Annual Kalisher Lecture[1]

Mind-Reading: Neuroscience and The Law[2]

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Introduction

1. Thirty years ago, I started pupillage at Michael Kalisher QC's chambers in Hare Court, Temple. As everyone who knew him will tell you; he was a very special person. He took people seriously. It wasn't how well you spoke, where you had been educated or what your parents did that mattered to him. He seemed to care about something different: he liked to give people a chance.

2. I'm very grateful for that pupillage. And a year or so later, for a tenancy in the same set where I spent 25 years in practice. It's good to see members of chambers here today and I'm proud and honoured to be asked to give this lecture in Michael's name. He knew of my interest in science, so he wouldn't be surprised by the choice of subject. I hope he would enjoy it and approve.

The Science – a brief synopsis

3. "Mind-reading" is a provocative description of neuroscientific techniques, which are enabling us to know more about how the human brain functions. The mystery of our consciousness; the subjective inner world that no one else can experience first-hand, is not capable of explanation. Professor Susan Greenfield[i] calls it 'the water into wine' phenomenon. When the alarm clock rings what is it that makes us conscious when we were not a moment before? As I explain in this lecture, neuroscientists are determinedly pragmatic; brain imaging is

[1] https://www.thekalishertrust.org/
[2] With gratitude to the Royal Society for allowing me to draw on a more detailed paper I presented there.

showing us more about the working of the physical brain than ever before and they may be bringing the compelling, and often beautiful, product of their work into a court near you soon. My modest aim today is to kick off a discussion among criminal lawyers about this science, which many people claim should have an impact on how criminal courts assess blame, decide punishments and treat offenders.

4. [Here are three types of mind-reading which neatly depict how the technology is moving on[ii]. Type 1 – a classic experiment depicting recognition of fear. The subject looked at pictures of faces displaying increasing degrees of fear. See the general blood flow and then see the exaggerated response via specific blood flow in the amygdala. Type 2 – Showing people many examples of a thing and so building up a map of what their neural code seems to be for that thing. Then later recognising if they are thinking about that thing. Type 3 – More up to date and innovative; reversing the order. The subject's brain is scanned when shown lots of movies and images, building a picture of how the brain reads those and then, when the subject is shown something new the computer in the scanner 'builds' a picture of what the subject is looking at purely from reading changes in the brain as compared to the brain scans from the known images.]

5. Now, as Jennifer Aniston might have said, "*Here's the science bit. Concentrate…*" The average human adult brain weighs 3 pounds and will fill the volume of (as I'm talking to lawyers) about two bottles of wine, with little space left over. Living brains have a consistency a bit like gelatine but despite that softness they are made up of regular shapes and structures that are generally consistent from person to person. The largest part of the human brain, about 85% of its volume is the cerebrum. It's found at the front, top and much of the back. The human brain differs from the brains of other mammals mainly because it has a much larger cerebrum. The surface consists of the cortex which is a sheet of grey matter a few millimetres thick. It's not smooth in humans but is heavily folded with valleys called sulci and bulges called gyri. These allow the surface area of the cortex, as well as its volume, to be much greater than other mammals while still allowing it to fit inside our skulls. Brains are part of our central nervous system.

6. Estimates of the number of cells in the human brain vary from a few hundred billion to several trillion. About 80 billion 200 billion of these brain cells are neurons, the most important cells in the nervous system. Neurons pass messages from one to another in a complex way that appears to be responsible for brain function, whether conscious or

otherwise. How this is done, the neural code, is one of the great mysteries of human biology[iii]. Communication between neurons occurs at areas called synapses, at the end of axons where two neurons almost meet. When a neuron fires, becomes active, it does so by generating an electrical current along its axon[iv].

