more controversy. Let's take for example the social networking sites and inducing wellbeing. Perhaps it is the case that if you are all conditioned to be like that then you'll be like that. Off course if you are used to being on the screen and other people are, then you are going to feel most comfortable and happy on the screen. I will stick to my point, two things, one is that nine hundred friends is not the same as ten friends that one might have in two dimensions. Chris Hughes co-founder of Facebook who I have got to know quite well has operated concern. Separate, the issue of media scares that are neither here nor there. Just because the media gets things wrong does not mean to say that it is wrong, the old idea about precedence. The old days, let's take the example of the TV, that was like a Victorian piano in the middle of the 20th century. The family would gather round the piano and talk, certainly my family talked all the time it was on and discuss it and so on. That is very different to someone going up and having a TV in their room alone and interacting with it and TVs and computers are verging so it's more and I think your point is very well made. Something which I think is very important is this issue of displacement that we are not talking about just for an hour or two because I do an hour or two, we all do it for an hour or two. It is more for those kids and I know of those that do it as an alternative to other things a lot of the time. I think that is something that just because some people have it as a portfolio of activities it doesn't pre-empt others. It is a bit like dare I say cannabis because some people are just fine but it doesn't mean to say that everyone is fine and I think that is the thing that we have to work on. Secondly, things that can be tested experimentally such as accuracy, reaction times and brain scanning, these are probably the things used to talk about higher IQ levels. Well yes, you are more efficient at processing and I would still part company with you probably on the issue that just because your cortex is working efficiently, just because you're accurate, does not mean that you understand something.

Lord Sutherland of Houndwood: Now the opportunities for thoughts come in, with questions or comments. But are there any individual who want to say something?

Earl Baldwin of Bewdley: Meta-analysis can only be as powerful as the studies that go inside them and therefore I want to know, well basically this is part of Susan's point, the quality of the studies, not just whether they ask the right questions but length of follow-up, numbers and all that. Are you satisfied that they are good quality studies?

Dr Vaughan Bell: Yes. These studies are very good quality, they have been published in places like The Lancet, Psychological Bulletin, in some of the best and rigorous scientific journals. One of the big issues is are there missing studies? In other words, are more people only more likely to publish studies that have a certain effect and certainly in America there were a group of researchers led by Ferguson who has argued that actually the effect of for example, violence on young people has been vastly over estimated based on the fact that studies which do not show that effect have not been published. The most recent meta-analysis by Anderson which I have pointed out and has just be published in Psychological Bulletin. They accounted for that. They also looked cross culturally so they looked at studies done in the West and Japan and they did the analysis both including unpublished studies and with solid published studies and despite these things they still came out with a small causal effect of violence. Actually I disagree that my picture is quite so rosy and think we should be very concerned about the effects of violent video games in young people who play a great deal of these things and I think that is a serious concern. There is a very good discussion about this in the Binary report about the safety of young children online. In that, we need to educate parents to help children manage those risks just as if we would help them walk across the road and so on. Unfortunately, most parents are not able to do that. I mean one of the most fundamental parts of online safety is setting privacy settings on Facebook and I bet you there are probably a handful of parents in the near vicinity who could teach their children to do that most effectively. So one of the big issues is that children need guidance in these things and I am a huge advocate of children working with their parents to learn these things, but unfortunately, parents are often worse at these things than their children are and this is a big problem.

Earl of Erroll: Two things very quickly. I think it is interesting that you are doing all these comparisons with these social networking sites etc, which are just a communication tool, and I wouldn't expect people to be dissociated or do anything funny. Basically, it's a place where if you take a photograph now you stick it on Facebook, if you want to organise a party you tell your friends through Facebook now. Before you picked up the telephone or wrote a letter. It is no big difference to society. When it comes to pros etc etc, the big problem they've got now is when you quietly dump someone than you no longer want to see because your lives are diverse. So somebody you were at school with first, your first school, they've gone off down one path and you've gone off down another path, they are desperately keen to keep in touch with you because they've ended up say fairly incompetent and say your successful, how do you ditch them as they will no longer match your new group of friends without insulting them as if that is someone who lives locally your going to have to run in to them. In the old days it was easy to do, Facebook is actually much greater on granularity on the way that it does these things and the problem is with websites as well. I would have been much more interested if you had done comparisons with Warcraft and Second Life, things which like to escape from reality. That would

be quite an interesting study because that does not mirror reality, it is a new advocate completely and I notice there was no reference to it at all.

