

How neuroscience might advance the law

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This essay discusses the strengths and limitations of the new, growing field of law and biology and suggests that advancements in neuroscience can help to bolster that field. It also briefly discusses some ways that neuroscience can help to improve the workings of law more generally.

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1. INTRODUCTION

These are exciting times for the curious and the contemplative, because the mysteries of the brain are beginning to be understood. The popular press is full of stories about studies attempting to locate the places in the brain where thoughts, perceptions, feelings and motivations are formed. For social scientists who create models of human behaviour, these findings have enormous potential theoretical value. For legal academics striving to find ways to use the law to maximize the beneficial effects of human tendencies, neuroscientific developments are potentially immensely important.

This essay proffers just a few of the myriad ways in which neuroscientific knowledge might be able to improve the law. I approach the topic as a law professor who attempts to incorporate knowledge developed in other disciplines into a behavioural model that informs decisions about legal policy. As a specialist in law and a student of neuroscience my scientific understanding is comparatively weak. In the spirit of attempting to promote interdisciplinary collaboration, however, this essay will nevertheless discuss some ways in which neuroscience carries the potential to help inform both our models of human behaviour and legal policy. In particular, this essay will discuss some ways in which neuroscience can help bolster and refine some of the implications of evolutionary theory for law. The first section of this essay will provide a brief description of the recent development, as well as some of the challenges and limitations, of the field of law and biology. The second section will discuss a few ways in which developments in neuroscience can be used to help overcome some of the challenges faced by those interested in using scientific knowledge to advance our understanding of human behaviour.

2. THE DEVELOPMENT AND CHALLENGES OF LAW AND BIOLOGY

Despite the enormous potential for law and biology, the movement was a little slow to move forward. The Gruter Institute for Law and Behavioral Research, founded by Margaret Gruter, has fostered research in law and biology since 1981¹ but attention to the field by the mainstream legal academy has been limited to the past five or so years. Today there are many very talented individuals engaged in

law and biology, and they have tapped into significant resources to advance our understanding of how behavioural biology informs legal policy-making.²

As interest in law and biology developed, the field attracted three different types of law professor. First were those law professors who were really natural scientists at heart. These professors probably should have explored careers in zoology or marine biology, as evidenced by the fact that they seem to know and care much more about the skeletal structures of mammals than they do about the Uniform Commercial Code or the Rule Against Perpetuities. For tenured law professors who missed their true calling, law and biology has become a mechanism by which they can turn avocation into vocation. While I must admit that I greatly enjoy talking with this group of individuals at conferences, these members are poorly suited to convincing the mainstream legal academy of the importance of evolutionary insights for the law. These professors tend not to be terribly interested in careful legal applications, with the result that others reading their work can too easily dismiss the movement as at best a marginally relevant interdisciplinary fad. Environmental, food and drug, and health-care policies might be important exceptions to charges of irrelevance, however, because much of the effectiveness of these policies turns on a careful understanding of current scientific knowledge. Although environmental and health-care lawyers are very much interested in biology, microbiology tends to be more directly useful to them than does evolutionary theory. Evolutionary theory can nevertheless help these policy makers to understand and predict how human behaviours such as antibiotic and pesticide use create evolutionary pressures on both humans and non-human organisms. In any event, the 'science buffs' have had little impact on how other law professors think about human behaviour.

A second group of law professors interested in evolutionary theory include those whose normative views lack strong social scientific support. These scholars seem pre-committed to strong ideological agendas. On the right, many complain that political correctness in the social sciences prevents honest discussion of such topics as the role of women in combat, racial differences in sports and academic performance, and the inevitability of workplace sexual harassment. On the left, where the crime control model, based on notions of deterrence and retribution, is being

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fought, the assumptions of free will and personal responsibility that underlie current legal structures are weakened by insights from evolutionary theory. In both cases, scholars appear to be attracted to the perceived determinism of the theory.

