DRUGS – FUTURE CHALLENGES TO BRAIN SCIENCE AND LEGISLATION

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INTRODUCTION

The brain is in essence an organ that functions through pharmacological interactions between neurones which makes it very amenable to manipulation by pharmacological agents which we call drugs. So far over 80 neurotransmitter and related substances have been identified in brain which gives many more targets for drug treatments than we currently have available to psychiatry and neurology. Areas of current clinical interest that may provide challenges for future legislation include drugs that enhance brain functions such as cognition and memory and those which give pleasure. Future areas are more speculative but include drugs that have the potential to ameliorate or even reverse the brain dysfunctions that underpin certain neuro-developmental syndromes such as Down''s, Fragile X and Retts syndromes.

THE CURRENT REGULATORY POSITION

Drugs are regulated in a number of ways depending on their perceived benefits, harms and history. Some are controlled by sales regulations. Freely available drugs that are simply taxed include tea and coffee plus the low-grade stimulant khat which is obtained by chewing fresh plant leaves that are imported from East Africa and charged VAT on arrival. Other legal drugs are regulated by age limits for purchase (solvents and glues) which is also the case for alcohol and tobacco products though these also attract drug-specific taxation and limitation of times and places they may be sold.

Drugs with medical uses are controlled under the Medicines Act which can punish the sale outside of approved medical indications, whereas drugs used for recreational purposes are controlled under the Misuse of Drugs Act 1971 (MDAct). In practice many drugs fall under both Acts as many of the drugs in the MDAct are also medicines. These include opioids [eg heroin] stimulants [amphetamines] benzodiazepines, ketamine, GHB and anabolic steroids.

The decision to regulate drugs under the MDAct is made by Government in consultation with the Advisory Council on the Misuse of Drugs (ACMD) a statutory body whose role is to consider relative drug harms and advise government on how to deal with them. Drugs considered sufficiently harmful to be controlled under this act are then put into one of three classes – A B C – with the most harmful being class A. The maximal penalties for possession and supply are then scaled according to the class.

The current MDAct has a number of major anomalies that have repeatedly been identified by scientists and government committees. These include the seeming arbitrary exclusion from the act of very harmful drugs such as alcohol and tobacco products and the mismatch of class to real harm in the cases of the mushrooms, MDMA [ecstasy] and psychedelics; all of which are clearly less harmful than the other class A drugs they sit alongside and would seem better placed in B or C if in the Act at all – note mushrooms were not added until 2005.

CURRENT ISSUES

Two areas of current concern re new drugs are those relating to cognition enhancers and the so called "legal highs".

Cognition enhancers are drugs that improve brain functions such as memory alertness and attention so may be used to enhance performance in some situations. Such drugs may already be known – eg the amphetamine stimulants – which have been used for over half a century to promote wakefulness in the face of limited sleep, but newer ones for vigilance enhancement such as modfinil (Provigil) are currently available. Others, eg the ampakines, are in development. These drugs often have medical roles and Modafinil is a licensed medication for conditions of excessive sleepiness such as narcolepsy and day-time fatigue. However, concern has been raised because they are being used by students to improve their ability to study and take exams (this is not new, stimulants such as methylphenidate (Ritalin) have been used like this since the 1950s). So should the possession or sale of modafinil for non-medical purposes be made illegal? We shall come back to this issue below.

Legal highs are currently legally-available drugs that are

used recreationally – usually by young people – to change their mind states. They come in various forms; some such as GHB/GBL are sedatives like alcohol, whereas others such as "spice" are variants on cannabis and others, eg benzylpiperazine (BZP), are stimulants. The link between them is that their use is outside the MDAct ie legal until/if the Government controls them. Many are imported, usually from India or China, and ordered by users over the internet. Their harms are not easily determined especially when use is just beginning and there is always the concern that they may be toxic. Based on the best evidence it had in 2009 the ACMD recommended all these three classes of legal highs be controlled and this has now passed into legislation. However the story doesn't end there; possibly in anticipation of the control of BZP new stimulant drugs of the cathinone variety (colloquially called plant food, bubbles or miaow miaow) became popular in the middle of 2009 and now are widely used by clubbers. Should they now be controlled under the MDAct? If they were it seems very likely that other new chemical variants would then emerge from the same chemical factories.

