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Law, evolution and the brain: applications and open questions

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This paper discusses several issues at the intersection of law and brain science. It focuses principally on ways in which an improved understanding of how evolutionary processes affect brain function and human behaviour may improve law's ability to regulate behaviour. It explores sample uses of such 'evolutionary analysis in law' and also raises questions about how that analysis might be improved in the future. Among the discussed uses are: (i) clarifying cost–benefit analyses; (ii) providing theoretical foundation and potential predictive power; (iii) assessing comparative effectiveness of legal strategies; and (iv) revealing deep patterns in legal architecture. Throughout, the paper emphasizes the extent to which effective law requires: (i) building effective behavioural models; (ii) integrating life-science perspectives with social-science perspectives; (iii) considering the effects of brain biology on behaviours that law seeks to regulate; and (iv) examining the effects of evolutionary processes on brain design.

Keywords: law; evolutionary analysis in law; brain; human behaviour; behavioural biology

1. INTRODUCTION

The odds seem stacked against the Saharan desert ant *Cataglyphis*. It must forage alone in scorching temperatures. It must travel vast distances. It must loop and zigzag in constant pursuit of the heat-stressed prey that it must somehow locate, overcome, and then carry. Perhaps most dauntingly, with prey or without, each ant must make its way back to a small and far-distant nest entrance, out there—somewhere—in a numbingly monotonous landscape.

Yet, from the moment it starts to return, no matter where it is and no matter how peripatetic its prior wanderings, *Cataglyphis* travels a straight line back to the nest. How can this be?

To do this, each *Cataglyphis* ant needs to keep track as it travels of its changing orientation with respect to the nest, so as to know which direction to head when returning. It also needs to update its approximate distance from the nest continuously, so that when it travels in the right direction it knows when to stop and begin a local search, neither over- nor under-shooting the actual entrance.

Using an ingenious combination of observation, experiments, robotics, artificial intelligence and neurophysiology, the zoologist Rudiger Wehner has demonstrated that the *Cataglyphis* compass is updated and optically mapped against ambient light, upon emergence from the nest, with the aid of the ant's multiple polarized lenses (Wehner 2003). Even more impressively, the *Cataglyphis* distance calculator can translate the varying three-dimensional heights and inclines of wanderings into a two-dimensional map (which is necessary, for example, if the outward journey is hilly and the return route is flat). This is rather remarkable for a species ignorant of trigonometry and sporting a brain that weighs barely one ten-thousandth of a gram.

The human brain, by contrast, weighs 13 million times as much, *ca.* 1300 g. What purposes call on such power? Although the brain constitutes merely 2% of our body weight, the brain's activities consume *ca.* 20% of the calories we ingest. Given the relentlessness with which natural selection punishes waste, such an energetically costly device must provide some significant compensating benefits. What these are, how they are procured and by what processes they came to be procured are among the great questions in modern science.

The editors asked each author in this theme issue to explore various implications of modern brain science for law. Each author will probably frame these implications differently. Here is how I would frame them. Law deals in behaviour, and behaviour arises (principally) from the brain. So learning more about brain design and function should prove useful to legal thinkers, who so often are tasked with changing various aspects of human behaviour to ensure that, by and large, people behave the way society prefers.

We could preliminarily subdivide into two main contexts the usefulness of bringing law and brain science together. The first context concerns internal states: what is happening on the inside, within the brain (as it perceives, assesses and chooses, for example). The second context concerns external effects: what happens on the outside as a function of brain operation (when a person behaves in ways discernible by others).

We could further subdivide legal issues relevant to the internal states of the brain into those concerning intervention technologies and those concerning imaging technologies (Garland 2004). Intervention technologies

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include existing drugs, as well as drugs in development, that may enhance cognitive capabilities. For example, researchers are reportedly investigating drugs commonly used to treat depression or attention deficit hyperactivity disorders (such as selective serotonin reuptake inhibitors and noradrenaline (norepinephrine) reuptake inhibitors) for their potentially cognition-enhancing capabilities in non-depressed individuals. Efforts are apparently underway to develop drugs that boost the levels of chemicals in the brain (such as cyclic adenosine monophosphate (cAMP), cAMP response element binding protein (CREB) and glutamate) involved in amplifying memory. And transcranial magnetic stimulation, which has been shown to be capable of exciting or inhibiting various areas of the brain, may also be capable of thereby enhancing certain cognitive functions (Tancredi 2004). How, if at all, should the legal system regulate such intervention technologies?

In contrast to these intervention technologies, imaging technologies enable us to perceive non-invasively what the brain is doing when a person engages in various physical or mental tasks. These technologies include existing techniques, as well as those in development, that may eventually help us to decide (to give just three examples of many) whether a witness or defendant is competent, whether an unconscious person is brain dead or whether a person is lying (Tancredi 2004).

For example, techniques in development that use near-infrared brain scans and magnetic resonance imaging can reveal activity in the prefrontal cortex and the anterior cingulate cortex in the superior frontal gyrus, respectively. Such techniques have already started to illuminate the neural basis for social cooperation (Rilling *et al.* 2002). Will these technologies someday enable us to identify the neurophysiological predicates of 'normal' self-control or to witness the effects of brain damage on law-relevant mental processing? Some preliminary brain-imaging work is already underway that appears to show the brain-state differences between thinking about a just result to a legal conflict and applying a provided rule to resolve that conflict (Schultz *et al.* 2001). Might this someday tell us something useful about how to encourage jurors to think more or less about either justice or rules, or about how to better achieve a desired balance of the two?

A new electroencephalograph (EEG) technique can apparently detect a particular brain-wave pattern known as P-300, the presence of which, many believe, reliably indicates that the brain is recognizing a familiar stimulus (Tancredi 2004). Will these and other windows on brain function ultimately tell us anything legally useful about whether a person is lying? Will the presence of the P-300 enable us to detect lying more reliably than when traditional lie-detectors are used? Suppose the stimulus is a picture of a crime scene that a suspect denies ever visiting. Should 'brain fingerprinting' evidence that reveals an absence of a P-300 wave in the defendant's brain when he was shown a picture of the crime scene be allowed as evidence in support of his defence? Courts have only recently begun to address such questions (e.g. Terry Harrington versus State of Iowa, Supreme Court of Iowa, 659 N. W. 2d 509 (2003)).

