KEYNOTE: Law and the Brain—Past, Present, and Future

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INTRODUCTION

Law has two problems. Step back far enough from the particulate nature of law as we daily experience it—from the contracts, courtrooms, and codes, from the policies, patents, and police—and then the nationally and locally and topically idiosyncratic features of this uniquely elaborate activity of our species gradually blends into a homogenized cloud of effort, surrounding the first of these problems, at the core. The problem of human behavior. For were it not for the stubborn refusal of everyone (else) to behave the way we wanted, there would be no need for law. Seen at this scale, law is an effort to contain and guide the chaos that results when many different people have many different goals.

Law's second problem is that the first—human behavior—is so poorly understood. And it's a special kind of poorly—one in which the very possibility, as well as the desirability, of acquiring *reconcilable* models of human behavior is often ignored or contested.

Consider a contrast. When solving the problem of transporting humans by air, those who study gravity and those who study aerodynamic drag can't ignore each other, or simply agree to disagree, where their models of plane flight aren't compatible. The nature of the engineering challenges they are up against is presumed to operate according to principles that, however varied, must be consistent. No one seriously contends that their favorite, special kind of plane obeys an entirely separate set of physical principles, different from all those other planes.

And yet that's precisely what happened with the study of human behavior. It started, unfortunately, in a strictly isolationist, rather than compatibilist, direction. Humans assumed that they were not only special (due either to divine creation or to transcendent intelligence and complexity) but in fact so

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very special that nothing relevant to the behavior of every other species on the planet was relevant to them, in any truly significant way.

Of course humans are special. We are smart, adaptable, self-reflective, communicative, and innovative in unprecedented ways. But we're still living organisms, subject to the same underlying principles that govern the construction, shape, and behaviors of all other life forms. And while those principles may not always dominate us, and we can soar far higher in some of the domains we care about, it is mistake to imagine that we are therefore fully immune to the influences of processes that led to our being precisely the ways we are. To ignore these is to perpetuate the mistake of complete human exceptionalism.

If law is about channeling behavior into socially acceptable and productive ways, then the better we get at understanding behavior the better a job law can do. In order to offer a few remarks about where I think things may be going, with respect to law's inevitable reliance on models of human behavior, including life science insights, I want to first highlight a few important features of where we've been, and where we are.

I. THE PATH TOWARD COMPATIBILISM, MERGER, AND INTEGRATION

A. Behavioral Biology Becomes a Field

Consider two separate histories—one the study of *human behavior*, the other the study of *non-human animal behavior* (or, as it is misleadingly called, *animal behavior*). It's impossible to pinpoint when humans first got serious about studying human behavior. But surely our close attention to the behavior of others in our species emerged in pre-hominid concert with social living, including the demands of cooperating and competing successfully. And surely there were countless people, schooled by daily experience and observation, who made understanding other people part of their life's work, if only to succeed at life, long before the emergence, centuries later, of religious and later secular institutions of higher learning. But the development over time of disciplines devoted primarily to key aspects of human behavior has led to our current framework that includes, for instance, anthropology, economics, politics, psychology, sociology, and the like.

Similarly, it's obvious that close attention to non-human animal behavior, whether that of prey or predator, has pre-hominid roots. It doubtless accelerated during the subsequent rise of domestication and, later, intentional breeding. But the study of animal behavior, or ethology as it is sometimes

known, didn't get really serious until after Darwin drew attention to natural selection as a major force in physical and behavioral evolution.[1]

In the 1920s and '30s the Austrian biologists Konrad Lorenz and Karl von Frisch, and the Dutch biologist Nikolaas Tinbergen, laid the foundations for the then-emerging field of ethology, earning them Noble Prizes.[2] In the 1960s, British biologist William D. Hamilton's work on inclusive fitness helped establish the increasingly gene-centric view of the evolution of behavior, providing the conceptual frameworks by which even complex behaviors, such as altruism, could evolve.[3] And major works by American biologist and sensation Robert Trivers, in a series of early 1970s papers on reciprocal altruism, parental investment, and parent-offspring conflict, not only provided foundational conceptual advances, but also shoved onto a faster intercept course the stubbornly different fields of human and non-human animal behavior.[4]

Later that decade, American biologist E.O. Wilson and British biologist Richard Dawkins each published lastingly significant popular works that helped push the fields further together.[5] And this in turn helped to inspire, across the 1980s and 1990s, new movements within psychology and anthropology—by scholars like Donald Symons, Lionel Tiger, Leda Cosmides, John Tooby, Steven Pinker, and David Buss—to reconcile long-isolated features of their fields with pan-behavioral developments in evolutionary biology.[6]

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1. *See generally* CHARLES DARWIN, ON THE ORIGIN OF SPECIES BY MEANS OF NATURAL SELECTION (1859); CHARLES DARWIN, THE DESCENT OF MAN, AND SELECTION IN RELATION TO SEX (1871); CHARLES DARWIN, THE EXPRESSION OF THE EMOTIONS IN MAN AND ANIMALS (1872).

