2008

Law, Biology, and Property: A New Theory of the Endowment Effect

Owen D. Jones

Sarah F. Brosnan
Georgia State University

William and Mary
Law Review

VOLUME 49 NO. 6, 2008

LAW, BIOLOGY, AND PROPERTY: A NEW THEORY OF THE ENDOWMENT EFFECT

OWEN D. JONES* & SARAH F. BROSNAN**

ABSTRACT

Recent work at the intersection of law and behavioral biology has suggested numerous contexts in which legal thinking could benefit by integrating knowledge from behavioral biology. In one of those contexts, behavioral biology may help to provide theoretical founda-

* Professor of Law & Professor of Biological Sciences, Vanderbilt University; Co-Director, MacArthur Foundation Law and Neuroscience Project, Network on Decision Making. B.A., Amherst College; J.D., Yale Law School.

Erin O'Hara, Russell Korobkin, Joni Hersch, Kip Viscusi, David Herring, Paige Skiba, and Bob Rasmussen offered useful comments on this manuscript. Chris Guthrie, Jeffrey Rachlinski, Greg La Blanc, Paul Edelman, Rebecca Brown, Richard Epstein, Kathy Zeiler, Susan Lambeth, Steven Schapiro, Oliver Goodenough, Jeff Stake, Ingrid Wuerth, Paul Zak, and Christopher Yoo provided other commentary useful to us in various aspects of this project, as did workshop participants at Cornell University Law School, Emory University School of Law, and Vanderbilt University Law School, as well as at conferences of the Society for Evolutionary Analysis in Law, the Gruter Institute for Law and Behavioral Research, and the Human Behavior and Evolution Society. We are grateful for research assistance from Amanda Richardson, Mary Catherine Mareno, Susan Eisenberg, Michael Austin, Shang Cao, Christopher Jaeger, and Martha Presley. The authors were funded, in part, by NSF grant SES 0729244 to SFB and by Vanderbilt University.

** Assistant Professor of Psychology, Georgia State University; Visiting Assistant Professor, Michale E. Keeling Center for Comparative Medicine and Research, University of Texas M.D. Anderson Cancer Center. B.A., Baylor University; Ph.D., Emory University (Population Biology, Ecology, and Evolution).

tion for, and potentially increased predictive power concerning, various psychological traits relevant to law. This Article describes an experiment that explores that context.

The paradoxical psychological bias known as the "endowment effect" puzzles economists, skews market behavior, impedes efficient exchange of goods and rights, and thereby poses important problems for law. Although the effect is known to vary widely, there are at present no satisfying explanations for why it manifests when and how it does. Drawing on evolutionary biology, this Article provides a new theory of the endowment effect. Briefly, we hypothesize that the endowment effect is an evolved propensity of humans and, further, that the degree to which an item is evolutionarily relevant will affect the strength of the endowment effect. The theory generates a novel combination of three predictions. These are: (1) the effect is likely to be observable in many other species, including close primate relatives; (2) the prevalence of the effect in other species is likely to vary across items; and (3) the prevalence of the endowment effect will increase or decrease, respectively, with the increasing or decreasing evolutionary salience of the item in question.

*The authors tested these predictions in a chimpanzee (*Pan troglodytes*) experiment, recently published in* Current Biology. *The data, further explored here, are consistent with each of the three predictions. Consequently, this theory may explain why the endowment effect exists in humans and other species. It may also help both to predict and to explain some of the variability in the effect when it does manifest. And, more broadly, the results of the experiment suggest that combining life science and social science perspectives could lead to a more coherent framework for understanding the wider variety of other cognitive heuristics and biases relevant to law.*

TABLE OF CONTENTS

INTRODUCTION

In a 2005 article, Jones and Goldsmith proposed and illustrated twelve broad contexts in which legal thinking could benefit by integrating knowledge from behavioral biology.[1] In one of those contexts, they argued, behavioral biology can help to provide theoretical foundation for, and potentially increased predictive power concerning, various psychological traits relevant to law. This Article describes the results of one effort to explore that context empirically. Along the way, it attempts to pull various threads of cognitive psychology, neoclassical economics, behavioral economics, evolutionary biology, primatology, and brain imaging into the same analytic space.

Specifically, this Article investigates whether insights from behavioral biology might usefully join with insights from other disciplines to help improve the theoretical foundation for, and predictive power concerning, the "endowment effect." The endowment effect is within a suite of related behavioral phenomena often referred to as reflecting "cognitive heuristics and biases."[2] Not only has the effect proven important to behavioral economists,[3] it also plays a key role in a large and interdisciplinary research program known to many as "behavioral law and economics."[4] That research

1. Owen D. Jones & Timothy H. Goldsmith, *Law and Behavioral Biology*, 105 COLUM. L. REV. 405 (2005). Goldsmith is Professor Emeritus of Biology at Yale University and author of THE BIOLOGICAL ROOTS OF HUMAN NATURE (1991) and BIOLOGY, EVOLUTION, AND HUMAN NATURE (2001) (with Zimmerman). The twelve contexts included the following: discovering useful patterns in regulable behavior; uncovering policy conflicts; sharpening cost-benefit analyses; clarifying causal links; increasing understanding about people; disentangling multiple causes; exposing unwarranted assumptions; assessing the comparative effectiveness of legal strategies; revealing deep patterns in legal architecture; identifying selection pressures that law creates; highlighting legal changes through evolutionary metaphor; and providing theoretical foundation for, and potential predictive power concerning, various psychological traits relevant to law.

2. *See generally* HEURISTICS AND BIASES: THE PSYCHOLOGY OF INTUITIVE JUDGMENT (T. Gilovich et al. eds., 2002); JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES (Daniel Kahneman et al. eds., 1982).

3. The endowment effect is considered to be "among the most robust phenomena in the emerging field of behavioral economics." Leaf Van Boven, George Loewenstein & David Dunning, *Mispredicting the Endowment Effect: Underestimation of Owners' Selling Prices by Buyer's Agents*, 51 J. ECON. BEHAV. & ORG. 351, 351 (2003).

4. Although there are overlaps in methods and personnel, it is important not to assume

program adds to (and in some cases challenges) neoclassical law and economics reasoning with various behavioral findings, most of which trace to work by cognitive psychologists.

As described more fully below, the endowment effect is a psychological phenomenon that appears to underlie some seemingly irrational pricing of property and to thereby impede efficient exchange. Because the effect seems inconsistent with standard neoclassical, rational actor, expected-utility theory economic assumptions, a large and growing swarm of articles and working papers—by both traditional and behavioral economists, among others—has explored and often contested its existence, causes, boundaries, and implications.[5] And, because the existence of the effect would suggest that one of the assumptions inherent in the Coase Theorem is rarely if ever true in practice, many legal scholars have raised concerns about the potential implications of the endowment effect for a wide variety of legal approaches to distributing goods and rights.[6]

---

that behavioral economists and scholars engaged in behavioral law and economics (B.L.E.) have exactly the same interests and priorities. Generally speaking, for example, although behavioral economists may be friendlier to paternalistic policies (to combat cognitive heuristics and biases) than are neoclassical economists, behavioral economists generally find paternalism less appealing than B.L.E. scholars.

For an overview of behavioral economics, see, e.g., Matthew Rabin, *Psychology and Economics*, 36 J. ECON. LITERATURE 11 (1998); Stefano DellaVigna, *Psychology and Economics: Evidence from the Field* (Nat'l Bureau of Econ. Research, Working Paper No. 13420, 2007), *available at* http://www.nber.org/papers/w13420. For an overview of behavioral law and economics, see Christine Jolls, Cass R. Sunstein & Richard Thaler, *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471 (1998); Christine Jolls & Cass R. Sunstein, *Debiasing Through Law*, 35 J. LEGAL STUD. 199 (2006); Christine Jolls, *Behavioral Law and Economics*, *in* BEHAVIORAL ECONOMICS AND ITS APPLICATIONS 115 (Peter Diamond & Hannu Vartiainen eds., 2007).

5. For partial lists, see, e.g., Owen D. Jones, *Time-Shifted Rationality and the Law of Law's Leverage: Behavioral Economics Meets Behavioral Biology*, 95 NW. U. L. REV. 1141, 1141-42 n.1 (2001); Serdar Sayman & Ayşe Öncüler, *Effects of Study Design Characteristics on the WTA-WTP Disparity: A Meta Analytical Framework*, 26 J. ECON. PSYCHOL. 289, 290-92 (2005).

6. A rough estimate of its influence: over 680 articles in the Westlaw journals and law reviews (JLR) database use the term "endowment effect." Of course, the endowment effect is not the only real-world consequence to suggest that, even in the utter absence of transaction costs, inefficient outcomes may follow. *See, e.g.*, Chullo Jung et al., *The Coase Theorem in a Rent-Seeking Society*, 15 INT'L REV. L. & ECON. 259, 266 (1995) (concluding that even in situations with low transaction costs "parties will attempt to rent-seek over the rights distribution").

Part I of this Article provides an overview of the central problem. It provides necessary foundation concerning the endowment effect, describing what it is, how it manifests, why it matters to law, and why there is much at stake. Part I also summarizes some prevailing social science theories for what may cause the effect. It then explains why these theories generally fail to provide a satisfying theoretical foundation for the phenomenon and explains why, as a consequence, we still lack any meaningful ability to predict or explain either when the endowment effect will appear or its relative magnitudes when it does appear.

Part II provides brief background on how life science perspectives might provide useful insight into the endowment effect. It describes why behavioral biology perspectives, in particular (and within that set, a subset of evolutionary biology perspectives), may contribute to a deeper and more scientifically coherent foundation for understanding the phenomenon, as well as provide some increased or expanded predictive power about when and how it may manifest. The Part then describes three novel predictions that arise in combination from a behavioral biology perspective and from no other known causal theory.

Part III then describes an experiment we and several colleagues conducted with chimpanzees (*Pan troglodytes*) and recently published in a leading biology journal, *Current Biology*,[7] to investigate those three predictions. We chose chimpanzees as our subjects because our first prediction concerns a possible evolutionary root to the endowment effect, which suggests that our closest primate relatives—with bonobos (*Pan paniscus*)—might also exhibit it. This Part discusses how the data currently provide evidence consistent with each of the three predictions.

Part IV then reflects on some limitations of the experiment. It considers a few possible confounds that could potentially be inconsistent with our interpretation of the data. And it describes how subsequent research might clarify these issues and extend our understanding of the endowment effect.

---

7. Sarah F. Brosnan, Owen D. Jones, Susan P. Lambeth, Mary Catherine Mareno, Amanda S. Richardson & Steven J. Schapiro, *Endowment Effects in Chimpanzees*, 17 CURRENT BIOLOGY 1704 (2007).

Part V considers how the hypotheses explored here, and the underlying theoretical framework they reflect, connect with the existing endowment effect literature, as well as with developments in brain-scanning.

Throughout, it should be remembered that our narrow focus on testing life science perspectives about the endowment effect in chimpanzees is only partly about the endowment effect itself, and the relevance of deeper understanding of that effect to the legal system. Although our work has potential implications for scholars in behavioral economics, primatology, and law, the entirety of our approach here is the exploratory front edge of a potentially promising research program that would—through synthesis of life science and social science perspectives—aid law's efficiency and effectiveness by increasing the accuracy and robustness of the behavioral models on which it necessarily relies.

I. THE ENDOWMENT EFFECT

A. What It Is and Why It Matters

As is well known, the Coase Theorem describes how—if several assumptions are true and the initial distribution of property rights is taken as a given—the end distribution in society of goods (and other tradable things, such as options and permits) will be Pareto efficient, regardless of the initial distribution.[8] That is, people will simply buy and sell goods and rights until they end up in the hands of the people who value them most.