Neuroscientific advances relating to the brain's internal states have already raised a host of legal questions concerning evidence, privacy, patents and the like (Greely 2004). What are the limits of discoverable correspondences between mental states and brain states? For some, advancing technologies raise variations on already-important questions concerning free will and responsibility (Gazzaniga & Steven 2004; Morse 2004). For others, technology offers the promise of revealing the neural bases of deciding, choosing, intending and acting.

Legal issues relevant to the external effects of brain function are somewhat different. The brain is, in many respects, a machine designed to correlate patterns of stimuli with patterns of behaviour. Behaviours relevant to law are products of perception, information-processing, emotions, deliberations, decisions and other states of the brain operating in dynamic ways that often reciprocally affect one another. Will a more detailed understanding of brain function enable us to predict a person's behaviour with the degree of confidence that different legal contexts may require? (Greely 2004). For example, would we want such an understanding to play any role in parole decisions, when the likelihood of recidivism is at issue?

The two different kinds of causes of behaviour, which biologists term 'proximate' and 'ultimate' (Mayr 1961), contribute to each of the two general contexts, discussed above, in which the legal system might attend to brain science: internal states and external effects. (Readers will recall that proximate causes involve immediate causal pathways and mechanisms; ultimate causes reflect the evolutionary pathways by which some proximate cues, rather than others, came to be correlated with some behavioural outputs, rather than others; Goldsmith & Zimmerman 2001.)

Biologists already know that proximate and ultimate causes are always present simultaneously. Every action of every organism reflects not only its unique developmental history and immediate environment but also its evolved species-typical capabilities and behavioural predispositions. To date, however, most of the law's limited attention to brain biology focuses exclusively on proximate causes. This may be because proximate causes are often easier to study. Or it may be because technological advances typically stem from studies of proximate causes and typically intervene among proximate causes.

There are probably other reasons too, but here I wish to underscore several advantages to law of knowing more about the ultimate evolutionary causes of human brain design and about the relationship between evolved behavioural predispositions and resulting behaviour.

A growing number of scholars (compiled in Jones 2004*b*) have for some time been engaged in what I have elsewhere described as 'evolutionary analysis in law' (Jones 1997*a*). Their common enterprise is to use knowledge about evolutionary processes, animal behaviour or both in ways that may further legal goals. In that enterprise, some things are known and many more are yet to be known.

In what follows, I first discuss the often under-recognized importance to law of sound behavioural models. I argue that these models—to be maximally effective—should eventually include life-science perspectives on the proximate and ultimate causes of human brain function. I then turn to raise briefly a variety of questions that need further attention as evolutionary analysis in law develops. The subsequent section offers some general thoughts about assessing and incorporating interdisciplinary perspectives,

such as those from biology. The final section provides a few brief illustrations of where and how evolutionary analysis in law can be useful.

2. LAW, BIOLOGY AND BEHAVIOURAL MODELS

For historical reasons, the social sciences and the life sciences remain more frequently divided than their significantly overlapping interests in humans might otherwise suggest. Specifically, the study of human behaviour is too often too separated from the study of animal behaviour. Over-separation is unsound; human behaviour is a subset of animal behaviour, and therefore the studies of each must in the end reconcile with studies of the other. Over-separation is also unwise; it can obscure patterns that offer both knowledge and utility, and that can be costly.

Integrating the behavioural aspects of social sciences and life sciences into a seamless behavioural science should have particular appeal to legal policy-makers. Society often charges legal policy-makers with moving a large human population to behave more this way and less that way, consistent with democratically percolated and pre-articulated goals. And a deeper understanding of the relationship between human behaviour and the brain's design and function should prove useful to that enterprise.

There are many fields in biology that can contribute to that deeper understanding. One such field is behavioural genetics, which attempts to trace the different behaviours of different individuals to different genes among them. Another is neuroanatomy, which can reveal where and how human states originate in the brain. To these (and others) one can add evolutionary biology, which helps to illuminate how different behaviours of different individuals can flow from species-typical brains that sport highly contingent evolved algorithms (which in turn increase or decrease the probabilities of given behavioural responses in reaction to varying environmental conditions).

It may be easy for legal policy-makers to ignore or to forget that evolutionary processes influence human behaviour as well as human morphology. For one thing, legal policy-makers often ignore a great many behavioural disciplines at a time, not just biological disciplines, when they deploy insights on behaviour that typically reflect various admixtures of common sense, sociology, religion, philosophy and the like. Also, legal policy-makers typically lack significant science education, and that enables deep misunderstandings about how genes, environments and evolutionary processes interact in ways that affect resultant behaviour. And a few legal policy-makers (in common with some in the general public) may still incorrectly assume that biological explanations are inherently deterministic in a way that will often lead to justifications for bad behaviour, converting description into prescription, as if the only role for behavioural biology would be to acquit criminal defendants.

Nevertheless, there are many different ways in which human behavioural biology can offer utility in law without altering normative agendas. Carefully done, for example, evolutionary analysis in law can help to reveal the unwarranted assumptions about how and why humans behave as they do that underlie some existing legal policies. It can help us to discover useful patterns in regulable behaviour, which may lead to different regulatory strategies. And perhaps most generally, evolutionary analysis in law can help to increase law's effectiveness and efficiency.

Here is the four-step logic: (i) effective law requires an effective behavioural model; (ii) law's commonly used behavioural models are importantly incomplete; (iii) building more robust behavioural models probably requires (among other things) the integration of social-science models with life-science models; and (iv) integrating social-science models with life-science models requires familiarity with behavioural biology, including the effects of evolutionary processes on species-typical brain form and function. This logic unfolds in the following way.

