Open Research Online

The Open University's repository of research publications
and other research outputs

Cognitive Neuroscience, Criminal Justice and Control

Book Section

How to cite:

Claydon, Lisa (2016). Cognitive Neuroscience, Criminal Justice and Control. In: McGuire, M. R. and Holt, Thomas J. eds. The Routledge Handbook of Technology, Crime and Justice. Routledge International Handbooks. Abingdon: Routledge, pp. 462–478.

For guidance on citations see FAQs.

© 2017 M. R. McGuire and Thomas J. Holt

https://creativecommons.org/licenses/by-nc-nd/4.0/

Version: Accepted Manuscript

Link(s) to article on publisher's website:
http://dx.doi.org/doi:10.4324/9781315743981-28
https://www.routledge.com/The-Routledge-Handbook-of-Technology-Crime-and-Justice/McGuire-Holt/p/book/9781138820135

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data policy on reuse of materials please consult the policies page.

oro.open.ac.uk

Chapter 27

How might cognitive neuroscience affect the criminal justice system?

Introduction

The aim of this chapter is to consider how our developing knowledge of cognitive neuroscience and its associated technologies may impact upon the criminal justice system. This chapter examines the claims that modern understandings of how the brain drives behaviour, based on new insights from cognitive neuroscience and neurobiology, will challenge certain tenets of the criminal law and the criminal justice system. In doing this it will be useful to examine the work of academic researchers who have been actively carrying out funded research in this area. This will assist in the process of scoping how future advances in our scientific understanding of the brain may challenge the criminal law. Additionally, it will be useful to assess the activities of learned societies and governmental bodies in reviewing the area. This will aid an understanding of how to evaluate the way in which academic and government funded research in the area of neuroscience and neurotechnology may impact upon and influence future developments in the criminal justice system.

For those readers who have not encountered this area of law before, it might be helpful to reprise some of the claims that have been made by academics regarding the impact of new cognitive neuroscientific understandings upon the law, and the criminal justice system. The introduction here will be necessarily brief but the analysis will continue throughout the article as areas of particular significance to future developments in the criminal legal system are examined.

A good place to start this review is with the work of Stephen Morse, an American legal academic who is well known for making the argument that criminal law presupposes and accepts a 'folk psychological' view of human behaviour. Morse explains what this folk psychological approach entails, and how it differs from a more determinist scientific explanation of behaviour. Folk psychology considers "mental states" as "fundamental to a full causal explanation and understanding of human action." (2011:25) Part of the argument Morse makes against the adoption of neuroscientific understandings of human behaviour is that the normative requirements of law presuppose a conscious actor who "forms and acts on intentions". From this standpoint more behaviourist explanations of how behaviour results from brain states will not assist the courts. Whilst Morse accepts that it is the brain that generates these experiences, the basic argument Morse makes is straightforward: "The law treats people generally as intentional creatures and not simply mechanistic forces of nature." (2011:25) This for Morse is one of the driving justifications for his call for "neuromodesty". For Morse law is normative and many of its norms are folk psychological in form. Morse argues forcefully that this should lead us to treat claims that advances in cognitive neuroscience will challenge the criminal law with scepticism. Morse's arguments are aimed at the structure and function of the criminal law, particularly Anglo-American criminal law. Additionally, he argues that nothing that neuroscience has produced by way of empirical research, so far, provides a challenge for the law. So his comments may be viewed as related to the structure and function of the law and what should be argued in court rather than broader issues in the criminal justice system concerning when interventions should be made prior to a criminal act taking place.

A slightly different view is expressed by Goodenough and Prehin who make the argument that cognitive neuroscience may add a depth to our understanding of how and why we hold people to blame for their criminal actions. They also point out that in order to gain some understanding of the relationship between brain and blame the scope of the interdisciplinary exercise is daunting to the lawyer. The disciplines such work encompasses are diverse. Goodenough and Prehin also suggest, that at the very least, some understanding of the work of cognitive neuroscience, psychology, philosophy, evolutionary biology, psychology and psychiatry is required (2006:78). The focus of part of their discussion is upon the dichotomy posed by "distinguishing between the reason based dictates of law and an intuition based sense of justice." (2006:80) They argue that advances in cognitive neuroscience will allow us "to reconsider our theories of normative judgment and apply new tools to its study." (2006:84)

This approach clearly differs from that of Morse. It does not deny that legal judgments are normative but rather suggests that as we learn more about behavioural aspects of actions we may amend our present normative approaches to blaming people for their actions. Neuroscientists tend to take an altogether different approach. Many would argue that the focus of their scientific work has nothing to do with issues of responsibility. They would argue that the nature of the relationship between action and blaming is one for moral philosophers, not for scientists. Colin Blakemore writing in 1988, about the issue of whether individuals have free will, suggested that the problem came with trying to mix "the judicial system with medical science". He identified that problem as being one of language, arguing that science has no place for the distinction of right from wrong, giving the following example:

> No one would try to assign *responsibility* for the fact that the earth orbits the sun. Nor is it the job of science to decide whether people are responsible for their actions that society judges to be wrong. (1998:270)[1]

This is a moot point. The responsibility for reaching judgment in a criminal case clearly rests with the court. However, accepting Blakemore's words at face value, if the scientist is a determinist, the meaning to him of the evidence that he gives may well be at variance from the meaning attributed to what he says by all non-scientifically trained people in the court room. A scientist might hold the straightforward view expressed succinctly by Colin Blakemore that:

> All our actions are products of the activity of our brains. It seems to me to make no sense (in scientific terms) to try to distinguish sharply between acts that result from conscious intention and those that are pure reflexes or that are caused by disease or damage to the brain. We *feel* ourselves, usually, to be in control of our actions, but that feeling itself is the product of the brain, whose machinery has been designed, on the basis of its functional utility, by means of natural selection. (1998:270)

This is indeed a different language from the folk psychological explanation described by Morse. The challenge for the law, if scientists wish to express their views about actions is that it is likely that scientists will be speaking a different language from the rest of the courtroom. If an expert was really talking a totally different language, Spanish, German or

[1] Emphasis in original

French, then the court would expect some sort of translation to take place. An understanding of the language used by expert witnesses would facilitate an evaluation of the blameworthiness of the accused's actions. Judges are not scientists and the prosecution and defence, whilst they and the expert owe their first duty to the court to achieve a just outcome, may not be able to convey the real meaning of the science to the jury. It seems therefore, that at least at a minimal level, a shared understanding of some of the evaluative scientific criteria will be required. How this is to be achieved whilst retaining objective neutrality is an interesting point.