The threshold for entry into the MDAct has never been formally defined. Drugs are placed in the Act based on the basis of evidence taken by the ACMD that they pose significant harms to individuals or society with the assumption (hope?) that legal controls will limit use. For some drugs, eg modafinil, there is good evidence that they are safe – as they have been extensively used in clinical practice and elsewhere with little evidence of harms. For other drugs, eg new legal highs such as the cathinones, there is virtually no evidence of what their effects are in humans other than from self-reports by users who cannot know what they are taking.

The key policy question now is whether a drug or drug class should be controlled if it is not harmful, indeed modafinil may even be beneficial, or before harm has been established? One way out of the cognition enhancer conundrum is to regulate use in other ways – eg universities could insist that students were not allowed to use performance enhancing drugs in exams in a way analogous to the banning of drug that enhance physical performance by sporting regulators. For newer drugs that are purely recreational a proven approach is to create a "holding category" – the so-called class D into which drugs may be put pending determination of their use and harms. This concept is used in various countries but was best formulated in New Zealand for BZP. Here sale was allowed of defined amounts of the pure drug (producers had to comply with good manufacturing practice) to people over the age of 18. Health warnings were issued and the industry worked together to self-regulate production and sales. Using this approach the amounts of BZP sold became clear so that the harms could then be much better assessed in relation to the use of the drug. A similar approach could easily be applied here for these newer stimulant drugs so at the very least we would have a good denominator of use against which to assess harms. Moreover, quality control could reduce the harms from contaminants and other products that might be mixed in, and educational messages could be clearly displayed and accessed.

FUTURE ISSUES

There are two areas I want to focus on. The first relates to the exclusion of alcohol from control under the MDAct. This is an historic anomaly or omission rather than a legal exclusion. It has long been felt by the ACMD that there would be no point in taking a stance to move alcohol into the Act since no government would countenance such a radical change. However, as alcohol is such a damaging drug, then another approach would be to find a safer alternative intoxicant, ideally one that did not cause dependence or addiction and one which could be reversed by an antidote or antagonist. Such drugs may exist, and indeed some of the newer benzodiazepines fall into this category. So could they be sold instead of alcohol? This is not yet known and will not be until such an alcohol alternative enters the market place. The main reason this approach has not been developed already is the concern that such a new drug would likely be subject to legal challenge either under the MDAct or Medicines Act. If government were to give its support for this health-improving approach by making it explicit that this is a desirable goal then we could move forward much more rapidly as major pharma or drinks industries would then be likely to put their immense resources into action.

Finally, there is the new challenge that molecular neuroscience will bring to areas such as learning disabilities (mental handicap). One of the most remarkable developments in the past few years is the discovery that in mouse models of human neuro-developmental disorders such as Retts and Fragile-X syndrome it is possible to reverse the brain abnormalities later in life by targeting certain gene effects. This offers a remarkable opportunity to human developmental doctors to translate these preclinical-clinical findings into clinical treatments. One area of immediate opportunity is in Down's syndrome where it has just been shown that in a mouse model of the disorder memory function can be significantly improved using drugs that were developed (so far unsuccessfully) to treat memory loss in Alzheimer's disease. Clinical trials in humans with Down's syndrome are now required but these pose significant ethical and health policy challenges – eg who should give informed consent (the parent/guardian of the patient) and at what age to initiate treatment? Such issues may require a new approach to drug regulation that borrows from new committees such as those regulating stem cell treatments.