First, almost anything law achieves it achieves by effecting changes in human behaviour. It effects changes, in turn, by inspiring people (or in rare cases forcing them physically) to behave differently from the way they would behave in the absence of the law's intervention. The ability to deploy legal tools to effect these changes at the least cost to society is importantly affected by the accuracy of the behavioural models on which law relies.

To put this more graphically, law is like a lever for moving behaviour, with a model of human behaviour serving as its fulcrum. That behavioural-model fulcrum consists of what we think we know about why people behave as they do. That is, the behavioural model constitutes the aggregated insights that underlie our prediction that if law moves this way, behaviour will move that way and not some other way.

Because soft fulcra are poor fulcra, we can consider the success of every legal system to depend, in part, on the solidity—that is, the accuracy and predictive power—of the behavioural model on which it both rests and relies. Flawed models will tend to yield less effective law, and legal approaches to understanding and influencing human behaviour that are based on outdated behavioural models are simply less likely to effect socially and legally desirable outcomes than are those based on more robust behavioural models. Consequently, effective law will generally require effective behavioural models.

Second, all theories of human behaviour are ultimately theories about the brain. The brain, of course, is a corporeal biological phenomenon, and modern biology makes it forcefully clear that the brain's design, function and behavioural outputs are all products of gene–environment interactions.

At present, however, the legal system tends to build its models for regulating behaviour by focusing only on the kinds of influences to which social sciences attend. Though these influences are useful to understand, they typically contribute only the environmental components of the gene–environment whole.

To put the magnitude of this oversight in sharp perspective: trying to build any human behavioural model from social sciences without life sciences is like trying to make iced tea with either water or tea leaves but not both. We know that behaviour is the result of inseparable environmental and genetic effects. Therefore, the routine omission of one of the two principal behavioural ingredients grossly oversimplifies something inherently complex, ignores interactions necessary for behaviour and renders law's general approach to behavioural models importantly inaccurate and incomplete.

Third, an objective reality underlies the influences on human behaviour. This reality cannot be captured by simplistic models that posit environmental determinism. Of course, integration of the behavioural sciences (both social and life) and behavioural influences (both proximate and ultimate) cannot guarantee perfect behavioural models. But integration, if done carefully and well, is probably a significant step towards more effective, efficient and accurate behavioural models than the ones legal thinkers commonly employ.

Integrated models, far from oversimplifying human behaviour, would reflect the most complete understanding available of the multiple and complex influences on behaviour. They would vindicate, more fully than prevailing unsupplemented social-constructivist models can alone, our species' unique history, consciousness, capabilities and richly complex behavioural processes. Consequently, building more robust behavioural models requires integrating social-science models with life-science models.

Fourth and finally, we can probably best achieve that integrated understanding of human behaviour by framing human behaviours against the backdrop of the pervasive evolutionary processes that enable and influence them. This requires a broader cross-disciplinary perspective, which at a minimum includes insights from evolutionary biology. Ideally, this would involve greater education for legal thinkers on both the immediate proximate causes of behaviours and the evolutionary causes that provide important context.

To summarize these points, then: (i) effective law requires an effective behavioural model; (ii) law's existing set of models is importantly incomplete; (iii) improving the behavioural models requires the integration of social-science and life-science models of behaviour; and (iv) such integration requires familiarity with behavioural biology. Put simply, because improving behavioural models can yield more effective legal tools and because human behaviour is influenced by the effects of evolutionary processes on the brain, greater knowledge of how evolutionary processes influence behaviour may improve law's ability to regulate it.

3. SEVERAL ISSUES WARRANTING FURTHER EXPLORATION

The editors of this theme issue encouraged the authors to raise questions about law and the brain, even when they had no answers to provide. In this section I respond to that invitation by raising a variety of topics in need of further exploration. First, I make a few general remarks, to provide context.

We already know that the gap between legal and scientific communities—in methods, assumptions, purposes and even vocabulary—is famously broad and observable in myriad contexts. For example, the gap is evident in environmental contexts, in which legal regulators attempt to balance economic interests with harms to enormously dynamic ecological systems. Also, it is evident in health contexts, in which legal regulators attempt to weigh toxicological risks against the costs of reducing those risks expressed in opaque statistics. But the law–science gap seems unusually broad in the context of human behaviour. I propose three of many possible reasons.

First, not everyone agrees that understanding more about the biology of brains and behaviours is a good thing. The historical over-division of reality into distinctly different disciplinary subcomponents (which in turn contributed to knowledge and culture gaps between disciplines) often creates turf wars over who speaks with importance on what topics. So, for example, biological perspectives on behaviour often encounter resistance from practitioners of sociology, philosophy and gender studies, as each of these disciplines has its own theories about where behaviour comes from.

Second, those who voice scepticism about biological perspectives on the brain are sometimes right. For example, they are right to raise concerns about the potential for misuse of biological information, because biology has been misused in the past. Properly understood, these are arguments more for caution than for exclusion. But caution is nonetheless often warranted. People respond differently to claims that evolutionary processes affect behaviour from the way they respond to claims that television and advertising affect behaviour.

Third, there is still widespread persistence of emotional commitment to human exceptionalism. We do not want to think that our transcendent capabilities are the products of purely terrestrial mechanisms. As my colleague Michael Saks succinctly put it in conversation: 'people don't want to be caused'.

Against this background, here are a few issues I would like to see more carefully explored in preparation for future evolutionary analysis in law. They are not unique to evolutionary analysis, but they seem particularly salient there.

(a) *What standards of proof are appropriate in those contexts in which law and behavioural biology meet?*

This is not as easy to answer as one might at first think. On the one hand, we generally want to base our legal approaches on well-established scientific principles. After all, why risk a change in legal policy if facts are still fuzzy? On the other hand, even brief reflection suggests that the situation is far too complicated for an approach that excludes all but well-established insights. There is an enormous literature spanning science, the history of science and philosophy of science that grapples with issues surrounding standards of proof. Although disagreements abound, it is at least presently clear that different standards of proof are customary when there are different purposes to different activities.