Why does evolutionary theory attract ideological extremes? The theory itself is positive, and of course, no positive theory can prove the soundness of a normative position. Moreover, nothing in the theory itself suggests that ideologically extreme positions are any more likely to follow from the theory than are more moderate positions. Instead, I believe that the extreme positions are better explained by what I will term a search cost theory of interdisciplinary work. Far too often, law professors start with a normative viewpoint that they wish to justify by reference to supporting interdisciplinary research. A writer who starts with an ideological viewpoint, or a set of priors formed from ideological beliefs, will tend to search only as far afield from legal literature as is necessary to find sufficient support for those ideological views or priors before proceeding with her legal proposals. Most mainstream normative views are already supportable with research in psychology, economics, sociology and political science. These social sciences are closer to law in terms of research methodologies, required knowledge base and terminology use than are the natural sciences, and given their backgrounds, the average law professor presumably is much more likely to have previously acquired social scientific than natural scientific knowledge. Because research in the natural sciences is more time consuming and difficult for law professors, they are much less likely to incur those costs in order to support moderate views. By contrast, those with more extreme views may find validation in those views only by bypassing the social sciences and heading for the natural sciences—here, to evolutionary theory. This biasing effect is most unfortunate for the development of the field. In fact, this ideological bias explains why ‘sociobiology’, the intellectual precursor to ‘evolutionary theory’ and ‘behavioural biology’ was so strongly and universally vilified by those in the social sciences. Evolutionary psychology is currently under fire for similar reasons, and behavioural biology is also beginning to be viewed suspiciously. For a survey and critical discussion of the various fields linking evolution and human behaviour, see Laland & Brown (2002).

The legal academy comfortably ignores science buffs working in the area of law and biology, regarding them as irrelevant. This second group of ideologically extreme scholars using evolutionary theory are less easily ignored but much more easily vilified. Rather than attacking the scholars and their questionable uses of evolutionary theory, however, many have simply attacked the use of evolutionary theory as dangerous. For a law review critique with references to several books that detail the abuses of biological theories, see Vogel (1997). The rest of us working in the field of law and biology bemoan the reflexive, emotional and ignorant rejection of evolutionary theory by many of our colleagues. The rejection is all the more frustrating when it is supported merely by glib comments that would have earned the rejector a grade of ‘D’ in high school biology. Moreover, because so much of legal literature is normatively driven, those of us who are interested in evolutionary theory for its own sake are presumed to have an ideologically extreme agenda. This assumption is often

incorrect, but the resulting potential derision causes many to steer clear of law and biology.

A third and growing group of scholars has very recently brought energy to, and promise for the future of, law and biology. These academics are interested in developing the best possible models of human behaviour. For these instrumental scholars, the law is a tool used to influence what people do, but efficient and effective use of these tools requires the best possible understanding of human behaviour. A few examples include Jones (1997, 2001), Geddes & Zak (2002) and O'Hara & Yarn (2002). Behavioural biology is viewed as one of several tools that provide useful insights into human behaviour. These lawyers, as human behaviour theorists, are more likely to be deeply committed to exploring legal policy than are the science buffs, and they are less likely to be driven primarily by a normative agenda than are the ideologically extreme law and biology hobbyists. They should be neither ignored nor vilified.

Before this recent emergence of law and biology, legal scholars were busy scouring the fields of psychology and economics to build and test frameworks for human behaviour. The strengths of economic theory lie in its rigour and in its ability to generate testable predictions about human behaviour (Posner 1992, p. 17). Central to economic theory is an assumption that people act rationally in pursuit of their goals (Posner 1992, p. 3). The goals themselves are defined as elements of the person's utility function. The idea behind individual utility functions is that individuals can and do have positive preferences for many goods, services and other things. People can desire almost anything, from leisure, status and marriage to chocolate chip cookies, children and Irish setters. People are also assumed to be able to order their preferences so that at any given point a marginal increase in each of these desirables—marital quality, cookies and leisure, for example—can be rank ordered against the other desirables.