These comments concern the use of neuroscientific findings in relation to individual actions, but neuroscientific understanding and empirical evidence may also be used to inform policy formation in the area of criminal justice. For example, when planning interventions to prevent anti-social behaviour, in working out how to assess racial bias of key personnel in the system, and measuring predispositions to violent criminal acts.[2] Interventions may take place to avoid an individual entering the criminal justice system or to prevent an individual from reoffending. Moral questions as to the rightness or wrongness of the intervention need to be addressed at the point of policy formation. A clear understanding of the scientific basis for making the intervention will be required by those advocating its use. Particularly, where the intervention might be based on more speculative neurocognitive experimental designs. Some claims made by neuroscientists, as previously identified by Stephen Morse, do seem to embody neuro-exuberance. An example of this is the claims made by researchers at North West University to be able to retrieve concealed memories from terrorist suspects using the P300 signal identified by the use of electrode technology.[3] The technology is based on EEG and the claim is that the signal reveals concealed knowledge.[4]

How can folk psychological understandings comprehend claims for technologies that appear to read minds? Particularly when faced with claims which "over-hype the potential of such technologies. Often this overselling results from the most positive gloss being placed upon research findings; added to this there is the commonplace method of press reporting that presents stories in a manner that grabs public attention.[5] This means that speculative ideas drawn from research by cognitive neuroscience, behavioural geneticists and neurocriminologists are often presented to the public as having an accepted basis in science; and therefore may directly enter the "folk psychology" belief systems held by jurors and indeed other actors within the system. The permeability of folk psychology to influence by scientific speculation or tides of national sentiment makes it a problematic barometer of right and wrong. This is not to dispute that the jury will make its decisions against the background of the prevailing perceptions of the society in which the judgment takes place as to what is

[2] For examples of interventions which have been researched using empirical data drawn from many scientific studies including those of cognitive neuroscientists and geneticists see Farrington et al (2003)

[3] http://neurosciencenews.com/reading-terrorists-p300-brain-waves-attacks/ accessed 10/3/2016 the arguments concerning retrieved memories will be considered later in the chapter.

[4] For further information about the test see Rosenfeld (2011)

[5] Not that this is new, harsh criticism has been made of the tendency of the press to fail to present information in an objective and measured way since newspapers first appeared. This is particularly the case in terms of the reporting of political issues: "What the proprietorship of these papers is aiming at is power, and ***power without responsibility – the prerogative of the harlot throughout the ages.***" Stanley Baldwin, Prime Minister, 17/3/1931 speech given 3 days before the general election was to be held. Though responsible reporting does take place through academic journals the worry is the level of reporting in mass circulation papers. See for example http://www.dailymail.co.uk/sciencetech/article-3433491/How-anger-changes-BRAIN-Aggression-causes-new-nerve-cells-grow-trigger-rage-future.html accessed on 10/3/2016. The article does not suggest that the experiment actually reveals anything about human behaviour but the omission of a discussion concerning the transferability of information from experiments on a particular mammal to other mammals is noteworthy.

right or wrong. It is to make a further assertion, that is that those giving and hearing evidence in court therefore bear a heavy responsibility. The responsibility is to make sure that the translation of the ideas of science into words that the court can understand is able to inform the jury's decision about guilt and innocence, in a meaningful and appropriate manner, in addition to being both an accurate and objective description of the scientific findings.

Novel technologies and how they might be applied

It would be useful prior to undertaking this review to look at a general definition of cognitive neuroscience and give a brief explanation of the associated technologies. Cognitive neuroscience is described by Goodenough (2006: 84) as:

> "an approach that seeks to integrate into the study of human thought, our rapidly emerging knowledge about the structure and function of the brain, and about the formal properties of agents and decision making processes … Although cognitive neuroscience was well launched before the advance of such imaging technologies as PET and fMRI, the availability of non-intrusive methods that allow us to establish functional connections between mental tasks and specific anatomical structures has increased its power and accelerated its application."

In 2011 The Royal Society published the first of its policy documents on neuroscience, society and policy.[6] The document assessed different types of neuroimaging and reviews the use of the technology to date. Reviewing these non-invasive ways of looking at the brain the review ranges from technologies such as computer tomography (CT) scans which uses x-ray technology to look at the structure of the brain to magnetic resonance imaging (MRI). MRI is described as the most common form of neuroimaging, having the advantage that it permits greater understanding of the anatomical structure of the brain. Diffusion-weighted MRI is described as enabling scientists to "visualise" connections within the brain.[7] Functional magnetic resonance imaging (fMRI) commonly measures blood oxygenation levels in the brain to look for evidence of functional activity. It is described as an "indirect measure of neural activity, through the effect of changes in neural activity on local blood flow in the brain."[8] The techniques limitations are noted in that its temporal resolution is slow and therefore it does not accurately capture rapid changes in brain activity.[9]

Additional techniques that are relevant are electroencephalography (EEG) and magnetoencephalography (MEG) which are not viewed as neuroimaging techniques, but are relevant techniques to this discussion. These technologies measure brain activity by using electrodes placed on the scalp. They differ from the other techniques in directly measuring, at the level of the scalp, neuronal activity. All the techniques described briefly here have shortcomings in terms of what they reveal about the activity within the brain. MRI is said to be the best technique for gaining structural information, fMRI for spatial resolution but having real limitations in terms of assessing when precisely the activity noted occurred. Positron emission tomography (PET) is seen as limited because it needs to be used with a radioactive tracer molecule. This is expensive and the technique is said to be inflexible, there being a limit to the number of scans that may be taken. MEG and EEG are seen also as having poor spatial resolution as the signals transmitted are "altered by the scalp and

[6] (The Royal Society 2011a)
[7] Ibid, 8
[8] Ibid, 9
[9] Ibid These types of rapid changes are said to be "associated with perception, thought and action."

tissues."[10] However, whilst criticisms can be made of aspects of each of these technologies, collectively they have provided scientists with the tools to develop a far greater understanding of the workings of the human brain.