The assumptions include the absence of wealth effects (by which one's demand for a good may vary with personal wealth), the absence of significant transaction costs (which could impede the ability of those who most value something from actually finding, negotiating for, and acquiring it), and the rational valuation of goods and rights.

---

8. *See* Ronald H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960). Note that Coase never believed that the conditions of the Coase Theorem were true in practice. His article was intended to highlight, rather than minimize, the significance of transaction costs, and is more heuristic than empirical. James Lindgren, *"Ol' Man River... He Keeps on Rollin' Along": A Reply to Donohue's* Diverting the Coasean River, 78 GEO. L.J. 577, 579 (1990).

Of these three assumptions, we are here concerned with the third. In this context, "rational valuation" means that the value a person ascribes to a good or right will be stable and insensitive to logically irrelevant circumstances. And the word "rational" bears its economic meaning (referring to a *substantively* efficient choice, regardless of the process deployed to achieve it) rather than to its common, psychological meaning (which often suggests, in contrast, that one is *procedurally* deploying self-conscious, analytic deliberation).[9]

In recent years, experiments in cognitive psychology and behavioral economics have given good reason to question whether in fact people always, or even generally, value goods and rights as rationally as both law and economics have tended to assume. In many experimental conditions, for example, it appears that people will often and genuinely value an item they have just acquired at a significantly higher dollar amount than the maximum price they would have paid for that item the instant before they acquired it.[10] That is, the instant people come to own something it often appears to acquire extra value to them—as if from thin air—by virtue of the mere fact of ownership. Importantly, this effect appears to arise before people have time, for example, to learn more about the item or to have experiences that may add sentimental value.[11]

This propensity to value an item not solely on the characteristics of the item itself, but also according to abstract notions of ownership, suggests that people are often pricing goods and rights irrationally.[12] For example, suppose that five minutes ago Fred

9. Herbert Simon clarified the distinction this way: "The rational person of neoclassical economics always reaches the decision that is objectively, or substantively, best in terms of the given utility function. The rational person of cognitive psychology goes about making his or her decisions in a way that is procedurally reasonable in the light of the available knowledge and means of computation." Herbert Simon, *Rationality in Psychology and Economics*, 59 J. BUS. S209, S211 (1986).

10. *See generally* Sayman & Öncülar, *supra* note 5. Russell Korobkin provides one of the best available overviews of the endowment effect, the studies of the phenomenon, and the theories concerning its variations. Russell Korobkin, *The Endowment Effect and Legal Analysis*, 97 NW. U. L. REV. 1227 (2003).

11. For an overview, see, e.g., Daniel Kahneman, Jack L. Knetsch & Richard Thaler, *Experimental Tests of the Endowment Effect and the Coase Theorem*, 98 J. POL. ECON. 1325, 1342-46 (1990); Korobkin, *supra* note 10; Sayman & Öncüler, *supra* note 5.

12. There have been some interesting semantic discussions of whether or not, even if it exists, the endowment effect is formally irrational. One can argue, for example, that once a person's preference for the item has increased, then acting consistent with that preference is

explicitly refused to purchase a given object for $25.00, thereby clearly indicating that he values $25.01 in cash more than he values that object. Under traditional economic reasoning, it should not logically be the case that, were Fred suddenly to own that same item, he would instantly and genuinely refuse to sell it for anything less than (say) $40.00. That would suggest he suddenly now values the item more than $39.99 in cash. Despite the apparent inconsistency, people often appear to behave this way. One experiment suggested, for example, that waterfowl hunters would not pay more than $247, on average, for hunting rights, but also would not sell those rights for anything less than $1044, on average.[13] Another experiment found that, while buyers would not pay more than $2.87 for a mug, sellers who had just been given the same mug would not sell for anything less than $7.12.[14]

This instantaneous jump between the maximum price one would have paid to acquire an item and the minimum price at which one would sell the item (having just acquired it) is often called the "endowment effect"[15] because it seems to inhere at the moment a

---

rational. Similarly, one could argue (perhaps tautologically) that seemingly irrational behavior simply reflects rational, utility-maximizing behavior among people who share an unexpectedly odd utility function. Alternatively, one could simply say that observed disparities challenge expected utility theory as a good model for decision making under uncertainty. Regardless of terminology, the key point is that the change in preference seems irrational, and if it is so, then even "rational" pursuit of an irrational preference can make problems for law.

13. JUDD HAMMACK & GARDNER MALLARD BROWN, JR., WATERFOWL AND WETLANDS: TOWARD BIO-ECONOMIC ANALYSIS 26-27 (1974).

14. Kahneman et al., *supra* note 11, at 1338-39.

15. Early studies include Elizabeth Hoffman & Matthew L. Spitzer, *Willingness to Pay vs. Willingness to Accept: Legal and Economic Implications*, 71 WASH. U. L.Q. 59 (1993); Daniel Kahneman, Jack L. Knetsch & Richard H. Thaler, *Anomalies: The Endowment Effect, Loss Aversion, and Status Quo Bias*, 5 J. ECON. PERSP. 193 (1991); Kahneman et al., *supra* note 11; Jack L. Knetsch, *The Endowment Effect and Evidence of Nonreversible Indifference Curves*, 79 AM. ECON. REV. 1277 (1989); Jack L. Knetsch & J.A. Sinden, *Willingness to Pay and Compensation Demanded: Experimental Evidence of an Unexpected Disparity in Measures of Value*, 99 Q. J. ECON. 507 (1984).

Some important recent studies include Robert Franciosi et al., *Experimental Tests of the Endowment Effect*, 30 J. ECON. BEHAV. & ORG. 213 (1996); John K. Horowitz & Kenneth E. McConnell, *A Review of WTA/WTP Studies*, 44 J. ENVTL. ECON. & MGMT. 426 (2002); Brett Inder & Terry O'Brien, *The Endowment Effect and the Role of Uncertainty*, 55 BULL. ECON. RES. 289 (2003).

For useful literature surveys, see Korobkin, *supra* note 10; Nathan Novemsky & Daniel Kahneman, *The Boundaries of Loss Aversion*, 42 J. MARKETING RES. 119 (2005); Charles R.

person is endowed with ownership rights. (The phenomenon is sometimes alternatively referred to as a species of the *status-quo bias*, or *buying/selling price preference reversals*, or *reference-dependent preferences*, or the *offer/asking gap*, or as either the *WTP-WTA gap* or the *WTP-WTA disparity*, referring to the difference between the maximum one is *willing to pay* (WTP) to acquire the item and the minimum one is *willing to accept* (WTA) to sell it.[16])

The existence of an endowment effect suggests that—wholly irrespective of wealth effects and transaction costs[17]—many initial distributions of goods and rights will tend to be "sticky," and therefore will not flow inexorably toward the most efficient distribution, as the Coase Theorem would otherwise predict.[18] That is, they will instead have a greater than expected tendency to adhere to the hands of those people into whose hands they first get.

Some important scholarship has questioned whether buy/sell and exchange asymmetries are meaningfully related to endowments, or are instead the artifactual by-products of insufficiently controlled

---

Plott & Kathryn Zeiler, *Exchange Asymmetries Incorrectly Interpreted as Evidence of Endowment Effect and Prospect Theory?*, 97 AM. ECON. REV. 1449 (2007) [hereinafter Plott & Zeiler, *Asymmetries*]; Charles R. Plott & Kathryn Zeiler, *The Willingness to Pay—Willingness to Accept Gap, the "Endowment Effect," Subject Misconceptions, and Experimental Procedures for Eliciting Valuations*, 95 AM. ECON. REV. 530 (2005) [hereinafter Plott & Zeiler, *Willingness*].

16. *See, e.g.*, William Samuelson & Richard Zeckhauser, *Status Quo Bias in Decision Making*, 1 J. RISK & UNCERTAINTY 7 (1988); Kahneman et al., *supra* note 15; Julie R. Irwin, *Buying/Selling Price Preference Reversals: Preference for Environmental Changes in Buying Versus Selling Modes*, 60 ORG. BEHAV. & HUM. DECISION PROCESSES 431 (1994); Michael S. Haigh & John A. List, *Do Professional Traders Exhibit Myopic Loss Aversion? An Experimental Analysis*, 60 J. FIN. 523 (2005); Ian Bateman et al., *A Test of the Theory of Reference-Dependent Preferences*, 112 Q. J. ECON. 479 (1997); Horowitz & McConnell, *supra* note 15. Some consider the nomenclature non-trivial, arguing that the term "endowment effect" not only describes the phenomenon of a pricing disparity, but also assumes that it is the endowment and not some other potential feature of the situation that causes the phenomenon. *See, e.g.*, Plott & Zeiler, *Asymmetries*, *supra* note 15, at 1453. We take no position on the merits of this debate over how to characterize asymmetries in exchange behavior, but simply adopt the terminology that is most used and least cumbersome.

17. Some have suggested that the endowment effect is itself a subset of transaction costs. But that is a semantic issue irrelevant to our discussions here.

18. Put another way: the endowment effect "implies that the initial assignment of the good, however obtained, may well determine its ultimate allocation even when transaction costs are zero." RICHARD EPSTEIN, SKEPTICISM AND FREEDOM: A MODERN CASE FOR CLASSICAL LIBERALISM 211 (2003).

experimental designs (including their instructions to subjects).[19] But if the endowment effect is real, at least under some real-world conditions, it arguably should matter a great deal to law.[20] For example, to the extent that the Coase Theorem assumes that "value is independent of initial assignment,"[21] and to the extent that insights of the theorem inform some legal policies—such as those underlying a market in pollution permits—then the stickiness of goods and rights could be quite problematic, even independent of transaction costs.[22] It would underscore the extent to which, when the legal system affects the distribution of goods and rights, the way in which it does so has important economic consequences. That in turn might suggest that the law could not so comfortably rely on market behavior to move goods and rights into the hands of those who will put them to the most economically productive use.[23] Indeed Arlen, Spitzer, and Talley have argued that "the endowment effect undermines—or at least complexifies—the concept of social welfare itself, making it difficult to define the cost and benefit of reallocating an entitlement."[24]

---

19. Plott & Zeiler, *Asymmetries*, *supra* note 15; Plott & Zeiler, *Willingness*, *supra* note 15.

20. *See, e.g.*, Jolls, Sunstein & Thaler, *supra* note 4; Jolls & Sunstein, *supra* note 4; Korobkin, *supra* note 10.

21. Eric J. Johnson, Simon Gächter & Andreas Herrmann, *Exploring the Nature of Loss Aversion* 4 (Ctr. for Decision Research & Experimental Econ., Discussion Paper 2006-02, 2006).

22. *See, e.g.*, JONATHAN BARON, THINKING AND DECIDING 290-91 (3d ed. 2000) (providing several examples). As Johnson et al. put it: "For consumer choice, these asymmetries have pervasive implications, suggesting that elasticities for product attributes will differ for increases and decreases from current levels, and that there will be less trading and more loyalty than would be suggested by a standard value maximization model." Johnson et al., *supra* note 21, at 4. EPSTEIN, *supra* note 18, at 210, notes: "One object of a system of free exchange is to move resources to higher valued uses. Unfortunately, that task is compromised if the value of the good depends on who owns it, for then the social program now appears circular."

The implications of the endowment effect can be far-reaching. Sunstein suggests, for example, that the operation of policies concerning the allocation of broadcast spectrum (by which, generally speaking, broadcasters are given broadcast rights for free) can be impeded by endowment effects. *See* Cass R. Sunstein, *Television and the Public Interest*, 88 CAL. L. REV. 499, 546-47 (2000).