Legal academics attempting to use economic theory have generated many useful insights, but in the process, they have confronted two types of limitation. First, although individuals are allowed to prefer practically anything under economic theory, most economists are reluctant to explore the content of individual preferences (Hirshleifer 1977). Instead, they make very simple assumptions about preferences. Most commonly, they assume that people have a taste for money, and empirical work in economics typically focuses on profits or dollars as a goal of human behaviour (O'Hara & Yarn 2002). No doubt money and wealth motivate much of human behaviour, but this assumption is not always helpful in attempting to explain or predict human behaviour.

Often a desire for money sits in tension with other less quantifiable goals. For example, a growing body of legal scholarship recognizes that suit and settlement decisions often have relatively little to do with the amount of money at stake. Instead, plaintiffs often leave money on the settlement table once they receive a heartfelt apology from the defendant (O'Hara & Yarn 2002). Plaintiffs want vindication and restoration of their dignity. They may seek money too, but a single-minded assumption that they merely seek to maximize the monetary gains from suit misses important settlement dynamics that are much more likely to drive the plaintiff's decision.

At other times monetary incentives signal that something is amiss with the proposal of the 'offeror'. If, for example, the local government offers modest monetary rewards to induce people to recycle, some of the citizens will interpret the incentive as a signal that recycling levels are quite low. To the extent that people care more about complying with social norms than they do about the modest monetary payoff for recycling, then recycling levels could actually fall with the monetary incentives in place. According to Vandenbergh (2003), one implication of the norm of conformity is that people will comply with the law only if they perceive others to also comply.

In a related context, day-care centres sometimes find that parents are more rather than less likely to pick up their children late when a modest late fee is introduced. Before the imposition of the late fee, parents made greater efforts to pick up their children on time out of a sense of moral duty. With the imposition of the fine, some of the parents decided that it was worth the stated price to come a bit later (Gneezy & Rustichini 2004). Here, too, a single-minded assumption that people only care about money can lead to counter-productive policies.

Even when economists correctly identify people's goals, the assumption that people are likely to act rationally in pursuit of those goals is sometimes subject to challenge. Put differently, those who use the rational actor model are prone to ignore a variety of limitations on our abilities to gather and process information. We are prone to make mistakes owing to hindsight bias, optimism bias, endowment effects, ambiguity aversion, framing effects and other cognitive phenomena. For a description of the cognitive limitations relied on by those critical of the rationality assumption underlying economic analysis, see Mitchell (2002) and Kornhauser (2003).

The law and psychology movement is currently capitalizing on these weaknesses in the use of economic theory. The field started with several academics who were interested in learning more about mental disorders, eyewitness testimony and jury decision-making (see, generally, Satin 1995; Rachlinski 2000), but more recently law and psychology has embraced more general empirical theories of decision making. As Jeffrey Rachlinski notes:

[t]hese new, empirical theories of decision making have an interdisciplinary origin. The field consists largely of psychologists, such as Amos Tversky and Daniel Kahneman, who refer to their work as the psychology of judgment and decision-making. It also includes many economists, however. Some economists in this field, such as Vernon Smith, embrace rational choice models, but seek to test their tenets empirically. They refer to their work as behavioral economics. Other economists, such as Richard Thaler and George Loewenstein, are skeptical of the rational choice models and use empirical research to document its flaws. These economists refer to their field by the name that many legal scholars have embraced: behavioral decision theory (BDT).

(Rachlinski 2000, p.739)

The cognitive phenomena that these scholars and experimenters have identified, including judgement biases, errors, aversions and framing effects, lack their own organizing theory (Jones 2001), however, and without a theory, we are unable to reliably predict or verify those contexts in which the cognitive phenomena are strong and when they are weak. Moreover, without a competing theory, many

remain doubtful of the validity of the methodologies creating these biases (Jones 2001).