In the courtroom

It is generally accepted that there is a problem with applying empirical data obtained from specific, group level, research findings to the individual in the criminal court room.[11] The problem revolves around a number of issues which are not dissimilar to the application of other scientific findings in the courtroom. Criticisms include: applying findings based on the averaging of research data obtained from many individuals to a single individual and the transferability and relevance of applying conclusions about human behaviour based on such data to the accused individual. There is a further difficulty in precisely identify the behaviour that the experiment was measuring and the relevance and applicability of the experimental results to the individual criminal action being assessed. There are also disputes regarding how the measurements are obtained and the accuracy of the measurement. However, such problems are not new to the courts. There is a robust form of control regarding the admission of evidence in England and Wales.[12]

Nor are these disputes confined to neuroscience, similar arguments are made about the reliability of assessing predispositions utilising genetic data. Nita Farahany and James Coleman makes the point well when writing about the use of scientific evidence by those accused of a crime in court in the USA:

> Although the science is at early stages of discovery, and scientists quarrel over basic methodology and the definitions and the metrics for measuring behavior, criminal law has already seized upon behavioral genetics and neuroscience evidence for a variety of purposes: as exculpatory evidence, to bolster preexisting legal defences, and as mitigating evidence during sentencing. As these fields progress and gain credibility, scientific results demonstrating a genetic or neurological contribution to behavioral differences in violence aggression, hyperactivity, impulsivity, drug and alcohol abuse, anti-social personality disorder, and other related traits will continue to be introduced into the criminal law.[13] (2009:183)

In court the best evidence will normally be the accepted scientific position. In developing areas of science, the best available evidence may not yet be received scientific opinion. However, if the accuracy of the science is sufficient to put before the jury, even if it is not

[10] Ibid14

[11] See discussion of this issue in the Royal Society (2011b: 2.4.3) see also Spranger, (2012:1-5)

[12] The rules for the admission of expert evidence into criminal courts are set out in the Criminal Practice Directions. At the times of writing the controls are stringent in requiring an assessment of the validity of the evidence. See for example the rules with regard to the content of the experts report which require, inter alia, details of expert's qualifications, statements of facts relied on, name and qualifications of person carrying out any tests referred to, summary of findings, reasons for the selection of opinions and any other information required for the court to make a decision with regard to admitting evidence. These include the limits of the expert's knowledge, and a summary of other expert opinion on the topic area where there are differing opinions regarding the evidence given. Details of any research literature relied upon in reaching an opinion must be included. Proof of expertise has to be established and the overriding objective is said to be objective and unbiased evidence. The duty of the expert is to the court. A declaration of truth is made by the expert witness.

totally validated by the scientific community, then the judge will have to consider its probative value to the jury.

Nita Farahany has carried out empirical research into the use of such evidence in the American courtroom by those accused of criminal offences.[14] This research has been mirrored in four other jurisdictions utilising the same search terms to research different national law databases: The Netherlands (de Kogel and Westgeest 2015), England and Wales[15] (Catley and Claydon 2015), Canada (Chandler 2015) and Singapore.[16] The English data is based on reported cases, these are largely appeal decisions and so may not reflect fully the use and extent of neuroscientific evidence in the criminal courtroom by those accused of crime. Case reporting tends to cover those cases where an important novel legal issue has been the subject of appeal following conviction. Over 70% of English cases, where someone is accused of a crime are resolved by a guilty plea.[17] Therefore, any snapshot seen in the case reports will only hint at the use of neuroscientific or genetic evidence by prosecution or defence. Nonetheless the research confirms that evidence from cognitive neuroscience is used in criminal trials in England by those accused of crime.

Using evidence based on cognitive neuroscience is likely to be expensive. In her article reviewing the area in the USA Nita Farahany suggests that wealthy defendants or those able to secure state funding or pro bono services are more likely to be able to introduce neurobiological evidence. (2015: 491)

Katie de Kogel notes a different issue in the Netherlands: -

> An issue in the Netherlands is that the pool of experts who report to the criminal courts about neuroscientific information is rather small. For instance, in the majority of cases in which neurological information was reported in relation to aggressive behavior, the same ‘behavioral neurologist was consulted. For the growth of expertise in this area, it is important to have more professionals. (2015: 602)

In England the courts admitted neuroscientific evidence for a wide number of reasons. On occasion the evidence was admitted in sentencing decisions and here there was a tendency for the information to operate as a double edged sword. This was also found to be the case in the Canadian research Jennifer Chandler writes:

> “The majority of the cases are sentencing decisions, which is useful given that it offers an opportunity to observe how judges wrestle with the tension at the heart of the justifications of punishment in the criminal law. Neuroscientific evidence

[14] Considering the problem of carrying out such research Farahany writes:

> Moreover, more than 90 per cent of criminal cases in the United States never go to trial. Most individuals who are charged with a crime forego their constitutional right to a trial and plead guilty in exchange for a plea agreement. Of those cases that do go to trial, while many are appealed, many more are not. Of cases that are appealed, there are narrow legal grounds available for overturning a conviction or setting aside a sentence and procedurally the cases must be raised in that manner. Moreover, investigation into neurobiological contributions to criminal behavior can be costly. In cases where the defendant has adequate resources, or able to secure resources from the state, or as pro bono services, they are more likely to be able to introduce neurobiological evidence. This may skew the kind of criminal defendants who raise claims rooted in neurobiology.” (2015:491)

[15] Hereinafter referred to as the law of England.

[16] This research was carried by Calvin Ho of the National University of Singapore

[17] Figure extracted from the Crown Prosecution Annual Report and Accounts 2014-15 HC20, Appendix D

> suggesting diminished capacity tends to reduce moral blameworthiness - a factor central to the retributive philosophy underpinning the requirement of proportionality between the degree of wrongdoing and the punishment - and yet it also tends to increase judgements about risk and dangerousness, given the view (expressed often in the cases reviewed here) that brain injuries can sometimes be managed but not cured. This makes neuroscientific evidence a 'double-edged sword' from the offender's perspective." (2015: 574)

The research in five jurisdictions suggests that where a defendant is well resourced they may be able to present defences based on neuroscientific evidence in court.

