
The brain and the law

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Much has been written about how law as an institution has developed to solve many problems that human societies face. Inherent in all of these explanations are models of how humans make decisions. This article discusses what current neuroscience research tells us about the mechanisms of human decision making of particular relevance to law. This research indicates that humans are both more capable of solving many problems than standard economic models predict, but also limited in ways those models ignore. This article discusses how law is both shaped by our cognitive processes and also shapes them. The article considers some of the implications of this research for improving our understanding of how our current legal regimes operate and how the law can be structured to take advantage of our neural mechanisms to improve social welfare.

Keywords: law; neuroeconomics; neuroscience

1. INTRODUCTION

For centuries, the study of human behaviour has been distinct from the study of the natural world. Because of the complexity of the brain and our historic lack of understanding of its operations, social science has not focused on the brain, but instead attempted to study that which can be analysed: behaviour itself (Goodenough 2001). For example, Sigmund Freud first began his study of human behaviour with physiological mechanisms but ended this research because the basic science had not yet advanced sufficiently to directly aid him in the understanding of behaviour (Gazzaniga *et al.* 2002). Arguably, his approach to human behaviour ended up deriving more from philosophies of Hegel and Schopenhauer than from neuroscientists such as Golgi and Cajal (Jones 1961; Ledoux 2002).

However, in recent decades it has become clear that neuroscience can contribute a great deal to our understanding of human behaviour. Because of recent advances in a variety of disciplines, we are now beginning to witness a merging of the hard and social sciences. Many researchers in human behaviour and biology have adopted an approach, referred to as cognitive neuroscience, that integrates psychology, biochemistry, neurology, evolutionary biology and related sciences to further our understanding of human behaviour (Gazzaniga *et al.* 2002).

Because social scientists have been studying human behaviour for well over a century, they have catalogued a wide array of behaviour and have developed many theories that attempt to explain these behaviours. This detailed observation has been invaluable in building a solid base from which to understand human behaviour. However, one problem is that the theories developed in attempting to explain behaviour are often contradictory. One can see this

in the contrasting views of human decision-making used in psychology and standard economics, which famously disagree over the degree to which humans behave rationally (Brocas & Carrillo 2003). This disagreement results in part from the fact that a behaviour itself leaves us with only an artefact which we must then interpret. For any given behaviour, it may be hard to determine if subjects were somehow rationally calculating their choices to maximize either their long-run or short-run interest, or if some other process is involved. Neuroscience can help us to sort through the various possible explanations of behaviour by allowing us to better discriminate between the competing models as a result of the information it gives us about brain mechanisms used to make the decision.

It has long been hypothesized that biological mechanisms can have direct control of our behaviour in particular areas (Lieberman *et al.* 2003). Merely understanding that there may be genetic influences on behaviour does not tell us how this behaviour is created nor how the mechanism used for one problem may influence other types of behaviour. Cognitive neuroscience can help us to resolve these questions, by directly examining the neural mechanisms involved.

One of the most important areas of human behaviour is the creation and enforcement of law. Because the meaning of the term 'law' is not self-evident, we need to be clear that for purposes of this article, the term 'law' means explicit rules by which communities of humans govern themselves. Therefore, law is not custom or other implicit rules that derive from genetic predisposition or cultural mores. Under this definition, only human communities have law, because only human communities have developed communication abilities of a sufficient complexity to consciously decide and promulgate rules (Posner 1983).

Because law can change and these changes are subject to selection pressures, law itself also undergoes evolution. As with other cultural institutions, law probably has experi-

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One contribution of 16 to a Theme Issue 'Law and the brain'.

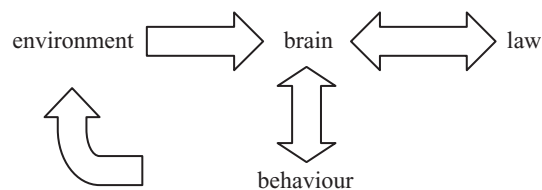


Figure 1. The interaction between the environment, human brains, law and behaviour.

enced a coevolution with the human genome (Bowles *et al.* 2003). There is a continuous interplay between the environment which acts on us in such a way that we create laws to address the problem we confront. These laws then interact with neural mechanisms to create behaviour. This behaviour then affects our environment, completing a circle as illustrated in figure 1.

This article examines the implications of the recent research in cognitive neuroscience to study of law. In particular, it examines the effects of the environment on the brain that might lead humans to create law, the effects of law on the neural mechanisms used to perceive and make decisions about the appropriate behaviour, as well as the effect of behaviour on the environment. Traditionally, economics has assumed that the effects of law on the brain operate through what are referred to as utility functions. These are functions which determine the value of any state of the world. It is assumed that humans behave so as to rationally choose the optimal behaviour given their own utility functions (Mas-Colell *et al.* 1995). Cognitive neuroscience indicates that the actual mechanisms involved are far more complicated than assumed in standard utility theory. This article will first discuss two questions that are foundational to understanding humans behaviour which has particular relevance to the study of law: how the brain maintains cognitive control and how it is able to engage in social interaction which involves trust. It then discusses some of the research that has been performed on how the brain deals with problems directly applicable to law. Finally, it discusses how this research impacts our understanding of the development and function of law.