Dr Vaughan Bell: Yes. There are many studies. Nick Yee I mentioned has done a huge amount on the social psychology of online immersive virtual worlds and he has recently written a very good paper with Scott Caplan about people who have problematic internet use and the features of immersive online games. One of the interesting things they found actually, was there was very little relationship between the features of the game and people's problematic use and that was largely explained by pre-existing depression and things like this. I think this goes back to Susan's point actually, that there are clearly some children who do these things to excess and actually we should be more concerned about those and what the literature suggests is that depression and anxiety, these pre-existing problems, are a huge risk factor for that.

Earl of Erroll: Then in that case if someone has pre-existing problems would it be better for them to immerse themselves say, in something like Second Life rather than taking drugs to control it?

Dr Vaughan Bell: So it comes back to coping strategies and yes a great deal of mental health is how do people manage their life problems, their poor moods and anxieties?

A. Baroness Susan Greenfield: Can I just say there is a third possibility to drugs and Second Life that is Cognitive Therapy where that is if you like, rearranging someone's connections for them. So it doesn't make the problem go away as it might if you take a heavy sedative and at the same time it does not make you escape from the problem, the problem is there. You see the problem in a different way because through careful conversations and guidance your connections have been rearranged and you view the world in a different way. I would say that as an alternative to drugs or Second Life I would take Cognitive Therapy every time

Earl of Erroll: One very quick point to say, that whole thing about displacement activities on the internet. Actually, I seem to remember that boys are very good at finding displacement activities that do not involve doing homework, I was certainly extremely good at that and my children of that, and I don't think anything is new but sometimes we blame the internet.

Lord Sutherland of Houndwood: Actually, my granddaughter is quite good at it as well so it's not just the boys.

Baroness Howe of Idlicote: I am at least glad that you are finding some concern about violence. During the Digital Economy Bill we would be looking at the sorts of things in game that are totally not suitable and you would find on the top shelf, if that, in a sex shop and trying to get something done about that. Interestingly, when I was doing a late degree at LSE there was a very similar, I think it was a participant observation scenario, where two lots of children learned studying English. One group was shown quite violent things from day one including some sexual violence and then at a certain stage both lots were shown the same thing. So the lot who hadn't seen any of this, they were horrified and the lot who got used to it, addicted if you like. Now I think that is the worrying side and I would like you to address that, not least because I don't know whether anyone else

would share this view that now all the soaps have got more and more violent and it is almost as if the audience having seen one level of stuff have just gone on to demand even more violence, even more family break-ups, you know all this sort of thing. That should surely have some concern.

Dr Vaughan Bell: The issue of violence in the media is of course a very deep and complex one and we live in a complex world and it is always that balance between freedom to consume media as adults and protecting children.

Baroness Susan Greenfield: If you think you are in a place where your smell and your touch are not being stimulated at all, in order to keep you engaged in that moment and in that experience you have to up the intensity of the senses that are being activated, hearing and vision presumably. So that is done with fast movement, with sound and that can very easily be done by something where you punch someone when red stuff comes out. Having someone talking to someone isn't very exciting whereas having actions that stimulate both your hearing and vision and especially if then the person just stands up again then there's no significance to it. This is a complex issue but I am just suggesting that there are elements here that would play to that.

Earl of Erroll: Susan you have just said an interesting thing as when I was having an argument with my son who was not sixteen at the time when he was playing a particular version of Grand Theft Auto and I sort of said to him are you meant to be doing that. He said "get a life dad" as they always do but the point is I said "are sure this doesn't make you violent?" He said "no this is clearly fantasy." He said one of the things that are really dangerous is things like films with Bruce Willis and people where they hit each other with iron bars, bounce back, and then beat each other back and any single blow would actually kill someone. He thought that maybe the fact that people are undergoing damage in muggings is that people thought that ordinary people are like Bruce Willis and you can beat them with an Iron bar and their get up and he thought that in films was far more dangerous as it has got real people doing it.

Baroness Susan Greenfield: The interesting issue there is how and at what stage, under what conditions, does someone distinguish fantasy from reality? People are different and what you might find easy to distinguish, some people might not so we are running the risk and we have a video of someone in Hong Kong fessing up and saying I found it very hard. So just because it can happen with one son, in I assume one very comfortable home with lost of things going on, doesn't meant that will generalise to everyone.