This research examines the present use of neuroscience by the accused in the criminal courts, but the purpose of this book chapter is to assess how neurotechnologies may be used more generally by the criminal justice system in the future. From time to time speculative pieces on this subject appear in the media. The Guardian in January 2016 featured an article entitled: *Can a brain scan uncover your morals?* The article reports the use of brain scans in cases heard by the American courts over a number of years. All the cases covered were high profile and included the case of John Hinckley who tried to assassinate Ronald Reagan. The focus of the article is the use of brain scans, rather than other evidence from cognitive neuroscience, but its conclusion, if accurate, is interesting. It reports that "the federal government is pumping millions of dollars into fMRI research on mental diagnoses, partly in anticipation of the judicial system benefitting from it."[18]

There is a further interesting assumption made at the end of the article in terms of the folk psychological view of neuroscience. The journalist writes:

> Everyone who has a stake in the science is hoping the scans will someday provide an unbiased truth. But there is a systematic problem because the law needs finality, while the science relies on continued research. And for now, there is no way to see intention in the scans – there is no record of the crime, of innocence, of morality, of honesty. Behavioural scans are as objective as their interpreters.

The comment could be read as suggesting that one day the scans will see the things that are now absent. This is extremely unlikely. The law would indeed be in trouble, if it were to become accepted folk psychology that brain scans could look back and see the intentions of the accused at the time of a crime. Rather than viewing folk psychology as the prevailing and accepted belief, perhaps folk psychology needs challenging as firmly as the view that brain scans will be able to identify our intentions. Arguably, the suggested focus of discussions about the value of cognitive neuroscience should be on what we use evidence for, what it establishes and how probative the expert evidence regarding the factual issues might be to assist in the determination of guilt or innocence. This could simply mean asking how relevant the evidence is to the individual case. It is apparent that there is little mileage in arguing neuroscientific research is of no use when it is used in many jurisdictions.[19]

The corollary to this finding is that key actors in the justice systems need to be trained about the relative strengths and weaknesses of the neuroscientific evidence. Additionally, there is a strong need to explain to juries where the folk psychological view of causes of criminal acts

[18] https://www.theguardian.com/science/2016/jan/17/can-a-brain-scan-uncover-your-morals

[19] (Spranger 2012)

is inaccurate or misleading. This will be of particular importance where this understanding directly feeds into the assessment they make of guilt and innocence. This may mean that the prosecution or defence might have to consider leading evidence to rebut the identified notions that folk psychology holds concerning how people are caused to act. The scope of this article is insufficient to consider what the whole ramifications of this might be, it is not suggested that the societal view that people are responsible for their actions be abandoned. But is this what really would have to happen? Many cognitive neuroscientists would argue that we need to hold people responsible for their actions if society is to protect itself from truly problematic and dangerous individuals. The question is whether our present explanatory structures of causality, and criminal responsibility function adequately in the courtroom in the light of advances in neuroscience and neurotechnologies.[20]

The work of the Presidential Commission *for the* Study of Bioethical Issues will be discussed later in the chapter. It is worth noting here that the view the commission took was that whilst neuroscience was unlikely to provide a determinative explanation of why a particular individual committed a crime, there was significant likelihood that politicians would use science including neuroscience to advocate policy agendas. (2015: 101)

In the criminal justice system

Raine argues that science and neurosciences may influence investments made by states in the resources employed to solve problems in the criminal justice system. In *The Anatomy of Violence: The Biological Roots of Crime*; 3 Raine advocates the argument, based in neurocriminological research, that biology can predispose individuals to violent behaviour. The natural corollary of this argument is, he suggests, that were we able to identify the most problematic individuals in our midst then society could take measures which could make it a safer place in which to live and work.[21] The book is intended to provoke discussion as to how societies should deal with such an assertion.

Raine's argument, is that modern science makes it possible to envisage a society which would intervene early in the criminal career of an individual. In some cases, possibly even before that career had begun. He points out that some sections of society and indeed politicians might think that this outcome would be better for all. Raine emphasises the fact that, in such a future, the outcome for some would be worse than it is at present. The basis of the argument is that if you start from the point that a few dangerous people cause a disproportionate amount of harm to other people, it is possible to progress to a view that something should be done about those people.[22] Raine envisages a future where a government following on from a violent incident where scores of people are killed, in response to public clamour for better protection, sets up a project to identify those who are a real threat to society.[23]

He names the project, LOMBROSO[24], he speculates that the state of scientific knowledge and the availability of other relevant scientific data would allow the project to commence in

[20] For a thoughtful review of this area see (Moore 2009)
[21] See particularly chapter 11, The Future.
[22] Raine considers the introduction of Imprisonment for Public Protection (IPP) by the Blair government in the UK in 2003 as an example of this trend. (Raine 2014:353)
[23] Ibid 342
[24] The choice of name is drawn from Cesare Lombroso who believed that you could identify criminals from certain physical traits. He published L'uomo delinquitte in 1876.

the 2030's. The aim of the project, as Raine envisages it, is to assess with accuracy the risk posed to the public by particular individuals. He suggests that in the 2030's it will be possible by testing all males over eighteen, for five variable factors and setting this against DNA and other relevant environmental and background information, to assess with accuracy the risk they pose to the public.[25] Raine argues that it is the ability to access big data sets and apply effective algorithms to make group data relevant to the individual that enables this to be a possible outcome. "The computerization of all medical, school, psychological, census and neighborhood data makes it easy to combine these traditional risk variables alongside the vast amount of DNA and brain data to form an all-encompassing biosocial data set."[26] From this Raine suggests that you could identify those men who had a 79% chance of committing a violent crime in the next five years. You could also identify a group who were "Lombroso Positive – Homicide" who would have a 51% chance of killing someone in the next five years, and another group "Lombroso Positive – Sex" who would have an 82% chance of committing either rape or a paedophilic offence.[27] Raine argues that were a society sufficiently outraged by a violent event, then the temptation to identify such people and commit them to indefinite detention might be too strong for politicians to resist.

He points to the fact that projects which are similar in terms of their outcomes to LOMBROSO have been "alive and well for years in countries like England"[28] An example of this is considered in a review of the "convergence of mental health and criminal justice systems policy, legislation, systems and practice." Entitled Blurring the Boundaries, the report published by the Sainsbury's centre reviews the present provisions for "Potentially Dangerous Persons" comments in looking at policy on present treatment of potentially dangerous criminal offenders that "the model is one that could be replicated (under appropriate ethical and clinical scrutiny) to those with chaotic lives, and multiple needs, who are not formally involved in the criminal justice system".[29] This comment relates to the treatment of those who have not yet committed criminal offences but whose life style and behaviours are identifiable as posing a risk to the society within which they live. The point made by Raine is that policy makers have to consider how to diminish the risk to the health and happiness of the rest of society and to decide whether compulsory treatment or incarceration is necessary. His focus is on what would happen if the evidence were to become far more compelling in its predictive efficacy which he sees as likely to occur within the next 20 years.