2. *See generally* KONRAD LORENZ, THE COMPANION IN THE ENVIRONMENT OF BIRDS (1935); KARL R. VON FRISCH, THE DANCING BEES (1927); Nikolaas Tinbergen, *On the Analysis of Social Organization Among Vertebrates, with Special Reference to Birds*, 21 AM. MIDLAND NATURALIST 210 (1939).

3. William D. Hamilton, *The Genetical Evolution of Social Behaviour I*, 7 J. THEORETICAL BIOLOGY 1 (1964); William D. Hamilton, *The Genetical Evolution of Social Behaviour II*, 7 J.THEORETICAL BIOLOGY 17 (1964).

4. Robert Trivers, *The Evolution of Reciprocal Altruism*, 46 Q. REV. BIOLOGY 35 (1971); Robert Trivers, *Parental Investment and Sexual Selection*, *in* SEXUAL SELECTION & THE DESCENT OF MAN 1871–1971, at 136 (Bernard Campbell ed., 1972); Robert Trivers, *Parent-Offspring Conflict*, 14 AM. ZOOLOGIST 249 (1974).

5. *See generally* EDWARD O. WILSON, SOCIOBIOLOGY: THE NEW SYNTHESIS (1975); RICHARD DAWKINS, THE SELFISH GENE (1976).

6. *See generally* DONALD SYMONS, THE EVOLUTION OF HUMAN SEXUALITY (1979); LIONEL TIGER, OPTIMISM: THE BIOLOGY OF HOPE (1979); JEROME H. BARKOW, LEDA COSMIDES & JOHN TOOBY, THE ADAPTED MIND: EVOLUTIONARY PSYCHOLOGY AND THE GENERATION OF CULTURE (1992); STEVEN PINKER, HOW THE MIND WORKS (1997); DAVID BUSS, THE EVOLUTION OF DESIRE: STRATEGIES OF HUMAN MATING (2003).

B. Law and Behavioral Biology

What's interesting for our purposes is the intersection with law of these developments in biology, psychology, and anthropology. And to begin tracing the origins of this, we have to go back a couple steps.

At roughly the same time that Trivers was conceiving his landmark papers, one Margaret Gruter attended Stanford Law School (after successfully running and selling a nursing home business) for the express purpose of combining her interest in animal behavior with her interest in law. Returning to school in 1969, she graduated with a J.S.M. (Master of the Science of Law) degree in 1973 (supplementing an earlier education in law, in Heidelberg, in the 1940s) at 54 years old.[7]

Then, at almost the same time that Wilson and Dawkins were claiming to international attention, in 1975 and 1976, that developments in evolutionary biology were arguably relevant to the human condition, Gruter published in 1977, and then in 1979, two articles—one in a law review and one in a biology journal—arguing that understanding the effects of evolutionary approaches on human behavior was important for law's efforts to understand human behavior and effectively guide it in pro-social ways.[8] Her commitment to bringing biology and law together led her to found the influential Gruter Institute for Law and Behavioral Research[9] in 1981, which then and since hosted conferences bringing legal scholars together with scientists in multiple fields of human behavior.[10]

The 1980s saw early, exploratory, law-relevant work published both from the biology side (such as Richard Alexander's works on the effects of evolutionary processes on moral systems[11]) and from the law side (such as in the works of Jack Beckstrom[12]). The first half of the 1990's saw early works

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7. Personal communication from her grand-daughter, Monika Gruter Cheney (Aug. 29, 2016) (on file with author). More on Margaret's life can be found in her auto-biography MARGARET GRUTER & ERIC T. MORHENN, SEARCHING FOR JUSTICE AND LIVING WITHOUT IT (1999).

8. Margaret Gruter, *Law in Sociobiological Perspective*, 5 FLA. ST. U. L. REV. 181 (1977); Margaret Gruter, *The Origins of Legal Behavior*, 2 J. SOC. & BIOLOGICAL STRUCTURES 43 (1979).

9. Information about the Gruter Institute can be found at its homepage: http://gruterinstitute.org (last visited Jan. 3, 2017).

10. The Institute is led today by her grand-daughter, Monika Gruter Cheney.

11. *See, e.g.*, RICHARD D. ALEXANDER, THE BIOLOGY OF MORAL SYSTEMS (1987).

12. *See, e.g.*, JOHN H. BECKSTROM, SOCIOBIOLOGY AND THE LAW: THE BIOLOGY OF ALTRUISM IN THE COURTROOM OF THE FUTURE 1 (1985).

by Jeff Stake,[13] myself,[14] and Oliver Goodenough.[15] And in 1997 I had the privilege to gather together a variety of law professors, sharing an interest in all the foregoing, to found the organization that gathers us here today—the *Society for Evolutionary Analysis in Law (S.E.A.L.).*[16]

The current Mission Statement of S.E.A.L., which has been only slightly updated over the ensuing 20 years, is:

> The Society for Evolutionary Analysis in Law (SEAL) is a scholarly association dedicated to fostering interdisciplinary exploration of issues at the intersection of law, biology, and evolutionary theory, improving the models of human behavior relevant to law, and promoting the integration of life science and social science perspectives on law-relevant topics through scholarship, teaching, and empirical research. Relevant disciplines include, among others, evolutionary and behavioral biology, cognitive science, neuroscience, complex adaptive systems, economics, evolutionary psychology, psychiatry, behavioral ecology, behavioral genetics, primatology, memetics, chaos theory, evolutionary anthropology, and gender relations.[17]

There are of course many valued fellow travelers, too numerous to list here, on this journey. In an on-line bibliography I maintain—which runs from the earliest-cited authors above all the way through key works of current S.E.A.L. officers Robin Kar[18] and Michael Guttentag[19]—I credit all the significant work of which I am aware at the intersection of law and evolutionary biology.[20] I have also further described some of this history,

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13. Jeffrey E. Stake, *Darwin, Donations, and the Illusion of Dead Hand Control*, 64 TUL. L. REV. 705 (1990).

14. Owen D. Jones, *Law and Evolutionary Biology: Obstacles and Opportunities*, 10 J. CONTEMP. HEALTH L. & POL'Y 265 (1994).

15. Oliver R. Goodenough, *Mind Viruses: Culture, Evolution and the Puzzle of Altruism*, 34 SOC. SCI. INFO. 287 (1995).

16. SOC'Y FOR EVOLUTIONARY ANALYSIS L., http://www.sealsite.org (last visited Jan. 9, 2017).

17. *Id.*

18. Robin Bradley Kar, *The Deep Structure of Law and Morality*, 84 TEX. L. REV. 877 (2006).

19. Michael D. Guttentag, *Is There a Law Instinct?*, 87 WASH. U. L. REV. 269 (2009).

20. *Useful Sources: Biology, Evolution, and Law*, SOCIETY FOR EVOLUTIONARY ANALYSIS IN LAW, https://www4.vanderbilt.edu/seal/scholarly-resources/useful-sources/ (last updated Nov. 30, 2016).

including updates for the most recent decade, in two book chapters on the subject of Evolutionary Analysis in Law.[21]

But what I want to highlight here and now is that the earliest decades of both the Gruter Institute and S.E.A.L. were times of excitement and rebellion. Excitement—for the twin reasons that so much was being discovered in science about the ways evolutionary processes affect the behaviors of living organisms, while at the same time law remained imperfectly effective at accomplishing society's varied goals. These sparked hunger for new information, ideas, and perspectives. Rebellion—because we were rejecting as over-simplistic the then-dominant idea (more of an unquestioned assumption, really) that all behaviors of any real significance to law could only be products of culture and socialization. This was dogma, scripture, orthodoxy. And we were bucking convention.

As I and others have noted, there are multiple reasons for the dogmatic tenor of the time. One is the wholly incorrect but nonetheless fervently held belief that environmental influences on behavior and biological influences on behavior must be zero-sum. It was often—indeed almost always—assumed that to grant any influence to biology was to subtract the influence of some other favored discipline or feature in equal amount.

But, in fact, biology is the study of what happens when genes and environments *interact*, which is the only way brains—or any other physiological feature for that matter—get built. So the false dichotomization of genes and environment—as if they were alternatives rather than inevitable partners—was pernicious. In much the same way it would be if we were to argue about whether it is the length or alternatively the width of a rectangle that defines its area.[22]

Another reason—given the timing—was the still-lingering and quite understandable desire to dissociate forcefully and publically from anything that could conceivably spark any mental connection, of any kind, to Nazi Germany. So if the Nazis had been inspired (largely by American eugenics arguments, it turns out) to try brutally and genocidally to shape the course of human evolution, then surely anything that used that e-word, or the related g-word "genes," must be motivated to achieve the same odious ends.

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21. Owen D. Jones, *Evolutionary Psychology and the Law*, *in* THE HANDBOOK OF EVOLUTIONARY PSYCHOLOGY 1180 (David M. Buss ed., 2d ed. 2015); Owen D. Jones, *Evolutionary Psychology and the Law*, *in* THE HANDBOOK OF EVOLUTIONARY PSYCHOLOGY 953 (David M. Buss ed., 2005).

22. This apt metaphor is typically attributed to renowned psychologist Donald Hebb, during some Q & A following a public lecture. *See, e.g.*, Michael J. Meaney, *The Nature of Nurture: Material Effects and Chromatin Remodeling*, *in* ESSAYS IN SOCIAL NEUROSCIENCE 1 (John T. Cacioppo & Gary Berntson eds., 2004).

Similarly, if Herbert Spencer had preposterously argued (to Darwin's great frustration) that a proper understanding of evolution could be thought to justify the riches of the wealthy, and the low position and treatment of the poor, then surely any mention of the D-man must reliably signal conservative and self-serving policies of social oppression. To this day, it is often unselfconsciously though incorrectly assumed that Darwin's own views—and indeed the implications of his works—have the substance of what was in fact Spencer's grotesque mis-invocation and caricature of them.