Behavioural decision theorists are beginning to focus on the operation of the human brain for a better understanding of these phenomena. Some deviations from rational choice theory stem from the fact that our capacity for attention and memory are limited (Rachlinski 2000). Other deviations originate from the fact that much of the brain's processing occurs outside of our conscious awareness, making correction of some phenomena difficult (Rachlinski 2000). And many deviations from rational choice arise from the fact that our brains are designed to respond to changes in wealth and risk rather than to their absolute levels (Rachlinski 2000). Understanding these facts about the brain is a step towards a richer understanding of these phenomena, but a greater appreciation for the contexts in which these phenomena appear requires an appreciation for the fact that our brains, like our other organs, are shaped by evolutionary pressures.

More specifically, evolutionary theory helps economists to better define the contents of the prototypical utility function (Hirschleifer 1977), and it can help those in behavioural decision theory to generate a sounder theoretical basis for some of the cognitive phenomena that are observed. As Jones (2005), a prominent law and biology scholar, explains:

All theories of human behaviour are ultimately theories about the brain. The brain is a corporeal, biological phenomenon. And modern biology makes forcefully clear that the brain's design, function, and behavioral outputs are all products of gene-environment interactions. At present, the legal system builds its models for regulating behavior using only social science components. And social sciences together typically comprise only the environmental half of the gene-environment whole.

Fortunately, this reality is beginning to change.

Moreover, evolutionary theory often feels comparatively familiar to interdisciplinary legal scholars because the methodologies of biology and economics are somewhat similar³ in that both use game theory to generate equilibrium models of behaviour based on a type of self-interest. Put differently, the learning curve for evolutionary theory is not as steep for these scholars as would be the curve for some of the other natural sciences.

It is here, with the behavioural theorists, that law and biology is finally gaining a foothold. The advance comes with some resistance, because busy law professors still view learning about another field as problematic and view evolutionary theory with some suspicion. Some students of human behaviour are attempting to cast behavioural biology aside as unhelpful or dangerous (Rachlinski 2001; Wax 2004). Nevertheless, a growing number are appreciating the value of learning about evolutionary theory (Posner 1998, 1999; Ulen 2001; Epstein 2002, p. 1307; Luban 2004, p. 111).

The progress that law and biology is making with this third discipline-based group is aided by the fact that economists, psychologists, sociologists and political scientists are beginning to find ways to move beyond the standard social science model to incorporate behavioural biology insights directly into the social sciences (Laland & Brown 2002, p. 2; Pigliucci 2003, pp. 882–884). To the extent that a lawyer who typically uses the tools of economics or psychology

sees that the academics in these fields are beginning to embrace evolutionary theory, he/she is less reluctant to draw on these tools him/herself. The insights are more quickly incorporated into legal analysis when the social sciences incorporate insights from behavioural biology into their own models. Put differently, a rich incorporation of behavioural biology into law might require that it first be heavily integrated with the social sciences. The same may be true for neuroscience.⁴

Although behavioural biology is increasingly incorporated into the social sciences, progress is hampered by three challenges that parallel the concerns about incorporating behavioural biology directly into law. The first two concerns, discussed earlier, are that evolutionary theory is irrelevant for explaining human behaviour and that, if relevant, the analysis is dangerous and politically unacceptable. A third concern raised by human behaviour theorists is that methodologically, evolutionary theory might be insufficiently rigorous. Scientific theories of human behaviour require that they be able to predict human behaviour. These predictions should enable the theory to be empirically testable and therefore falsifiable, and effective testability requires that observations of human behaviour be subject to control conditions (Rachlinski 2001). Evolutionary theory, as applied to humans, admittedly does face some challenges in these categories. Scientists are limited in the experimentation that they are allowed to perform on humans, we still have limited scientific information on the exact link between genes and behaviour, and we face extremely limited information about the timing and the content of the critically important EEA. In fact, these limitations have caused one commentator to claim that evolutionary theory is simply unscientific.