7. You will be familiar with **CT/CAT** (computerised axial tomography) scans (basically three-dimensional computer-assisted X-rays with poor resolution but enough to see structural abnormalities). A CAT scan was adduced in the 1982 trial of John Hinckley for the attempted assassination of President Ronald Reagan. It was argued that widened sulci in the cortex demonstrated that he suffered from organic brain damage in the form of a shrunken brain. The effect of the evidence on the verdict is unclear (he was found not guilty on the grounds of insanity.)

8. **PET** scans require the injection of a radioactive substance into the bloodstream, which can then be mapped as it moves around and decays, while the brain is functioning. PET scans are good at showing where brain damage has caused certain regions to become abnormally inactive for example through Alzheimer's disease or stroke.

9. Structural **MRI** (Magnetic Resonance Imaging) was developed in the 1970s. It uses deceptively simple physics to disrupt hydrogen molecules using very strong magnetic fields. Recording how quickly the molecules return to their original orientations after the electromagnetic pulse, lets the scanner generate very high-resolution images, including of soft tissue in the brain. These can be used to identify structural abnormalities, large and small.

10. Functional MRI (**fMRI)** was invented in the 1990s. An fMRI machine is a remarkable piece of engineering and a tribute to the intelligence of man. The doughnut you put your head into is huge magnet able to create a magnetic field 10,000 times stronger than the earth's natural magnetic field. Billions of neurons which communicate with each other using electric signals are being fired during brain activity and the neurons are using energy: they are active. Finding the exact origin in the brain of the signals you want to study is not easy because neurons are firing away even when the brain is resting. So distinguishing what neural activity is to do with some specific thought, decision, emotion or task is the problem which fMRI solves. How?

11. Blood flow in the brain is regionally regulated by the brain itself. When neurons use more oxygen, chemical signals cause nearby blood vessels to

dilate. The increase in vascular volume leads to a local increase in blood flow and this can be measured. Imagine, Adam a junior barrister, he's late for court so as he is running to the tube in the morning his body will send more oxygen to his limbs because they are working harder than usual. In the same way when he gets into court and starts cross-examining a witness his brain will need more oxygen delivered to those parts which are forming the questions, concentrating on the answers and thinking of the implications; in short he needs more oxygen at the precise areas of his brain that are working hardest at that particular moment.

12. If Adam were to do his cross-examination while in an fMRI scanner the magnets will create fields which don't interfere with his thinking process, but measure blood oxygenation levels within small cubic volumes of brain tissue known as voxels as those levels change with the varying demands of active neurons. The functioning of the brain is thus detectable. The more active the neurons concerned are, the more they need blood to provide oxygen, so there is an increase in the size of blood vessels surrounding them. Our bodies are mainly made up of water and each water molecule has what is called a SPIN which is its own magnetic property. You can get those water molecules to shift their magnetic orientation a bit like shaking a compass which always points north. If you shake the compass around the needle will shift until it gets back to pointing north. To shift the water molecule in the blood which is rushing to get to the active neurons you need a very powerful magnet, like the fMRI machine.

13. When a brain is being scanned in fMRI each beep is a radio frequency magnetic pulse that re-orientates the hydrogen atoms in the water molecules in all the blood in the brain, The speed with which they come back to their original orientation is a measure of how much oxygenated haemoglobin there is in the blood. The more there is then the more oxygen was needed by that part of the brain. This is called the BOLD response (blood-oxygen-level dependent response.) Greater blood flow change is traced by the scanner and that is the part of the brain that the scientists say was particularly active when the activity being measured, was taking place[v]. If Adam was scanned again when he was back in chambers reliving his forensic triumph of earlier in the day, the mind-reading fMRI would detect a different pattern of brain activity.

14. Typically, in a fMRI experiment the subject lies in the scanner and the scientists will measure the differences in the BOLD response between different conditions. For example, he might be told to look at a video screen on which there are images of places alternating with images of

faces. By collecting data on which parts of the brain were more active when the screen contained faces as opposed to when the screen contained places, researchers will infer that those regions were in some way involved in how the brain processes images of faces. And the results will be shown as a brain image on which areas of greater activation are illustrated by different colours. The colours are all chosen by the researcher and it is the computer in the scanner that maps the activity in the pictures, these are not like x-rays. They are an indirect representation generated by the sophisticated machine.