Lord Sutherland of Houndwood: Well I am very keen to see if there are folks out there desperate to come in with other comments of questions.

Mrs Ann O'Hara (*Personalised Learning and Support Manager, Gloucestershire County Council*): Is there a connection between the addiction that you have identified and the increased displacement? So we are seeing

young people become addicted to screen activities and therefore increase their time that's displaced from academic activities

Dr Vaughan Bell: Yes, I mean they are indistinguishable in the diagnostic criteria for addiction. So by definition if someone is classed as addicted to video games I have to say that I don't have any faith in the diagnoses of computer games despite the fact that there are clearly people who have a problem with playing too much but that is part of the definition, so by definition they are displacing other activities

Baroness Susan Greenfield: Well it certainly could be a vicious cycle that the more you enjoy doing something, the more you will displace other time to do it which means you won't be rehearsing those other things. So you will be most comfortable, at ease and full of wellbeing in the thing that you are doing so rather like a cycle it will be a self-fulfilling prophecy. You will seek out and be good at the things that you enjoy and vice versa and avoid doing things that you find aversive, unpleasant or uncomfortable, perhaps speaking to people in 3D dimensions.

Dr Vaughan Bell: This is actually, what Scott Kaplan has found actually. He has looked at a link between internet use and depression and anxiety and he has found exactly the same.

Richard Churches (CfBT): My question is about levels of research and what I am hearing from you is that the levels of research where we can operate statistically certain things we can measure there don't seem to be the concerns and at another level, the neuroscience and biochemical level, there are good reasons to question. Now it seems to me that what Susan's argument was about was that another level of research, which almost links into an anthropological level if you like, our ability to cope and construct social meaning level. There might well be significance there and I am wondering whether how many of these studies have sort to control for the normalising effect of familiarity which I think is what you were saying and even attempt to measure some of these higher cognitive interactions socially and whether they have thought to do that.

Dr Vaughan Bell: I mean a lot of the studies on the internet have done exactly that. They use measures of quality of relationship, social connectedness and things like that so they are exactly the same measures we would use in psychiatry research and in the social science research.

Richard Churches (CfBT): I guess my point perhaps is how do we establish with some sort of control group the familiarity of believing the internet is ok, we believe the sorts of things on soaps is ok. How does that affect someone on measurements? Perhaps we might need different studies and different people in the country with complete lack of familiarity in technology.

Baroness Susan Greenfield: I will answer your question with another question. For example, academic performance, which sounds very good but is that multiple choice for example, or is it something like essay

writing. So something that perhaps someone like me, with all my biases and culture generation would nonetheless put a premium on the ability to express yourself, argue something and come to conclusions and give evidence and so on. It's very different from many of the things people do. I know this because I see it at Oxford, people are less used to developing structured arguments and very good nonetheless at getting to answers within paragraphs. So I think you have to be very cautious, again Richard's point, about the kinds of things we measure, I am not in any way disparaging what you're measuring but they will be things because of what scientists do that are easily quantified like reaction times, brain imaging, you know. Harder things to measure are things perhaps that people might not put the same emphasis as someone else might, like degree of understanding Shakespeare and empathy and so on. So I think that we have to be very careful and I say that whilst these kinds of studies are valuable we shouldn't generalise that all is well.

Dr Vaughan Bell: No, I quite agree but I have to say that we also shouldn't scare people by saying there could be dreadful risks when we simply don't know. We obviously should be saying well actually, we don't know.

Lord Sutherland of Houndwood: The public hate that though when you say you don't know.

Baroness Susan Greenfield: But what I have personally never said but what people have said I've said is quote "it damages the brain". I have never said that, I said there is a risk the person might be different from other generations that might be good, that might be what you want, fine but let's discuss it and decide that's what we want.

Dr John Miles: Yes, I think it is quite difficult to determine whether the technology is the symptom of a problem or the cause of the problem. In other words, if you've got a poor environment that leads to overuse of the technology or the gaming or whatever I think that is one aspect. Also I realise Dr Bell that you had to summarise things but a lot of them were averages and I suspect here that it is not the average it is the lower quartile or whatever where the danger if it lies at all. Now my suggestion would be, given this is a multi-dimensional problem, really difficult to get a handle on, is to go to the teachers. There the ones who are dealing with the younger children and can determine to some extent their life-style or could if given the right sort of prompt to determine their life-style and observe any effects that the technology or their life-style is having. That might be a way of trying to focus the next dimension of the research, the line of research.