This article will not discuss some areas of neuroscience research that are commonly addressed in legal scholarship, such as the impact of neuroscience on notions such as insanity and culpability or related notions such as ability to form intent in contract, tort and criminal law. Its focus is the development and the effect of law on the main body of society. As with any area of research, the implications of the research that has already been conducted may be significantly modified by future research. Although we have learned an astonishing amount about the neural basis of human decision making, we are also discovering new information quite literally every day. The intent of this article is to describe some of these findings and how they affect our models of human behaviour and how these affect our understanding of the law.

2. RELEVANT COGNITIVE NEUROSCIENCE

(a) *Neuroscience and the basic issues that each brain must solve*

We have seen in the past few decades a massive increase in our understanding of the mechanisms we use to perceive the world around us and those we use to make decisions. Of

particular relevance to the study of law are the advances in the understanding of human decision making. To see the impact of neuroscience on the study of law, we will first discuss two key problems directly relevant to legal questions: how human brains maintain cognitive control and how the neural mechanisms are involved in decisions of whether to trust as well as whether to reciprocate trust.

(i) *Cognitive control*

Cognition is a costly resource. Because brains are finite and because there is a pay-off to increasing our understanding of the world, the constraints on the capabilities of our brains can seriously affect the manner in which functions are performed (Simon 1987). Two key questions are then how does the brain decide which problems it will address, and once this selection has been made, what neural mechanisms are used to solve the problem? The responses to these questions essentially create an economics of neural function. Not surprisingly, it appears that the answers are governed by rules similar to those that economists and operations research specialists use in their optimization calculations. In particular, many biologists argue that the brain consists of modules that solve particular kinds of problems (Wood & Grafman 2003). There are clear evolutionary advantages to this. Humans are confronted with only a finite, although very large, set of problems. Solving the specific problems presented, and having tissues structured for solving those problems would be more efficient than having general purpose tissues, which would probably be more costly, and not as well adapted (Roland & Zilles 1998).

The starting point for understanding the modern research on how specific structures of the brain are adapted for certain functions is the work of Korbinian Brodmann, who in 1909 discovered that the neurons in different areas of the brain exhibit different types of cytoarchitecture (Brodmann 1909). He hypothesized that these different types of tissue performed different functions. This hypothesis has been largely confirmed. Of course, in discussing localization of function, one must also note that generally many different areas of the brain are often invoked in any addressing any single problem. Function is therefore both localized and distributed. The particular pattern for any individual problem is to some degree unique to that problem although it may share similarities with other problems. In some ways this can be analogized to an alphabet. A particular sound is represented by a letter (localized), but to write a word or sentence, many letters are required (distributed function).

Because there are a nearly infinite number of stimuli in the world at any given time, to focus on any object, we must decide to ignore some stimuli and focus on others. Even after we are aware of a 'problem', we have many potential mechanisms to use to address the issues it raises. For example, we may react 'emotionally' or 'irrationally'. The research in cognitive neuroscience suggests that different methods of problem solving are located in different parts of the brain. As evidence of this, patients with damage to the ventromedial PFC are unlikely to exhibit emotional responses to stimuli, whereas those patients with dorso-lateral PFC damage appear to have problems in cognitive processing of tasks that do not seem to evoke emotional processing (e.g. the Wisconsin card sorting tasks)¹ (Gazza-

niga *et al.* 2002). Interestingly, both types of reasoning seem to be necessary for optimal problem solving. Because of cognitive limits, it is not the case that one should always use either cognitive processing (or more colloquially ‘logic’) or affective processing (more colloquially ‘emotion’), which has been conditioned by evolutionary pressures to punish or reward behaviour. Because of these conflicts, and the lack of inherent superiority of one mechanism over the other, there needs to be some mechanism to resolve these conflicts. A significant amount of research now focuses on how this resolution occurs. The goal of this research is to discover how we maintain cognitive control over our state of mind as well as our actions (Rilling *et al.* 2002).

One region of the brain that is clearly involved in cognitive conflict resolution is the ACC. This area is currently thought to be involved in registering a conflict between regions. Some researchers argue that after a conflict is recognized, various areas of the PFC also become active and that the choice of regions activated depends on the cognitive requirements of the problem presented (Ponchon *et al.* 2002). In addition, the context in which the problem is presented may have a significant impact on the mechanism used to address the problem (Metcalfe & Mischel 1999).

Many of the mechanisms used by the brain to deal with situations of cognitive conflict are illustrated in the ultimatum game (which is discussed in § 2b(ii)). The neurological studies of how players of this game make decisions illustrate the mechanisms the brain uses to resolve the conflict between deciding whether to accept money (something generally desired), but at the same time also accepting what individuals are likely to view as an unfair bargain, or to choose to reject the money and enforce fairness. Similar mechanisms appear to be invoked whenever actions against the subject’s immediate self-interest are chosen.

How decisions are made and to what extent legal rules affect the various decision mechanisms of cognitive or emotional processing are key questions for the academic study of the law. Some economists have argued that even self-destructive behaviours can best be modelled as rational choices (Becker *et al.* 1991). Whereas others, generally psychologists, argue that these behaviours are the result of lack of control and these individuals did not set out to become criminals or addicts, but these are the results of cognitive or emotional deficits. Both sides have significant evidence for their arguments. The neuroscience of decision making can help us both to understand these situations as well as understand the effects of legal rules in addressing these problems.