Further reading

EMCDDA monograph 2009. Addiction neurobiology: ethical and social implications

http://www.emcdda.europa.eu/publications/monographs/neurobiology: ISBN 978–92–9168–347–5 doi: 10.2810/48676

Nutt, D. 2006. Alcohol Alternatives: A Goal for Psychopharmacology? Journal of Psychopharmacology, 20: 318-320

Nutt DJ, Robbins TW, Stimson,GV Ince M and Jackson.A (2006) Drugs and the Future: Brain Science, Addiction and Society. Elsevier. ISBN 0-12-370624-6

Williams T and Nutt DJ 2005 – Khat (qat): assessment of risk to the individual and communities in the UK – Home Office on-line publication http://drugs.homeoffice.gov.uk

SOCIAL CHALLENGES FROM NEUROSCIENCE

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The presentation, available on the website as a PDF, presents technologies for observing and manipulating human brain function, which is advancing rapidly using structural imaging [CT, MRI, DTI], functional neuroimaging [PET, fMRI, EEG, ERP, MEG], and transcranial magnetic/DC stimulation. Knowledge of molecular mechanisms is leading to new drugs. Brain structure and function are revealed with the help of these technologies which enable the following; eavesdropping on the mind, controlling and extending brain function, and challenging the concept of responsibility. This creates several ethical dilemmas related to social inequalities in access to brain enhancement, personal freedom to use brain modification, behavioural manipulation in children and criminals, the use of mind probing by commercial organisations, such as the police and the military, and modification of the concept of guilt.

WHAT ARE THE PROBABLE SOCIAL IMPACTS OF THE LATEST BRAIN RESEARCH?

ADMISSIBILITY OF LIE DETECTOR TESTS

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SUMMARY

In England and Wales evidence of the results of a polygraph test (or other existing lie detection processes – eg truth drugs) is not generally admissible at trial. In *Bernal and Others v The Queen (Jamaica)* [1997] UKPC 18, their Lordships did not find it necessary to express any final conclusion as to whether or not there may be *"exceptional cases where the evidence of an expert may be admissible to testify as to the results of a polygraph test. The arguments against the admission of such evidence are very formidable."*

OBJECTIONS TO ADMISSIBILITY

There are at least seven reasons why lie detection tests have not been received by the criminal courts.

1) The principle of orality: *"Pervasive orality"* and the *"principle of testament* by identified witnesses" are integral components of the English criminal trial.[1] Traditionally, disputed evidence will be received orally from the witness, who will be examined and cross-examined in open court before fact-finders who may have regard to the witness's demeanour. Lie detection examinations of witnesses take place out of court; the questioning is controlled by the forensic examiner and not by the court or by the advocates.

2) Encroaching upon, or usurping, the function of fact-finders. The focus of the polygraph examination *is on its results* and the conclusions of the *examiner*, rather than on the conclusions to be drawn from the *content* of the witness' answers having regard to his/her demeanour. To that extent, the examination encroaches upon the ordinary trial process. Even if the polygraph examination was video recorded, that would not fully meet this objection, or resolve other issues, such as the weight to be given to the test results (even assuming that they had probative value) or a perceived danger that jurors might be unduly persuaded by the results of an examination that is styled "scientific."[2]

3) Rule against narrative; self-serving consistent statements: Although now subject to many exceptions, the usual rule is that a witness's previous consistent out-of-court statement is inadmissible to bolster his/her oral testimony. Self-serving statements are easily manufactured, and "pervasive

orality" and "oral testimony" are integral components of the English criminal trial. A lie detection test result that suggests that the witness has told the truth, would offend these principles. It would have the effect (arguably) that an accused would be able *"to elect not to deny his crime under oath and to substitute for his own evidence the results of a test administered by a mechanical device." (Phillion v R.,* [1978] 1 S.C.R. 18). [3]

Where a witness blurts out that he/she is telling the truth, and has undergone a polygraph test to prove it, the jury can be told to disregard the remark: *Chapman* [2006] EWCA Crim 2545.

4) Third party *character evidence* bolstering the witness' evidence: evidence given by the polygraph examiner that the witness 'passed' the test, might be treated by fact-finders as evidence of the witness' good character. The reality might be very different, for example, where the witness has criminal convictions. A witness who has passed the test on more than one issue might be treated as having a propensity to be truthful when, in fact, (the witness?) W has convictions for offences of dishonesty (perhaps following a trial having given evidence that was rejected).