23. For a discussion of how the endowment effect can have implications for legal thinking about choices between property rules and liability rules, see Jeffrey Rachlinski & Forest Jourden, *Remedies and the Psychology of Ownership*, 51 VAND. L. REV. 1541 (1998).

24. Jennifer Arlen et al., *Endowment Effects Within Corporate Agency Relationships*, 31 J. LEGAL STUD. 1 (2002) (citing Hoffman & Spitzer, *supra* note 15, at 103-12).

Similarly, the very existence of disparities between how much people would pay to acquire, and how much people would demand to relinquish, can have significant effects for such things as determining contingent valuations and just compensation.[25] Willingness-to-pay data are not only provided to policy makers considering the economic value of nonmarket environmental assets (such as when determining the merits of a proposed habitat improvement program).[26] Willingness-to-pay data are also often considered appropriate for establishing levels of compensation for harms, as to coastal fishers after an oil spill, for example.[27] That's because conventional economic thinking tells us that willingness-to-pay and willingness-to-accept measures should be nearly identical.[28] Yet the existence of endowment effects suggests that using willingness-to-pay measures to determine compensation may substantially underestimate the loss.

In addition, the endowment effect can have implications for the law of contracts. Portions of contract law are devoted to decreasing transaction costs and enabling efficient breaches—in the belief that goods and services will flow efficiently to those who value them most. The presence of endowment effects suggests that decreasing —or even eliminating—transaction costs in contract contexts would not guarantee this result. A person in possession of a contract right may value it more than he was willing to pay for it, arguably suggesting that traditional compensation after breach for such things as lost profits and the costs of arranging substitute transactions may undercompensate. Indeed, endowment effects may even warp the negotiation of contracts, as people may demand far more to give up a standard provision in their own standard contracts than they would have been willing to pay to acquire exactly what that provision provides, if they had to bargain for it anew.[29]

---

25. For an example of careful thinking about this problem, see David S. Brookshire & Don L. Coursey, *Measuring the Value of a Public Good: An Empirical Comparison of Elicitation Procedures*, 77 AM. ECON. REV. 554 (1987); *see also* COST-BENEFIT ANALYSIS AND THE ENVIRONMENT: RECENT DEVELOPMENTS 507-55 (2006).

26. *See* Thomas C. Brown & Robin Gregory, *Survey: Why the WTA-WTP Disparity Matters*, 28 ECOLOGICAL ECON. 323, 323-24 (1999).

27. *Id.*

28. *Id.* at 324 (citing R.D. Willig, *Consumers' Surplus Without Apology*, 66 AM. ECON. REV. 589 (1976)).

29. *See* Russell Korobkin, *The Status Quo Bias and Contract Default Rules*, 83 CORNELL

Some have argued that the unpredictably low demand for reverse mortgages—contracts in which homeowners sell homes to a bank in exchange for an annuity and life insurance—may be a function of irrational endowment effects.[30] Some find important implications of the endowment effect for corporate law.[31] Others have explored the implications of the endowment effect for such things as zoning, takings, and the doctrine of adverse possession in property law, as well as the fair use doctrine in copyright law.[32]

Given the importance of the endowment effect, it would clearly be useful to gain a deeper understanding of its causes and patterns. A number of studies (mostly, but not exclusively, by psychologists and economists) have suggested that one variable or another (such as perception that a good was earned by one's performance, rather than by chance) increases or decreases the probability of, and magnitude of, endowment effects.[33] There have been some significant efforts to try to categorize these variables—into economic and psychological factors, for example[34]—and to assess their relative significance.[35]

At present, however, the profusion of studies demonstrates endowment effects that are all over the place, but not (yet) predictable—appearing here, disappearing there—and showing very large effects in some contexts with small effects in others.[36] See Figure 1. Studies are far better at discovering where the effect may exist than why it does so.[37] For example, endowment effects appear to be present for mugs but not for tokens that can be exchanged for mugs.[38] Regular folk sometimes exhibit the effect, while those who

---

L. REV. 608 (1998) (discussing how the endowment effect may effect default rules in contracts).

30. *See* Steffen Huck et al., *Learning to Like What You Have—Explaining the Endowment Effect*, 115 ECON. J. 689, 690 (2005).

31. *See, e.g.*, Arlen et al., *supra* note 24.

32. *See generally* Korobkin, *supra* note 10.

33. A useful overview of these appears in *id.* at 1235-42.

34. *See, e.g.*, Brown & Gregory, *supra* note 26.

35. *See, e.g.*, Sayman & Öncüler, *supra* note 5.

36. *See* Brown & Gregory, *supra* note 26; Sayman & Öncüler, *supra* note 5.

37. *Cf.* Jennifer Arlen, Comment, *The Future of Behavioral Economic Analysis of Law*, 51 VAND. L. REV. 1765, 1768-69 (1998) (observing this with respect to behavioral economic studies of biases generally).

38. Kahneman et al., *supra* note 11, at 1329-32.

professionally trade in the item in question sometimes do not.[39] (Though sometimes even this finding is exactly reversed.[40]) And some have proposed,[41] while others have found, that there are likely variations in effect magnitudes as a function of some demographic variables. The ratio of maximum price for purchasing and minimum price for selling (which can be considered a measure of the magnitude of the effect) has been found to vary at least from .14 (which, being less than 1, represents a reverse endowment effect) to 113.[42] (One meta-analytic study reports a mean of 7.1 and a median of 2.9.[43])

39. *See, e.g.*, John A. List, *Does Market Experience Eliminate Market Anomalies?*, 118 Q. J. ECON. 41 (2003) (showing that endowment effects diminish or disappear among experienced, professional traders, for their traded items); John A. List, *Neoclassical Theory Versus Prospect Theory: Evidence from the Marketplace*, 72 ECONOMETRICA 615 (2004); John A. List, *Substitutability, Experience, and the Value Disparity: Evidence from the Marketplace*, 47 J. ENVTL. ECON. & MGMT. 486 (2004).

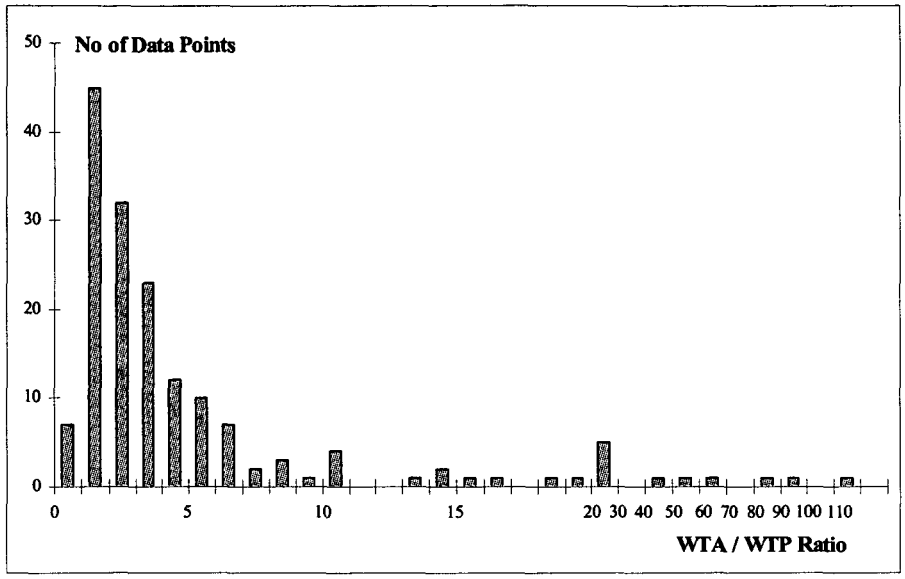
40. *See, e.g.*, Haigh & List, *supra* note 16.

41. *See, e.g.*, Gregory Mitchell, *Taking Behavioralism Too Seriously? The Unwarranted Pessimism of the New Behavioral Analysis of Law*, 43 WM. & MARY L. REV. 1907 (2002); Jones, *supra* note 5.

42. *See, e.g.*, Sayman & Öncüler, *supra* note 5, at 300, 302 fig.1.

43. *Id.* at 300.

Figure 1: Histogram of WTA/WTP Ratio. The scale of the horizontal axis compresses at the right. Reprinted from Serdar Sayman & Ayşe Öncüler, *Effects of Study Design Characteristics on the WTA-WTP Disparity: A Meta Analytical Framework*, 26 J. ECON. PSYCHOL. 289, 302 (2005), with permission from Elsevier.



It can hardly be overemphasized that most, perhaps all, of these studies arise from essentially theory-free trial-and-error explorations—investigating everything from eggs, density of park trees, and lottery tickets to odor-free air, electric service reliability, and binoculars.[44] Meaningful theories of causation that might help to explain observed anomalies within the endowment effect, lead to a systematic investigation of the effect, help to predict future manifestations of the effect, or aid law's ability to combat the effect (where appropriate) are still up for grabs.[45]

44. *See id.* at 301 tbl.1; *see also* Brown & Gregory, *supra* note 26, at 325 tbl.1.

45. A meta-analytic study concluded, for example, that the phenomenon "seems to be, to some extent, good-specific[,] [but] [t]he reason for this is not clear." Sayman & Öncüler, *supra* note 5, at 308.

B. Causes of the Endowment Effect

This is not to say there aren't theories. Some have speculated that endowment effects are caused principally by the role of personal wealth in valuation processes.[46] Others have argued that a person's "preference uncertainty" or unavoidably strategic misrepresentation of preferences underlies endowment effects.[47] Others speculate that the inevitable transaction costs to changing your mind, and implementing that change, might be sufficiently great to explain a rational bias toward the status quo.[48] Others—including those who have attempted formal models—argue that buying scenarios create a materially different expectation and reference point than selling scenarios and that this explains the phenomenon.[49]

But the prevailing perspective at present appears to be that endowment effects are merely specific instances of generalized "loss aversion" (and related phenomena).[50] Loss aversion describes a mental condition whereby a person weighs the losing of a thing he

---

46. *See* Korobkin, *supra* note 10, at 1247-49.

47. *See* Sayman & Öncüler, *supra* note 5, at 291.

48. Personal Communication with Kip Viscusi (Feb. 2006).

49. *See* Botond Koszegi & Matthew Rabin, *A Model of Reference-Dependent Preferences*, 121 Q. J. ECON. 1133 (2006).

50. *See, e.g.*, Colin Camerer, *Three Cheers—Psychological, Theoretical, Empirical—for Loss Aversion*, 42 J. MARKETING RES. 129 (2005); Johnson et al., *supra* note 21; Kahneman et al., *supra* note 15; Kahneman et al., *supra* note 11; Amos Tversky & Daniel Kahneman, *Loss Aversion in Riskless Choice: A Reference-Dependent Model*, 106 Q. J. ECON. 1039 (1991). An overview of relevant phenomena appears in BARON, *supra* note 22, ch. 11, ch. 12. For discussion in legal contexts, see Chris Guthrie, *Prospect Theory, Risk Preference, and the Law*, 97 NW. U. L. REV. 1115 (2003) (discussing prospect theory, of which loss aversion is a component); Korobkin, *supra* note 10, at 1242-55.