While the effort to avoid such politically-motivated miscarriages of justice is of course commendable, the baby for too long got tossed with the bathwater. Few recognized the importance of distinguishing *information* (developments in evolutionary biology) from agenda-driven *uses of information*. Failure to make this core distinction would be like rejecting that gravity exists, upon unhappily discovering that someone had used its force in designing and deploying a guillotine.

Put simply, it was often mistakenly assumed, without self-reflection, that to invoke evolutionary processes as relevant in any way to understanding human behavior was to be engaged in the effort to use biology in one very particular way—i.e., to justify inequality, oppression, and self-interest.[23] While it is always important to be alert for agendas, and agenda-driven motivations for doing or using science, it is at least as important to recognize that knowledge and its use are two very different things.

So given the intellectual climate at the time—of aggressive rejection of arguments that biological principles affected, in some ways, the behavior of our biological species—it was an exciting time to explore a new and relatively forbidden frontier.

Biologist Tim Goldsmith and I, for instance, identified and illustrated in our piece *Law and Behavioral Biology*, in the *Columbia Law Review*, a wide variety of ways that evolutionary perspectives on human behaviors could aid the goals that a democratic society sets for itself—*whatever those goals may be*.[24] These include:

1) Discovering useful patterns in regulable behavior
2) Uncovering policy conflicts
3) Sharpening cost-benefit analyses
4) Clarifying causal links
5) Increasing understanding about people
6) Providing theoretical foundation and potential predictive power

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23. More on these subjects can be found in Owen D. Jones & Timothy H. Goldsmith, *Law and Behavioral Biology*, 105 COLUM. L. REV. 405, 484–99 (2005).

24. *Id.* at 431–84.

7) Disentangling multiple causes
8) Exposing unwarranted assumptions
9) Assessing the comparative effectiveness of legal strategies
10) Revealing deep patterns in legal architecture
11) Identifying selection pressures that law creates
12) Highlighting legal changes through evolutionary metaphor

And Sarah Brosnan and I, in a series of published experiments, concretely tested implications of my arguments, in a 2001 article,[25] that evolutionary perspectives on human behaviors could provide novel insights into the patterns of quirky psychological phenomena highly relevant to law—including the so-called "endowment effect."[26] The results—the first to directly demonstrate a trade-based endowment effect in another species (chimpanzees, and later orangutans)—were immensely gratifying. Building upon evolutionary biology premises, we predicted the presence of the endowment effect in a non-human relative. We predicted that the effect size would vary within that species. We predicted the kinds of objects that would increase or decrease the prevalence and magnitude of the effects. And the results of our experiments were all quite consistent with our predictions, while not being predicted by any other extant endowment effect theory. Even more, we were ultimately able to demonstrate that, by carefully manipulating contexts in ways an evolutionary perspective can suggest, we could in fact turn the endowment effect on and off *for the very same object*.

C. Today

We are now in a very different intellectual climate than 20 years ago. For one thing, the sciences of behavioral biology—including but not limited to evolutionary biology, cognitive neuroscience, and behavioral genetics—have exploded. It is hardly possible to open *Science*, the world's premier general journal of science, let alone any of the dozens of specialized journals covering

25. Owen D. Jones, *Time-Shifted Rationality and the Law of Law's Leverage: Behavioral Economics Meets Behavioral Biology*, 95 NW. U. L. REV. 1141 (2001).

26. Sarah F. Brosnan et al., *Endowment Effects in Chimpanzees*, 17 CURRENT BIOLOGY 1704 (2007); Owen D. Jones & Sarah F. Brosnan, *Law, Biology, and Property: A New Theory of the Endowment Effect*, 49 WM. & MARY L. REV. 1935 (2008); Sarah F. Brosnan et al., *Evolution and the Expression of Biases: Situational Value Changes the Endowment Effect in Chimpanzees*, 33 EVOLUTION & HUM. BEHAV. 378 (2012); Timothy M. Flemming et al., *The Endowment Effect in Orangutans*, 25 INT'L J. COMP. PSYCHOL. 285 (2012). An overview of this work appears in Owen D. Jones, *Why Behavioral Economics Isn't Better, and How It Could Be*, *in* RESEARCH HANDBOOK ON BEHAVIORAL LAW AND ECONOMICS (J. Teitelbaum & K. Zeiler eds.) (forthcoming 2017) [hereinafter Jones, *Behavioral Economics*].

these fields, without learning of important new developments—often by new researchers using new technologies and new methods. What once was a trickle is now a deluge. There is a truly enormous corpus, growing daily, on the many causal pathways by which biological processes influence behaviors in all species, including humans.