(ii) *Trust and theory of mind*

Another area of research with particular relevance to legal scholarship relates to the notions of trust and TOM. By ‘trust’, we mean the willingness to behave in such a way that only makes sense if you believe that others will reciprocate any benefits to you extend to them. Robert Axelrod’s famous experiments discussed in his books (Axelrod 1982, 1997) describe how cooperation can evolve even in a population of completely self-interested individuals (Samuelson 2002). Even with these arguments, however, the subject of

precisely how such trusting and reciprocal behaviour evolved is the subject of some debate (Gintis *et al.* 2003; Nowak *et al.* 2004).

Without some theory of how others will react, many of the predictions of game theory become indeterminate. To illustrate this, consider the centipede game. This game is essentially a multi-round version of the trust game (which is described in § 2b(iii)). The rounds in this game are structured in such a way that if you believe the other player will defect in the next round, you should defect in the current round. However, if they will cooperate in the next round, it makes sense to cooperate in this round as well. Therefore, the predicted strategy of the other player determines your optimal strategy (Camerer 2003a, pp. 94–95). The model of the other’s persons mind is often referred to as a TOM. The notion of trust and TOM are intimately tied together because inherent in trust must be some theory of what is occurring in mind of the other player (Firth 2001).

Other mechanisms are also involved in trusting behaviour. It appears that trusting behaviour involves an ability to suppress the immediate response to simply take what is in front of them and defect in favour of longer-term goals, which may invoke reciprocity and other social mechanisms. Therefore conflict control is also important (Rilling *et al.* 2002).

A relatively simple version of a TOM would be to assume that the other person will do what we would do in the same situation (Stahl & Haruvy 2003; Ramnani & Miall 2004). Recent evidence indicates that determining the actions of others activates regions of the brain that attempt to determine how others will behave by attempting to see how they themselves might behave. The primary areas involved in deriving the TOM appear to be the medial PFC, the related area of the OFC, paracingulate cortex, the temporal poles and the posterior STS (Frith & Frith 2003).

Notions of trust and trustworthiness are integral to our understanding of legal regimes. Degrees of trust, reciprocity and cooperation matter in nearly all areas of law including contracts, business organization law and tax law. The degree of trust in the society matters crucially in structuring nearly all legal rules. In many ways, our institutions in the Western world are dependent on fairly high degrees of trust and trustworthiness. Trust and trustworthiness keep many individuals from violating promises and reduce the incidence of bribery, decrease cheating on tax rules, etc., which then in turn reduce monitoring costs and allow for a more efficient society (Zak & Knack 2001). However, because trust appears to be related to both positive and negative reciprocity (McCabe & Smith 2000; Camerer 2003b), there is also a downside to reliance on these mechanisms. When the rules are violated, then harmed individuals often desire to impose greater penalties than are socially optimal. This may result from the evolutionary advantage of having a reputation for over-reacting to violations (Posner 1983). If modern society were to rely on the intuitive mechanisms for enforcement of agreements, for example in the form of vengeance, society would have both over- and under-deterrence of many offences.² Furthermore, those who are given power to make decisions about how to spend public money may use these tools for profiting themselves at the expense of society at large. To the extent this occurs, this tends to break down society and governmental structures. Therefore, the optimal set of

rules will diminish the opportunities for governmental agents to take these kinds of actions, while still allowing them some freedom to exercise their presumably better knowledge concerning public policy.

This issue raises one of the key problems that law attempts to address: monitoring costs. Even if two parties agree to perform certain actions, how is it that each party attempts to ensure the other side will perform? Monitoring can be a major feature of any agreement. Law can therefore reduce transactions costs by helping to reduce monitoring costs. By studying how it is that we can actually motivate people to behave in optimal manner, we can understand how to reduce monitoring costs. One of the more interesting findings along this line is that CEOs of corporations might actually be more trustworthy than the average person (Fehr & List 2002). Perhaps the process by which they are selected will choose those who are more trustworthy. However, there also may be other explanations of the results. For example, it is not clear if CEOs are innately more trustworthy or if they simply know how to manipulate individuals more. To the extent that already existing processes select for trustworthy behaviour, law makers need to take care not to harm the processes that help to foster trust already in place.

(b) *Five areas of neuroscience research of particular application to law*

This section discusses five of the most important areas of current research in cognitive neuroscience that concern the understanding of law and its effects: the neurobiology of moral questions, the neural functioning of individuals in ultimatum games and trust games, the neurobiology of social rejection, and finally the research concerning how conscious decisions become automated over time. The section also discusses how this research may help to explain some of the cultural differences we observe in behavioural game-theory experiments and how this can help us to structure rules to encourage socially optimal behaviour.

(i) *The resolution of moral dilemmas*

Questions, such as what is moral reasoning and how we reason morally, are among the most important questions for legal scholarship. Do we base these decisions on rational reasoning based on explicit rules, or on non-conscious processing (i.e. gut feelings) or something in between? Some argue morality is based on explicit moral reasoning (such as Kantian moral theory) which is independent of any evidence, others that it derives from habits of thought and action that we developed over time (such as Aristotelian virtue ethics). Knowing the answer is important if we wish to influence these decisions by legal rules.