The role that evolutionary forces have played in the development of cognitive processes, and thus in the development of law, is not readily observable. Consequently, evolutionary theories needed to explain law are not subject to empirical testing, and hence, not scientific. . . Without the ability to identify the environmental pressures that produced human cognition or the ability to compare human cognition to that of similar species, evolutionary analysis of law inevitably will lack precision and empirical support.

(Rachlinski 2001, pp. 366, 370)

The charge is puzzling, for in some ways evolutionary theory has been empirically verified more exhaustively than any other. Many observed human behaviours can be ultimately explained by evolutionary theory. Moreover, the specific implications of evolutionary theory for human behaviour are themselves very often verifiable. No doubt behavioural biology can be more finely honed and therefore more useful to policymakers if theories of potentially evolved human behaviours are both informed and confirmed by empirical testing.⁵ Further empirical testing is likely to proceed slowly, however, and in the interim those of us interested in evolutionary theory will have to contend with the charge that it is 'mere speculation' to assert that evolutionary pressures help to shape our tastes, personalities, cognitive thought processes, behaviour and emotions.

3. HOW CAN NEUROSCIENCE HELP?

Developments in neuroscience are providing important empirical support for evolutionary claims that our brains are the product of evolutionary forces and that our brain

structures influence our thoughts, feelings and actions. For those interested in evolutionary theory, neuroscientific findings are increasingly able to provide at least indirect empirical verification of the validity of the predictions of evolutionary theory. The observations not only help to test our current evolutionary theories; they also help to shape a stronger and more relevant behavioural biology. The neuroscientific focus on present manifestations of the evolution of the human brain also helps to distract attention from our paucity of knowledge about the EEA.

Moreover, in some cases, legal scholars can accept the findings of neuroscience without having to take a position in the debate about the usefulness of evolutionary theory. Stated differently, neuroscientific studies are often predicated on hypotheses generated by applying evolutionary theory to the study of the brain (LeDoux 1996; Newsome 1997; Damasio 2003). To the extent that scholars are solely interested in the behavioural phenomenon as it is observed, they are able to bypass the evolutionary psychology debate.

Neuroscientists are learning a great deal about the human brain and how it functions, and along the way we are reminded that behavioural biology has its limits as well as its powerful applications to human behaviour. In other words, we are learning how our brain seems predisposed to function, but we are also learning a great deal about its plasticity in response to environmental factors.⁶ Greater knowledge about the plasticity of our cognitive processes can help to identify the limits of the implications that can be gleaned from evolutionary theory. Presumably, knowledge of the brain's plasticity coupled with knowledge about its predispositions helps us to generate a more robust theory of human behaviour than does a singular reliance on evolutionary theory.

Aside from providing contributions to the theory of human behaviour, advances in neuroscience also promise to aid the efforts of the law to better achieve just outcomes.⁷ As an example, advances in neuroscience have made possible the development of 'brain printing technology' that serves as a type of high technology lie detector.⁸ In essence, the technology can be used to determine which of a series of scenic images the defendant has some prior familiarity with. Several scenes can be shown to a defendant, including some aspect of the scene of the criminal activity, to get a sense of whether a defendant who claims he had absolutely nothing to do with a crime is telling the truth. The technology may evoke the same concerns about reliability and prosecutorial abuse as do more traditional forms of lie detector technologies, but at the same time it promises to aid the exculpation of innocent defendants. If it can do this successfully, then the legitimacy of the State's use of its criminal justice powers can be enhanced.

There are many other areas in which neuroscientists could focus their energies to enhance the functioning of the law, and I will use the remainder of this essay to describe a few possibilities that seem potentially promising to me. In doing so, I run the very real risk that I assume too much of the potential for neuroscientific research or too little about the current state of neuroscientific knowledge. I proceed nonetheless in the hope that at least one of the research avenues mentioned below could actually promote advancement in the law.