For another thing, the public is increasingly immersed in the relevance of evolutionary processes to matters both major (such as the evolution of resistance to antibiotics[27] or pesticides,[28] and the evolution of disease, as a function of transmission vectors)[29] and minor (such as the fact that, if you use poisoned sugar in an effort to eliminate cockroaches, natural selection strongly and quickly favors cockroaches in whom have arisen any distaste for sugar).[30]

Yet another reason is the saturation, in both scholarly and public outlets, of human brain studies highlighting far more graphically and specifically the ways in which human behavior is a function of patterns of brain activity in specific locations, operating in specific ways. To give but one illustration of many possible, in an article published in a top neuroscience journal[31] colleagues and I recently used functional magnetic resonance imaging (fMRI) to isolate the brain regions and activities involved in making four inter-related legal judgments:

1) Assessing how much harm a defendant caused;

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27. *See, e.g.*, Stephen Baker, *A Return to the Pre-Antimicrobial Era? The Effects of Antimicrobial Resistance Will Be Felt Most Acutely in Lower-Income Countries*, 347 SCI. 1064 (2015); Manos Perros, *A Sustainable Model for Antibiotics: How Can We Foster the Development of Novel Drugs Against Resistant Bacteria?*, 347 SCI. 1062 (2015); Judy Stone, *Dreaded Superbug Found for First Time in U.S. Patient—A Physician's Perspective*, FORBES (May 26, 2016, 11:59 PM), http://www.forbes.com/sites/judystone/2016/05/26/dreaded-superbug-found-for-first-time-in-u-s-patient-a-physicians-perspective/#6e53ca656241; Sabrina Tavernise & Denise Grady, *Infection Raises Specter of Superbugs Resistant to All Antibiotics*, N.Y. TIMES (May 26, 2016), http://www.nytimes.com/2016/05/27/health/infection-raises-specter-of-superbugs-resistant-to-all-antibiotics.html.

28. *See, e.g.*, Robert M. May & Andrew P. Dobson, *Population Dynamics and the Rate of Evolution of Pesticide Resistance*, *in* PESTICIDE RESISTANCE: STRATEGIES AND TACTICS FOR MANAGEMENT 170 (National Academy Press, 1986).

29. *See, e.g.*, Paul W. Ewald, *Evolution of Virulence*, *in* 18 INFECTIOUS DISEASE CLINICS N. AM. 1 (2004); Paul W. Ewald, *The Evolution of Virulence and Emerging Diseases*, 75 J. URB. HEALTH 480 (1998); Andrew F. Read, *The Evolution of Virulence*, 2 TRENDS MICROBIOLOGY 73 (1994).

30. Ayako Wada-Katsumata, Jules Silverman & Coby Schal, *Changes in Taste Neurons Support the Emergence of an Adaptive Behavior in Cockroaches*, 340 SCI. 972 (2013).

31. Matthew R. Ginther et al., *Parsing the Behavioral and Brain Mechanisms of Third-Party Punishment*, 36 J. NEUROSCIENCE 9420 (2016).

2) Evaluating the blameworthiness of the defendant, as a function of his/her mental state;
3) Integrating the information about harm and blameworthiness; and
4) Deciding how much the defendant should be punished.

What all of these developments and others have led to, alongside the democratization of knowledge the internet enabled, is a world in which people are more aware of, more informed about, and more accepting of the multiple biological influences on the human brain, and hence on human behavior. So instead of it being fully avant-garde to argue for the relevance of behavioral biology to various human affairs, and patterns of human behavior, it is now largely accepted, mainstream. As but one illustration, schools like Harvard, Stanford, Johns Hopkins, and others today offer various courses and programs with foci on human behavioral biology.[32]

That is not to say that there are not still pockets of resistance in fields that have long traditions of excluding behavioral biology from the human domain. There are of course still such pockets, particularly among the most insular fields—such as sociology. But those pockets are dwindling, as the sciences advance, as the inevitable need for cross-disciplinary reconciliation of human behavioral models becomes more and more obvious, and as those who replace retiring faculty increasingly were raised and trained in a trans-disciplinary world in which biology is just another field, among many, for investigating complex human phenomena.

There are, undoubtedly, those who remain staunchly opposed, within law, to the kind of cross-disciplinary integration that bridges the natural sciences with the social sciences. Given the heavy normative emphases in law, it is often assumed that there are specific, normative, agenda-driven motives underlying most (or all) legal scholarship. And given the lag time between developments in other fields on which law relies and incorporation of those developments in law, it would not be surprising to see law among the last places that new developments in behavioral sciences would affect. This is doubtless exacerbated by the extent to which non-reactionary and slow change is—for understandable reasons relating to socio-legal stability over time—considered an outright virtue in law.

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32. *See, e.g.*, *Department of Human Evolutionary Biology*, HARV. UNIV., http://heb.fas.harvard.edu/home (last visited Jan. 9, 2017); *Stanford Bulletin Explore Courses*, STANFORD UNIV., http://explorecourses.stanford.edu/search?view=catalog&filter-coursestatus-Active=on&q=BIO%20150:%20Human%20Behavioral%20Biology&academicYear=20132014 (last visited Jan. 9, 2017); *David S. Olton Program in Behavioral Biology*, JOHN HOPKINS UNIV., http://krieger.jhu.edu/behavioralbiology/academics/ (last visited Jan. 9, 2017).

But I hasten to add, however, lest anyone think I've a rosier view than I do about all this—that not all resistance is anachronistic. So long as it does not ossify to close-mindedness, skepticism is a good thing, to be encouraged across all swaths of human endeavors.