5) Unwarranted adverse inferences by not taking the test: If lie detection tests were admissible, there is a risk that a jury might draw adverse inference against suspects who declined to submit to a test. This argument influenced the European Commission on Human Rights in *A v Germany* (1984) 6 E.H.R.R. CD 360. The Commission considered it justified that *"no general right for the use of a lie detector is granted to suspected persons, or to convicted persons":*

"The authorisation of some persons to use a lie detector would inevitably influence the position of other persons who would refuse to be subjected to the lie detector. Their refusal might be interpreted as a sign of guilt."

6) When is a fact true or false? The questioning of a person in the course of a lie detector test will not replicate the close forensic examination at trial by advocates who are expert in the law. Some facts can be established by way of a "yes" or "no" answer to a carefully framed question. However, many facts do not have a straightforward structure, and an accurate test result may depend on the witness' ability to understand concepts that are integral to the trial. For example, consider the question: "Did you steal the car?" As a matter of law, theft is not to be equated with merely taking somebody else's property. The element of "dishonesty" is an important element of the offence. But, a *dishonest* person might *truthfully* answer that he did not regard his actions as dishonest. Many persons confuse a "lie" with being "mistaken". This is not an isolated example.

7) The test is reputedly unreliable. The polygraph test has not received a favourable press in terms of proof of reliability. This has probably been the greatest stumbling block to its reception in a criminal trial. The widely held perception is that that lie detection tests are unreliable, so that a nervous but truthful witness may be said to have told "untruths", whereas an habitual liar can out-smart the test and have his credibility bolstered in consequence.

CURRENT RELIANCE ON POLYGRAPHS IN THE CRIMINAL JUSTICE SYSTEM

Under ss. 28 to 30 of the Offender Management Act 2007 the Secretary of State may include a polygraph condition in the licence of a person (1) *serving a relevant custodial sentence*; (2) in respect of a *relevant sexual offence* (eg rape) if released on licence by the Secretary of State; and (3) he is not aged under 18 on the day on which he is released. A "polygraph condition" is a condition which requires the released person to participate in polygraph sessions conducted with a view to monitoring his compliance with his licence or improving the way in which he is managed during his release on licence. Mandatory polygraph tests are being piloted in limited areas until 31st March 2012.[4] *The Prison Service Instruction 04/2009* (as at 9th March 2009),[5] advises that the polygraph condition should be worded in these terms:

"To comply with any instruction given by your supervising officer requiring you to attend for a polygraph session, to participate in polygraph sessions and examinations as instructed by or under the authority of your supervising officer, and to comply with any instruction given to you during a polygraph session by the person conducting the polygraph session."

The offender is required to participate in polygraph sessions at specified times and to comply with instructions of the "polygraph operator." The Secretary of State has issued *A guide for offender managers ("Mandatory Polygraphy for Sex Offenders Pilots")* which the polygraph officer must have regard to. The guide sets out matters that constitute a "pass" or a "fail" and recognises that tests can be inconclusive. Importantly, the guide also emphasises that the result of a polygraph test (either a pass or fail) cannot, in isolation, be used as a basis for decisions – such as whether to recall to prison. In addition, the guide regulates the process where an offender discloses information which was previously unknown. Any disclosure by the offender of risky behaviour should be dealt with through a variety of means, such as supervision, or, in cases where the potential for a further crime is indicated, through report to the police. Section 30 of the 2007 Act also provides an important safeguard: no use can be made in any trial of statements made or psychological reactions of the released person while participating in a polygraph session.

In *Corbett v National Offender Management Service* [2009] EWHC 2671 (Admin), the Court rejected an argument that imposing a polygraph condition breached an offender's right to respect for private life under Article 8 of the ECHR.

THE FUTURE

Although the Privy Council in *Bernal v The Queen (Jamaica)* left open the possibility that there may be exceptional cases where the evidence of an expert may be admissible to testify as to the results of a polygraph test, it is unlikely that, WITHOUT a proven record of reliability, the courts will be ready to receive evidence of lie/truth detection results. Even if reliability were to be established, other objections to the adduction of such evidence at trial would remain.