15. Looking into the brains of healthy people non-invasively, without harming them and then correlating what is seen in the physical brain with the subjective mental state of the person being scanned enables science to begin to unpack complex processes such as brain activity associated with perception, memory and thought as well as how brain development relates to cognitive capacities. As the research continues mapping the brain activity associated with decision-making processes may eventually enable us to understand how an individual's history, experiences and cognitive limitations have affected their ability to make good choices.

What does it mean?

16. Where does all of this get us? As lawyers we are not taken by surprise by brain imaging and neuropsychological methods, because in personal injury or clinical malpractice claims such evidence is directly relevant to whether and what injury or lesion has been acquired. We are also familiar with structural imaging assessments of brain function in neurological conditions such as epilepsy. Structural brain scans have also been offered in evidence in this jurisdiction when assessments of dangerousness and considerations of mental health are in play during sentencing[vi]. I will call this 'the old neuroscience' because it is forensically familiar.

17. A new form of cross disciplinary study called Neurolaw has developed at the intersection of neuroscience and criminal law. Proponents argue that the findings of neuroscience have the potential to amount to mind-reading and should be deployed as a tool to help the legal system. It may be possible to present evidence supporting an argument that a defendant has a predisposition to commit a crime and should be excused or his punishment mitigated. Or that another has an idiosyncratic reaction to some form of provocation and is more likely to lose his self-control under certain circumstances. Tests that measure the effect of social deprivation on brain development and demonstrate the difficulty a subject has in resisting an urge to commit a crime may be marketed.

18. Some neuroscientists and legal academics go much further and say that a truly scientific, mechanistic view of the nervous system makes nonsense of the very idea of responsibility.[vii] Others have said that free will is an illusion.[viii] That we can look forward to "a world of criminal justice in which there is no blame, only prior causes."[ix] I want to turn to some of these ideas before looking at how lawyers might want to test this evidence should it become available for introduction in the criminal courts and then say something about the potential impact on rights that this technology has.

Brain-scans as evidence

19. Let's consider the prospect of neuroscientific evidence of brain scans being presented as potentially relevant to the class of <u>legal</u> questions which require an evaluation of the subject's mental states in conjunction with his actions. 'Is the defendant fit to stand trial?', 'Is he telling the truth when he gives an alibi?' and 'Did he intend to kill?' How accurate is the witness's memory?

20. Mental states are part of the explanation of human behaviour. A crime will usually have an act and a mental element. If the mental element can be illustrated through brain imaging, that evidence would be relevant to the issue of whether the requirement has been satisfied. A word of caution here, because the law does not expect or require that the causal mental variables must always be conscious and that every action is preceded by a practical syllogism.

21. Experts educate the courts. In our adversarial system we frequently have experts on both sides. The Criminal Practice Directions and Criminal Procedure Rules set out the position. Relevant evidence makes a legally determinative fact more, or less probative than it would be without the evidence. Even if evidence meets this basic standard the judge can preclude its being led by the Crown in a criminal trial if its probative value would be outweighed by the danger of unfair prejudice or if introduced by any party, if it would confuse the issues, cause undue delay or be repetitive.

22. Brain imaging shows us something real. But what is it? It can be real but irrelevant, or real but unclear. It is certainly indirect evidence. Judges will need help as to whether admissibility thresholds have been met, possibly from experts for both sides. The vital precondition for admission of brain imaging evidence is demonstrating how it relates to and answers the

specific legal question it is intended to address. This is the "translation" question and it's the most significant barrier to the use of the new neuroscience[x]. If the brain imaging is contradicted by actual behavioural evidence: then actions speak louder than images. Absent a robust explanation to the contrary, the behavioural evidence is more direct and probative of legal criteria.