For example, there are good reasons to be skeptical about the distance that must be traversed between accepting in principle that evolutionary processes have affected law-relevant behaviors and agreeing on precisely what those processes have done, how, and with what effect. There are good reasons to be skeptical about the distance to be traversed between identifying gene-environment interactions that increase the probabilities of various behaviors relevant to law, on one hand, and knowing what best to do with that information, on the other.

Here, as in other areas of applied science, the devil's in the details. And it long will be. Nevertheless, the extent to which understanding and acceptance of the biology of human behavior has grown, in general terms, represents dramatic progress toward a fuller integration of the many sciences that each—like the blind men with an elephant—offer separate views on a complex whole.

II. MERGER AND INTEGRATION

A. What Law Does, and What It Needs to Do It

Much of what law does is social engineering. We see some behavioral problem in society—something that is, say, harmful, insufficiently pro-social, inefficient, wasteful, unfair, or short-sighted. We are motivated to address that problem. And law presents several of the tools we use to do it.

Very occasionally, for instance, we'll use the physical force of law to force one behavior in substitution for another, such as when we make people live behind bars, in order to stop them behaving as they had been. But the vast majority of the time we use law's power to change the environment—thereby manipulating various incentive structures that we believe will inspire people, in turn, to want to change their own behaviors.

The choices we make, in using law to implement one kind of environmental change instead of another, thereby to inspire one kind of behavioral change instead of another, reflects our best understanding of where behavior comes from. That is, why people behave the ways they do, what affects their choices, and how. So, the effectiveness and the efficiency of law frequently and crucially depends on the accuracy of our behavioral models. And it is today crystal clear, in a way it wasn't twenty years ago, that

no model of human behavior that relies on social science insights *alone* can possibly be accurate. The brain doesn't work that way.

Of course the reverse can be said of the life sciences. Any model that ignores social science perspectives can't possibly be accurate and complete either, given the extraordinary complexity and diversity of human behavior, capacity for self-reflection, and cultural variability.

So the only sensible path toward increasing the accuracy—and thereby the utility for law—of the operational behavioral model is to find ways to bring together all the balkanized fields bearing on human behavior, to integrate them, and to constantly improve. How?

One could in theory attempt this by bringing all disciplines simultaneously together, as if into one giant room, and somehow forcing them to reach common agreement on a Grand Unified Model before we'd let them out. But nothing in human history suggests that such a thing is practical.

At the opposite extreme, one could pick any dyad at random—say Sociology and Behavioral Genetics—and force them to reconcile, before then adding in a random third field, or the end result of some other randomly merged dyad. And so on and so on, in incremental accretions, until arriving at a unified model.

Far more practical, it seems to me, is to begin by trying to reconcile fields that already have the least conceptual, topical, and methodological distances between them. That is, to gradually reconcile various social science fields on one hand, while trying to pull together various life science fields on the other, until pulling the then-current results of the two domains together. That would mean, for instance, trying to dissolve boundaries and unify perspectives between, say, anthropology, sociology, and political science, on one hand, while doing the same with evolutionary biology, neuroscience, and behavioral genetics, on the other.

Dissolving boundaries and unifying perspectives can, in turn, be approached in the abstract—such as by asking: where do assumptions of the instant disciplines overlap or diverge, and what can we do to reconcile them? Or it can be approached more concretely—such as by asking: what are the perspectives of the instant disciplines on this one specific problem for law (within domains of criminal or tort law, for instance), and what can we do to reconcile them?

My own view is that these two approaches—the abstract and concrete—can usefully make progress in parallel, and cross-fertilize their results along the way—suggesting we should pursue them simultaneously.

B. The Example of Law and Neuroscience

I want to talk next about some work that I and others are pursuing at the intersection of law and cognitive brain science, in what's recently emerged as a new field of *Law and Neuroscience*. Because on the path toward trying to integrate several behavioral biology perspectives on concrete issues in the legal domain, we are first trying to understand—and through both conceptual and empirical work to explore—what advantages the neuroscientific tools, perspectives, and results of neuroscience may provide.

Over the last decade, I've had the privilege of being involved in a variety of cross-disciplinary law and neuroscience initiatives. Most recently, I had the good fortune to receive four grants from the MacArthur Foundation—totaling over $7,600,000—to create, design, populate, and direct the *MacArthur Foundation Research Network on Law and Neuroscience*.[33]

Headquartered at Vanderbilt, the *Research Network* includes selected *Members* at the core, who are leading neuroscientists, judges, and legal scholars, as well as a number of invited *Research Network Scholars*, who work on some particular projects of the *Research Network*, all of whom together span such universities as Yale, Columbia, Virginia, University of Pennsylvania, and Harvard, in the East, to Stanford, UCLA, and Hastings, in the West.