Some fundamental neurological experiments in this area have been conducted by a team at Princeton University (Greene *et al.* 2001). They have investigated the neural mechanisms involved in the reactions of subjects to standard hypothetical moral dilemmas. While using functional magnetic resonance imaging technology to image the brains of the subjects, they asked several questions, including how the subjects would respond if faced with the situation of a train coming down a track, and if they did nothing, the train would hit a car on the track and five people would be killed, and if they pressed a button the

train would move down a sidetrack and only one person would be killed. As has been known for many years, most people report they would choose to press the button. Interestingly, the response is quite different if a similar, but slightly different, situation is presented. In this second moral dilemma, the subjects would have to push the person next to them onto the track, killing the other person. Here, most people answer they would not do that. The study shows that the parts of the brain that are actively involved in the decision to push the person are similar to those involved in fear and grief. The decision to flip the switch, which would also result in killing a human, involved far fewer emotional reactions. In particular, the areas more likely to be active in personal moral dilemmas (such as pushing the person on to the tracks) were areas of the medial frontal gyrus (in Brodman areas 9–10), the posterior cingulate gyrus and the bilateral STS. These areas are normally involved in social–emotional processing (Greene & Haidt 2002). The non-moral or impersonal dilemmas (e.g. switching the train track) tend to activate areas in the dorsolateral PFC and the parietal cortex (normally involved in calculation) and executive function (Dehaene 1996). For those subjects who did decide to push the person next to them, one might argue that ‘logic’ or cognitive processes prevailed over ‘emotion’. Interestingly, those who did decide to push the other person took significantly longer in making this decision than those who chose not to push the other person (a difference of 5 s for those who would not push the person versus 6.75 for those who would). There was very little difference between the brain activation or decision time between impersonal moral dilemmas and non-moral dilemmas (less than one-half of a second). This would tend to indicate that the more impersonal the decision becomes, the more we can be ‘rational’ or rather adopt socially optimal decision-making mechanisms. This suggests that certain types of moral decision making involve a fair amount of social thinking and invoke notions of positive and negative reciprocity, and personalization. Other more recent experiments confirm that the regions of the brain involved in moral processing are also the same regions used in social cognition (Moll *et al.* 2002a). One recent study by Moll *et al.* (2002b) attempted to separate out the regions involved in moral judgements as opposed to those involved in emotional processing. They found that moral situations differentially activated the STS and the OFC. One key distinction between this experiment and the Greene experiment is that here the subjects were merely reacting to stimuli, not making decisions about how to behave.

Consistent with these experiments as well as many others, it appears that the method of reasoning changes depending on the nature of the problem presented. This may have many applications for our understanding of law and the legal system. For example, in attempting to understand how juries reach the decisions they do, we can see that individuals may make socially optimal choices more when they keep the subjects of the decision at a distance. If the decision is personalized in some way, this can, in and of itself, alter the decision. Of course, more work needs to be done to fully understand what kinds of situations result in personalization and the precise way in which reasoning processes differ between personal and impersonal situations. To the extent that these conclusions from these

experiments bear up in further experiments, society may have an interest in depersonalizing problems that are presented to decision-makers. In addition, objectivity may require more than simply not being related or having a direct stake in the outcome. These and other experiments suggest even having to face someone is enough to invoke personal and social triggers (Ledyard 1995). This research may also indicate that society needs to frame interactions so that the 'personalization' will result in actions that are in accord with what is socially optimal, rather than being in conflict with it (e.g. attempt to use personalization to obtain optimal cooperation). One hopes that further research in this area will examine how individuals personalize problems when the stakes to personalization are high.

The decision of whether to take action or not involves apparently both cognitive mechanisms and trust and reciprocity and social mechanisms. Interestingly, the experiments reveal a fair degree of heterogeneity in the population of whether the social mechanism trumps the cognitive or vice versa. Not everyone chose the 'personal' decision over the socially optimal. Furthermore, these experiments suggest the application of the results of one or a group of experiments to a complicated moral situation may not necessarily be straightforward. It appears that moral reasoning is spread across many neural mechanisms (Casebeer & Churchland 2003) and which mechanism dominates for any one problem is complex issue. Any one moral problem may be approached in a very different manner than one that many seem to be similar. Therefore, an important line of future research is to attempt to understand the mechanisms by which problems are interpreted. In particular, how problems become perceived as social and how at other times problems can be interpreted as 'simply' cognitive problems is one of the key questions for understanding the impact of law on behaviour.

(ii) *The ultimatum game*

The ultimatum game has been one of the most important games used to differentiate actual human behaviour from those of standard non-cooperative game theory. In the standard version of this game, there are two players. The first player is given a 'stake', which can be divided in any way that the first player chooses; however, the second player can veto this distribution, in which case both players get nothing. The traditional game theoretic prediction was that the first player would keep almost all the 'stake', reasoning that the second player will take whatever they can get. Experimental research indicates that this is not generally what occurs. Often, first players offer 40–50% of the stake to the second players. An important feature of the ultimatum game research is that the behaviour of the subjects is generally highly dependent on the particular context in which these decisions are made (Henrich 2000). For example, the offers are substantially reduced if the players competed for the right to be the first player, or if they are framed as competitors (Hoffman *et al.* 1994). Various theories have been created to explain behaviour in the ultimatum game, such as inherent fairness or reciprocity (Fehr & Schmidt 1999).