23. There are very real hurdles to admissibility of brain imaging, which is said to demonstrate, let's say, that an individual didn't form an intention to cause really serious harm or to kill. Technical advances will continue apace but there is, currently, a very limited amount of data from fMRI. There is nothing like a DNA database for example and no one has yet cracked the neural code (the language used by neurons to drive cognition etc). The brain is also plastic, unlike DNA. Interpreting fMRI scans of a single individual is extremely difficult and vulnerable to false positive and false negative statistical errors, which may only be avoided through robust group analysis and rigorous experiment protocols. In this field the protocols must make allowance for not testing in real-life conditions.

24. Seven obvious issues to be addressed in future legal arguments when it is proposed to lead this type of evidence (each only touched on briefly) are[xi]:

    1) **Independent replication**: this is an issue in many areas of scientific research at present. Without replication there cannot be peer review and it is harder to develop common protocols or minimum standards. Original research is valued and more likely to receive funding, than replication. In these circumstances can there really be said to be a reliable scientific basis for admitting the evidence[xii].

    2) **Test not fit for purpose**: how well was the test designed for the legal question the evidence seeks to answer? How legitimate is it to extrapolate real world from findings based on the subject's reactions in a scanner? The BOLD signal is a proxy for neural activity above or below baseline activation and the brain is never physiologically inactive.) There is intrinsic 'noise' in the results, and it is impossible to completely control what someone is thinking in a test. fMRI is not a time machine and it cannot map a subject's state of mind in the past. There is also a risk of reverse inferences: inferring a mental process from the observation of activity patterns without a consideration of the actual behaviour or circumstances.

3) **Subject selection and the number of subjects**: fMRI is expensive and small studies are done. How representative are the samples being collected – mainly from students, often medics, so a homogenous bunch – which form the baselines or comparator group?

4) **Group Averages** – applying group averages to individuals is an accepted scientific process, eg in medicine, but in the legal field that has a strong health warning as a concept – the criminal law is concerned with this individual, not a class of like people. Brains are complex, it is not possible to state definitively 'brain pattern A follows stimulus B', in every person, every time or even that it is true for one individual every time.

5) **Technical accuracy and robustness**: there are variations between scanners and scanners behave differently from day to day, they are very sensitive instruments needing lots of maintenance and adjustments[xiii]. An accuracy rate of 60% or so is acceptable to scientists. Not so in court.

6) **Statistical issues**: these are legion – unlike DNA there is no database/control/baseline/default brain. The researcher must set his own threshold for saying that voxel was activated, or that it was not. Some may look for a strong effect, other settle for a weaker one. Both may be right. How many voxels need to be activated before a result is deemed to be a positive one? If too many then false positives will arise and if too few then a false negative mistake will creep in.

7) **Countermeasures**: playing the machine. The subject has to comply with the test and follow instructions. Just a couple of examples: physically the subject can disrupt the disruption by moving around in the scanner or dampen their responses by taking alcohol or biting their tongue. How do you stop someone thinking something else when they are meant to be focussing on the task in hand?

25. Let's think about competence to stand trial. This requires that the defendant understands the charges & the proceedings and can instruct counsel. It is his understanding and ability to communicate which are engaged: whether he can function behaviourally in these ways. There is no yet conceived brain image exemplar of someone who is unfit to stand

trial[xiv]. No research has demonstrated that people who have been found legally unfit to stand trial share any brain image in common.

26. Insanity is a rarely encountered plea these days but arises if mental disorder means D didn't understand the nature of what he was doing, or whether it was right or wrong. The mental disorder criterion is proved behaviourally by considering D's cognition, his mood and other mental state variables. No imaging test is diagnostic of this degree of mental disorder on its own, i.e. brain imaging which un-erringly replaces a psychiatric or psychological test. But even if it did, eg if mind-reading scans demonstrated he was probably hallucinating, both unfitness to stand trial and insanity are legal conclusions. Any test result will be part of the evidence, no more.