Although there are both civil law and criminal law dimensions to the intersection of law and neuroscience, my *Research Network* focuses on the criminal justice domains. And the Working Groups I established focus in turn on: Detection and Classification of Mental States; Detecting Deception and Recognition; Punishment Decisions; Adolescent Development; Evidentiary Issues; and Education & Outreach (to bench and bar).[34]

Although there are a wide variety of neuroscience tools that could also be used—such as Electroencephalography (E.E.G.), Positron Emission Tomography (P.E.T.), and Diffusion Tensor Imaging (D.T.I.)—the

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33. The homepage of the MACARTHUR FOUNDATION RESEARCH NETWORK ON LAW & NEUROSCIENCE, www.lawneuro.org, (last visited Jan. 30, 2017), provides a wealth of information, not only about the design, activities, and publications of the Research Network itself, but also on all the law and neuroscience literature of which we are aware, all organizations internationally that have also come to pursue this work, and all the increasing number of talks, conferences, and symposia taking place.

34. For conceptual overviews of the *Research Network*, see on the network website *Conceptual Framework*, MACARTHUR FOUND. RES. NETWORK ON L. & NEUROSCIENCE, http://www.lawneuro.org/_resources/pdf/LawandNeuroscience_ConceptualFramework1.pdf (last visited Jan. 30, 2017), and *Network Overview*, MACARTHUR FOUND. RES. NETWORK ON L. & NEUROSCIENCE, http://www.lawneuro.org/networkoverview.pdf (last visited Jan. 30, 2017).

experiments designed and conducted within the *Research Network* have used Functional Magnetic Resonance Imaging (f.M.R.I.).

In broad brush, that technique draws inferences about neural activity by tracing differences in blood flow—over time, and within small regions of the brain—as the brain engages in different cognitive tasks that our subjects perform while in a strong and manipulable magnetic field. It can do this (again in broad brush) because the more neurons work, the more they call up blood-delivered resources (oxygen and energy). And oxygenated and deoxygenated blood has, fortunately, different magnetic properties. The axes of spin of subatomic particles align in the presence of the powerful magnetic field that scanner generates. And then those axes of spin are knocked temporarily out of alignment by radio waves. When the axes snap back into alignment they release tiny bits of energy that the scanner can detect, in time and space. And that enables the research team to infer when and where the neurons in some areas of the brain are working harder than are neurons in other areas of the brain. And by correlating these data with information from the stimuli inputs, and the subject's behavioral outputs (usually through choices subjects make by pushing different buttons), one can draw inferences about where and how the brain operates differently when engaged in distinctly different decision-making tasks.

We've already published more than sixty of our projected eighty-plus deliverables.[35] But to give just the briefest flavor of the work being done, consider that:

1) It is possible to decode from brain activity—with over 90% accuracy in some conditions—whether a person recognizes a face or life-event as previously encountered, or instead perceives it as novel.[36]
2) The brain areas and network interactions correlated with assessing harms, assigning blame, integrating those two pieces of information, and then choosing punishments have been identified.[37]

35. To learn more, see *Publications*, MACARTHUR FOUND. RES. NETWORK L. & NEUROSCIENCE, http://www.lawneuro.org/publications.php (last visited Jan. 30, 2017).

36. Jesse Rissman et al., *Decoding fMRI Signatures of Real-World Autobiographical Memory Retrieval*, 28 J. COGNITIVE NEUROSCIENCE 604 (2016).

37. Matthew R. Ginther et al., *Parsing the Behavioral and Brain Mechanisms of Third-Party Punishment*, 36 J. NEUROSCIENCE 9420 (2016).

3) Decision-making about the mental states of defendants is far more sensitive to small variations in language describing those mental states than is commonly presumed.[38]
4) Areas of the brain that regulate judgment and self-control are still not fully mature in young adults, rendering behavior more impulsive and juvenile-like in emotionally-charged contexts.[39]
5) Using countermeasures can reduce or eliminate the effectiveness of brain-scanning for lie detection purposes.[40]
6) Disrupting the activity of neurons in a small targeted area of the brain can, as predicted, change how much subjects punish protagonists in hypothetical criminal scenarios, without at all affecting how much subjects blame those same protagonists for their behaviors.[41]

In what ways might these and other neuroscience studies help to advance the goals of law? There are many.[42] But my own view is that we might best consider them, in overview, by sorting them into seven, as follows[43]:

1) Buttressing. Neuroscientific evidence can strengthen conclusions as to which there is already corroborating evidence. For example, when providing evidence of structural abnormalities in, or damage to, the brains of defendants whose behaviors already suggest the possibility of mental disorder.
2) Challenging. Neuroscientific studies may challenge the bases for psychological assumptions that underlie various legal rules.

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38. Francis X. Shen et al., *Sorting Guilty Minds*, 86 N.Y.U. L. REV. 1306 (2011); Matthew R. Ginther et al., *The Language of Mens Rea*, 67 VAND. L. REV. 1327 (2014).

39. Alexandra O. Cohen et al., *When Is an Adolescent an Adult? Assessing Cognitive Control in Emotional and Nonemotional Contexts*, 27 PSYCHOL. SCI. 549 (2016).

40. Melina R. Uncapher et al., *Goal-Directed Modulation of Neural Memory Patterns: Implications for fMRI-Based Memory Detection*, 33 J. NEUROSCIENCE 8531 (2015).