Agency plays an important role in the law. We often enlist others to act on our behalf, and sometimes the law imposes special fiduciary obligations on our agents to attempt to maximize the likelihood that they will fulfil their roles honourably and responsibly. Neuroscientists and neuroeconomists have learned a fair amount about our theory-of-mind mechanisms that enable us to glean and interpret the understandings, behaviour and intentions of others.⁹ In interpersonal settings, we use this theory of mind mechanism to form judgements about whether another is more likely to act as 'friend' or 'foe', to forecast whether they are likely to behave coincident with our own self-interest and to make judgements about the extent to which another can be trusted. The decision about whether to trust is better understood today.

Many legal rules focus on the other end of this interpersonal dynamic, however, because they are primarily aimed at determining when we can realistically expect the agent to act in a trustworthy fashion. To try to encourage trustworthy behaviour, the law imposes on some agents' fiduciary duties of loyalty and care (Goodenough 2001). In other contexts, agents are simply prohibited from certain behaviours out of an intuition in the law that these behaviours will unduly compromise the trustworthiness of the agent's actions. For example, in some states a realtor earning a commission on the sale of real estate is barred from serving as power of attorney for the purchaser in the transaction (Walker 1922). Trustees are not permitted to commingle trust funds with personal funds.¹⁰ Federal judges who have a pecuniary interest in one of the parties in a lawsuit are required to excuse themselves from involvement in the particular case.¹¹ These are all examples of situations where rule-makers question the ability of individuals to be loyal agents owing to their potentially conflicting personal interests.

In other areas of the law, however, agents need only disclose potentially conflicting situations, and the principal is left to determine how much scrutiny of the situation is warranted. A real estate attorney or divorce lawyer might for example be permitted to represent both sides of a legal matter (Galaty *et al.* 1974; Aronson & Weckstein 1980), and a realtor can refer clients to lenders that are financially aligned with the real estate company. Moreover, debates exist in corporate law and elsewhere about whether fiduciary duties should be contractually waivable by the parties (Blair & Stout 2001; Ribstein 2001).

The lines that are drawn and argued about in the law turn, in part, on as yet unanswered empirical assumptions about the potential trustworthiness of the agent. To what extent can, and do, we place ourselves mentally into the role of another when we are enlisted to act on their behalf? The law and legal advocates form intuitions about when that mental representation will be overridden with conflicting self-interest, but how accurate are these intuitions? People presumably vary in their trustworthiness, and our understanding of the role of the prefrontal cortex in human behaviour is improving dramatically. Much more important for legal policy purposes, however, is a need for a better understanding of the extent to which our intuitions about the limits of trustworthiness should change or vary with the behavioural context. Neuroscience might help us to better understand which sets of empirical assumptions

about contextual trustworthiness are ultimately supportable.

A second place where neuroscientists can help to advance the law is in sorting deception from self-deception. *Mens rea*, or the state of mind of the defendant, is often important to our legal determinations of guilt or liability, particularly in the areas of criminal law and intentional torts. When a judge or jury is asked to make a determination about whether the defendant acted with 'knowledge', 'intent' or 'purpose', they are often forced to infer the defendant's state of mind from facts that can be gathered about his actions. Under the Model Penal Code, for example, crimes can require one of four mental states on the part of defendant. These four categories are as follows.

- (i) Crimes requiring *intention* (or *purpose*) to do the forbidden act (omission) or cause the forbidden result;
- (ii) Crimes requiring *knowledge* of the nature of the act (omission) or of the result which will follow therefrom or of the attendant circumstances;
- (iii) Those requiring *recklessness* in doing the act (omission) or causing the result (...the actor must in his own mind realize the risk which his conduct involves); and
- (iv) Those requiring only *negligence* in so doing or causing (...the actor need not realize the risk in order to be negligent...) (LaFave 2000, pp. 229–230).