27. It may disappoint some here but the metaphysical or free will concepts often discussed alongside neuroscientific developments, are not directly related to any part of the law. 'Causation', in the sense of why someone decides to do something, what causes him to act or to what degree he consciously decides to act, does not provide a defendant in a criminal case with an excuse. So, the philosophical idea that unless we act out of our own free will we will be excused of responsibility, is not legally sound[xv]. The real foundations of responsibility, embedded as they are in our daily experiences and ideological framework, are relatively impervious to science.

28. Take Suspect X, if it were possible to show (literally in arresting pictures from fMRI), how socio-economic factors such as, say impoverished education leading to a limited understanding of life choices or lack of self-discipline or self-control, have had an impact on the patterns of activity in the brain, and that those changes are also in play at a time when it is alleged the subject had the mental state sufficient to prove a crime, it is unlikely that Suspect X will therefore be excused as lacking culpability[xvi]. 'Causation' isn't the same as compulsion. Being compelled, by contrast, under duress <u>can</u> excuse in law.

29. Neurolaw also forecasts that neuroscience will be able to predict criminal behaviour. The same educationally deprived person with limited understanding of their choices in life, might be predicted, statistically in terms of his membership of a group with proven criminal proclivity and via brain imaging results, to be somebody who is likely to commit a criminal offence. But predictability is not an excuse in law. The same prediction might be made from a look at his previous convictions. 'Causation' will only excuse if it produces a genuinely excusing

condition such as a lack of rational capacity but in that situation it's the lack of rational capacity, a behavioural criterion, that is doing the excusing. In short, the arguments of some neurolawyers that mind-reading will demonstrate that there is no such thing as free will or that if anything is to blame, it is society or genetics, is probably an example of what critics call Neurolaw's 'Brain Over-claim Syndrome'.

30. Whatever an individual's life chances and choices the fundamental question for the law is still the behavioural criterion. What did he deliberately do? The law recognises that people with the same diagnosis or condition are behaviourally heterogeneous and ultimately it is the behaviour that is legally relevant and not the diagnosis.

31. On the other hand, it would be short-sighted to limit the potential impact of brain imaging on the basis that behavioural criteria are somehow privileged as a demonstration of mental states[xvii]. I venture that whether the brain is identical to the mind or not isn't really of any interest to lawyers. Surely we should be concerned with whether brain imaging can add something reliable to the array of evidence upon which the judge or jury decides?

32. So how far has neuroscience really come? It is possible to tell the difference between a brain that is alive and a brain that is dead. But we have no idea how the brain enables the mind, how consciousness is produced, how action is created. Elements of the connections between these things may be demonstrated, the pre-frontal cortex plainly has a role, but the inherent problem is very difficult. Manifestly, there is presently no prospect of isolating an anatomical area of the brain at which we can determine whether and what responsibility a person bore for a decision. This quest is known among neuroscientists as the 'functional specialisation' question: some call it 'The new Phrenology'[xviii].

33. Remember Wittgenstein's famous question[xix]; "*Let us not forget this: when I raise my arm, my arm goes up. And the problem arises: what is left over if I subtract the fact that my arm goes up from the fact that I raise my arm?*" This could be termed 'the black box' phenomenon. No presently predictable advances in neuroscience will answer that question. So, the best description of responsibility is that the law is 'capacitarian': mind-reading may be most powerful forensically if it demonstrates incapacity firmly. Capacity includes, of course, the luxury of contradicting anyone's predictions of our behaviour, whether based on brain imaging or our history. Having the capacity to act and acting creates a responsible agent. H.L.A. Hart, the legal philosopher took the "*fair*

chance of avoiding wrongdoing" as the foundation of criminal responsibility[xx]. But the emphasis there should be on the word 'fair' rather than 'chance' and fair meaning 'equitable' rather than 'just.' Our concept of law is society's construct and what criminal responsibility requires is an individual's capacity to act, in a manner deemed appropriate to the realisation of the related intention, given his knowledge of social norms defining what is acceptable and unacceptable.