Basic research scientists are the most conservative, because they want to build edifices of knowledge with building blocks that are highly unlikely to be wrong. Applied scientists adopt more varying standards to meet the particular probabilities of costs and benefits in the specific contexts in which they may be working. Similarly, legal policy-makers have long correlated different standards of proof with different interests at stake (Faigman 2002). Evidence sufficient for legislative action is measured differently from evidence in adjudicative contexts, for example. The latter are even further differentiated: the criminal threshold for proof 'beyond a reasonable doubt', for example, is far higher, and appropriately so, than the civil threshold of 'the preponderance of the evidence'. Law and science play very different roles, and there are very different sub-roles within each. Thus we explicitly or implicitly want there to be—and indeed need there to be—standards of proof that vary context by context.

Nevertheless, we need to know more about what this means for evolutionary analysis in law. It probably means four things at a minimum. First, it probably means that we must think harder about who within the scientific community speaks with authority when hypotheses are disputed. Second, it probably means that we should remember that risks surrounding uncertainty tend to come in pairs. That is, it is not clear that the risk in law of treating a biobehavioural hypothesis as true when it is not true is greater than the risk of treating it as untrue if in fact it is true. The magnitudes of these respective risks (false positives and false negatives) will vary by context. Third, it probably means that law should not deploy a single standard of proof for incorporating into law a biobehavioural hypothesis, since the presence of differing risks can logically support differing standards of proof. Fourth, and more specifically, it probably means that we should not *automatically* apply to the hypotheses of different disciplines whatever standard of proof is generally dominant within that discipline. To do so could, paradoxically, privilege a non-scientific perspective over a more scientific one, simply because the former is more easily supported within the discipline from which it hails.

(b) *What should 'testability' mean where law and behavioural biology meet?*

On the one hand, it is inherent in the notion of science that hypotheses should be testable. On the other hand, the concept of testability is often misunderstood in legal circles. Hypotheses are sometimes incorrectly deemed untestable because there are no immediately practical ways, given the existing state of technological affairs, to test the hypothesis. In fact, only some naturalistic way of testing the hypothesis is necessary to satisfy the testability criterion, even if it requires means that are beyond our current technological capacities. Something can be appropriately testable in theory, even if not *immediately* testable in fact. Also, hypotheses are sometimes incorrectly deemed untestable when the necessary tests would require clearly unethical treatment of human beings. However, this renders the tests impermissible, not impossible. Hypotheses are sometimes also incorrectly deemed untestable because it is assumed that only traditional experiments are tests. However, it is widely agreed in animal-behaviour communities that, in addition to experiments, appropriately conducted observational and comparative techniques can also test hypotheses.

Clearly, we want to test hypotheses by the best means available. But what the best means are, and what degrees of confidence different means will provide, necessarily vary. Hypotheses about proximate mechanisms are often more easily tested than hypotheses about historical pathways of evolutionary processes. How should this affect our willingness to entertain evolutionary hypotheses? And how shall we deal, in law, with the general principle that conclusions drawn from tests of hypotheses are necessarily functions of considered judgement rather than unimpeachable empirical reality? We often draw, in other contexts, conclusions about what is probably true in humans on the basis of admittedly unrealistic studies of other animals. For instance, the hypothesis that a given substance will be safe in a large population of humans with varying physical characteristics, at a particular dosage, is generally tested by tabulating adverse effects of mega-doses of that substance given to a comparatively small number of animals of a non-human species. We need to think more about what testability means in the context of law and behavioural biology.

(c) *What role does the general concept of falsifiability play where law and behavioural biology meet?*

Falsifiability is important. However, precisely what role falsifiability plays in science, and precisely what it means when applied in differing contexts, are not nearly as clear as they are often thought to be. On the one hand, the existence of a falsifiable hypothesis has come to be seen by many in law as an infallible discriminator between good science and non-science. (For instance, the US Supreme Court invoked the principle reverentially in Daubert versus Merrell Dow Pharmaceuticals, 509 U. S. 579 (1993).) On the other hand, the falsifiability criterion is more subtle to apply than to discuss, and it has been subjected to sufficiently strong and numerous critiques that it is rather widely regarded by scientists and philosophers of science as by no means infallible, despite its demonstrated utility. A growing literature suggests that the principle of falsifiability does not play nearly as important a role in how scientists actually conduct their research as the popular image suggests (Hempel 1966; Woodward & Goodstein 1996; Goodstein 2000; Ulen 2002).

To make matters even more complicated, the notion of falsifiability is often further misunderstood in some legal circles, because of a failure to differentiate between falsifying a hypothesis, on the one hand, and falsifying a general theoretical framework (the metatheory) from which the hypothesis is generated, on the other. That is, it is sometimes assumed in legal discussions concerning behavioural biology that if a given hypothesis about how humans might be expected to behave proves incorrect then somehow the notion is also incorrect that humans are meaningfully influenced in these behaviours by the effects of evolutionary processes on brains. That does not follow. But precisely what does follow warrants more rigorous examination.

(d) *What is the proper role of parsimony in evolutionary analysis in law?*

Like falsifiability, parsimony is more frequently invoked than defined. Indeed, even the literature that specifically addresses it reflects no single settled definition. In legal circles, it is sometimes incorrectly assumed that the sole criterion for parsimoniousness is the number of assumptions a theory requires, with preference to be afforded to that theory with the fewest. But this is probably importantly incomplete. Many have noted that the same claims can be formulated in so many different ways that the number of constituent assumptions is not easily determined. Moreover, even were we to employ only the definition of parsimony that counts the readily agreed number of assumptions, parsimoniousness properly favours not the theory with the fewest assumptions but rather the theory with the fewest assumptions that is consistent with all the known facts.