This leads him to conclude that societies have to reach a view as to what type of future they wish to have. In his view all sectors of society need to be thoroughly engaged in the debate. Raine is not just a popular writer, he is an academic neurocriminologist based at the University of Pennsylvania. He has a critical perspective on how politicians may react to public outcry: pointing out that they may continue to "overreact" to "quell the public outcry and try to solve society's problems."[30]

---

[25] The tests include: "a quick brain scan, and DNA testing. Then a five-minute brain scan for the "Fundamental Five Functions": First, a structural scan provides the brains anatomy. Second, a functional scan shows resting brain activity. Third, enhanced diffusion-tensor imaging is taken is taken to assess the integrity of the white-fibre system in the brain, assessing intricate brain connectivity. Fourth is a reading of the brain's neurochemistry that has been developed from magnetic resonance spectroscopy. Fifth and finally, the cellular functional scan assesses expression of 23,000 genes at the cellular level. (Raine 2014: 342)

[26] Ibid

[27] Ibid 343

[28] Ibid 254

[29] (Rutherford 2010:70)

[30] (Raine 2014: 357)

All of this academic speculation by Raine does not lead to the view that we should abandon cognitive neurobiological research, or argue that reviewing the evidence has no place in law. The truth, he argues, is that these concerns deserve much greater prominence. An informed debate needs to take place about the nature of risk and the responsibility of society towards its individual members. The debate is not an easy one to have and it requires considering some fairly unpalatable truths. What Raine wishes to engender by his imagined LOMBROSO project - whilst it would incarcerate men who did not pose a real risk - would probably not be racially biased. But Raine is also cautious about trusting politicians to use such tools: "Let's face it, elements are already in place right now. The prison in Guantánamo Bay is just one such example of how indefinite detention is being used by countries throughout the world in the name of national security."[31]

Researching the intersection of law and neuroscience

One way of scoping likely future developments that may influence the interrelationship between law and neuroscience is to look at where interdisciplinary work is taking place, the aims of the research and the reported outcomes. It will also be useful to look at the work of politically influential groups. Two influential reports have appeared scoping this area, one produced in England by The Royal Society and the other in the United States by the Presidential Commission for the Study of Bioethical Issues.

Learned Societies and policy development

The Royal Society

In 2011 the Royal Society set up a working group to report on the policy implications of developments in neuroscience which could impact upon the law. The group was tasked inter alia to:

- provide an introduction to the questions raised around the intersection of neuroscience and the law, and the link between the brain, mind states and behaviour
- provide an assessment of how neurotechnologies might be able now, or in the future, to contribute to the quality of decision making in legal proceedings.[32]

The areas that are of particular relevance to criminal responsibility that were identified as worthy of review were risk, developmental maturity, and memory, including the reliability of witness testimony. The report sounds the expected note of caution about the extrapolation of insights from neuroscience via scientific descriptions of mental processes into estimations of individual responsibility. The report took a necessarily broad view of areas of neuroscience that would be of interest to the criminal justice system. The report the working party included some discussion of behavioural genetics and neuropsychology. Identifying mental activity "such as thinking, feeling, sensing, attention, memory and consciousness"[33] as areas of relevance to the criminal law.

[31] Ibid 351-2
[32] (The Royal Society 2011b:2)
[33] Ibid 1

Overall the strong conclusion of the report was that neuroscientific understanding of the brain and human behaviour was developing. However, it noted the gap in understanding between the work of neuroscientists and "the day to day realities of the justice system"[34] as being an area of concern. The report recommended the creation of a forum where the two parties could have a fruitful exchange of ideas. Such a forum was seen as existing in other countries, particularly the United States, where the working group noted the work of the MacArthur Foundation and the work of the National Academy of Sciences in bringing neuroscientists and lawyers together. It was argued that both scientists and lawyers would benefit at undergraduate level in receiving some training in the other discipline.[35] Finally it was felt that the criminal justice system would benefit from further research into risk assessment. The ESRC was asked to consider providing funding to support neuroscientific research in this area to evaluate the "relative efficacy of various models of risk assessment in the context of probation."[36]

Gray Matters

The Presidential Commission for the Study of Bioethical Issues has produced two reports entitled *Gray Matters* concerning neuroscience, ethics and society. The first report looked at Integrative Approaches for Neuroscience, Ethics and Society;[37] the second at Topics at the Intersection of Neuroscience, Ethics and Society.[38] The second report devotes a complete chapter to the consideration of "Neuroscience and the Legal System."[39] The chapter starts with an assertion that "the brains of criminals have captured the public's imagination for centuries."[40] Then a clear statement is made regarding the usefulness of neuroscience to improving policymaking. The areas of use include "increased accuracy and decreased errors in advancing justice", which appear to be two sides of the same coin. The areas of concern identified are "scientific reliability, misapplication and overreliance on developing science", areas about which the Royal Society also had concerns. *Gray Matters* reiterates the importance of thinking about the ethical implications of growing neuroscientific knowledge and the power of prediction. Particularly concern is expressed about the effect that greater neuroscientific knowledge will have on "conceptions of free will, mental privacy and personal liberty."[41]

The report notes the relevance of neuroscience to the legal system.[42] It conjectures that the science may be at its most effective at the policy level. Interestingly the report states the neuroscience "may guide normative assessments" in the legal arena. Though it robustly states

[34] Ibid 30
[35] Ibid 31
[36] Ibid
[37] http://bioethics.gov/node/3543 accessed 11/3/2016
[38] http://bioethics.gov/node/3543 accessed 11/3/2016
[39] Gray Matters vol 2, Chapter 4
[40] Ibid, 86
[41] Ibid
[42] Neuroscience has a variety of potential applications to the legal system and already is employed in many relevant contexts, including increasingly in criminal law … Prosecutors and defense attorneys use neuroscience evidence in criminal proceedings to support propositions concerning, for example, competency to stand trial, mitigation of criminal responsibility, and predicting future dangerousness. Parties also use neuroscience evidence in the civil context to provide objective evidence of "invisible" injuries, such as toxic exposure, pain, and suffering. Policymakers have invoked neuroscience to advocate for legislation and reform; scholars have advocated using neuroscience to address biases in legal decision making; and even some commercial entities have introduced novel uses of neuroscience for investigative purposes. Ibid 86-7

that it must not solely define them.[43] The report makes some clear assertions about the potential value of neuroscience to the criminal justice system:

> "Neuroscience has the potential to advance justice by increasing accuracy in legal decision making and policy development. A deeper understanding of the human brain, cognition, and behavior on both individual and societal levels might help tailor policies and sentences, determine guilt and innocence, evaluate blameworthiness, and predict future behavior. For example, evidence of brain abnormalities might help determine whether a criminal defendant is competent to stand trial. Neuroscience evidence might contribute to a jury's determination of guilt or innocence, by helping jurors understand a defendant's mental state, intent, or voluntariness of action. A deeper understanding of the development and capacity of the adolescent brain might help formulate policies about the sentences that young adults and adolescents should receive. Neuroscientific techniques like brain imaging might help detect juror bias or determine the reliability of eyewitness testimony. Overall, neuroscience might contribute to more accurate decision making and fairer outcomes. Justice requires that we use empirical evidence, including neuroscience, to strengthen the decisions made in these central civic and political realms."[44]

One of the conclusions of the report which does also urge caution about neuro-exuberance is that more research is required and it looks to funders like the National Academies of Science, U.S Department of Justice, and the Social Security Administration to support further research. The focus of the research it suggests should be the use of neuroscience in legal decision making and policy development.[45] One foundation that has consistently supported and indeed driven academic research in this area is the MacArthur Foundation.

Funded Research

MacArthur Foundation

The MacArthur Foundation has greatly supported the researching of the interface between neuroscience and law. In the USA the Foundation has invested a considerable amount of money in the interdisciplinary study of areas of mutual interest to scientists and criminal lawyers. MacArthur at the point when this article was written in 2016 had already invested $7,600,000 into funding interdisciplinary study in this area. At present MacArthur highlights three areas as being of importance to assist in developing the knowledge base in the area of neuroscience and criminal justice.

> 1) investigating law-relevant mental states of, and decision-making processes in, defendants, witnesses, jurors, and judges; 2) investigating in adolescents the relationship between brain development and cognitive capacities; and 3) assessing how best to draw inferences about individuals from group-based neuroscientific data.[46]

[43] Ibid 88
[44] Ibid 88-9
[45] Ibid 112
[46] http://www.lawneuro.org/ accessed 11/3/2016

Thus its concerns focus on similar areas to those already discussed. The chapter has already considered how big data might be utilised in examining the work of Adrian Raine. Additionally, it is worth considering the influence of an organisation which spends considerable sums of money funding the work of cognitive neuroscientists.

DARPA

All this funding for academic research in the United States of America pales into insignificance when compared to the spending in this area of the Defence Advanced Research Projects Agency (DARPA). This agency in 2014 invested $50,000,000 into the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative in the USA.[47] One of the projects for which it announced funding is highly ambitious. The project will cost millions of dollars and aims to repair memory loss in those who have suffered traumatic brain injury. The project is shared between University of Pennsylvania and University of California Los Angeles The aim of the project is to build a direct brain recording device. The University of California in its announcement says it will receive funding of $15,000,000 for its part of the research.[48]

Information on the DARPA website about the research programme, which it calls RAM contains the following statement:

> "In addition to human clinical efforts, RAM will support animal studies to advance the state-of-the-art of quantitative models that account for the encoding and retrieval of complex memories and memory attributes, including their hierarchical associations with one another. This work will also seek to identify any characteristic neural and behavioral correlates of memories facilitated by therapeutic devices."[49]

This is just one of the programmes which DARPA is funding that will enable a greater understanding of the function of brain areas.

The laudable declared aim of RAM is to help restore memory loss in those who have suffered traumatic brain injury. This is not the application of research into memory that tends to worry lawyers or raise concerns about mental privacy. These concerns arise when the research understanding obtained by neuroscientists is applied to investigating the contents of human

---

[47] The Office of the Press Secretary The White House 2/04/2013 FACT SHEET The Brain Initiave, https://www.whitehouse.gov/the-press-office/2013/04/02/fact-sheet-brain-intiative accessed on20/2/2016

[48] "The UCLA Henry Samueli School of Engineering and Applied Science has been tapped by the Defense Advanced Research Projects Agency to play a key role in an innovative project aimed at developing a wireless, implantable brain device that could help restore lost memory function in individuals who have suffered debilitating brain injuries and other disorders." http://engineering.ucla.edu/ucla-engineering-plays-key-role-in-darpa-neuroprosthesis-research/ accessed on 11/3/2016

[49] This explanation is preceded by further explanation of the research "The end goal of RAM is to develop and test a wireless, fully implantable neural-interface medical device for human clinical use, but a number of significant advances will be targeted on the way to achieving that goal. To start, DARPA will support the development of multi-scale computational models with high spatial and temporal resolution that describe how neurons code declarative memories—those well-defined parcels of knowledge that can be consciously recalled and described in words, such as events, times, and places. Researchers will also explore new methods for analysis and decoding of neural signals to understand how targeted stimulation might be applied to help the brain reestablish an ability to encode new memories following brain injury. "Encoding" refers to the process by which newly learned information is attended to and processed by the brain when first encountered." http://www.darpa.mil/program/restoring-active-memory accessed on 12/3/2016

memory. Particularly where the investigation is of the memory of someone accused or suspected of a crime.

Memory tests – finding the truth?

Memory is key to our human identity.[50] Through memory we lay down the autobiography of our life. This helps us to understand who we are and how we interact with the world. Loss of memory as is the case with some forms of severe brain injury, or Alzheimer's, may lead to a loss of a sense of personal identity. Memory of events therefore is personal and generally people do not share intimate memories with anyone but their closest family and friends.

Memory of events has historically been viewed in a similar fashion by the law. This is particularly true when the content of that memory could incriminate an individual. The boundary between the state and the individual was marked by the understanding that the individual should be assumed innocent until proven guilty and the prosecution carried the burden of proving guilt beyond reasonable doubt. The accused was not required to prove his innocence.[51] Thus in England and the United States the right not incriminate oneself has long been enshrined in law.[52] In England, in the late 20th Century, that right to silence was limited by statute but an accused can still not be compelled to give evidence. An individual suspected of a criminal offence will be advised that he has the right to remain silent but if he does so adverse inferences may be drawn from his silence.[53]

Claims are made by those who are experienced in the use of lie detection technology that it is possible to detect when someone is not telling the truth. Indeed, in terms of one of the older forms of lie detection, using polygraph technology, then the technology in routinely used in England to assess the risk to the community of convicted sex offenders released on licence.[54] This belief in a technology which has been shown to be flawed is concerning.