In studying the neural mechanisms activated by playing the ultimatum game, one study found that 'unfair' offers resulted in activation of areas related both to cognition (e.g.

the dorsolateral PFC) and emotion (e.g. the anterior insula) (Sanfey *et al.* 2003). The insula is a cortical region often active in the sensations of disgust, such as bad smells (Camerer *et al.* 2004). There was higher activity in the insula for rejected offers than for accepted offers indicating that emotion and in particular disgust or similar emotions, was part of the motivation in the rejections (Damasio *et al.* 2000; Sanfey *et al.* 2003). The ACC activation indicates that there was a cognitive conflict between accepting the money and the emotional desire to be treated fairly. The brains of the first players were not imaged in this study, because the first players, unbeknown to the second players, were computers.

We suspect that in the case when the status as 'first player' is earned the other players will expect to earn less and so there will be less disgust with lower offers (Holroyd *et al.* 2003). This result would be consistent with both the neural mechanism of cognitive control revealed in this experiment, as well as those revealed in other experiments on rewards (Breiter *et al.* 2001).

(iii) *Trust games*

Another group of experiments with particular relevance to understanding the creation and function of law are those involving 'trust' games. Trust games involve situations in which one player can increase the pay-off for both players, but for this increase to occur the first player must choose to allow the second player to decide how to split both the amount contributed by the first player and the surplus. That is, the first player would have to trust that the second player will reciprocate the first player's 'contribution' and return some of the added pay-off. Alternatively, the second player could choose to 'defect' (i.e. not exhibit trustworthy behaviour) and optimize their own utility (see figure 2). In general, over half the population exhibits both trusting and trustworthy behaviour (Berg *et al.* 1995).

One neuroeconomic study indicates several interesting features of trust games. This study was conducted on 12 right-handed subjects. This experiment had several interesting results. First, those who trusted generally activated similar regions of the brain (in particular, Brodmann areas 8 and 10), which are generally thought to be involved in social cognition. In addition, those who chose not to cooperate generally had patterns of brain activation similar to those who were playing against a machine (McCabe *et al.* 2001). This argues that those who choose to trust are conceiving of the problem as a social problem. Conversely, this evidence indicates that those who did not cooperate perceived the problem more simply as one of maximizing their own utility.

In another study which examined the neurobiology of trust behaviour (Rilling *et al.* 2002), 36 right-handed women were studied in trust games. The researchers found that those who trusted were more likely to have higher activation of the nucleus accumbens, the caudate nucleus, ventromedial frontal and orbitofrontal cortex and the rostral ACC. These areas are all commonly involved in emotional processing. They studied what mechanisms are used to overcome that natural desire to defect and take the prize in favour of exercising reciprocal altruism. This study seems to indicate that emotional responses may be important in trust as well.

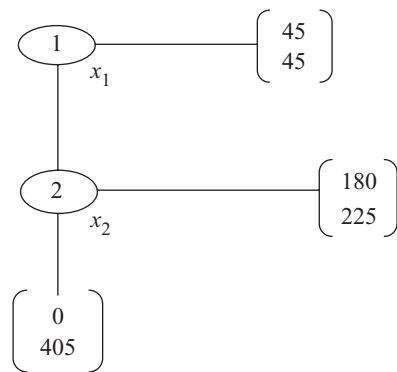


Figure 2. Diagram of the decision tree for the trust game. In the trust game, the first player can either decide to move right, opting to award each player a pay-off of 45, or move down, which gives the second player the ability to decide the outcome of the game. If the second player moves right, the first player will get a pay-off of 180 and the second player will get a pay-off of 225. If the second player moves down, the first player will get a pay-off of 0, and the second player will get a pay-off of 405. In moving down, the first player is effectively trusting the second player to reward the first player by moving left, rather than defecting by moving down.

(iv) *The interplay between rejection and other forms of enforcement*

Some evolutionary psychologists argue that social rejection might be encoded in our brain as pain because those who are motivated to maintain group relations would be more likely to survive. Therefore, finding pain and suffering in social rejection may be an optimal evolutionary response for individuals (La Ferrara 2003). In a noisy environment, individuals should be sensitive to perceptions of others about reciprocity and trustworthiness, and should be motivated to maintain positive relations even if they themselves are unaware of a violation. If these models are correct then, social exclusion can be a significant enforcement mechanism. One study that supports this view (Eisenberger *et al.* 2003) found that the ACC was more active when a participant was excluded from a virtual ball-toss game played on the computer with others. The researchers noted that physical pain also activates the ACC in similar way, and as discussed earlier, the ACC seems to be a conflict-monitoring circuit.³ In addition, the authors found significant activity in the right ventral PFC which is thought (through efferent connections to ACC) to be involved in the regulation of pain. Thus, the activation from intentional social exclusion is similar to what one finds when actual physical pain occurs (Coghill *et al.* 1999). The researchers also compared this with the activation in situations where the subjects were excluded from the game, but were told this was because of technical difficulties. Here, they found that there was also ACC activation, but the activation in the right ventral PFC was significantly less. This could be explained if the subjects still experienced some conflict from being excluded, but it was not as acute as when they were intentionally excluded.