Lord Sutherland of Houndwood: One of the things that teachers will tell you without doubt is that going back to the earlier points about isolated and enriched environments, children who come in from non-enriched environment linguistically have tremendous problems, educational, social, behavioural and it is the absence of capacity to communicate through the use of word. Yes, I take your point that first impressions have little to do with word but when you get into a conversation your view of somebody changes. Going right back to the classroom when children come in, whose parents don't talk to them, it's appalling. You like me will probably be

amazed that that's the reality and so the isolation is total and the capacity then to learn, to get on with others... you go on.

Baroness Susan Greenfield: I was just going to say I am not knocking words.

Lord Sutherland of Houndwood: And I would be very interested to see whether or not children who have enriched language skills react differently to these various electronic possibilities and can cope with different levels of sophistication in the games that they play and equally those that do not have extensive linguistic skills. I mean if you stick to Twitter your linguistic skills would platter out pretty fast I would have thought but that's one of the kinds of questions that I'd hope to ...

Baroness Susan Greenfield: Can I just say, stress very quickly, that that was my whole point about words they give you a sense of metaphor because you can see one thing in terms of something else. So we are grown-ups, all of us in this room use metaphors all the time. Of course, we approach it differently than someone who just take what this is as what they get; you know it's very different.

Lord Sutherland of Houndwood: For what it's worth David Hume's had a very interesting and important view that was for society to progress and to become more civilised language was at the core of it because unless you have certain linguistic skills and abilities the discrimination is necessary for emotional communication, for political communication, they will not be open to you, their structures would be shut down. But sorry that's the philosophical bit. Are there any other comments?

Professor Peter Simpson (Scientific Secretary & Editor of Science in Parliament): Professor Nutt known to all of us, pointed out very recently that legal substances such as alcohol and smoking cause far more brain damage than many of the illegal drugs. Therefore, my question is to what extent do these conflict with the ability of scientists to collect objective scientific data about the state of the brain?

Baroness Susan Greenfield: Very quickly again because I have views discrepant from Nutt's. If you talk about damage, what he was talking about and many people talk about is your risk of dying but there is more to life than death. What concerned me about that debate was the concern for many parents, because there are three levels. Firstly, you might die. No that's not an issue. Second, you might if you have a predisposition present to schizophrenia or depression and you don't know in advance that you have that predisposition so it is not exactly easy to find out or worse and this is the main issue, which was never addressed, is that it's not an issue that you even go to A & E but it just might decrease your motivation or impair your cognitive skills in a way that is not pathological which means that it would never be picked up unnoticed but your life would not be as fulfilling as it would have been had you not been taking those. So the reason I used that, we are not talking about cannabis now, is that you have to be very careful about what you are measuring and mistakes that you are making, so just because it doesn't kill you doesn't mean all is fine. Here just because for example

something might improve your reaction skills doesn't mean to say everything else is fine. I think we need to be much more nuanced in what question we're asking and questioning what exactly we're measuring.

Dr Puvanendran (Paediatrician): Now we are seeing more and more children with neurodevelopmental problems/learning difficulties and other children more vulnerable, I talk to them and they spend more time in this game zone, media activating. They lose their kind of empathy, emotional development and social development so it will have an impact on them. Gaming can also be used with a positive aim to improve attention and maybe improve their learning so some people have developed games to improve learning especially with children with Autism to use this in a positive way. We need to see how we can make this easily accessible for teaching and learning those vulnerable children and also to safeguard them as parents don't know how their spending time. So they may have access internet and computer in the room but parents don't know how to safeguard them. There should be some structures and safeguard measures put in place or to help parents.