Further, I have on occasion observed legal scholars to comment that any theory invoking evolutionary influences on human behaviours is necessarily less parsimonious than

one that assumes no such influences. After all, the reasoning goes, why complicate matters by adding in biology if culture without biobehavioural hypotheses can adequately explain a given phenomenon? This reasoning misses two important points. First, culture cannot be divorced from biology, inasmuch as all behaviour reflects the interaction between genes and environment. Second, a theory that dispenses with evolutionary history raises more complications than it dismisses. (To think that the historical context evolutionary history provides necessarily renders a given behavioural theory less parsimonious is to think that a theory of a building that starts on the ground floor is less parsimonious than a theory of a building that starts on the 50th floor, because the latter requires 49 fewer assumptions.) The important point is that parsimony, too, bears clarifying in the context of behavioural biology.

(e) *What is a mechanism, and in what contexts need it be specified?*

Darwin was the first to demonstrate that the effects of evolutionary processes can be meaningfully identified and understood, even if various relevant mechanisms (in his case, the particles of heredity) are not known. What will count as a mechanism for behaviours relevant to law? When should reference to a mechanism be required? And when, in any event, would knowing genetic, neuroanatomical or neurochemical mechanisms be useful in law?

Some people reject a given evolutionary perspective on human brain functioning so long as neither the genetic nor the neuroanatomical mechanisms influencing the resultant behaviour have been identified. (I have elsewhere referred to this as 'The Argument from Missing Mechanism'; Jones 2001*d*.) On the one hand, this seems an over-conservative basis for rejecting potentially useful knowledge: we know neither the genetic nor the complete neuroanatomical pathways for sleeping behaviour or sexual desire, and yet no one seriously disputes that these are products of evolutionary, rather than purely sociocultural, phenomena. On the other hand, it seems a mistake to forget that evolutionary processes do require actual practical mechanisms. How shall we know when mechanisms will matter to law?

(f) *How shall we best understand the relationship between theories and empiricism where law and behavioural biology meet?*

Some have argued that we do not need evolutionary theories, in law, because we can just observe how people behave and then formulate legal regimes accordingly. They have the advantage of common sense: who needs theory when facts will do? On the other hand, data do not collect and organize themselves into patterns from which important conclusions can be drawn. This is one of the reasons why the purely observational approach (sometimes known as inductivism, Baconian inductivism (after proponent Francis Bacon) or naive inductivism) was largely rejected as either a descriptively accurate or a normatively sufficient and appropriate approach for generating knowledge. (In part, it seemed clear that the very process of attending to some facts while ignoring others, and cross-correlating some facts with others, is necessarily a function of some pre-existing theory, however tentatively advanced.)

To the extent that inductivism has been replaced by a less rigid and more dynamic process involving theory formulation, data collection and theory reformulation (Woodward & Goodstein 1996), what does this mean for evolutionary analysis in law? Is there any systematic way to anticipate when theory is likely to be more useful or less useful?

(g) *What role should prediction play in evolutionary analysis in law?*

On the one hand, we expect science to help us to predict narrow aspects of the future. For instance, science has helped us to predict with great accuracy the flight trajectory of cannon-ball after cannon-ball. On the other hand, organisms are not cannon-balls. One cannot predict with great accuracy the precise foraging pattern of even a single *Cataglyphis* ant, let alone the future behaviour of an individual human being. This cannot mean that predictions, in the life sciences, are simply unnecessary or up for grabs. Predictions in behavioural biology are inherently probabilistic. They often attend not to the behaviour of an individual but rather to the patterns most likely to emerge from the collected behaviours of a large number of individuals. That is importantly parallel to what much of law is about: trying to affect populations in probabilistic ways. So thinking that biology is unhelpful to law because it cannot predict the behaviour of a single identified individual is like thinking that meteorology is unhelpful to sailors because it cannot predict where an individual cloud will rain, or thinking that geology is unhelpful to oil companies because sometimes there is no oil where geologists think there might be. Biology and physics are sufficiently different that we expect different things from their predictions. But what else do we need to know about the process of making useful biological predictions? By what measure do we determine whether a prediction is valuable or not?

4. DISCUSSION

That was but a small sampling of the questions warranting further exploration. Others include: what does biology have to tell us about how law-relevant behaviours are likely, in theory, to vary across animal populations? What does biology have to tell us about the ways in which law-relevant behaviours are likely to manifest, phenotypically, in human populations? What environmental variables are most associated with given law-relevant behaviours? What can we learn from studies of other animals about patterns in behaviours suggesting a sense of fairness, justice, property, trust, jealousy and deception? To what extent does the change from ancestral to modern environments contribute to an ability, or inability, to say something useful about evolved law-relevant features of the human brain?

Given the foregoing questions, how can we decide whether, when and how to incorporate evolutionary perspectives on the human brain, and hence on human behaviour, into law? Undoubtedly, it will require judgement on a context-by-context basis. Nonetheless, a few general remarks are in order.

It is important to distinguish the separate relationships that law and science have with reality. Speaking generally, scientists and legal policy-makers share an interest in gaining an improved understanding of reality. However, scientists and legal policy-makers are trying to achieve very different things, and this has implications for how insights from science can or should enter the legal arena. While

scientists often seek an improved understanding of reality for its own sake (and ever subject to revision), legal policy-makers are instrumentalists, charged by society with juggling a number of often conflicting goals and effecting positive change in some contexts, often at some cost in other contexts.

For example, a rule that affords present justice to one category of individual may do injustice to many more in the future. A policy that increases freedom of speech may paradoxically protect harmful hostile speech. A population may want increased national security but bemoan intrusions on privacy. An elected representative may see that a majority of his constituents support a legislative outcome that will later have adverse effects that those constituents do not yet recognize and later will not want. Tax rates sufficient to ensure the safest achievable food, through governmental oversight, may be higher than citizens are willing to pay. Ensuring that drugs (for example, AIDS drugs) are safe and effective may slow their delivery to patients, some of whom may die waiting.

This is not to say that instrumentalism makes an accurate understanding of a situation irrelevant. There are in fact many ways—none of them perfect—in which legal systems encourage the discovery and incorporation of truth in legal affairs. For example, oversight agencies, backed by government lawyers, try to ensure efficient markets by creating incentives for accurate corporate disclosures. Litigants, through discovery rules and adversarial processes, are encouraged to present and support, through evidence, truths relevant to disputes. Both elected representatives and agencies hold hearings on matters pertinent to new legislation and regulation. Freedom of the press helps expose corruption, and legal academics theorize, criticize, propose and comment.