However, if the results of the pilot under the Offender Management Act demonstrate that these methods are reliable indicators of a risk of re-offending, it is possible that they will be used to assist the court *at the stage of sentencing* where the judge has to assess dangerousness and whether the risk of reoffending merits the imposition of particular orders.

Arguably, different considerations apply where a case is tried by judge alone rather than by juries (but would there then have to be different rules in respect of criminal cases that can be tried with and/or without a jury?).

1 Per Buxton LJ, *R. v Derodra* [2000] 1 Cr. App. R. 41.

2 Neal Feigensona1, *Brain imaging and courtroom evidence: on the admissibility and persuasiveness of fMRI*, International Journal of Law in Context (2006), 2: 233-255 Cambridge University Press.

3 Supreme Court of Canada.

4 See the *Offender Management Act 2007 (Commencement No 3)* Order 2009 (SI 2009/32) which brought into force the relevant provisions of the Act for a period beginning on 19th January 2009 and ending of 31st March 2012.

5 *Polygraph Rules* have been made under the 2007 Act (see SI 2009/619) and these came into force on 8th April 2009.

BRAIN SCIENCE: IN THE REGULATORY SPOTLIGHT

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One by one, emerging technologies move into the regulatory spotlight. Sometimes, the questions, as with nanotechnologies and synthetic biology, are about safety, about risk and benefits, about precaution and regulatory prudence. Sometimes, the questions, as with red biotechnologies, are about regulatory legitimacy – not so much about acceptable risk but purely and simply (although with much disagreement) about acceptability. Sometimes, the questions, as with the control of on-line suppliers of goods and services, are to do with regulatory effectiveness. And, in almost all cases, there are questions about maintaining an adequate connection between the law and these rapidly developing technologies. Now, it is the turn of brain science together with the new generation scanning technologies to move into the spotlight – most recently, with the results published by Adrian Owen's team (raising the prospect of checking the status of persons who are in a vegetative state and, possibly, of communicating with locked-in agents). What should regulators make of these technologies?

By and large, scanning technologies do not seem to give rise to special questions of safety; and, while there are many questions about the privacy and confidentiality of the information obtained by a scan, legitimacy concerns will probably be assuaged by ensuring that those who are scanned do so on the basis of a free and informed consent – or, where scans are not authorised by consent, that the justifying reasons have more weight than the public interest in respecting privacy and confidentiality. Whether or not brain-based technologies will be sufficiently reliable to make an effective contribution to various kinds of non-clinical assessment (for example, to assessments made by employers or insurers, or in courtrooms) will also be an issue; and there will be connection questions if, say, scanning devices become smaller, cheaper, and more widely distributed as has been the case with computers. At the top of our agenda, however, I suggest that we should consider the regulatory implications of scanning technologies in a context of much more intensive surveillance coupled with a tendency towards profiling and prevention.

The law, whether made in Brussels or at Westminster, regulates human conduct in a way that carries with it no guarantee of compliance. The signal to regulatees is that they ought or ought not to do such and such a thing. Sometimes, as with the classical criminal law, the message is that the acts that are prohibited are not only legally, but also morally, wrong; the signal to regulatees is that, if they are to do the right thing, then such acts ought not to be done. For some regulatees, the moral signal might not be decisive; but, where the law also signals that there is a sanction for non-compliance, regulatees might be persuaded that, prudentially, it is in their interest to comply. At all events, the law operates with two principal registers: the moral register (appealing to regulatees doing the right thing); and the prudential register (appealing to regulatees acting in a way that, all things considered, is in their own interest). If the former exhortation is to comply because "you know that this is right", the latter is to comply because "you know that this makes sense". With the emergence of modern technologies, technologies with radical regulatory potential, all this is set to change.

The first change involves the use of technologies, such as

CCTV, DNA profiling, and (if recent reports are to be taken seriously) surveillance drones flying at 20,000 feet, to harden both the perception and the actuality that non-compliers are likely to be detected. This is not a revolutionary move because, as I have said, the prudential signal is already an important element in the regulatory repertoire. However, the shift away from the moral signal towards reliance on the prudential signal already marks a society in transition.