In addition, some crimes require no proof of mental state at all. These crimes are known as strict liability crimes (LaFave 2000, pp. 257–265).

When *mens rea* is disputed, the defendant claims that he did not intend to harm or that he was unaware of the consequences of his actions, and the legal decision-maker must determine whether his claim is credible. In many situations, the judge or jury must effectively determine whether the defendant is attempting to deceive them about his intentions or knowledge. This finding might in turn depend on a determination about whether the defendant, whose position is clearly unreasonable, is engaging in deceptive or self-deceptive claims. Evolutionary theorists have argued that self-deception can evolve as an effective mechanism for deceiving others (Trivers 1985, pp. 415–418; Moomol & Henzi 2000). The idea is that the telltale physiological signs of deception can be suppressed only if the actor himself is unaware of his deceptive behaviour.

Although evolutionary theorists might label self-deception as just another form of deceptive behaviour, the law often cares a great deal about the distinction between the two. For example, the crime of fraud requires not only that the defendant intended to behave the way that he did, but also that he intended to deceive and defraud his victim (LaFave 2000, p. 230). If the defendant deceived himself into believing his intentions were honourable at the point in time that he interacted with his victim, then he lacks the state of mind necessary to be guilty of fraud. More generally, under the Model Penal Code, only negligence and strict liabilities crimes do not require awareness on the part of the defendant about what he is doing or the likely consequences of his actions. Negligent and strict liabilities crimes are disfavoured in the criminal law (Parker 1993), however, so most crimes require that the defendant be consciously aware of his actions and/or their harmfulness at the time of acting. If one is, by definition, unaware of self-

deception, then at least some of our concepts of legal blame do not attach to the situation. The defendant may be negligent for failing to comprehend that he was deceiving himself, but he cannot be said to have acted knowingly or intentionally.

Jurors and judges make their determinations about the defendant's state of mind based on a 'gut instinct' that may be infected by unfortunate biases or prejudices. If neuroscience could develop a more reliable way to separate deception from self-deception that could be used in the courtroom, the accuracy of these legal determinations could be greatly improved. Some evolutionary theorists posit that self-deception occurs when the conscious and subconscious hold contradictory beliefs about the self.¹² One can only hope that this, or some alternative understanding, could be more precisely identified.

Another place where the law makes blameworthiness or credibility distinctions is in those contexts where people are believed to 'snap'—that is to become suddenly unable to control their behaviour with conscious deliberations about the costs and benefits of their responses. For example, my colleague Michael Vandenberg has begun work on the evidentiary reliability of 'excited utterance' rules given what we now know about the neuroscientific basis of the phenomenon. A second context in which the law could be better informed by neuroscience is provocation. The provocation doctrine in criminal law enables a charge of murder to be reduced to a charge of manslaughter if the defendant was provoked into killing (Perkins & Boyce 1982, pp. 84–85). In general, the provocation must be of a type that would cause the average person to lose control (Perkins & Boyce 1982, p. 87), but US courts have differed in the contexts in which the partial defence of provocation can be invoked. All courts allow the provocation defence in cases where the defendant witnesses his wife engaged in sexual relations with another man, but more difficult issues about provocation arise when the news of adultery is reported to the defendant third-hand, when the killer has been victimized by domestic violence or social taunting, and when the provocation involved a mere fist fight (Perkins & Boyce 1982, pp. 88–98). Moreover, in all states the provocation defence is unavailable if enough time passes between the provocation and the killing to enable the defendant to regain his composure (Perkins & Boyce 1982, pp. 99–101). The appropriate length of this cooling off period is left to juries and varies considerably from case to case (Perkins & Boyce 1982, p. 100). Presumably, the greater the provocation the longer the permissible cooling-off period (Perkins & Boyce 1982, p. 101). In addition, circumstances could prolong or reignite the emotional reaction (Perkins & Boyce 1982, p. 101). Although variation in the availability of, and limitations on, the use of the provocation defence are appropriate, a better understanding of the neurochemical response to varying forms of provocation might help the criminal law courts to fine tune their delivery of justice.