These findings might help to explain how culture can constrain individuals. We desire to be in the 'in-group', but not necessarily as a result of a conscious rational calculation of the benefits it will generate for us. To see how this might apply to the law, one should first note that penalties

meted out by legal authorities can either conflict with or align themselves with group pressures. To the extent the latter happens, enforcement of the laws may be cheaper and more effective. Because social pressure can create actual pain, the law should attempt to align this pain with the socially desired behaviour.

(v) *Automation*

Another key finding in neuroscience is the ability for the brain to 'automate' processes that had previously required conscious thought, thereby conserving cognitive resources. The idea is that if there is a behaviour that we commonly perform, we simply begin to perform the action without much thought (Heiner 1983). In fact, the brain is continually 'automating' much of our behaviour (Gazzaniga *et al.* 2002). As many have pointed out, it would be impossible to make all the calculations we need for daily life consciously. Perhaps the most familiar example of 'automation' is learning to ride a bicycle. We have to do it consciously at first, but then over time we simply do it 'without thinking' (Roth 2004). This occurs because conscious processing is apparently more costly than unconscious processing. That cognitive processing is a scarce resource has been understood for decades, whereas unconscious parallel processing seems significantly less limited (Miller 1956). This process may help to explain behaviour such as that observed in the ultimatum game when the same subjects (who are in the position of player two) are knowingly playing with a computer, and the computer has given them a 'bad' deal, they may still attempt to punish it. This indicates personification or at least the carrying over of models that one uses in everyday life to situations where personal models are not particularly helpful. To the extent that behaviour becomes automated, this may have effects on things such as compliance with law, or systematic biases which can have detrimental effects of society.

A variety of theories have been proposed to explain how this occurs. Marcus Raichle and Steven Peterson have proposed a 'scaffold to structure theory'. Under this theory, learning a task first requires conscious processing until the memory is consolidated. Once the brain activity is learned, brain activity and involvement change, or in terms of the model, the scaffolding is removed. Using positron emission tomography scans, they demonstrated that conscious processing uses a different network of brain regions than does learned unconscious processing. Another study examined the neural activity of expert chess players playing largely by intuition (Chabris & Hamilton 1992). For novices, the lightning fast play of experts is impossible, whereas for those with the proper level of experience, this type of play is automatic. The research in this area indicates that there is a high activation in the PFC during the process of learning a task, but as it is learned, the parietal, temporal and sub-cortical regions become relatively more active. If, as is often thought, 'executive function' is similar to conscious functions, these findings are indicative of lower conscious activation in the learned task. By this mechanism, the brain economizes on scarce cognitive resources.

This research has a variety of consequences for legal scholarship. For example, cultural differences in trust games and ultimatum games may be a result of automated processes that result from observing others around them

and developing certain notions of trust and trustworthiness in similar situations (Henrich 2000). Law is intended to create context in which cooperative and other socially optimal behaviour is beneficial. This research indicates that such learned behaviour can in fact be altered (Ledoux 2002), yet to the extent it has become automated, it may take time and significant resources to alter behaviour in the preferred manner. In addition, one of the hopes for the law is that it will be able to influence behaviour even when it is too costly to monitor behaviour directly. To the extent we understand how behaviour and decisions are automatic, we can hopefully use this to influence choices and 'automate' trust and trustworthiness.

That culture can have a significant impact on the way in which initial decisions are made is shown by the experiments in which initial behaviour is different and more cooperative than after multiple rounds of behaviour (Palfrey & Prisbey 1997). At a minimum, we need to establish a framework in which cooperative behaviour that already exists is not unlearned. One study conducted by a group of very prominent evolutionary psychologists, game theorists and others shows that initial behaviour in economics experiments generally reflects the everyday level of cooperation within the society (Henrich *et al.* 2001).

3. THE IMPACT OF COGNITIVE NEUROSCIENCE ON THE STUDY OF LAW

(a) *The development of the law*

Many authors have discussed how a basic form of society could exist without laws as we use the term (Ellickson 1994). In such situations, custom or other norms have arisen over time without an explicit central authority issuing them. It is often discussed how Homeric Greek society and Medieval Icelandic society, as exhibited in the epics written about them, seem to have existed without central authorities to promulgate rules (Miller 1996). These societies probably exemplify the environment in which human brains evolved, i.e. without explicit authority and with frequent repeat interactions. Evolutionary psychology and neuroeconomics demonstrate that our brains are well adapted to dealing with personal exchange: monitoring and reaching optimal levels of cooperation within reasonably small groups. How these norms and conventions are created is probably a result of the coevolution of culture and genetic expression (Bowles *et al.* 2003). As many authors have noted, a modern society could not really exist entirely based on reputation. We simply have too many small interactions with too many people for this to function. However, there are probably intermediate situations in which certain members or groups of society may function as go-betweens trusted by all members of society (McCabe & Smith 2000). But even in these situations reputation is the operative force. It is merely that certain members of society have been allocated the task of coordinating the trust relationships, which can economize on the number of goodwill accounts. In fact, even modern society relies to an enormous degree on reputation and repeat dealing. Most interactions, above a certain minimal threshold, that we have on a daily basis involve a fair amount of personal interaction. In a world where there is repeated interaction all the time, someone who calculates whether they will cooperate each time will be spending too many resources on making these

calculations. Therefore having a default of cooperation results in saving cognitive energy.