A concise summary of prospect theory appears in BARON, *supra* note 22, at 250-60. In brief, prospect theory suggests that "preferences are characterized by two fundamental features: (1) reference-point dependence (i.e., gains and losses are evaluated from some reference point), and (2) loss aversion (i.e., the notion that individuals experience more disutility from losses than they do utility from gains of the same size)." Charles R. Plott & Kathryn Zeiler, *Asymmetries in Exchange Behavior Incorrectly Interpreted as Evidence of Prospect Theory* 3 n.8 (Am. Law & Econ. Ass'n Annual Meeting, Working Paper No. 63, 2005) (citing Daniel Kahneman & Amos Tversky, *Prospect Theory: An Analysis of Decision Under Risk*, 47 ECONOMETRICA 263 (1979)) (cited by permission). Tversky and Kahneman phrase this somewhat differently in 2000, but loss aversion remains a central feature. Amos Tversky & Daniel Kahneman, *Advances in Prospect Theory: Cumulative Representation of Uncertainty*, *in* CHOICES, VALUES, AND FRAMES 44, 45 (Daniel Kahneman & Amos Tversky eds., 2000). For more detail, see DellaVigna, *supra* note 4.

has more heavily than the failure to gain that same thing from someone else—even though the two conditions are economically equivalent. This is commonly summarized: losses loom larger than gains.

If one accepts that people are generally loss-averse, then loss aversion indeed seems to explain endowment effects. But there are several reasons why loss aversion is unsatisfying as a theoretical foundation for this phenomenon.

First, it comes suspiciously close (if not closer) to explaining one mystery with another, merely abstracting the causal question up one level. As one commentator put it, explaining the endowment effect with loss aversion is like saying that rain is caused by a rainstorm.[51] If the endowment effect reflects loss aversion, then where does loss aversion come from?

Second, loss aversion is an assumption, not a theory.[52] It does not purport to explain why this seemingly irrational predisposition is spatially and temporally widespread and directionally oriented as it is. Why, when pricing goods and rights, are people more afraid to lose something they have than they are to lose the opportunity to gain the same thing? Is it just coin-flipping odds whether humans might instead have been more afraid to lose the opportunity to gain something than to lose it?

Third, recourse to the loss aversion assumption provides no coherent basis—none at all—for predicting how the presence and magnitude of the endowment effect will vary, or according to what.[53] Knowing that potential losses are weighed more heavily than equivalent potential gains simply does not (and cannot) help us explain existing and observed variations in endowment effect magnitudes, or predict where future effects are most likely to be found. While it is true that hundreds of researchers are out there enthusiastically cataloging the prevalence of and magnitudes of endowment effects for various groups encountering various goods and services, no one has a clear vision of what variables—in product

51. Edward J. McCaffery, *Cognitive Theory and Tax*, 41 UCLA L. REV. 1861, 1865-66 (1994).

52. CHOICES, VALUES, AND FRAMES, *supra* note 50, at xiii.

53. On the limits of prospect theory, with respect to predictive power, see W. Kip Viscusi, *Prospective Reference Theory: Toward an Explanation of Paradoxes*, 2 J. RISK & UNCERTAINTY 235, 238 (1989).

or service attributes, in contexts, or in people—are actually relevant to record or experimentally manipulate. Loss aversion provides no help in making such predictions.

Fourth, simply situating the endowment effect within loss aversion overlooks the possibility that the effect may connect at some deeper causal level to the other cognitive quirks that have attracted attention in recent years and which collectively constitute the core of behavioral economist's concerns. These include intertemporal choice anomalies, irrationally discounted futures, framing problems, mistaken assessments of probability, and the like.[54] Ideally, scholars should seek a broader theoretical foundation that could reconcile all or many of these at once.[55] Given the wide variety of cognitive heuristics, biases, and quirks that have been feted as significant to human behavior, economics, and legal regimes, we should aspire not to ad hoc explanations for each, but instead to a connective theory that might make seamless and coherent sense of the phenomena as a group.

The next Part very briefly describes a hypothesis, derived from behavioral biology, that may offer a significant step toward eventual understanding of these greater puzzles. Specifically, it may help to improve the theoretical foundation for understanding the phenomenon, may help to explain the breadth and directionality of the effect, may help improve our predictions about where the effect will arise and with what relative consequence, and may help to connect the effect, at a deeper level, to other law-relevant quirks in human psychology.

To be clear, we do not propose that behavioral biology provides all the answers. But we think it is an important part of any coherent answer. And, given the current vacuum (in which predictions derive principally from observed patterns and assumptions, rather than from theory), any theory offering even modest predictive gains will represent significant progress. Some will argue that the endowment effect is not so much caused by "loss aversion" as it is a function of "prospect theory"—of which both "loss aversion" and "reference

54. *See generally supra* note 4. A collection of some of the key works in behavioral economics appears in ADVANCES IN BEHAVIORAL ECONOMICS (Colin F. Camerer, George Loewenstein & Matthew Rabin eds., 2004).

55. For one argument for such a theory, see Jones, *supra* note 5.

dependence" are parts. Regardless, our point here is that these latter three terms, concepts, or theories, in whatever combination, provide no theoretical foundation in the scientific sense. They are, instead, descriptions of observed patterns in the variables that appear to be correlated with the phenomenon at issue. They are not theories of *why* those particular patterns in those particular variables exist.[56]

II. AN EVOLUTIONARY HYPOTHESIS

This Part does three things. Section A provides brief background, for context, on the general relationship between law, biology, and behavioral models. It explains why—as a threshold matter—we think it often important to consider information from the life sciences when seeking to understand human behavior relevant to law. Section B very briefly summarizes some prior theoretical work,[57] which drew on behavioral biology to detail bases for hypothesizing that the endowment effect (among other cognitive heuristics and biases) may reflect an evolved behavioral predisposition that is common to *Homo sapiens*, at least under some circumstances. Section C describes three specific, novel predictions arising from this work (as to which the subsequent Part will provide experimental data).

A. Law, Behavior, and Behavioral Models

By way of background, the basic logic connecting law and behavioral biology is this:[58] Law (construed broadly) exists largely to effect changes in human behavior.[59] (For when humans already behave as society wants, legal interventions are unnecessary.) Law's ability to effectively and efficiently deploy legal tools to achieve these changes often (though, importantly, not always) depends on

56. For more on prospect theory generally, see *supra* notes 50 and 53.

57. *See* Jones, *supra* note 5.

58. A lengthier and more detailed explanation appears in Jones & Goldsmith, *supra* note 1, at 411-23.

59. This is not to deny that there are expressive functions to law, beyond the instrumental functions. *See, e.g.*, Richard H. McAdams, *An Attitudinal Theory of Expressive Law*, 79 OR. L. REV. 339 (2000).

the accuracy of the behavioral models on which law relies. The behavioral model is that which sums our empirical and theoretical understandings of why people behave as they do and how they are likely to change their behaviors as a function of changes in law. (For example, a behavioral model may reflect the assumption that youth violence is largely a function of cultural messages transmitted through television and video games, which should therefore be regulated, or may reflect the assumption that making it harder to divorce will cause married couples actually to reside together longer.) So, speaking metaphorically, the behavioral model is a fulcrum on which the lever of law rests. And a soft fulcrum—that is, an insufficiently accurate and robust behavioral model—will undermine the effectiveness and efficiency of law's purposive interventions.

With some exceptions (particularly in the arena of economics), contemporary behavioral models in law are rarely explicit. The models, and their constituent assumptions about behavior, vary by jurisdictions, regulatory bodies, and behaviors. And viewed as a whole, the models are unsystematic and informed by various amalgamations of experience, path dependence, observation, intuition, trial-and-error, self-reflection, imitation, hope, and the influence of various disciplines that seem appealing at a particular time. Despite their surface differences, however, the behavioral models law deploys are generally similar in one important respect: their nearly wholesale reliance on social science insights to the exclusion of the many life science insights regarding where behavior comes from, how it emerges and develops, what various processes give rise to behavioral patterns across a species, and how multiple causal influences intersect in body and brain to enable and generate behavior.

This exclusion of life science perspectives on behavior reflects the general division within a university, whereby, with only minimal overlap, human behavior is studied in one set of buildings, and the behavior of every other species on the planet is studied in a different set of buildings. But that structural comfort is obsolete and belies the underlying problem. There are no bright boundaries between psychology and biology, since all psychological phenomena arise from and operate within an evolved and biologically corporeal

brain.[60] Indeed, there are no bright boundaries between biology and economics, as economic principles (choice, under conditions of scarcity) are inherent in evolutionary processes—and evolutionary processes (including natural selection) are reciprocally the most relentlessly economizing forces in the history of life (resulting in tendencies, within both plants and animals, to bias form, function, and behavior toward substantively "rational" outcomes).[61]

To be clear, social science perspectives are valuable and not to be overlooked or underestimated. We are not arguing that life science perspectives should somehow supplant social science perspectives. Instead, we and a number of other scholars make the more modest argument that in order to construct the best available behavioral model for the lever of law, it will be useful to *integrate* social science and life science perspectives into a more unified whole.[62] Behavioral biology (composed of a variety of subdisciplines, including evolutionary biology, behavioral ecology, cognitive neuroscience, behavioral genetics, and others) already constitutes an enormous body of literature, nearly untapped by legal thinkers, which is now growing at an accelerating pace. And some of the things that this literature reveals may prove useful to understanding phenomena such as the endowment effect.

B. Applying Behavioral Biology Perspectives to Endowment Effects

The remainder of this Article builds on a variety of foundational concepts in evolutionary biology detailed elsewhere.[63] The key

60. That is, incidentally, why so many psychology departments have in recent years "gone neuro"—shifting investigations into neurological phenomena.

61. There is growing interest in the relationship between evolutionary biology and economics. *See, e.g.*, Larry Samuelson & Jeroen Swinkels, *Information, Evolution, and Utility*, 1 THEORETICAL ECON. 119 (2006); Luis Rayo & Gary S. Becker, Evolutionary Efficiency and Happiness (Working Paper, 2005). For discussion of similarities and differences, see Owen D. Jones, Erin O'Hara & Jeffrey E. Stake, *Law, Economics, and Biology* (submitted).

62. An extensive bibliography of such sources (maintained by Owen D. Jones) appears on the website of the *Society for Evolutionary Analysis in Law* (S.E.A.L.) at http://www.sealsite.org/ (last visited Mar. 30, 2008).

63. Key works in evolutionary biology generally include MARK RIDLEY, EVOLUTION (3d ed. 2003) and DOUGLAS J. FUTUYMA, EVOLUTIONARY BIOLOGY (3d ed. 1998). Useful works with behavioral emphases include TIMOTHY H. GOLDSMITH & WILLIAM F. ZIMMERMAN, BIOLOGY, EVOLUTION, AND HUMAN NATURE (2001) and JOHN ALCOCK, ANIMAL BEHAVIOR: AN EVOLUTIONARY APPROACH (8th ed. 2005). Primers written explicitly for legal thinkers also

concept for present purposes is that evolutionary processes have inevitably influenced (though generally not determined, an important distinction) various human behavioral predispositions by affecting the structure and operations of the human nervous system, including its most significant feature, the brain.

The two-paragraph sketch is this: Evolutionary processes—including natural selection, sexual selection, mutation, genetic drift, and gene flow[64]—influence the commonly observable external anatomy (morphology) of every species, such as large ears in rabbits, sharp teeth in sharks, and opposable thumbs in primates. Similarly, those processes also influence the internal structure and capabilities, such as olfactory senses, digestive systems that convert external resources into energy, and mechanisms (such as hearts) to circulate oxygen and nutrients. Most importantly for present purposes, the reach of evolutionary processes into internal structures and operations extends to shaping nervous systems themselves, which are the essential connection between mere anatomy, on one hand, and successful organismic *functioning*, on the other.

That is, evolutionary processes have left every animal species with nervous systems that incline bodies to engage their ever-shifting surroundings with behaviors that, on average, were more likely to result in successful reproduction, within persistent environmental features of a species' evolutionarily recent past, than did alternative behaviors. Put simply, evolutionary processes lead to future generations of organisms that are better able to deploy their physical capabilities in circumstances appropriate to the context. For example, and at the most general level, animals are more likely to flee danger than to embrace it, to select appropriate foods and mates for their species, and so forth. And beyond this, evolutionary processes can narrowly tailor behavioral predispositions to variations in circumstances regularly encountered in evolutionary history, such as to cause a greater likelihood of fleeing the danger of a predator than of fleeing the danger of confrontation with a same-sex challenger in a mating competition.