Nevertheless, legal policy-makers must often make important choices in the absence of clear, accurate and robust understandings of a situation. Disputants may have equally supported but nonetheless materially inconsistent versions of the facts. Some relevant facts—such as a person's state of mind at the time he killed someone, allegedly in self-defence—are simply not directly knowable. And, most importantly for this discussion, circumstances may warrant legal action before scientists have achieved a high degree of certainty about a given phenomenon.

In fact, and for quite sensible reasons, we often want our legal policy-makers to act before confidence is very high or a situation is understood thoroughly. Imagine, for instance, that scientific studies suggest a possible connection between the amount of chemical x released from the smokestack of corporation y and the incidence of leukaemia in the children of local neighbourhood z, where you and your children live. How certain would you want your legislators to be of the causal relationship between the chemical and leukaemia before they intervene to prohibit—even if temporarily—the flow of chemical x into the air your children breathe? One hundred per cent certain? Seventy-five per cent? Even at 50% certain there are coin-flipping odds that this chemical materially increases your child's risk of developing leukaemia. For this reason, many people would prefer some regulatory action at even lower thresholds of certainty. How probable must something be before you would prefer that it be considered operationally true—for the time being—until better information comes along?

Clearly, when legal policy is at issue, we want our relative concern for certainty to vary as a function of the severity of the harms to be avoided and the benefits that might, through inaction, be foregone. The key points are these: (i) scientists and legal policy-makers undertake entirely different things; (ii) the degree of certainty to which scientists aspire is different from the degree of certainty necessary for legal action, just as we want it to be; and (iii) the degree of certainty necessary for legal action will vary as a function of the costs and benefits that a given problem and its partial solution may impose or offer, respectively.

When it comes to theories of causation that may help us achieve our goals, using the tools of law, we may often care more for utility than for reality. In this respect, evolutionary analysis in law is similar to economic analysis of law. In each case, the legal system is more concerned with the utility of the hypotheses about how humans will behave than it is with the accuracy of the factual premises on which various hypotheses about human behaviour are based.

Don't get me wrong. Accuracy is a virtue in its own right. But, just as it sometimes does not matter for legal purposes whether people consciously choose to maximize their self-interest or merely act 'as if' they were so choosing, it often will not matter whether people consciously choose behaviours that would have improved their reproductive success in ancestral or current environments, if they generally act 'as if' they were so choosing.

Consequently, when considering whether information from the biological sciences may be incorporated into legal policy-making, these conclusions emerge. First, it is perfectly appropriate, in some circumstances, to base changes in the legal system on reasonable hypotheses as opposed, to well-confirmed hypotheses. Second, it is perfectly appropriate, again in some circumstances, to base changes in the legal system on the triangulation of information from many different points, even if none of these is individually compelling.

One of several possible approaches (the discussion of which may at least illuminate several important factors to be judged) would be to ask this: is the information or approach suggested by developments in another discipline sufficiently likely to improve matters to warrant at least its temporary use in a legal context, given what is at stake? Several aspects of this approach bear further discussion.

First, this hypothetical formulation of an initial approach to interdisciplinarity in law is fundamentally sensitive to the existing state of affairs. That is, one must have some loosely quantified sense of the magnitude of existing harms, in the context under discussion. (For example, an incident of domestic physical abuse is typically far more serious than an incident of littering.)

Second, use in law is rarely a one-way ratchet. So use can be temporary and can result in periodic modifications as legal policy-makers seek improved solutions. Also, we should not neglect the potential for the legal system to be part of the hypothesis-testing enterprise. For one of the purposes to which a hypothesis can be put, in law, is to use it tentatively and selectively in an effort to test its potential utility.

Third, our approach to interdisciplinarity should be sensitive not only to the potential benefits that

incorporating the perspective might bring but also to the potential harms that such incorporation may involve. A decision on whether to incorporate a biobehavioural perspective should attend to the net of the costs and benefits. Note that the question is not whether or not this perspective will single-handedly achieve some pre-articulated policy goal. The question is whether the best possible approaches incorporating this perspective stand a sufficient chance of being better than what we currently have. That is, the assessment here is comparative, not absolute, because an improvement over existing affairs may warrant use, even in the absence of a fully optimal outcome.

Finally, any useful approach probably requires some assessment of the probability that the projected benefits will come to pass. That complex assessment requires judgement as informed and sound as feasible under the circumstances, though it will be necessarily imperfect.

What all this means, in the context of human behaviour, is that the legal system should adopt an approach that is inherently sceptical, but not unduly so, scrutinizing of scientific developments, but not wholly risk averse, and calibrated by judgement of the harms avoided and the potential gains to be had. This means that, while it should encourage and expect of science all the usual rigours of science, it should not exclude proffered findings of biology any more aggressively than it excludes equally tentative proffered findings of psychology, psychiatry, sociology or economics. That is, we can, at the same time, believe on the one hand that we should aggressively seek a greater understanding of reality and believe on the other hand that we need not be certain before we act, because certainty may come either never or too late.

5. EXAMPLES

I have elsewhere addressed several methodological and substantive issues in evolutionary analysis in law (Jones 1997*a*, 1999, 2001*a*), and, in a work in progress, Yale biologist Timothy Goldsmith and I propose more than a dozen different categories of utility, with brief examples of each (Jones & Goldsmith 2005). Below I provide a short overview of four of them: clarifying cost–benefit analyses; providing theoretical foundation and potential predictive power; assessing comparative effectiveness of legal strategies; and revealing deep patterns in legal architecture.

(a) *Clarifying cost–benefit analyses*

One of the advantages for law of an evolutionary approach to understanding brain design is that it can help us to clarify some of the cost–benefit analyses legal thinkers undertake when assessing various approaches to legal problems. Sometimes, an evolutionary perspective reveals that two policies, deemed independent, may trade against each other at the subsurface, such that the pursuit of either one inhibits the pursuit of the other.