How might mind-reading help justice?

34. If brains are not responsible and acting people are responsible how might this technology help law's goals? Distinguishing between truth and lies about the past is a core task of the justice system. The traditional polygraph is not admissible in this jurisdiction. However, research suggests that the combination of machine learning algorithms with brain scanning can tentatively distinguish between someone remembering an image they have seen before and one they have not[xxi]. This is promising. With well-designed research, testing a wider range of subjects under a broader range of conditions, we might reasonably expect brain-based lie detection to improve sufficiently to become the subject of admissibility arguments[xxii].

35. Memory detection too appears conceptually and scientifically within reach and it must be capable of good experiment design, particularly in simple cases eg does the subject recognise stimuli such as the gun used during the offence, or the getaway car, or the victim, or at least, does his brain react as if he does? Methods to evaluate the accuracy or degree of confidence in reported memories may be found. It's hard to see such evidence ever being determinative but it may well be admitted as part of the 'array'.

36. Evidence of significant changes in brain structure and function during adolescence providing support for behavioural evidence to justify treating adolescents as immature, was used in a juvenile death penalty trilogy of cases in the US Supreme Court[xxiii]. If enough group data on normative and a-typical brain function is obtained, then the congruence of behavioural science and anatomical imaging studies, could be informative when framing legislation to differentiate between the appropriate degree of punishment for a young person and a fully developed adult[xxiv]. Or assessing the impact of incarceration on young people.

37. On recidivism and dangerousness many have expressed the hope that identification of neural markers will eventually improve the accuracy of

predictions made by sentencing judges and parole boards. This is an enduring challenge. However, the prospect of the legal system moving from a retributivist approach where criminals 'deserve' their sentences to a consequentialist framework where considerations of outcomes for the group prevail such as deterrence, prevention and treatment, is hard to see. It is worth stepping back and remembering that abandoning merits to justify sentences doesn't necessarily lead to softer sentences. In our own system draconian aspects of punishment are usually motivated by consequential concerns, for example the (IPP) imprisonment for public protection sentencing regime. Disproportionate punishment can easily be imposed where prevention is the aim.

38. Less revolutionary, but potentially efficacious, mind-reading may deliver innovative treatment for individual offenders who have disorders with substantial neurological underpinnings, such as addictions or post-traumatic stress disorder. And, investigation of the neurological impact of conditions of confinement could lead to prison reform[xxv].

39. The "reasonable" person standard is frequently employed in criminal law when an objective assessment is required. Juries are left to their own devices to apply the test. This is because the law assumes they are, at least collectively, reasonable. Studies have demonstrated all sorts of common cognitive biases are present in many, perhaps most individuals[xxvi]. Should it be proved that the average person has a tendency for example to overestimate the value of their own judgements and to ignore conflicting information, that might lead to a change in the paradigm of the 'reasonable person' and in directions given to juries.

40. There may even be a sub-conscious bias in favour of brain-mapping itself! Decision-makers may afford neuroscientific evidence such as brain images more weight than it is properly due. There is something about the pictorial representation of a living brain that can appear …. compelling!

41. What about other biases? Might neuroscience help to advance our ability to identify and counteract biases in decision-making in the justice system? Racial ethnic and gender biases, where present, are particularly problematic. But other biases including hindsight, anchoring and framing biases can also lead to injustice. Neuroscience together with cognitive psychology may be successful especially in respect of unconscious bias. Perhaps there will come a time when every candidate for judicial office or jury service will undergo brain imaging as routine!