Impersonal exchange is often a much more efficient exchange mechanism, as the Internet merchants like eBay have demonstrated. It is probably the case that, for most goods the most efficient supplier of the goods does not personally know those who value the goods the most, and so impersonal exchange can be substantially more efficient in many circumstances than personal exchange.

One way to understand the development of law is through the framework put forth by Tooby & Cosmides (1996) to explain human behaviour. This approach focuses on the interplay between the adaptive or evolutionary problem which the behaviour in question evolved to address, the cognitive programme used to solve this problem, and the particular neurophysiological mechanism used to enact this cognitive programme. One of the benefits of this approach is that it helps us to understand both the original benefits of the behaviour, as well as the limitations the solutions impose on us today.

Our brains developed at a time when the economies of scale of the existing technologies were relatively limited. In such circumstances, personal exchange is a very efficient model of trade. At some point in human evolution, technology developed in such a way that many products could be more efficiently produced for large groups than they could for small groups. Therefore, to take advantage of these technologies, humans needed to develop institutions that could foster trust in these larger groups (Arrow 1974). At first, intermediate steps, such as those previously described of having go-betweens or 'middlemen' may have been sufficient (McCabe & Smith 2000). However, mechanisms such as this can create high transaction costs if sufficiently large groups need to be involved (for example, one can think of the transaction costs of the Silk Road). Although these regimes worked for many years and in many places where the technology that existed did not require mass population for its optimal operation, as technology developed further, there became advantages to trading over larger areas. Legal regimes that allow one to seek restitution even from parties one does not know personally increases willingness to deal with those with whom one has not yet had repeated dealings. For these legal regimes not to collapse, there needs to be some mechanism of enforcement which all parties trust. Many authors have discussed the development of law and the efficiency of legal regimes in these circumstances (North 1991). However, all of these legal regimes involve individuals whose reasoning mechanisms are adapted to different situations. By studying precisely how these mechanisms function, as well as how other decision-making mechanisms operate, we can better understand the limits and proper scope of law.

As discussed above, for a non-governmental state to function (as they did in Homeric Greece and medieval Iceland), there must be a great deal of positive and negative reciprocity (e.g. revenge).⁴ In addition, because game-theoretic concerns are important, understanding the other person's strategy is also important. This means that mechanisms such as TOM are crucial for such societies. When transactions beyond the family or local group were necessary, these would generally involve interacting with individuals who were either known to the group, or who were members of a family that had frequent interactions

with the group (La Ferrera 2003). In the society that existed in many ancient cultures, people knew each other very well, or certainly knew the reputation of those connected to those with whom they are dealing. Therefore, the information about parties' behaviour was not as asymmetric as is the case with the impersonal dealing we have today. In addition, because of these and other personalizing features of these relationships, such as repeat bargaining and social sanctioning, behaving in a cooperative manner was very likely to be favoured. If the rational strategy is to cooperate, one can see how it is efficient to save cognitive calculation by simply having this as the initial first offer. This would be optimal because most decisions most of the time are made on the basis of heuristics and emotion, and such processing is cheaper.

(b) *The impact of law*

In small groups with repeat interactions, generally private law as we know it is not necessary. Honour and similar behavioural restraints would ensure that the parties to agreements would not generally defect, because in such situations reputation and the threat of punishment matter. Hence, early societies were probably able to solve these simple material allocation problems fairly easily once modern humans evolved. However, as discussed above, as larger social interactions became both possible and necessary, reliance on these mechanisms of personal reciprocity became suboptimal. First, where reputations are either not well known, or if the impact of defection in one case would not significantly impact reputation, trust can be diminished. Second, it is not always optimal from a social perspective that contracts are honoured, and so there needed to be some mechanism to ensure that agreements are not over-enforced as well.

Neural mechanisms that may have evolved to punish 'defectors' within a group are suboptimal for many important functions in large societies. We may prefer to use these 'personal' mechanisms for interacting with others because they involve use of fewer cognitive resources than impersonal bargaining. Personal exchange appears to be more automatic. However, impersonal exchange can often be more efficient and can allow for fewer resources spent on developing networks, etc. that are not directly productive. So for society to advance further, there would need to be some mechanism that would both allow impersonal bargaining to occur by linking it to generally applicable cognitive patterns, as well as reducing the effects of patterns of cognition applicable to personal bargaining which may impede impersonal bargaining.

One of the key functions of law is to create at least some minimal levels of trust between persons who have not previously had reason to trust each other. This can actually help to foster a greater network of trust relationships by creating networks of interactions. That is, exchanges that might not take place because of an initial lack of trust will now occur, and because of these transactions more goodwill accounts are generated, where they would not have been before. By facilitating impersonal exchange, law may be helping to foster greater and more efficient investment in personal exchange as well. One cautionary note about this description is that because law is generally generated by a subgroup, it most probably will operate to promote that subgroup's welfare. Therefore, it is not necessarily

the case that law will always create the optimal level of impersonal exchange if that will come at the expense of the ruling groups welfare. However, legal regimes are only likely to be selected if they do not create enormous amounts of social strife and to the extent one group reduces the welfare of society, there will be pressure to change.