Dr Vaughan Bell: I mean I completely agree. I mean it's a question of what sorts of things do we allow our children to play on and at what stage? I really recommend the Byron report 2008, the government's report on safer children in a digital world, which had lots of very good advice on this. Actually it was an interesting point that in a lot of the focus groups that this report ran to look at these issues lots of parents actually said well actually they preferred their kids on computer games because they know where they are and there safe in their house. These days we have a big fear of children being outside especially in cities and so on and I think a great deal of this is encouraging parents to find out what kids are doing, how much are they playing, what are they playing rather than packing them away. I have to say on your point about televisions in their rooms I have to say that the specific research has shown that having a television in your room or computer in your room rather than just one in the house, is a risk factor for slow development and health problems and so on. So parental involvement, parental monitoring I think is essential.

Baroness Susan Greenfield: I know it always comes down to the same issue of the good parent who brings up their kid is concerned, who works with them, sits with them, on the one hand, but technologies always can be used for good and it can be abused. I never argue that it per se is bad, it's the way it's used or the assumptions that are made and well I think that everyone in this room is not concerned about Lord Erroll here but more about the people who are falling through the cracks, the Canyons in 21st century society.

Andrew Inglis (Headteacher): Could I just say something. I am no scientist but I am a headteacher as well as a parent and since I knew I was coming here this evening I did three of my own studies. So what I am about to say is observational rather than any firm evidence. The first study, I am a headteacher of a boarding school and as it happens we don't allow the children to bring back computer games of any sort, internet access is limited, there's no mobile phones and so on. Perhaps very old fashioned but that's what we do. Last Sunday I did my own research of a boy who was able to spend a whole afternoon in our computer room playing computer games so computer games are allowed on a Sunday afternoon, great excitement. So he had three hours playing computer games and another boy who didn't know I was studying him but I was and he had a lovely

afternoon, he spent the whole afternoon outside with his friends playing games, interacting and so on. I then chose to sit down with them and have a conversation and it was fascinating to see the difference in level of conversation between each of the two boys. The gamer if you like, had very little to say to me, they were similar characters, very little to say to me, to elaborate on what he'd done except from he'd got to level fourteen on whatever game he was playing. The other boy who spent the time outside, talked about how they'd made this amazing den, how they'd given various other boys different characters and this event had taken place in three hours without any adult supervision at all. It was a very enriching conversation I had with him; it was fascinating to hear this little imagination he'd used during the course of that afternoon. So that's my first study. My second study as a parent, my five-year-old son suddenly heard about Wii, heard about Nintendo, heard all his friends had got DS and we again old-fashioned, decided that no you can't. He went to his friend's house the other day and he came back and I said, "What did you get up to?" Again lovely sunny day. "What did you get up to?" "Oh we just played on his DS". So I said "what the whole afternoon?" And he said "yes, the whole afternoon. We had tea but we didn't really talk much at tea, straight after tea we played on his DS all evening". You can read into that what you will. Finally, my third study was talking to my particular class, of again, boys, thirteen year olds, elegant, interesting, there well aware their old-fashioned headmaster doesn't know anything about technology but I was talking about different characters within the school and I said what about games, what about computers, what about the internet? And they talked about different characters in the school. He's a big gamer, he loves it, he spends his whole time on computer games and I said do you notice anything about these particular boys? Yes. There much more aggressive than many of their peers. They are not able to develop the same friendships that other boys do and every time you have a conversation with them, there's the issue there is the element of aggression there. So it is not necessarily a question but it is three observations that I find quite interesting.

Lord Sutherland of Houndwood: Thank you very much. I will ask our two speakers if they have any other comments but are there any last questions that you want them to take into account.

Mrs Ann O'Hara: I would just like to concur with those comments because I am from the field of education as well and the schools that I work with, we are seeing an increase in pattern in conversational abilities on entry. Previously, you may associate poor communication skills with particular social economic backgrounds. Now you can but the social economic backgrounds is at the other extreme, the families where they can buy the computer consoles and the games can replace face to face interaction and so there is a much greater weakness of communication skills on entry and that's spreading.

Lord Sutherland of Houndwood: With all the consequent problems, quite. Vaughan do you want to react and then I'll ask Susan.

Dr Vaughan Bell: I mean I think Susan had raised some very valuable points about measurement, cohort observation and so on, but I have to say that for many of the questions that she raised have been addressed

with appropriate measures, some of them obviously have not and it is just really important that we consider this evidence in this debate because there is a huge amount of evidence and we need to understand it and we need to apply it.