For example, it is clear that the legal system is charged with attempting to reduce the sum of the costs of infanticide and the costs of reducing infanticide. It is also clear that many people would like to see the legal system reduce historically prevalent stigmatization of step-parents (and perhaps even move to bring step-parents into greater legal parity with genetic parents).

An extremely rich and broad evolutionary literature (Hausfater & Hrdy 1984; Parmigiani & vom Saal 1994; and surveyed in Jones 1997*a*) provides ample reason to believe that these two policies may trade against each other. Infanticide in numerous species, widely distributed across taxa, is often perpetrated by a male against an unweaned infant of a mother with whom he might (and later often does) mate. Natural selection appears to have favoured, in many species, a male predisposition towards such selective infanticide because it tends to increase the male's reproductive success. The behaviour is extremely narrowly tailored along many dimensions. For example, the risk to an unweaned infant (whose nursing causes lactational amenorrhoea, a contraceptive effect) is far greater than the risk to a slightly older infant that has ceased nursing. In humans the risk to an unweaned infant of infanticide is roughly 100-fold greater if there is an unrelated adult male in the household than if the male is the genetic father, and this risk drops off just as precipitously, post-weaning, as it does in other species.

This suggests that if the legal system were, for example, legislatively to bias the limited investigative resources of child protective services toward homes with step-parents over homes with genetic parents, when rumours of child abuse were received as to each, it might help to reduce the rate of infanticide. Of course, that benefit might come at the cost of stigmatizing the vast majority of step-parents who never abuse.

Biology cannot tell us whether to prefer preventing infanticide over preventing stigmatization. The point here, however, is that evolutionary analysis can help to sharpen the cost–benefit analysis. The cost of continuing to pursue the non-stigmatization goal may now be increased by the potential cost of a few otherwise preventable infant deaths. Alternatively, the cost of preventing those deaths may be the increased stigmatization of step-parents who never abuse. Whichever course we choose, evolutionary analysis puts the potential advantages or disadvantages in sharper relief.

(b) *Providing theoretical foundation and potential predictive power*

Evolutionary analysis in law may offer, at times, theoretical foundation for known human behavioural data. For example, there is, at present, no satisfying non-evolutionary foundation for a wide number of puzzling human 'irrationalities'. (Rationality, in the economic sense adopted here, refers not to procedural rationality, in the sense of conscious deliberation, but rather to substantive rationality, in the sense that the outcome of the behaviour is appropriate for achieving particular goals, given conditions and constraints, regardless of how the behaviour was actually chosen.) These puzzling irrationalities include such things as the propensity to discount future interests too steeply (over-valuing the small early gain relative to the larger later gain) or to endow an object just received with a higher value than the maximum price one would have paid to acquire it. Such seeming irrationalities matter to legal policies affecting, for example, rates of savings for retirement and the efficient distributions of property rights; these policies, like many others in law, reflect the economic assumption that people will make economically rational and efficient decisions, and if the assumption is wrong, the laws may be too. For example, people may save less for their own retirements than expected, and they may refuse

to bargain away a legal right that they would have refused to purchase from someone else, making the initial distribution of rights inefficiently 'sticky'.

Existing theories purporting to explain the variety of irrationalities are largely *ad hoc*. They attribute such irrationalities to brain defects, assume they are the result of insufficient capacity or time for the complex cognitive processes necessary to reach rational decisions, or merely re-label deviations from rational choice predictions (describing endowment effects, for example, as a function of 'loss aversion'). Consequently, the theories provide no theoretical framework to explain the particular *patterns* in seeming irrationalities (such as why people would not be equally likely to exhibit gain aversion as loss aversion). They provide no underlying structure that would connect together the wide variety of highly patterned deviations from narrow economic rationality that we observe. And they provide insufficient purchase on the problem to enable prediction of as yet undiscovered patterns.

The evolutionary perspective on the human brain suggests that a great number of deviations from rational choice predictions may reflect a temporal mismatch between design features of the brain appropriate for ancestral environments and the quite different environments humans encounter in modern times. Specifically, some irrationalities may be as widely distributed as they are, in the patterns they exhibit, because they predisposed people to behave in ways that led to substantively rational outcomes in past environments. That is, they may be what I have elsewhere referred to as 'time-shifted rationalities' (TSRs) (Jones 2001*a*).

A TSR reflects the propensity of the human brain to bias perception, information processing, emotions, tastes, decision making and other states of the nervous system, as a consequence of evolutionary processes, in ways tending to increase the probability of behaviours that were adaptive, on average, in ancestral environments, even if those behaviours are maladaptive in present circumstances (Jones 2001*a*). Some economically irrational behaviours currently ascribed to cognitive limitations may reflect not defects, random effects or inevitable computational limitations, but rather finely tuned features of brain design that are bumping up against novel environmental features in a way that yields outcomes that are puzzlingly irrational only if measured for rationality in present environments.

Thus, for example, contemporary human patterns in discounting future interests may be out of step with novel environmental features such as (i) sharply increased median lifespans, (ii) sharply increased probabilities of minimally stable futures and (iii) the invention of currencies and financial institutions that enable long-term storage of value. In addition, patterns in over-endowing items just acquired may reflect the modern invention of abstract tradable 'rights' to receive resources in the future.

(c) *Assessing comparative effectiveness of legal strategies*

From economics, we know that when the cost of a good increases the demand for that good generally decreases. Similarly, from the combined insights of law and economics, we know that when the cost of a behaviour increases (through legal sanctions, for example) the incidence of that behaviour tends to decrease, and the incidence decreases along a demand curve that describes the relative sensitivity of the demand to the legal 'prices'.

Speaking quite generally, a steeper more vertical demand curve (or portion of a curve) means that it takes a greater increase in sanctions to yield a given drop in demand. A more horizontal curve (or portion of a curve) means there is a far greater drop in demand for a given increase in sanctions. So far so good. But how steep are the curves for different behaviours? What *return*—measured in decreased behaviour—will we get for a given investment in costly sanctions, for a given behaviour we seek to deter?