Rights implications

42. Once the technology becomes cheaper and is more readily useable what rights will be engaged? How are the courts likely to interpret those rights in the age of mind-reading? Will there be a right to refuse to allow your mind to be read, to be protected from compulsion? Could a judge issue an order for a potential witness to undergo such a brain-capture? Even further into the future, technology may emerge which doesn't require confinement in an fMRI scanner. What if every public doorway incorporated a device that mind-mapped everyone who entered or exited? The State, capturing, accumulating and processing our thoughts.

43. The right against self-incrimination has already been challenged in this jurisdiction by the right to draw an adverse inference from a failure to answer questions, or to account for evidence found. There are safeguards; it must be a case strong enough to require an answer and it must have been an informed and independent decision. Why shouldn't the refusal to submit to an fMRI scan fall into the same category eventually?

44. One of the private law arenas in which brain imaging could play a role is that of the job market. Employment contracts in the future may include terms that permit brain mapping to measure compliance and detect dissent, identify potential whistle-blowers or check for extremist or subversive tendencies and ideas. Might such terms be permissible on commercial interest grounds or will the law have to act to protect cognitive dissonance in society and the value of the diversity of ideas, which is being increasingly understood? We are becoming aware of the inbuilt biases of artificial intelligence such as those being developed to carry out the sifting of CVs. Although brain image is peculiar to the individual how can it be demonstrated that the test design or comparator images are not influenced by subconscious or other bias?[xxvii]

45. This brings me neatly but briefly onto counterterrorism and intelligence applications. The gathering of data from electronic communication is usually justified in the context of security endeavours and there are parallels to be drawn with passive or non-coerced reading of minds. Axiomatically, once technology is in existence totalitarian governments will want to make use of it. In our own democratic society those who defend the community from harm may not prescribe 100% accuracy in a mind-reading lie detection system before being able to use it to cut down the number of 'persons of interest' to pursue. Scientists have also discovered that some people are more resistant to brain-imaging because

their BOLD responses do not show up as clearly as others do. Just as in DNA testing some people shed more readily than others. Will being a closed mind to mind-reading be an advantage in the future or not?

46. Let's take stock. Generic human rights protect individuals and promote the healthy progress of society. Might we need new human rights as this technology begins to make its mark? Freedom of thought, conscience and religion is currently protected under Article 9 of ECHR, but the Article is not in absolute terms. There is a great deal of caselaw on freedom of religion et cetera but very little on freedom of thought. That's not surprising is it? Thoughts have been private and hidden beyond the law's reach. Thus far we have had no way of policing thoughts but now we need to think what freedom of thought means. We know that Facebook is working on mind-reading technology, using a physical brain interface- the ultimate password that passes straight from your thought to access an account. If we detect someone's murderous thoughts will protection of 'freedom of thought' mean that we don't act to protect potential victims? What about for treatment or rehabilitative purposes? The duty of candour may apply to those who conduct the mind-mapping; may those scientists find they owe a duty of care to vulnerable people or children within a household or institution for example?

47. It may be worth making a comparison with the present state of the law in respect of freedom of speech. Article 10 ECHR protects freedom of expression including speech. Again, it is not absolute. We protect free speech quite rigorously, but distinctions are drawn between hate speech, speech that incites violence et cetera and other speech. Could similar distinctions be formulated for hate thoughts? In the future, if it is possible to mind-read extreme racist thoughts will we continue to only react to them once they leave the brain and are expressed either through words or actions?

48. Our terrorism law is restricted to the manifestation, communication or publication of terrorist intent even where it falls short of preparing for acts of terrorism. In an era of mind-reading, particularly if technology developed so that multiple brains were imaged or scanned at the same or over a short period of time, will we enter the realm of thought-crimes?