Baroness Susan Greenfield: Well I remain concerned as I am a neuroscientist as opposed to a psychologist so as Richard said my level of concern is at that level of neural mechanisms and the transmitters that underlie certain things like addiction and given that it is hard to see how it could not be changed given the sensitiveness that what we know of the brain. It would be very odd if you changed the environment the brain doesn't change at all, it would mean you're measuring something different. Now whether it is changing for better or worse, of course one can discuss and it means what your measuring as I say there are a whole lists of things that are most readily quantifiable which are the things that we don't necessarily put a premium on. So I don't what to set aside me saying its all evil it rots the brain and Vaughan saying its fantastic go off and multiply with computers! Neither of those answers would do justice to either of us and clearly we have had this debate as a whole conference and so on. But rather my own plea is that every parent I have spoken to is concerned, everybody, I have yet to meet one and I meet lots of parents. So given that, oh ok everyone apart from one (Earl of Erroll)

Earl of Erroll: The world changes, develops.

Baroness Susan Greenfield: Well ok, we have to be careful what we are measuring and above all, yes the world does change and develop, we do have to have a debate beyond the science. You don't need us, if I ask you and this will be another time don't worry, what kind of kids do you want? What kind of qualities do you want them to have? What kind of abilities and talents? What things if you were ranking are you going to prioritise? Because until we know that we can't say whether things are good or bad or what we should be doing. So really, that's not with the scientists, it's the parents and you know society as a whole. What kind of citizens do we want?

5. Round-up comments Lord Sutherland of Houndwood

Just to conclude. I thought the slides that Susan showed of the piano playing experiment which I have seen a version of before were quite fascinating and they justify, actually justify your job as a neuroscientist I think, those slides, because they tell us something about the impact outside the human body on the human brain and nothing could be more fascinating, probably more important. The second thing I want to say which sums up a point that others have been making, that was there were discussions exactly like this four, five hundred years ago and they referred to what that chap Bill invented. Not Bill Gate, Bill Caxton because he was the one who invented printing and they had huge debates about how this was going to ruin society and bless him Francis Bacon, one of the founders of British science, he I quote, "Many an honest plough boy has been ruined by the grammar school" I mean the Luddite approach to all sorts of things that you look back and this is why

it's important to read history, we have been here before. We are now looking at a different technology with a huge range of options, it will change us and if we are frightened of change that's bad news. But it will change us and we need to understand as well as we can just how it will change. Now with those attitudes I ask you to thank are two speakers.

End of seminar

List of Delegates:

Dr Nina Adetueru	CSJ Mental Health Review
Ms Ros Baynes	Teachers' Pocketbooks
Dr Vaughan Bell	University of Antioquia
Earl Baldwin of Bewdley	Crossbench Peer
Mr Joe Butler	Open University
Ms Sophie Caruth	Mason Rose
Mr Andrea Chiari-Gaggia	
Mr Richard Churches	CfBT Education Trust
Professor Clive Coen	King's College London
Ms Carole Cowe	Darrick Wood School
Dr Kshipra Desai	
Dr Ian Devonshire	The Institute for the Future of the Mind
Dr Ellie Dommett	Open University
Baroness Frances D'Souza	Crossbench Peer
Ms Linda Edge	Teachers' Pocketbooks
Earl of Erroll	Crossbench Peer
Ms Melanie Gill	CSJ Mental Health Review
Ms Janet Gordon	Salisbury Park Primary School
Baroness Susan Greenfield	Crossbench Peer
Ms Ann O'Hara	Gloucestershire County Council
Ms Charlotte Hendey	Darrick Wood School
Baroness Howe	Conservative Peer
Mr Andrew Inglis	Ludgrove School
Dr John Miles	
Ms Christine Miller	Resource Magazine
Ms Naomi Neathey	St Georges College Junior School
Lady Dalit Nuttall	WestValley Capital
Mrs Lucy O'Donnell	Lovedean Granola
Dr K Puvanendran	Child Development Centre, Basildon Hospital
Mr Rory Ross	
Ms Emma Sewter	The Institute for the Future of the Mind
Professor Peter Simpson	Scientific Secretary and Editor of Science in Parliament
Mrs Nancy Sladek	The Literary Review
Ms Sheena Sutherland	
Lord Sutherland	Crossbench Peer
Mr Santi Tonsukha	Royal College of Art
Mrs Susanna Way	
Dr R Wickramasinghe	Science Policy Centre
Mr Matt Williams	Learning and Skills Council