---

appear in Jones & Goldsmith, *supra* note 1, and Owen D. Jones, *Evolutionary Analysis in Law: An Introduction and Application to Child Abuse*, 75 N.C. L. REV. 1117, 1127-57 (1997).

64. *See generally* FUTUYMA, *supra* note 63; RIDLEY, *supra* note 63.

Thus, organisms' behavior and decisions, on average, increase fitness (e.g., reproduction) in their natural social and physical environments, because evolutionary processes have selected for these behaviors and winnowed others from the population. Wild-bred organisms within species tend (on average) to make substantively rational behavioral choices[65] (at least for the historical environments long occupied by the species) because evolutionary processes have winnowed away heritable predispositions toward structures and states of nervous systems that tended to lead toward behavior that was less beneficial or had a sufficiently high potential for disaster.[66]

What all this means is simply that evolutionary processes have created brains with (among other things) algorithmic (that is, "if-then") operations. These in turn yield states of the nervous system, which in turn spark physical changes (such as increased heart rate, sexual arousal, the motivating effects of hunger, and the like), that in turn tend to result in adaptive behaviors, compared to other possibilities. Depending on context, these inclinations can be weak or strong. And depending on species, there may be greater or lesser ability to reflect on consequences and actively choose alternative behaviors.[67] Given both the extent to which natural selection[68] can

---

65. Recall that substantive rationality is distinct from procedural (deliberative) rationality. *See supra* note 9 and accompanying text.

66. Note that this does *not* mean that every organism will behave rationally. There is inevitable variation, particularly in sexually reproducing species, which typically yields genetically unique individuals. Natural selection does not guarantee that heritable maladaptive features won't arise; instead, it operates in such a way that, all else equal and given variation in the population, the most maladaptive features will tend to become less prevalent in successive generations. *See supra* note 63.

67. Note that some species are genetically predisposed to choose one particular alternative and that this requires no understanding on the part of the organism. It is essential to recognize that even the capacity of many species to learn is a result of evolutionary processes, which involve considerable tradeoffs. The human brain, for example, is roughly 2 percent of the body's mass, but consumes roughly 20 percent of its energy, a circumstance only sustainable because the advantages such a large brain provides generally outweigh the disadvantages (energy costs, difficult childbirths compared to other primates, and so forth). David Attwell & Simon B. Laughlin, *An Energy Budget for Signaling in the Grey Matter of the Brain*, 21 J. CEREBRAL BLOOD FLOW & METABOLISM 1133, 1133 (2001).

68. Natural selection is the result of three conditions: (1) replication of genes; (2) variation of genes (as a function of mutation, as well as unique combinations of genes arising from sexual reproduction); and (3) differential reproduction of individual organisms (as a consequence of their genetic variation). Put simply, randomly arising heritable traits that

(and does) winnow context-specific, condition-dependent, algorithmic behavioral predispositions, many of the general regularities of human behavioral predispositions (in contexts of fear, love, or anger, for example) have been acted upon by natural selection and are adaptations to environmental conditions that have been prevalent over our evolutionary past (and have not yet been selected against).[69]

True, humans differ from other animals in their highly developed capacities for behaviors such as language, analysis, and extensive cumulative culture. And it would be here, as generally, unsound to simply assume that all behavioral regularities reflect species-typical psychological adaptations. We do not do so.[70] But it would be equally unsound to unreflectively assume (as is generally assumed in the literature discussing cognitive heuristics, biases, and irrationalities[71]) that psychological features under study are unrelated to adaptations. Natural selection exerts powerful influences over vast aspects of behavior in all species, and taking its effects into consideration can consequently be useful for, among other things, generating hypotheses that when tested can yield new and useful information.

Specifically, one general line of inquiry—raised somewhat differently and independently by Gigerenzer,[72] Haselton,[73] and Jones[74]—is that species-wide patterns in behavioral predispositions

---

provide incremental advantages to their owners in survival and reproduction tend to appear, all else equal, in increasingly large percentages of subsequent populations, often becoming so widespread as to be characteristic of the species.

69. There is far more to this proposition than can be discussed here. This subject is covered in greater detail in Jones & Goldsmith, *supra* note 1, at 423-31.

70. Moreover, there is no such thing as a "perfect" adaptation. This is true for several reasons, including that the variation (mutation) may not have occurred, environments continue to change, natural selection may work on a suite of related behaviors rather than on a single one, and 'perfect' adaptation in one area may cause problems in another. Thus, not all adaptations will be perfectly fitness enhancing, nor will they always appear (or be) ideal.

71. For an overview, see generally Jones, *supra* note 5.

72. *See* GERD GIGERENZER, ADAPTIVE THINKING: RATIONALITY IN THE REAL WORLD (2000).

73. *See, e.g.*, Martie G. Haselton & Daniel Nettle, *The Paranoid Optimist: An Integrative Evolutionary Model of Cognitive Biases*, 10 PERSONALITY & SOC. PSYCHOL. REV. 47 (2006) (discussing error management theory, in the context of cognitive biases).

74. Jones, *supra* note 5. For discussion of similarities and differences among these views, see Owen D. Jones, *Evolutionary Psychology and the Law*, *in* THE HANDBOOK OF EVOLUTIONARY PSYCHOLOGY 958-60 (David M. Buss ed., 2005).

that appear to be substantively irrational may be the product of a mis-match between an evolved predisposition of the brain and one or more novel environmental features. That is, the brain may incline us toward behavior that was once adaptive but is often, under modern conditions, less so—in the same way that moths navigated quite effectively by celestial lights before electricity but behave "irrationally" today when encountering streetlamps. Or in the same way that the human taste for sweets and fats inclined us adaptively toward high energy foods when these were scarce, but now results in temptation and health problems in an evolutionarily novel world of boundless, ultra-concentrated calories. Extending this reasoning, the endowment effect may reflect an evolved inclination that is irrational under many present conditions, but that (perhaps like other heuristics and biases identified in recent years) may have proved useful under long-stable (but meaningfully different) ancestral conditions.[75]

In 2001, one of us (Jones) laid theoretical foundation for this idea, which will not be reiterated here.[76] In sum, it proposed that a large number of current irrationalities comprising the collected heuristics and biases—including endowment effects[77]—might all be reconciled under a principle that could be called (in the context of and language of rational actor economics) *time-shifted rationality*. Time-shifted rationality describes "any trait resulting from the operation of evolutionary processes on brains that, while increasing the probability of behavior that was adaptive in the relevant environment of evolutionary adaptation in the ancestral past, leads to substantively irrational or maladaptive behavior in the present environment."[78] Put another way, the set of all irrational psychologi-

75. Of course, whether or not an inclination is adaptive says precisely nothing, normatively, about whether it should be cultivated, accommodated, or countered. For further discussion of this point, see Jones & Goldsmith, *supra* note 1, 484-85.

76. *See* Jones, *supra* note 5; Owen D. Jones, *The Evolution of Irrationality*, 41 JURIMETRICS J. 289 (2001). These were later augmented by the work of Jones & Goldsmith, *supra* note 1.

77. Other features addressed include inconsistent preferences, over-cooperativeness, intertemporal choice anomalies, irrationally discounted futures, framing problems, mistaken assessments of probability, ultimatum games, irrational taste for spite, and the like. Jones, *supra* note 5, 1169-87.

78. So defined in *id.* at 1172.

cal features may include a subset of features that once (and indeed long) were substantively rational, in the traditional economic sense.

As argued there, endowment effects might be the results of adaptations to conditions in which the probable results of continued possession were less risky than the probable results of attempted exchanges.[79] That is, the historical contexts for exchange involved evolutionarily significant risks that are simply less present under modern conditions. This time-shifted rationality perspective focuses attention on the fact that such things as reliable exchanges, abstract notions of "rights" to things, doctrines governing contracts, highly organized mechanisms for enforcing bargains, money, banks, increased median life spans, interest rates, storable surpluses of resources, reliable futures, and even the language enabling complex communication and negotiation are all environmental features that arose since our differentiation from the other apes, and are thus fairly recent (in some cases extremely recent) in our species' evolutionary history.[80] In particular, exchanges are fraught with the potential for defection, particularly in the absence of reliable property rights and third-party enforcement mechanisms (such as the legal rules and institutions of modern humans).

The core notion is therefore this: it may be the modern conjunction of an evolved psychological predisposition and these novel environmental features that render a general leaning toward the

79. For a recent and different perspective on possible evolutionary underpinnings of the endowment effect, see Steffen Huck et al., *supra* note 30. Various mentions of possible effects of evolutionary processes on the endowment effect also appear in PAUL RUBIN, DARWINIAN POLITICS: THE EVOLUTION OF POLITICAL PREFERENCES 173 (2002); Richard A. Posner, *Rational Choice, Behavioral Economics, and the Law*, 50 STAN. L. REV. 1551, 1565 (1998); Jeffrey E. Stake, *The Property 'Instinct,'* 359 PHIL. TRANSACTIONS ROYAL SOC'Y B. 1763, 1767 (2004). More recently, an economist has independently adopted a similar view. Herbert Gintis, *The Evolution of Private Property*, 64 J. ECON. BEHAV. & ORG. 1, 2-3 (2007). And biological perspectives on property, generally, are appearing with increasing frequency. *See, e.g.*, Uta-Maria Niederle, *From Possession to Property: Preferences and the Role of Culture*, *in* COMPLEXITY AND THE ECONOMY: IMPLICATIONS FOR ECONOMIC POLICY (John H. Finch & Magli D. Orillard eds., 2005); Gintis, *supra*; Paul H. Robinson, Robert Kurzban & Owen D. Jones, *The Origins of Shared Intuitions of Justice*, 60 VAND. L. REV. 1633 (2007); Stake, *supra*. A recent argument connecting evolutionary processes to prospect theory, to which the endowment effect is related, is forthcoming in Rose McDermott, James H. Fowler & Oleg Smirnov, *On the Evolutionary Origin of Prospect Theory Preferences*, 70 J. POL. (forthcoming 2008).

80. *See, e.g.*, Jones, *supra* note 5, at 1183-85.

endowment effect (which can also be described as the tendency to "hang on to what one has") "irrational."

C. Predictions

In light of the foregoing, and starting in 2000, Jones[81]—and subsequently Jones and Brosnan[82]—predicted in a series of talks that:

(1) The endowment effect, if it exists, is likely to be observable in many other species, including primate relatives.
(2) The prevalence of the endowment effect in other species is likely to vary across items.
(3) The prevalence of the endowment effect will increase or decrease, respectively, with the increasing or decreasing evolutionary salience of the item in question.

Here's why: Prediction One (endowment effect in close primate relatives) follows if the endowment effect has deep evolutionary roots (perhaps in adaptation to the asymmetric risks of keeping versus exchanging), rather than being either a random psychological quirk of modern humans, or a very recently and wholly culturally-contingent phenomenon.[83]

Prediction Two (endowment effect likely varies with characteristics and contexts of items) follows because brains evolve under specific conditions, not broad theoretical ones. As a consequence, while human brains have some general, self-conscious, deliberative analytic capabilities, we have every reason to believe (and neuro-

81. *E.g.*, Owen D. Jones, Behavioral Biology and Endowment Effects, Address at Arizona State University College of Law (Apr. 2004); Owen D. Jones, Evolution, Behavior, and Legal Systems, Plenary Address, Human Behavior and Evolution Society Annual Conference (2007).