The effect of the use of evidence from lie detection tests, to assess risk in the released sex offender population is covered in an article in the Guardian. Where the technology is seen as yielding results supporting the accused's innocence, there is some evidence that it has been used by defence lawyers. The investigative journalist also reports the use of a lie detection test, on behalf of a client, to avoid the client being charged with a sex offence. Quoting a barrister and solicitor as believing that the tests were effective in persuading the police to drop the charge.

> a solicitor of Litigaid Law in Southport, who was formerly a police detective in London and Merseyside, and Mark Tomassi, a barrister, said: "My client said the sex had been consensual. He passed a lie detector test with flying colours. In the end he was never charged" … A person suspected of sexual crime could and should be offered the opportunity to take a lie detector test … If such a test is sufficiently

[50] For a thorough introduction to the importance of memory to the construction of our individual identity see (Rose 2003)
[51] In England these rights are poetically described as "the golden thread" that runs through the criminal law see *Woolmington v DPP* [1935] AC 462
[52] For example, The United States Constitution 5th Amendment
[53] In England the right is qualified by s34 of the Criminal Justice and Public Order Act 1994, the accused is advised of his right to silence but also warned that adverse inferences may be drawn from his silence if he fails to reveal something when questioned that he later relies on in court.
[54] https://www.gov.uk/government/news/compulsary-lie-detector-tests-for-serious-sex-offenders accessed 11/3/2016. Gives information about the use of the technology.

> reliable to protect the public from future offences from those already found by the courts to be guilty, it is but a modest proposal to allow an innocent person at least a chance of persuading a prosecutor to think again.[55]

Concealed information testing.

Scientists at present are working on identifying with the use of electrode technology the content of memories. This could be used to identify for example whether the accused had a memory of a place that he denied ever having visited. Clearly this would be useful to investigators who were trying to establish whether this accused had visited a particular location. The distinction is made by comparing neural patterns where the scan is taken under highly controlled circumstances: neural patterning for places that are known will differ from neural patterns when an accused is shown locations that they have not visited. However, such assessments have been shown to be flawed because of the possibility of taking counter measures which would skew the results obtained.[56] Were such applications of scan technology to improve in accuracy, or to be routinely used by the State, then clearly the issues surrounding the right to silence would need to be revisited as a matter of urgency.

Gershon Ben-Shakhar writes of lie detection technologies: One of the most serious deficiencies of CIT [Concealed Information Test] is its vulnerability to countermeasures by guilty or deceptive examinees." (2011:200) However, the converse argument that these countermeasures are detectable also needs to be weighed into the argument.[57]

Conclusion

Clearly our knowledge of the brain, how it functions and how that leads us to certain behaviours is expanding. The new knowledge generated by neurotechnology advances will and should find its way into the courtroom and will lead us to take a different view of why people act and the basis on which we hold them responsible for their actions. Ethical consideration will need to be given to the introduction of interventions in the criminal justice system. The point that Adrian Raine makes is well made – should we lock up people before they commit a criminal act? In making the question as difficult as possible for us to answer Raine asks that the reader consider the case of "Fred Hatoil". Fred is someone who suffered an abusive childhood, a "traumatic" home life, four brothers and sisters died before reaching adulthood. Repeatedly moved from house to house he performed poorly at school and left without qualifications. He became a message runner in world war one and was gassed. Following his harrowing war experience, he suffered from post-traumatic stress disorder. Like many veterans of war Raine tells us his "emotional compass was blunted." Gradually Raine builds a picture of unemployment and failed applications to art school and architecture courses. An inability to form intimate relationships and an individual who is socially dysfunctional. He poses the question if Fred is charged with murder whether the court and judge should show clemency. Raine argues that for many people the facts of the life of Fred would mean that clemency should be shown to him. In the United States clemency of course means something different from the same word in Europe. This is because 31 states still have

[55] http://www.theguardian.com/society/2014/aug/08/lie-detector-polygraph-tests-introduced-monitor-sex-offenders accessed on the 11/3/2016
[56] (Uncapher et al 2015)
[57] See (Rosenfeld et al 2008)

the death penalty.[58] In the final part of the scenario Raine reveals Fred's true identity to be that of Adolf Hitler and asks if we still wish him to avoid the death penalty.[59] Raine goes on to point out that many of the worst tyrants in history had deprived and disrupted childhoods.

This argument may make us focus on the most appropriate form of disposal for those who are at risk but it does not make us consider what the right ethical basis is for intervention in other people's lives. Those answers will only arise when the basis on which intervention, be it in the form of punishment, treatment or incapacitation is known. Whether the life experience of someone like Hitler and his mental condition at the time of his crimes should offer some excuse is an ethical question. In order to grapple with new challenges to our ethical understandings then lawyers, neuroscientists and moral philosophers need to work together. None of these groups will be able to grasp the nettle and start down the path to resolving the issue without an open and flexible exchange between all three disciplines.

Relevant to this exchange is Daniel Dennett's idea that we totally abandon the metaphysics of free will and replace metaphysics with an ethical stance which would recognise that we blame someone for their choices. It is the failure to act otherwise and avoid the crime for which society holds them responsible. He argues that the idea of choice is central. Determining when an agent "could have done otherwise" focusses on the ethical idea the "pivotal phrase *could have done otherwise*" ascribes responsibility and makes blame and punishment appropriate. He concludes that the "the fact that free will *is* worth wanting can be used to anchor our concept of free will". He concludes that "metaphysical myths" will fail to achieve this. (2003: 297)

In doing this Dennett, arguably, frees society from having to develop a deeper understanding of determinism or indeterminism in developing an ethical framework for blaming people for their actions. Societal judgment may then be determined against this background by developing firm ethical frameworks situated in shared understandings of what is or is not acceptable in terms of punishment or other intervention. This leaves the focus of what is, or is not acceptable, regarding interventions in the criminal justice system examining the efficacy and ethical appropriateness of proposed solutions against the background of the fact that society in general holds people responsible for their acts rather than their potential for criminal behaviour.