The truly revolutionary change occurs when technologies are employed in a way that makes it no longer reasonably practicable or simply impossible to act other than in accordance with the desired regulatory pattern. The regulatory signal is no longer that one ought or ought not to do such and such; now it is that such and such cannot be done. Already, we find ourselves locked out without passwords or trapped in systems (such as transport systems) that are coded in a particular way. When code and design rule, we have no choice; and, in practice, the philosophical agonising about free will is academic – the fact of the matter is that we are moving towards being regulated in a way that treats us as though we cannot act otherwise than we actually do (how we act being determined by the design of the regulatory environment in which we find ourselves).

Technologies that are developed around brain science need to be viewed, not in isolation, but as a part of this larger regulatory picture. If courts admit the evidence of a scan, the traditional role of the jury is likely to be diminished; and, if (as Canadian neurosurgeons have suggested) deep brain stimulation can improve recall, then the evidence of eyewitnesses who have undergone such stimulation might be treated as privileged: the forensic implications are highly significant. Of far greater significance, however, is the prospect of scanners being installed at the entrances to airports, government buildings, theatres, restaurants, and shops with a view to detecting some kind of brain activity that is classified as "risky". If scanners, in conjunction with an array of profiling technologies, routinely sound the alarm or simply deny access to high risk individuals, then (for better or worse) we are in a new regulatory world.

Finally, there is the question put by Colin Blakemore: if the application of these regulating technologies produces a pattern of behaviour that is in line with moral requirements, if the pattern is of people doing the right thing, does it really matter why they do it? To be sure, if humans were morally omniscient, and to the extent that moral requirements were beyond question, we might well reason that it would not matter. Indeed, even absent moral omniscience, we might reason that, where moral requirements are agreed, it does not matter – for example, why should it matter whether traindrivers respect the life and well-being of their passengers by freely choosing to stop when the signals are on red, or whether they stop because the train is designed in such a way that it cannot pass signals that are on red? However, for communities with moral aspirations, the moral development of humans does matter; the much-maligned idea of human dignity is precisely about humans trying to do the right thing in the face of opportunities to do the wrong thing. This is not to say that we should take Samuel Butler's advice, destroying our machines and turning our backs on technology. Far from it; we want to enjoy the benefits of technologies, including scanning technologies; but we also need room for moral debate and development. In the coming decades, for parliamentarians and for the community at large, the Blakemore question is fundamental: how do we create regulatory environments that employ smart technologies to safeguard vital human interests while still cultivating the virtue of human dignity, of doing the right thing for the right reason?

DURING DISCUSSION THE FOLLOWING POINTS WERE RAISED:

Scientific evidence from post epileptic automatism research has important implications for the legal system. An example of a lorry driver was described who had no recollection of a series of serious road accidents, but who was found not guilty in court of all dangerous driving offences when it was subsequently demonstrated from an EEG scan that he suffered from epilepsy. That type of evidence is therefore a perfect defence.

There are many defences and offences in which scientific and medical evidence is critical. Concern arises when scientific evidence is used to determine whether someone is capable of telling the truth and deciding whether scientific evidence is a better judge of that that a jury. The bad news is that some of the other examples given are all treated as insanity. The definition of insanity was established and has not changed in criminal law since 1840. It is the same in Parliament as well! However, the NHS may able to make much greater use of brain scanning techniques in future to support medical treatments for disorders likely to result in antisocial behaviour, and thereby putting lawyers out of business in 100 years time!

We should accept the fact that people take drugs and people have always taken them as a defining characteristic of hominids. Almost no one has not tried to alter their mental state with something, including tea or coffee. Why we do it is fascinating. As a scientific committee we should accept that and when we do, it should be to the best advantage and the least disadvantage. If Ecstasy is a popular drug, why don't we encourage the pharmaceutical industry to make a safe version of this drug? This is an interesting philosophical position which few people are discussing. It would be reassuring for parents to know that their children are taking drugs which are acceptably safe. There is no reason why society should not accept such a view.

Could courts recommend that antidotes be administered to prevent repetition of certain crimes? This already happens with heroin addicts who have the choice of prison or an antidote.