41. Joshua W. Buckholtz et al., *From Blame to Punishment: Disrupting Prefrontal Cortex Activity Reveals Norm Enforcement Mechanisms*, 87 NEURON 1369 (2015).

42. For an overview of law and neuroscience, see generally OWEN D. JONES, JEFFREY H. SCHALL & FRANCIS X. SHEN, LAW AND NEUROSCIENCE (2014); Owen D. Jones & Matthew R. Ginther, *Law and Neuroscience*, *in* INTERNATIONAL ENCYCLOPEDIA OF SOCIAL AND BEHAVIORAL SCIENCES (James D. Wright ed., 2d ed. 2015); Owen D. Jones & Francis X. Shen, *Law and Neuroscience in the United States*, *in* INTERNATIONAL NEUROLAW: A COMPARATIVE ANALYSIS 349 (2011); Owen D. Jones et al., *Brain Imaging for Legal Thinkers: A Guide for the Perplexed*, 2009 STAN. TECH. L. REV. 5; Owen D. Jones et al., *Law and Neuroscience*, 33 J. NEUROSCIENCE 17624 (2013).

43. For further discussion of these, see generally Owen D. Jones, *Seven Ways Neuroscience Aids Law*, *in* NEUROSCIENCES AND THE HUMAN PERSON: NEW PERSPECTIVES ON HUMAN ACTIVITIES 181 (Antonio M. Battro et. al eds., 2013), http://www.casinapioiv.va/content/dam/accademia/pdf/sv121/sv121-jones.pdf. This work benefitted from comments of colleagues in The Working Group on Neuroscience and the Human Person, Vatican City, hosted by The Pontifical Academy of Sciences.

For example, it could test the validity of the rationale (that people can't lie quickly, when excited) for the excited utterance exception to the evidentiary rule against hearsay testimony.

3) Detecting. Neuroscience may help us to detect the presence of conditions relevant to the administration of justice. For example, in detecting the presence and severity of pain.
4) Sorting. Neuroscience may help us sort individuals within the purview of law into different categories, with differing legal consequences. For example, in distinguishing between addicted and non-addicted criminals, for purposes of differential access to medical treatment.
5) Intervening. Neuroscience may help us to develop, in some suitable cases, psychoactive drug interventions. For example, to minimize various urges relevant to law, such as pedophilia.
6) Explaining. Neuroscience can help us understand, in useful ways, the pathways by which people make law-relevant decisions. For example, understanding the pathways by which the brain assesses mental states, estimates harm, integrates those two pieces of information, and decides on a punishment amount may help us, over time, to develop behavioral training and interventions to debias these kinds of decisions.
7) Predicting. Neuroscience may, through the study of correlating brain biomarkers, aid the continuing quest for data that can help us predict law-relevant behaviors. For example, the probability of re-arrest for similar offenses.

C. How to Integrate

So far so good. But all of that is still an effort to focus on how a single life science discipline may aid law. How does one go about taking the next big step, and trying to integrate various life science perspectives on where behavior comes from, in a way useful for law?

I've written separately, and preliminarily, about how this process may best proceed.[44] But in short, the *Converging Questions* method I propose would start with a concrete application—the problem of violence, for instance. It then categorizes the different kinds of questions that are relevant to understanding the phenomenon—such as by firmly delineating, for instance, the "What is the problem?" question (which addresses its features, such as who exhibits it when and where) from the "Why does it occur?" question (which addresses the causal origins) from the "How does it come to pass?"

44. Jones, *Behavioral Economics*, *supra* note 26 (providing a general illustration of how the Converging Questions method would operate with reference to the endowment effect).

question (which addresses the more mechanistic and immediate causal pathways).

It then sorts the disciplinary fields according to their own foci on answering the respective questions. For example, evolutionary biology is more directed toward answering the why than the how questions, while the reverse is true for neuroscience. One then would focus first on integrating disciplinary perspectives, as sorted, *within* the questions before, later, working to make the combined perspectives cross-consistent *across* questions.

This is, of course, where the hardest work gets done. It requires that people from different disciplines: 1) sit down with one another to identify their assumptions and conclusions; 2) identify where those are cross-disciplinarily compatible or incompatible; and 3) integrate the former, while finding ways to empirically test, and resolve, the latter.

III. CONCLUSION

Law is one of those domains—like medicine or engineering—where theory is supposed to meet practice. Where the rubber hits the road. Where people are charged with actually doing something to improve the world, or at least a single life, using the accumulated knowledge then on hand. Consequently, it really matters to law's success, and to the thriving of citizens law governs, that law's efforts to guide and change human behavior are informed by accurate and useful models of where behavior comes from, and why it manifests in the ways that it does.

That, in turn, requires that knowledge be integrated, to be best applied, rather than divided (as it largely still remains) by the often too-rigid borders of university departments. To integrate the relevant information, in furtherance of a more accurate and useful behavioral model, we need to work much harder not only to integrate the social sciences and life sciences perspectives themselves, but also and ultimately to integrate them all with one another.