Legal enforcement of agreements is likely to create at least two positive effects. It reduces the loss to the individual from potential defection by others, which would both encourage more interactions and reduce the desire to spend resources on offensive and defensive capabilities. In addition, because those who are defected against do not share in the benefits of defection, a successful evolutionary strategy would be to punish defection by others excessively. Others will be less likely to defect against those who adopt this strategy. As a consequence, neural mechanisms have developed to exhibit punishment behaviour even when it is not efficient from a societal perspective (for example, the punishment behaviour of ultimatum games). Therefore, a key element of law may be to diminish the desire for negative reciprocity to the socially optimal level.

In many ways, one can argue that the effect of law is to operate in connection with impersonal exchange as a substitute for the trust mechanisms that operate in personal exchange. We discussed earlier how these trust mechanisms can help to ensure optimal behaviour. Law then needs to foster optimal behaviour in the absence of standard personal bargaining.

One thing that is clear from the experimental economics literature is that the institutional structure used can have a large impact on the efficiency of the outcome (Smith 1982). To be effective, an institution has to be able to convey messages to the members of the society in a form that they will be able to interpret and which will cause them to generate optimal exchange solutions. Therefore an efficient institution will be structured to account for our desires for personal exchange and the neural mechanisms of social exchange used in personal exchange.

Governmental agents will attempt to develop institutions to encourage compliance with their decisions. In so doing, it will have to implicitly or explicitly rely on the neural mechanisms discussed early to encourage compliance with public obligations. Often the government will attempt to rely on mechanisms that were developed for both negative and positive reciprocity to encourage compliance. As discussed earlier, emotional or automatic processes allow for quick reactions which can save on 'expensive' cognitive processing. If it can frame violations of its rules as defections from social norms, they are more likely to be punished and often private punishment is enough to enforce this obligation. To the extent that society is able to frame defection as cheating and invoke social sanctions, enforcement will become easier. It is likely that compliance with directives of newly formed governments that differ from traditional obligations will evoke only cognitive and rational responses, at least initially. Those societies that have attempted to supplant smaller group loyalties too quickly have often been unsuccessful, whereas those who were able to co-opt local individuals with influence and leaders of pre-existing social groups have been more successful. In so doing, they are able to align social sanctions with the new regulatory structure. Therefore, initially explicit rules may be necessary to enforce compliance, but

if over time others begin to observe general compliance, they too may begin to comply regularly, and not only because of rational calculation (Carpenter 2004).

Governments that are able to develop institutions which extend the scope of trust and trust-like relationships are likely to yield efficient outcomes. The neurological evidence indicates that individuals are likely to switch from perceiving a situation as one of impersonal exchange to viewing it as one of personal exchange, with very little change to the underlying facts. This particular feature of human behaviour can both help to foster optimal social behaviour (e.g. cooperation with those we barely know) and create harmful social behaviour (e.g. the awarding of the benefits of public funds to friends of governmental agents). Interestingly, research that is being conducted in areas like neuromarketing may be able to help governments to understand the impact of various types on institutional structure.

It is likely that punishment of violations will always have to be part of the arsenal of any government authority, because of the heterogeneity of the population. In fact, the problem may be even more entrenched owing to the evolutionary game theoretic predictions that such heterogeneity is a stable equilibrium (Harsanyi 1973).⁵

4. CONCLUSION

In many ways the creation of modern society, with its reliance on impersonal exchange, is astounding, given the preference for personal bargaining that we exhibit. Many institutions have developed to make use of the mechanisms that we have for trust and reciprocity. For example, it is often said that soldiers do not fight for the army as whole as much as they fight for their immediate platoon or squad. By organizing soldiers into groups of a size where repeat interactions are common, they each will begin to behave cooperatively with other and will behave altruistically as well. This is an example of a social ordering that was explicitly created to take advantage of particular features of human behaviour. Research shows that human behaviour is a function of a complex interaction of neural mechanisms. By understanding the neural mechanism, which we use to solve problems, we can hope to create laws and other rules that will help to foster socially optimal behaviour. Such research has already given us important insights into behaviour. However, future research is likely to be able to tell us how to significantly enhance compliance with law at a minimal cost and to encourage better forms of social interaction. This research will probably completely change the way we view nearly every area of law.

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ENDNOTES

¹ The Wisconsin Card Sorting Task involves sorting cards that have objects on them that vary along three dimensions: shape, colour and number. The cards are to be sorted according to a method determined by the experimenter, but not explicitly told to the subjects. The subjects learn the rule by trial and error, or by feedback from the experimenter as to whether a particular sorting is in accord with the rule or if it violates it.

² One might very well not wish to break a contract with a powerful person, even if such a breach might be efficient, but one might violate contracts or commit torts against a powerless person with impunity.

³ In particular, it activated the dorsal ACC.

⁴ One should note that when we say that reputation and other features of repeat interaction were sufficient to ensure cooperation, we are not saying that defection never occurred. Rather that the level of defection was sufficiently low so that the basic parts of the system households, clans or other groups, were able to function.

⁵ To some extent heterogeneity would be predicted under Harsanyi's model whenever the Nash equilibrium involves a mixed strategy.

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GLOSSARY

- ACC: anterior cingulate cortex
 CEO: chief executive officer
 OFC: orbital frontal cortex
 PFC: prefrontal cortex
 STS: superior temporal sulcus
 TOM: theory of mind