82. *E.g.*, Owen D. Jones & Sarah F. Brosnan, Investigating Endowment Effects in Chimpanzees, Address at Gruter Institute for Law and Behavioral Research (May 2005); Sarah F. Brosnan, Owen Jones, Susan P. Lambeth & Steven J. Schapiro, Endowment Effects in Chimpanzees, Address at American Society of Primatologists Annual Meeting (June 2007).

83. Of course, it could have evolutionary roots of comparatively recent origin, i.e., subsequent to the divergence of human and chimpanzee lineages. However, primate relatives are a good place to look for evidence that it may be older than the divergence. For example, one recent study suggests the more general phenomenon of loss aversion may be present in capuchin monkeys. Laurie Santos & Keith Chen, "The Economics of Nonhuman Primates," Neuroeconomics: Decision Making and the Brain Symposium, NYU, Jan. 11-13, 2008.

scientific work is daily confirming) that they also have some anatomically and functionally specialized cognitive mechanisms.[84]

Selection pressures can narrowly tailor brain structures and reactions (and regularly do) to environmental conditions long encountered over evolutionary time. To illustrate, consider the way humans process information signaling danger. Sometimes, particularly when the stimulus is evolutionarily salient (such as when unexpectedly encountering a snake), the brain's evolved information-processing predispositions typically yield immediate emotional attention and reaction. At other times, such as when people learn that electrical sockets can kill, the risk can only be processed through more analytic parts of the brain, which do not necessarily yield the emotional responses honed by evolutionary processes.[85] Biologically speaking, basic emotions—such as fear, disgust, love, lust, and the like—are simply states of the nervous system that reflect evolved shortcuts, inclining us in the direction of behaviors—fleeing, avoiding, pursuing, mating, and the like—that had, and often continue to have, adaptive value. And just as different parts of the brain are involved in assessing different kinds of risks (e.g., evolutionarily salient snakes versus invisible electricity), it is more likely than not that different regions of the brain are involved in assessing the value of very different kinds of items—particularly items that vary in evolutionary salience.

If so, one expects there to be variations in the prevalence of and magnitudes of the endowment effect across kinds of items. For example, there is simply little reason to assume that all items in one's environment (e.g., concrete tangible goods, on one hand, and abstract, imaginary "rights" to goods, on the other) are valued using the same general-purpose cognitive machinery. The more an item is either similar to items that, or can be used in contexts that, were long part of a species' evolutionary history, the greater the likelihood that evolved, heuristic valuation mechanisms will be currently

84. *See generally* THE COGNITIVE NEUROSCIENCES III (Michael S. Gazzaniga ed., 2004); GOLDSMITH & ZIMMERMAN, *supra* note 63; PRINCIPLES OF NEURAL SCIENCE (Eric R. Kandel et al. eds., 2000).

85. Unless, of course, a person has had personal experience with an electrical shock. In that case, fear conditioning—an adaptation to quickly learn to avoid novel, negative stimuli in a changing environment—may render a similar reaction as the snake would.

activated and the greater the likelihood that resultant behavior will reflect an endowment effect.

Prediction Three (evolutionary salience is likely to *increase* manifestation of the endowment effect) follows by combining the logic for Prediction Two with these following additional premises: (1) the fitness risk entailed in giving up an evolutionarily salient item, and getting nothing in return, is greater than the symmetric risk of losing a less evolutionarily salient item; (2) natural selection can make (and in many contexts has made) brain operations, and resultant behaviors, sensitive to asymmetric costs of alternative behaviors; and (3) the longer the item in question has been within a category of items that was persistent across the species' evolutionary history and also important to the reproductive success of members of that species, the more likely it is that neural processes for valuing the item will draw upon evolutionarily old parts of the brain, with concomitant emotional short cuts toward valuation. So some objects (such as food items) are likely to be more evolutionarily salient than other objects (such as DVDs). And tangible goods (such as mugs) may be more evolutionarily salient than abstractions (such as tokens that can be exchanged for mugs).[86] Consequently: if the endowment effect is an evolved feature, then (all else being equal) its prevalence and magnitudes may increase with the evolutionary salience of the objects and conditions, compared at least to far more novel objects and conditions.

III. AN EXPERIMENT WITH CHIMPANZEES

The three sections in this Part describe, respectively, an experiment designed to test those predictions, the results of that experiment, and some implications.[87]

A. Experimental Design

Starting in 2004, the two of us teamed together to begin testing these hypotheses in chimpanzees. The experimental design was

86. There is evidence, for example, that mugs yield endowment effects while tokens for mugs do not. Kahneman et al., *supra* note 11, at 1330-32.

87. *See* Brosnan et al., *supra* note 7.

inspired by (but is in several important ways quite different from) an experiment by Knetsch.[88] In the Knetsch design, college students within three groups encountered three different conditions. Students in the first group were offered in advance of a questionnaire a choice between a coffee mug and a chocolate bar, as compensation for completing the questionnaire. Students in the second group were given a coffee mug at the beginning of the task, as compensation, then offered at the end of the task the opportunity to exchange it for a chocolate bar. Students in the third group were given the chocolate bar at the beginning of the task, as compensation, then offered the opportunity to exchange it for a coffee mug at the completion of the task.

Under the choice condition, 56% of the students (N = 55) selected the mug. For the group endowed with the coffee mug, 89% (N = 76) refused to trade it for a chocolate bar. For the group endowed with the chocolate bar, only 10% (N = 87) agreed to trade it for the mug.[89] If one assumes that an initial preference under a choice condition for mug or chocolate bar was evenly distributed across the three groups, then these results suggest an endowment effect. That is, nearly 90% of the students endowed with a mug refused to trade it for a chocolate bar, while at the same time 90% of the students endowed with the chocolate bar refused to trade it for the mug. In each case, people exhibited a strong tendency to hang on to what they had.

Our chimpanzee experiment was designed to use the same three conditions, with some important differences. First, whereas in the Knetsch experiment each subject encountered only one condition, we tested each of our chimpanzee subjects in all three conditions (in a different sequence with each condition completed on different days).

---

88. Knetsch, *supra* note 15.

89. *Id.* at 1278. In a similar experiment, three groups of college students responded to three different conditions. Students in the first group, designated as choosers, were asked individually to choose between a coffee mug and a sum of cash, for each of a variety of prices, ranging from $0.00 to $9.25. Students in the second group, designated as sellers, were given the mug and asked to indicate whether or not they would sell the mug at each of the same price intervals. Another group, designated as buyers, examined an identical mug, and were asked to indicate their willingness to buy one at each of the same price intervals. The results were aggregated for each group, revealing that the median valuation for choosers was $3.12, the median valuation for sellers was $7.12, and the median valuation for buyers was $2.87. The large discrepancy between the median valuations of sellers and buyers—for the same item—suggests an endowment effect. Kahneman et al., *supra* note 11, at 1338-39.

We used this method both because chimpanzees are less numerous than college students and because it seems useful to collect information about the individuals that did and did not display endowment effects (if any), rather than simply aggregating the data to find effects between groups, instead of within individuals.[90] Second, there is no suggestion in our chimpanzee experiments that the chimpanzees "earned" the items they were given, which is a potential confound in the Knetsch design. Third, our chimpanzee subjects were offered the opportunity within only two to five seconds, under exchange conditions, to trade the item they had for the item they didn't (whereas the longer duration of "ownership" in the Knetsch design is also a potential confound). Fourth, our protocol was designed to measure the endowment effect (if any) separately for non-food and food items, so as to allow a direct comparison of the independent effects for the two different kinds of items themselves.

Specifically, the non-food items in our chimpanzee experiment were common dog toys: one rope toy and one rubber bone toy. Toy items such as these are known to be interesting to the subject chimpanzees, who have frequent interaction with similar items, both in material and form, as enrichment on a regular basis.[91] Selecting suitable food items was trickier for three reasons: (1) our experimental design required that a chimpanzee not only have (own) an item, but also that he or she have a meaningful opportunity to exchange it for another item; (2) chimpanzees tend to immediately eat any food they acquire; and (3) all items had to be shaped to easily fit through the mesh of a fence wall for exchange to occur.

---

90. Interestingly, although there are many dozens of articles reporting on endowment effect experiments, most report effects that are evident across groups encountering different conditions from each other, rather than effects that are evident within individuals encountering a series of different conditions. *See* Horowitz & McConnell, *supra* note 15, at 426 (describing typical experiment). There has been remarkably little discussion of the potential differences between within-subject designs and between-subject designs. One exception is Sayman & Öncüler, *supra* note 5, at 296, 305.

91. "Enrichment" refers to items and activities providing for the psychological well-being of non-human primates, as required by the 1985 Animal Welfare Act (AWA). *See generally* KRISTINA M. ADAMS, M.S., U.S. DEP'T OF AGRIC., AWIC RESOURCE SERIES NO. 32, ENVIRONMENTAL ENRICHMENT FOR NONHUMAN PRIMATES RESOURCE GUIDE (July 2006), *available at* http://www.nal.usda.gov/awic/pubs/Primates2006/Primates.htm.

In the end, Brosnan developed an experimental technique involving: (1) a popsicle of frozen fruit juice (which chimpanzees, like humans, consume fairly slowly) and (2) peanut butter inside a length of common PVC (polyvinyl chloride) pipe, with a small stick protruding (which enabled but slowed the extraction of peanut butter). Again, both frozen fruit juice and peanut butter are known to and well-liked by the subject chimpanzees, and all subjects were competent at eating peanut butter in this fashion. Neither food was consumed so quickly as to eliminate the opportunity for exchange.

Our thirty-three, adult chimpanzee subjects (nineteen females and fourteen males) were drawn from a colony of captive chimpanzees at the Michale E. Keeling Center for Comparative Medicine and Research of the University of Texas M.D. Anderson Cancer Center.[92] These subjects lived in multi-male, multi-female social groups of between seven and fifteen individuals which had been stable for more than thirty years. These groups were housed in large outdoor compounds connected to a series of indoor runs. All compounds and runs were equipped with vertical climbing structures, resting platforms, ropes and swings for climbing, and other material enrichment such as bedding, branches, and toys. In addition to their basic diet, subjects received enrichment feeds of fruits, vegetables, and treats (yogurt, nuts, seeds) four times a day. All subjects had continuous, on-demand access to primate chow and water and were never food- or water-deprived for any testing.

For the study, subjects were first trained to exchange (or, in many cases, were reminded of prior training in exchange). Specifically, the chimpanzees were trained to exchange inedible items (such as a tongue depressor) for a food reward. They were then trained to exchange one food item (such as a carrot) for a preferred food (such as a grape). When a given chimpanzee could, on a new day, exchange at least four out of five times, unprompted except by the outstretched hand of the research assistant, which cued an opportunity to exchange, then he or she qualified as a subject for the experiment. (In practice, subjects exchanged virtually every time the experimenter offered the opportunity.)

92. By primatological standards, thirty-three subjects provide an enormous *n*. Captive populations of primates generally have few individuals (even for far smaller primates, such as capuchins), such that many leading primate studies reflect experiments with fewer than ten individuals.

For non-food items on one hand, and then food items on the other, there were three separate conditions—one choice condition (to establish preference) and two exchange conditions (to investigate possible endowment effects, given separately expressed preference). We will illustrate these three experimental conditions discussing the non-food items.

In the choice condition, a research assistant beyond arm's reach of the chimpanzee offered a rope toy in one hand and a bone toy in the other. (Across chimpanzees, the hand in which each toy appeared was varied, so as to eliminate the possible confound of any side preference.) The chimpanzee expressed his or her preference, as between the two offerings, by gesturing to the item it preferred. The chimpanzee then immediately received that item, and that individual's preference for rope toy or bone toy was recorded.