Finally, neuroscience can play an important role in helping the legal system to devise mechanisms for creating optimal incentives for individual and corporate behaviour. Most often injuries occur out of sheer inadvertence or ignorance of the risk of harm on the part of the injurer. The law imposes potential fines or other liabilities on these actors in an effort to draw their attention to the ways in which their behaviour can harm others. This legal response

is well supported in neuroscience because it is now well understood that brains respond to changes or challenges in the environment rather than paying careful attention to all potential information available (C. Camerer, G. Loewenstein, D. Prelec, personal communication). When the law imposes a new obligation, it does so in a way calculated to gain the attention of potential injurers in the hopes of deterring future injuries. Unfortunately, if the law responds very dramatically to the problem, it risks triggering a fear response in potential defendants, and the law risks over-detering socially useful conduct in its efforts to promote care. As Camerer *et al.* (2005) explain the phenomenon, 'much risk averse behavior is driven by immediate fear responses to risk, and fear, in turn, seems to be largely traceable to a single small area of the brain called the amygdala' (Camerer *et al.* 2005). Any nuanced neuroscientific understanding of how legal responses might catch the attention of potential injurers without causing significant reaction in the amygdala could prove enormously helpful to the development of legal development and enforcement efforts.

4. CONCLUSION

A neurologist once questioned why the lawyers at a Gruter Institute conference were so interested in learning about brain physiology. Who cares how the brain functions technically when all the lawyer really cares about is how people actually behave? The answer to his question is threefold. Some delight in learning about the science for its own sake. Others seek radical knowledge about the brain to support their radical normative views. But the third group—the one to pay attention to—hopes that a more sophisticated understanding of the brain can eventually help us to sort out the validity of competing and complementary theories of human behaviour. On a more pragmatic level, brain technologies promise to improve the legal system's delivery of justice. This essay mentions just a few of the questions that lawyers hope neuroscientists can help us resolve.

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ENDNOTES

¹ <http://www.gruterinstitute.org> (visited 16 February 2004).

² For more information on law and biology see the website for the Society for Evolutionary Analysis in Law at <http://www.sealsite.org> (visited 21 October 2004).

³ Charles Darwin was heavily influenced by Adam Smith's work (Gould 1995, p. 329).

⁴ Neuroscience too is slowly working its way into the literature of other fields. See, for example Pigliucci (2003), Casebeer & Churchland (2003), Debiec & LeDoux (2003) and Liberman *et al.* (2003).

⁵ Russell Korobkin (2001) does a wonderful job of describing the intellectual synergies that can be produced by combining evolutionary theory with economic theory, experimental economics and cognitive psychology.

⁶ I have discussed this topic and its importance for human behavioural theorists in general, and lawyers in particular (O'Hara 2001).

⁷ For excellent efforts at merging the fields, see the other articles in this issue, especially Goodenough & Prehn (2004).

⁸ Alan Elsner, New 'brain fingerprinting' could help solve crimes, posted at <http://www.rense.com/general34/newbrainfingerprinting>. See also Becky McCall, Brain fingerprints under scrutiny, at <http://news.bbc.co.uk/2/hi/science/nature/3495433.stm>.

⁹ On theory of mind and its role in making cooperative decisions (see, generally, Fletcher *et al.* 1995; Happe *et al.* 1996; Frith 2001a,b; McCabe *et al.* 2001).

¹⁰ Restatement (Second) of Trusts § 179 (1959).

¹¹ 28 U.S.C.A. § 455.

¹² See Moomol & Henzi (2000) for a discussion of competing theories of self-deception.

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GLOSSARY

EEA: environment of evolutionary adaptation