Slutsky's equations, economists tell us, can help us to predict the trade-offs people will make, among various alternative behaviours, given people's preferences with respect to those activities (Varian 2003). However, taking people's preferences as given is precisely what we do not want to do. We want to know enough about where those preferences come from, and what forms they are likely to take, to design maximally efficient incentives and disincentives using the tools of law.

As I have argued elsewhere (Jones 2000, 2001*a*,*c*), we can derive a general approach from the general principle of TSR. Specifically, I define 'the law of law's leverage' as follows:

> the magnitude of legal intervention necessary to reduce or to increase the incidence of any human behaviour will correlate positively or negatively, respectively, with the extent to which a predisposition contributing to that behaviour was adaptive for its bearers, on average, in past environments.
>
> (Jones 2001*a*, p.1190)

A more accurate (but more cumbersome) rephrasing is this: the magnitude of legal intervention necessary to reduce or to increase the incidence of any human behaviour will correlate positively or negatively, respectively, with the extent to which a behaviour-biasing information-processing predisposition underlying that behaviour (i) increased the inclusive fitness of those bearing the predisposition, on average, more than it decreased it, across all those bearing the predisposition, in the environment in which it evolved, and (ii) increased the inclusive fitness of those bearing the predisposition more, on average, than did any alternative predisposition that happened to appear in the environment during the same period.

Consequently, it will under most circumstances be less costly to shift a behaviour in ways that tended to increase reproductive success in ancestral environments (measured, of course, in inclusive-fitness terms) than it will be to shift behaviour in ways that tended to decrease reproductive success in ancestral environments. I should not be read to suggest that evolutionary processes are not still operating on human populations. But the general point here is that the slope of the demand curve for historically adaptive behaviour that is now deemed undesirable will tend to be far steeper (reflecting less sensitivity to price) than the corresponding slope for behaviour that was comparatively less adaptive in ancestral environments. This rule is likely to hold even when the costs that an individual actually and foreseeably incurs in behaving in a historically adaptive way exceed the presently foreseeable benefits of such behaviour.

This predicts that, in criminal law, family law, torts, property and the like, behaviours involving the following

things will prove more difficult to modify than the behaviour of median difficulty: mating, fairness, homicide, child-rearing, status-seeking, property and territory, resource accumulation, sexuality (including infidelity and jealousy), speech, privacy, empathy, crimes of passion, moralistic aggression, risk valuation and risk taking, cooperative or altruistic behaviour, male mate-guarding and related violence and the like (Jones 2004*a*; Jones & Goldsmith 2005).

The law of law's leverage may offer some novel and useful insights into the different ways in which law and behaviour interact, even if it will not predict with precision either the demand curves for given behaviours or the individualized curves of a single person. By highlighting for legal thinkers the fact that the brain tends to process information in ways that tended to yield adaptive solutions to problems encountered in the environment of evolutionary adaptation, the law of law's leverage encourages the anticipation that behavioural inclinations will vary in their susceptibility to different legal tools in non-arbitrary loosely predictable ways. This may enable legal thinkers to estimate more accurately the relative costs and benefits to society of attempting to shift different human behaviours in different ways.

(d) *Revealing deep patterns in legal architecture*

Evolutionary analysis may also eventually provide a window into why human legal systems tend to manifest some of the features they do. My hypothesis (explored further in Jones 2001*b*) is that—just as beaver dams, despite their differences, all reflect the effects of evolutionary processes on beaver brains—legal systems, despite their differences, all reflect the effects of evolutionary processes on human brains. That is, it will be possible to view at least many of the largest-scale features of legal systems as reflections of human neural architecture.

Consider, for example, that we might trace the characteristics of legal regimes—with respect to a particular subject—according to four variables. *Topics* would describe the main things that people care about. *Content* would capture the normative preferences that people generally associate with that topic. *Tools* would reflect the types of legal interventions deemed useful in attempting to ensure that individuals conform to the content preferences. *Effort* would quantify the relative amount of difficulty in using that tool to ensure conformity to the content preferences. An evolutionary perspective suggests that, were we to trace the variations in these four variables for the main features of legal regimes around the world and across time, we would see a decidedly non-random macro-pattern in legal regimes. This would reflect the species-typical brain.

For example, we would expect to see great concern devoted to the acquisition of private resources. From which, perhaps, emerges a finite set of materially similar approaches to the law of property. We would expect to see concern for facilitating exchanges and gains from trade. From which, perhaps, emerge a finite set of materially similar approaches to the law of contracts. We would expect to see sharp concern for bodily safety. From which, perhaps, emerges a finite set of materially similar approaches to laws concerning crimes and torts. We would expect to see great concern devoted to the subject of mating and child-rearing. Hence family law, etc.

6. CONCLUSION

The complexity of human behaviours provides unending challenges for legal systems, which seek to regulate some of those behaviours with the tools of law. Yet, behind that complexity is an even more complex human brain, which in turn reflects the intricate interactions of genes and environments.

We know that the interaction between genes and environments is governed by evolutionary forces: natural and sexual selection, drift, gene flow and mutation. So, in theory, the more we know about the ways in which these forces ultimately affect species-typical brain design, the better we can know the subject we regulate with law and the better we may be able to guide behaviour in democratically percolated and pre-articulated directions that are socially, politically and economically desirable. It seems time, given what we know, what we do not and the tools at our disposal, that we focus more of the attention of legal thinkers on the brain itself.

Advances in neuroanatomy, neurochemistry, psychopharmacology, neuroimaging and evolutionary biology have helped us begin to fathom how the brain actually does what it does. Although this will doubtless provide no magic window on behaviour, making all causes transparent to modern science, even incremental improvements are improvements nonetheless. It seems clear that we should not exalt biology over all other sources of knowledge. At the same time, it is clear that biological perspectives on the brain, its information-processing characteristics and the behaviours to which these lead are essential components of any modern understanding of behaviour. They are consequently important for law.

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GLOSSARY

TSR: time-shifted rationality