49. Another question is the extent to which our thoughts are our own, conscious choice? How to allow for day-dreaming? If we are not allowed to think the unthinkable how do we challenge the unthinkable? Or prove that the only reason we were thinking the unthinkable was to challenge the unthinkable, not because we enjoyed it. If the desire for a dopamine

spike can keep us glued to our Facebook pages hoping for likes, advertising can manipulate our priorities when we go shopping, and hate preachers can colour our thinking towards other religions, to what extent can we ever be held truly responsible for our own thoughts? Have we come back round to metaphysics and free will?

50. It may be that society will accept reading someone's mind against their will is not torture and could be ethical (imagine the ticking time bomb scenario.) How would the law react? Coercion raises many questions in our jurisdiction. If the authorities wish to coerce suspects to undergo a brain scan in the hope of eliciting evidence of guilt, or during the sentencing stage to obtain evidence relevant to future dangerousness then rights under Article 3 the prohibition on ill-treatment and Article 8 which protects the right to respect for private life are engaged. Proportionate interference where necessary is permitted. In the Netherlands the non-consensual taking of DNA is permitted on the basis that DNA exists independently of the will of the individual and a limited infringement with his rights is proportionate. Our thoughts may or may not exist independently of our will (therein lies one of the premises of this lecture) but if neuroscience enabled them to be captured against our will the current expression of our human rights be up to the job?

51. To end it may well be that some of the dramatic claims made by the prophets of Neurolaw are conceptually confused[xxviii]. It is not possible to attribute to the brain or its parts, psychological properties that belong, in law, only to people. But when advances in science start to come, they sometimes come thick and fast. I am sure that Michael Kalisher QC would have encouraged all of us lawyers to engage and collaborate with scientists engaged in this fascinating work so that, in due course, justice may be served by it. As has already been observed; 'For the law, neuroscience changes nothing, and everything.'

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[i] London School of Economics and Political Science: Lecture – A day in the life of the brain. Professor Susan Greenfield 2016

[ii] Using slides throughout the lecture: which are not replicated here. At this point they were images of the brain patterns analysed.

[iii] Professors Greely, Dean & Wagner Anthony for National Academy of Sciences 3rd Edition: *Reference Manual on Scientific Evidence: Guide to Neuroscience ISBN 978-0-309-21421-6 DOI10.17226/13163*

[iv] Stanford Technological Law Review: Vanderbilt University Law School Public Law and Legal Theory: *Brain Imaging for Legal Thinkers 2009*

[v] Professor Carol Snead *Neuroimaging and the Courts: Standard and Illustrative Case Index (2009)*

[vi] Catley and Claydon *The Use of Neuroscientific Evidence in the courtroom by those accused of criminal offences in England and Wales* The Journal of Law and the Biosciences 14 July 2015 510-549

[vii] Dawkins, R. (2006). Let's all stop beating Basil's car

[viii] Philos Trans R Soc Lond B Biol Sci. 2004 Nov 29 Greene and Cohen

[ix] Sapolsky, R. M. (2004). The frontal cortex and the criminal justice system. *Philosophical Transactions of the Royal Society of London, 359*, 1787–1796.
[x] National Academy of Sciences: Neuroforensics: *Exploring the Legal Implications of Emerging Neurotechnologies.* Harvard Workshop March 6 2018 Keck Centre of the National Academies, Washington DC
[xi] A few references: Ioannidis John 2011 *Excess Significance Bias in the Literature on Brain Volume Abnormalities;* Douglas Husak and Emily Murphey 2013*The Relevance of the Neuroscience of Addiction to the Criminal Law*; Professor Stephen Morse 2015 *Neuro-prediction: New Technology: Old Problems* & Denes Szucs 2016 *Empirical Assessment of Published Effect Sizes and Power in the Recent Cognitive Neuroscience and Psychology Literature. bioRxiv.goi.org/10.1101/071530*
[xii] Gilbert Daniel, King Gary, Pettigrew Stephen and Wilson Timothy, *Comment on 'Estimating the Reproducibility of Psychological Science'* Science 351 (6277): 1037a
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