In one of two exchange conditions, the chimpanzee was shown both items, then received either the rope toy or the bone toy and, approximately two to five seconds later, was offered the opportunity to exchange it for the other toy.[93] The willingness to exchange, or the refusal to exchange, was recorded. If no exchange took place within three minutes, the trial was recorded as a refusal to exchange.[94]

In the other of the two exchange conditions, the chimpanzee received the toy it had *not* received in the prior exchange condition, and was again offered the opportunity to exchange it for the other toy. If under these conditions a chimpanzee refused to trade a less preferred item for a more preferred item, we consider that some evidence for an endowment effect (ownership-dependent valuation) in chimpanzees. That is, such a circumstance suggests that the value of the less-preferred item when "owned" immediately jumped to more than the value of the item in the choice condition. We included controls to eliminate other obvious possibilities.

The three conditions (choice, exchange, and exchange) were presented in random order to each subject, counterbalanced so that

93. The delay is short for two reasons. First, a much longer delay (say, a minute) would have enabled the subject in the food conditions to consume the item entirely. Second, and as a consequence, it would be inappropriate to consider the chimpanzee's subsequent inability to exchange consumed food as a refusal to exchange. That approach would simply skew the data in favor of our predictions. Thus, the short delay represents a conservative approach.

94. Note that in the case of food items, the chimpanzee lost the ability to exchange if more than a single taste of the food was consumed.

one-third saw each condition first. This is done to counteract any influence that the order of the conditions may have upon the outcome. One-half of the subjects began with the food condition, completing all of these trials prior to participating in the non-food condition. The other half of the subjects completed the non-food condition first. All testing was done with the chimpanzee subjects temporarily isolated from their peers within one of the runs in their indoor enclosure. This guards against the possibilities that subjects will alter their behavior as a function of the presence of others (as is known to occur in other contexts), and that future subjects will alter their behaviors as a function of observing the behavior of prior subjects (also known to occur). The three conditions using the food items were conducted in the same way as for toys (except that, given that food is divisible, any attempt by the chimpanzee to exchange a food item after more than one taste or bite was counted as a refusal to exchange).

B. Results

Thirty-three individuals completed all three sessions involving food items, and thirty-one individuals completed all three sessions involving non-food items.[95] We analyzed the data in two ways. First, we compared aggregated chimpanzee choices to expected choices, on the basis of the group preferences. We refer to this below as the "group level analyses." Second, we compared each individual chimpanzee's choices to that chimpanzee's own expressed preference

95. This discrepancy is due to the fact that some individuals would not come inside from their outdoor enclosure to be tested alone (usually due to social situations within their large groups) and therefore not all sessions could be completed on all individuals. We obviously cannot force a chimpanzee to participate, but we also only test subjects who voluntarily come in to assure that their choices are not due to an experimentally meaningless attempt to complete the study and exit the experiment.

in a choice condition.[96] We refer to this below as the "individual level analyses."

The data support each of the three predictions at both the group level analyses and the individual level analyses, which are summarized in subsections 1 and 2 respectively.

1. Group Level Analyses

a. Prediction 1

Our first prediction was that the endowment effect is likely to be observable in chimpanzees. The group level data support this prediction. As a group, 58% of the chimpanzees preferred the peanut butter to the juice when given a choice between the two. However, when endowed with the peanut butter, 79% of the chimpanzees preferred to keep the peanut butter rather than exchange for juice ($\chi^2 = 6.079$, $p = 0.014$). This result indicates that approximately 20% more of the group kept the peanut butter than would be expected from the group-wide preference. Likewise, when endowed with juice (preferred by 42% of the subjects), 58% of the chimpanzees chose to keep the juice rather than exchange for peanut butter ($\chi^2 = 3.102$, $p = 0.078$). That indicates that approximately 15% exhibited an endowment effect for the juice.[97]

---

96. There are ample reasons to believe that subjects understood both the choice condition and the exchange condition. Chimpanzees are highly intelligent primates. *See* JANE GOODALL, THE CHIMPANZEES OF GOMBE (1986). They are skilled at cognitive tasks. *See* PRIMATE ORIGINS OF HUMAN COGNITION AND BEHAVIOR (T. Matsuzawa ed., 2001). They understand exchange tasks with each other, D. Paquette, *Object Exchange Between Captive Chimpanzees: A Case Report*, 7 HUM. EVOLUTION 11 (1992); John C. Mitani, *Reciprocal Exchange in Chimpanzees and Other Primates*, *in* COOPERATION IN PRIMATES AND HUMANS (Peter M. Kappeler & Carel P. van Schaik eds., 2006), and with humans, Charles W. Hyatt & William D. Hopkins, *Interspecies Object Exchange: Bartering in Apes?*, 42 BEHAV. PROCESSES 177 (1998); Sarah F. Brosnan & Frans B.M. de Waal, *Responses to a Simple Barter Task in Chimpanzees*, Pan troglodytes, 46 PRIMATES 173 (2005); Sarah F. Brosnan et al., *Tolerance for Inequity May Increase with Social Closeness in Chimpanzees*, 1560 PROC. ROYAL SOC'Y B. 253 (2005). They are also proficient at using the dichotomous choice task to indicate preference. *See* Sarah F. Brosnan et al., *Chimpanzee Autarky*, 3 PLoS ONE e1518 (2008).

97. We also analyzed the data using a Cochran's Q Test for multiple comparisons (nonparametric) and found significant variation between the three conditions ($N = 30$, Cochran's $Q = 7.6$, $df = 2$, $p = 0.022$). We further analyzed the results with post hoc pairwise comparisons and found that there was a significant difference between their tendency to keep the item (say, juice) when given it, on the one hand, and their tendency to exchange for the

b. Prediction 2

Our second prediction was that the strength of the endowment effect in chimpanzees would vary across items. The group level data support this prediction. The group as a whole preferred the bone to the rope 74% of the time in the preference tests. However, when endowed with the bone, subjects kept it only 16% of the time (Figure 2; $\chi^2 = 54.587$, $p < 0.001$) and, when endowed with the rope (26% preference), subjects kept it only 10% of the time ($\chi^2 = 4.212$, $p = 0.040$).[98] These are significantly different from the corresponding figures for the food conditions (Wilcoxon signed-rank test; $z = -4.59$, $p < 0.001$).[99] Both of these indicate far *more* exchange of non-food items than would be predicted by the separately expressed preferences for these items individually. This is an intriguing "reverse-endowment effect," indicating that when these non-foods are involved, chimpanzees either do not have strong preferences or prefer opportunities to interact with the experimenter to the item itself.[100] The essential finding for this stage of the analysis is that the prevalence of endowment effects varies considerably across items.

---

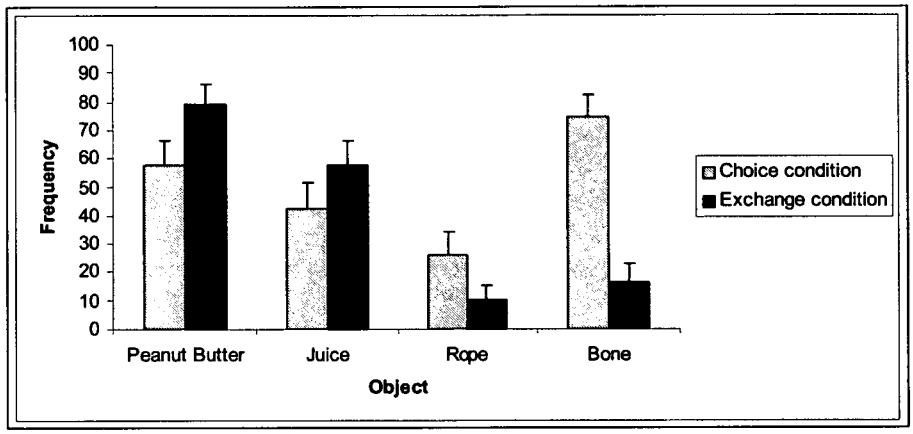
same item (juice), when given the other (McNemar's Test; $p = 0.013$). This is consistent with an endowment effect, as the preference for an item changes depending on whether it was given to them initially or they were required to exchange to get it, with a higher preference if it was the initial endowment.

98. Again, we analyzed the data using a Cochran's Q Test for multiple comparisons (nonparametric) and found significant variation between the three conditions ($N = 30$, Cochran's $Q = 28.5$, $df = 2$, $p < 0.001$). McNemar's Test indicates a significant difference between their tendency to keep the item (say, bone) when given it, on the one hand, and their tendency to exchange for the same item (bone), when given the other ($p < 0.001$). Moreover, subjects were significantly likely to keep an item if given it in the exchange tests than indicated in the preference tests ($p < 0.001$). Both of these results are consistent with an endowment effect.

99. As many readers will know, this means that the likelihood that this result arose from chance alone is less than 1 in 1000, which far exceeds the standard threshold in science—5 in 100, (or $p < 0.05$)—at which data are accepted as likely due to the experimental manipulation, rather than chance.

100. There are some intriguing leads in the literature that suggest the endowment effect also occasionally reverses in humans. *See, e.g.*, Sayman & Öncüler, *supra* note 5, at 300. To our knowledge, there has to date been no systematic study of contexts in which the endowment effect reverses, which in our view warrants separate examination.

Figure 2: *Group-Level* Comparisons of Preferences in the Choice and Exchange Conditions. Gray bars represent the percentage of the group that preferred the object in a choice condition and black bars represent the percentage of the group that chose to maintain possession in the exchange condition. Figure reprinted from Sarah F. Brosnan et al., 17 *Current Biology* 1704 (2007).



c. *Prediction 3*

Our third prediction was that the endowment effect will generally be more pronounced or less pronounced, in accordance with the relative degree of evolutionary salience. We therefore predicted that if our Prediction 2 were correct (i.e., that the prevalence of the endowment effect would vary between non-food and food items), then the prevalence of the endowment effect for food items would be significantly *greater* than for non-food items. The group level data support this prediction. The group level endowment effects for the two food items ranged from 15% to 20%, whereas for the non-food items they ranged from -16% to -58%.[101]

101. As mentioned earlier, our study design counterbalanced the initial presentation (i.e., first condition any individual chimpanzee encountered) to minimize the bias inherent in multiple sampling of the same group. However, we still found it interesting to examine separately the choices made in each subject's *first* encounter with either a choice or exchange condition. We then compared independent groups, as was done in the Knetsch study, using the group in the choice condition to establish a baseline group preference. Even looking just at this subset of our data, the data remain consistent with our main finding of an endowment effect for food items, and reveal the same general pattern as shown in Figure 2. However, the

2. Individual Level Analyses

a. Prediction 1

Recall that our first prediction was that the endowment effect was likely to be observable in chimpanzees. The individual level data support this prediction. If the endowment effect were to be present at the individual level, we would expect that a subject would twice refuse to exchange, both: (1) maintaining possession of the preferred item; and (2) also maintaining possession of the less-favored item. This was, in fact, the most common behavior for food items, with 42% of individuals maintaining possession of both foods—that is, their preferred food and their less-favored food, the latter of which is consistent with an endowment effect (Figure 3; $\chi^2 = 9.14$; $p < 0.05$; i.e., the likelihood that these results are due to chance alone is less than 5%). Eighteen percent of individuals behaved inconsistently with their preference under the choice condition, maintaining possession of the less-favored food and exchanging their preferred food. (This behavior is difficult to interpret; while maintaining the less-favored food is consistent with an endowment effect, exchanging the preferred item may indicate the individual does not have strong preferences between the two items.) Thirty-three percent of the subjects showed exchange behavior that matched their preferences, maintaining possession of a preferred food item and exchanging a less-favored item for the preferred one. Only 6% of subjects exchanged for the other food in both situations, indicating a preference for interaction or exchange.