Cannabis is more dangerous than tobacco due to lung cancer. There are synthetic cannabinoids that relieve pain and nausea and help MS patients. There is now available a purified cannabis leaf administered by adsorption through a mucous membrane and not through smoking.

If brain imaging of lying and the resulting brain pattern can be shown to be definitively reliable there is no reason why it should not overcome the most significant objections in law. It is wrong to assume the technology will never be better. We need to be thinking about it now. Laws regulating drugs are not up to it and are not any use for regulating drugs. We need scientists to challenge political judgements.

DEBATING THE IMPACT OF TECHNOLOGY ON THE BRAIN

The All-Party Parliamentary Group on Scientific Research in Learning and Education was established in 2006 to explore how the ever-increasing body of scientific information on child development and learning can be used to inform education policy and practice. Since its launch, the APPG has held meetings on neuroscience in the classroom and the use of cognitive-enhancing drugs. The group attracts broad cross-party support and the meetings provide a unique opportunity for parliamentarians to meet with scientists, teachers, parents and charities to discuss such topical issues.

The most recent meeting, chaired by Lord Sutherland, focused on the impact of technology, such as computer gaming, on the brain and featured presentations from Baroness Professor Greenfield (Oxford University) and Dr Vaughan Bell (University of Antioquia, Columbia and King's College, London). The meeting began with Greenfield presenting evidence of the brain's unique ability to adapt to whatever it encounters, thus demonstrating its impressive sensitivity to experience. She posited that whilst this quality is essential for an individual's uniqueness it also means that experiences could have a detrimental effect on the brain. She went on to suggest that intense use of technology, such as gaming, may result in an individual returning to the highly sensory world of young children, rather than the sophisticated, cognitive world of the adult; that is to say, a return to experiencing sensations, rather than thoughts. In addition, users may have shorter attention spans and lack an ability to use abstract concepts and meaning. Furthermore, Greenfield suggested that these could lead to reduced empathy and identity and increased recklessness. Greenfield acknowledged that there is some evidence for positive effects of gaming, with some studies showing improved reaction times, for example, but that more research was needed as simple improvements in reaction time would not be outweighed if the capacity to exhibit empathy, for example, was lost. She concluded that we cannot afford to be complacent and we would be doing a disservice to the next generation if we did not ask, and attempt to answer, questions about the potential of technology to harm brain function.

Dr Bell was charged with providing the counter-argument and he gave an excellent overview of existing research, drawing on 1500 scientific articles. He suggested that the high level of media interest was merely history repeating itself: comics, television, records and radio have all been similarly criticized. Much of this criticism is based on two premises: firstly, that technology can be damaging and secondly, that the content is poor. Addressing the first premise, Bell presented data showing that gaming improved reaction time, whilst not altering accuracy or impulsivity. He conceded that there was evidence that those who engage in gaming have slowed academic performance but only when gaming displaced academic work, ie homework. Given the recent concern that violent games increase the incidence of violent behaviour, Bell provided an overview of the relevant research, agreeing that violent games are associated with increased aggressive thoughts and behaviour but that this was due to the content of the game rather than the act of gaming itself. Social networking sites such as Facebook have also received significant attention recently but, despite suggestions that those who rely on such two-dimensional interactions may become less capable of forming other relationships, Bell stated that, in fact, the reverse may be true as research has shown online networking to enhance offline friendships.

At first glance, Greenfield and Bell appeared to present opposing arguments but nevertheless agreed on a number of key points. Firstly, that more research is needed – especially in examining the impact of technology on behaviour more complex than, for example, reaction times – and secondly, that it may well be that such technologies have different effects on different individuals, with those already predisposed to depression or anxiety for example, being more at risk to any detrimental effects. Thirdly, both agreed that playing computer games or watching television in isolation may have very different effects to doing these same activities in a social setting, such as with family or peers. It seems then that it is too early to make any firm conclusions about the impact of technologies on the brain. There do appear to be some positive effects, but the content of the game and its displacement of other activities can lead to detrimental outcomes. What is clear is that we should continue debating and researching such topics to ensure that we, as a society, are aware of these effects, both good and bad.