Further difficult questions will need to be resolved for example: the appropriate response to risk. More problematic is research into jury and court behaviours which suggest judge and juror's judgment may be biased. Research in this area is being carried out at present by the MacArthur foundation who are "investigating law-relevant mental states of, and decision-making processes in, defendants, witnesses, jurors, and judges".[60] Understanding such processes may provide further challenges for society. However, developing a more robust framework to ensure that these decision-making processes are as just and fair as possible can only strengthen the criminal justice system not weaken it.

What has emerged from this review of the area is an acceptance that cognitive neuroscience and neurobiology will add to the sum of knowledge of what it means to be human. This new understanding will be generated by the research enabled by advances in neurotechnologies such as neuro imaging and the growth of the ability to construct mathematical algorithms that

[58] http://www.deathpenaltyinfo.org/states-and-without-death-penalty accessed on 13/03.2006
[59] (Raine 2014: 321-22)
[60] See the section entitled Funded Research and the discussion around fn 50

will permit the interrogation of the data from neuroscientific research to be more applicable at the level of the individual actor. Despite differences and disagreements between scientists AFTas to the meaning and applicability of their findings to specific circumstances discussed earlier. It is like that the money which is being invested by governments in researching the brain means there will be a drive to convert the fruits of the research into meaningful outcomes that will show the policy impact of the Governments' spending. At present the spending on the European Union's Human Brain Project is estimated at 1.19 billion euros over ten years.[61] In the United States the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative, which was launched in 2013, to be supported jointly by state funding and private donors, has an estimated resource allocation of 200 million dollars per annum.[62] How this will feed into the criminal justice system is a matter for speculation and possibly concern. The impact is potentially wide ranging. If the evidence to date is examined through the response to the pressure to assess and blunt terrorist threats or to deal with the risk posed by convicted sex offenders, then the response of policy makers and law enforcement agencies has not always led to the most transparent responses. In this sense taking forward the academic research agenda to develop appropriate ethical frameworks is both necessary and essential.

Ben-Shakhar, G. (2011) 'Countermeasures', in Verschuere, B. Ben-Shakhar, G. and Meijer, E. (eds) *Memory Detection Theory and Application of the Concealed Information Test*, New York: Cambridge University Press.

Blakemore, C. (1988) *The Mind Machine*, London: BBC Books.

Catley, P. and Claydon, L. (2015) 'The use of neuroscientific evidence in the courtroom by those accused of criminal offenses in England and Wales', *J Law Biosci* 2(3): 510-549 doi:10.1093/jlb/lsv025.

Chandler, J.A. (2015) 'The use of neuroscientific evidence in Canadian criminal proceedings *J Law Biosci* 2(3): 550-579 doi:10.1093/jlb/lsv026.

Dennett, D.C. (2003) *Freedom Evolves* London: Penguin.

Farahany, N. (2015) 'Neuroscience and behavioral genetics in US criminal law: an empirical analysis' *J Law and Bioscis*, 2(3): 485-509 doi:10.1093/jlb/lsv059.

Farahany, N. and Coleman, J. (2009) Genetics Neuroscience and Criminal Responsibility in *The Impact of the Behavioral Sciences on the Criminal Law* Nita Farahany ed. New York: Oxford University Press.

Farrington, D. and Coid, J. (eds) (2003) *Early Prevention of Adult Anti-social behaviour*, Cambridge: Cambridge University Press.

[61] The Human Brain Project Report to the European Commission 2012 available at: https://www.humanbrainproject.eu/documents/10180/17648/TheHBPReport_LR.pdf accessed 16th April 2016

[62] The Office of the Press Secretary The White House, 2 April 2013, FACTSHEET, The Brain Initiative available at https://www.whitehouse.gov/the-press-office/2013/04/02/fact-sheet-brain-initiative accessed 16th April 2016

Goodenough, O.R. and Prehn, K. (2006) A neuroscientific approach to normative judgment in law and justice in Zeki, S. and Goodenough, O.R. (eds) *Law and brain*, New York: Oxford University Press.

de Kogel, C.H. and. Westgeest, E.J.M.C. (2015) 'Neuroscientific and behavioral genetic information in criminal cases in the Netherlands' *J Law Biosci* 2(3): 580-605 doi:10.1093/jlb/lsv024.

Lombroso, C. (1876) *L'uomo delinquente*, Gibson, M. and Rafter, N.H. (2006) (trans) Durham, N.C.: Duke University Press.

Morse, S.J. (2011) 'NeuroLaw Exuberance: A plea for Neuromodesty' in *Technologies on the stand: legal and ethical questions in neuroscience and robotics*, van den Berg, B. and Klaming, L. (eds) Nijmegen: Wolf Legal Publishing.

Moore, M. (2009) *Causation and Responsibility*, New York: Oxford University Press.
Presidential Commission *for the* Study of Bioethical Issues, (2015) *Gray Matters: Topics at the Intersection of Neuroscience, Ethics and Society*, Vol:2. Washington: http://bioethics.gov/sites/default/files/GrayMatter_V2_508.pdf

Raine, A. (2014) *The Anatomy of Violence*, London: Penguin.

Rose, S. (2003) *The Making of Memory*, London: Vintage.

Rosenfeld, J.P. (2011) 'P300 in detecting concealed information' in Verschuere, B. Ben-Shakhar, G. and Meijer, E. (eds) *Memory Detection Theory and Application of the Concealed Information Test*, New York: Cambridge University Press.

Rosenfeld, J.P. Labkovsky, E. Winograd, M. Lui, M.A. Vandenboom, C. and Chedid, E. (2008) 'The Complex Trial Protocol (CTP): A new countermeasure- resistant, accurate, P300-based method for detection of concealed information' *Psychophysiology*, vol 45(6) 906-919.

Rutherford, M. (2010) *Blurring the Boundaries: The convergence of mental and criminal justice policy, legislation, systems and practice* London: Sainsbury Centre for Mental Health.

Spranger, T. (2012) 'Neurosciences and the law: An Introduction' in Spranger T. (ed) *International Neurolaw: A Comparative Analysis*, Heidelberg: Springer.

The Royal Society (2011a) *Brain Waves Module 1: Neuroscience, society and policy*, London: The Royal Society.

The Royal Society (2011b) *Brain Waves Module 4: Neuroscience and the law*, London: The Royal Society.

Uncapher, M.R., Boyd-Meredith, J.T., Chow, T.E. Rissman, J. and Wagner, A.D. (2015) 'Goal-Directed Modulation of Neural Memory Patterns: Implications for fMRI-Based Memory Detection' *Journal of Neuroscience*, 35(22): 8531– 8545.