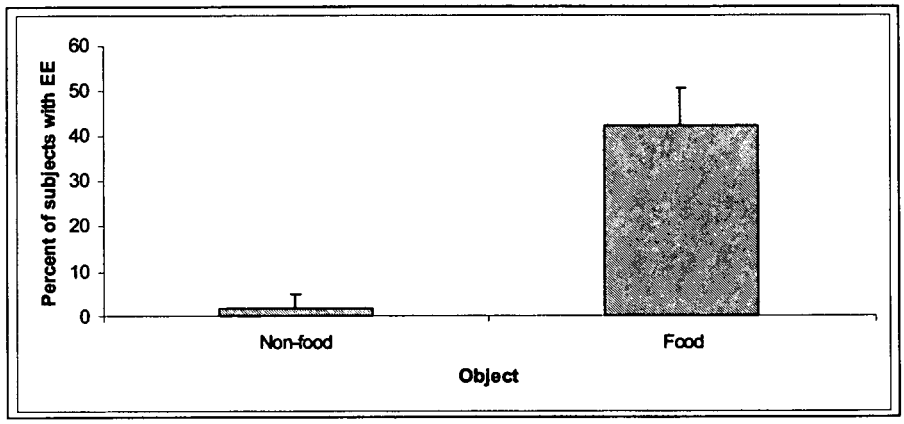
b. Prediction 2

Our second prediction was that the strength of the endowment effect in chimpanzees would vary across items. The individual level data support this prediction.

---

statistical power of that particular inquiry of the subset of the data was very limited. For although we are testing an enormous group, given the rarity of chimpanzees, it is still too small for a meaningful conclusion using this alternate approach.

Figure 3: Percentage of Individual Subjects Exhibiting Endowment Effect for Non-Foods Versus Foods



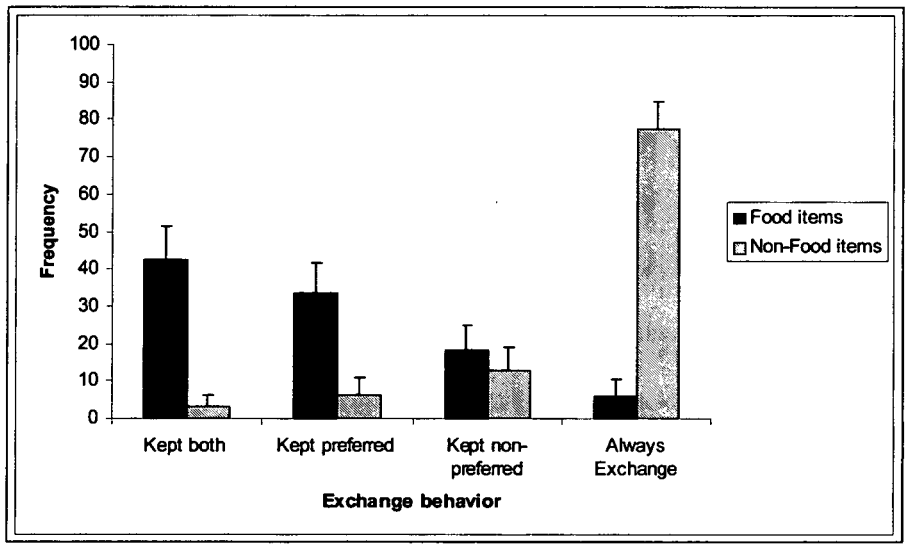
Whereas 42% of the chimpanzees exhibited an endowment effect in the trials involving food items, only one of the chimpanzees—or 3%—exhibited an endowment effect in the toy condition. That is: (1) when given the toy they had preferred under the choice condition, they refused to exchange it for the less preferred toy; and (2) when given the less preferred toy; they also refused to exchange it for the previously preferred toy. The majority of subjects exchanged in both toy situations, that is, regardless of which item they initially possessed (Figure 4; 77% of subjects, $\chi^2 = 39.41$, $p < 0.05$). This result may indicate that, when given less evolutionarily salient objects, subjects are more interested in the interaction of performing the exchange than in the items themselves. Of the remaining individuals, 6% showed exchange behavior consistent with their established preferences (e.g., exchanged the less-favored item and did not exchange the preferred item) and 13% showed exchange behavior inconsistent with their established preferences.

c. Prediction 3

Our third prediction was that the endowment effect will generally be more pronounced or less pronounced, in accordance with the relative degree of evolutionary salience. The individual level data support this prediction. The prevalence of the endowment effect was

far greater for food items (42%) than for non-food items (3%). See Figure 3 & Figure 4. Note that, had we tested only non-food items, it might have seemed quite reasonable to conclude that chimpanzees do not exhibit endowment effects.

Figure 4: The Behavior of *Individuals* in the Four Tests. "Kept both" indicates individuals who chose to maintain possession of both foods or both non-foods rather than exchange. "Kept preferred" indicates individuals who chose to maintain possession of their favorite item, but exchanged for the other when endowed with their less preferred. "Kept non-preferred" indicates individuals who chose to maintain possession of their non-preferred item, but exchanged for the other when endowed with their preferred item. "Exchanged both" indicates individuals who chose to exchange for the other item in both situations. Solid bars indicate food items and gray bars indicate non-food items. Figure reprinted from Sarah F. Brosnan et al., 17 *Current Biology* 1704 (2007).



C. Discussion of Results

All three predictions are supported in both group level and individual level analyses, and these data are supported by a variety of subsequent controls, to test for a variety of possible confounds

(described below in Part IV). First, to our knowledge, our study is the first to have documented endowment effects in chimpanzees. Second, our data show that, in chimpanzees, the prevalence of the endowment effect varies across items. Moreover, our data show that the prevalence of the endowment effect in chimpanzees varies across items within *single individuals*. Third, our data show that the prevalence of the endowment effect for food items is significantly greater than it is for non-food items, which is consistent with our hypothesis that evolutionarily salient items are more likely to yield endowment effects than less evolutionarily salient items.

Several items bear noting. First, it is important to clarify that our finding should not be understood to merely suggest that chimpanzees like food more than they like toys (though this is likely the case). What we instead tested for and found was that, when given opportunities to trade *within a class of items* (food on one hand, and toys on the other), chimpanzees are far less likely to trade their less-preferred food for their more-preferred food than they are to trade their less-preferred toy for their more-preferred toy. This simultaneously demonstrates an endowment effect, shows that the probability of the effect varies across items, and suggests that the probability that the effect will manifest varies with the evolutionary salience of the item in question.

Second, there is, on the surface, some seeming tension between the results of our experiment and the results of the Knetsch experiment mentioned earlier. Though Knetsch apparently did not set out intentionally to compare food with non-food items (and to our knowledge has not considered the distinction potentially meaningful), Knetsch happened to have done so and happened to have found high levels of endowment effects for both food and non-food items, while our chimpanzee data find sharp variation. There are at least several possibilities that confound meaningful comparison of the two studies. The Knetsch study, but not ours, involved possession of the objects by study subjects for an extended period of time before the opportunity to exchange. It seems possible, even probable, that the longer one has possession of an item, the greater the likelihood of an endowment effect. In addition, the Knetsch study, but not ours, gave subjects items as compensation or reward for doing a task, which may have increased the prevalence of the effect. In addition, our study, but not Knetsch's, compared effects *within* classes of items,

instead of *across* classes of items. And finally, our study, but not Knetsch's, involved within-subject trials and analysis, instead of only across-group trials and analysis. Some researchers have concluded that across-group designs generally find a greater prevalence of the endowment effect than within-subject designs—and this may also affect the relative prevalence of the effect.[102]

Third, it is not a simple matter to compare the prevalence of the endowment effect in chimpanzees to the prevalence of the effect in humans, much as it would be useful to have a clear comparison. At a minimum, it is clear that in humans, as in chimpanzees, many study subjects do not exhibit the endowment effect, even when other study subjects do. Ideally, we would like to know how the percentage of humans *who actually exhibit the effect*, in various experimental conditions, compares to the percentage of chimpanzees who exhibit the effect. But this turns out to be more difficult to determine than originally expected.

One reason is that most endowment effect experiments have been more concerned with the magnitude of the difference between median or mean WTA and WTP *prices* among study subjects than they have been with an examination of the percentages of the study subjects who actually manifest the endowment effect.[103] Moreover, the vast majority of studies are across-group studies, rather than within-subject studies.[104] Consequently, they generally report the median price for a group of sellers, on one hand, and the median price for a separate group of buyers, on the other. And when comparisons are made across these different groups, under different test conditions, the existence of significantly different median buying and selling prices *in the different groups* is considered evidence that the endowment effect exists *within individuals*—even though, technically speaking, the individuals themselves have generally not been separately tested in buying and selling scenarios.

---

102. Sayman & Öncüler, *supra* note 5.

103. Horowitz and McConnell reach a similar conclusion when considering patterns in data aggregation. Horowitz & McConnell, *supra* note 15, at 430 ("Most studies report only mean WTA / mean WTP, even when open-ended WTA and WTP values were collected from all individuals.").

104. *See supra* note 90.

Even among the relatively few within-subject studies that have been conducted, the data are not generally published in a way that enables a reader to determine the percentage of study subjects who actually exhibited the endowment effect. A tiny set of studies, outliers in this respect, do report data that enable some calculation of percentages by readers.[105] And an examination of one of these studies suggests that the range of human subjects who appeared to exhibit endowment effects (under those precise experimental conditions) ranged widely, from 53% to 95%.[106]

The endowment effect percentage we report for chimpanzees in food exchange conditions (42%) is beneath the low end of the range in this particular subset of published endowment effect experiments. However, even if we were to assume that this small subset of human experiments were a representative sample, comparing it to our data in chimpanzees nonetheless indicates a robust endowment effect.

IV. POTENTIAL CONFOUNDS, LIMITATIONS, AND RESEARCH QUESTIONS

Every experiment entails a risk of unidentified confounds, uncontrolled variables, and limitations inherent in the data. In Section A, we report the results of several control experiments, which exclude several potential confounds. In Section B, we describe some potential limitations of our analysis.

A. Control Conditions

1. Stability of Preferences

In the initial study, we ran only a single food-preference test, in order to avoid overexposing the subjects to the foods and, thus, potentially altering their preferences. This left open the possibility that the preferences of the subjects were not stable. To verify that the food preferences were stable over a series of choices, we ran

105. *See* Knetsch, *supra* note 15, at 1278, 1280-81; Knetsch & Sinden, *supra* note 15, at 511-14; Kahneman et al., *supra* note 11, at 1331-42.

106. Kahneman et al., *supra* note 11.

three additional control sessions at the conclusion of the study. In each session, subjects made four choices between the same food items as in the original study, using the same procedures, as in the original protocol. Overall, the group maintained its preference for peanut butter, chosen by 69% of subjects. The preference was extremely consistent, with 69% of subjects choosing peanut butter in the first of the three sessions, and 67% of subjects choosing peanut butter in the first trial of each of the three sessions. This consistency indicates that the single choice in the original study adequately described the group food preferences. On an individual level, 87% of subjects favored one food at least two-thirds of the time across the twelve trials, including all but one (91%) of the subjects who showed an endowment effect in the exchange study.

2. Effect of Interaction with Experimenter

Our second control probed the extent to which some of the exchanges could be due to a preference for interacting with the experimenter, rather than a preference for the other offered item. We presented subjects (in random order, counterbalanced across subjects) with opportunities to trade each of the four objects for an identical object. No subject exchanged the peanut butter. Only one subject exchanged the juice. This indicates that food rewards were indeed more valuable to the chimpanzees than was the exchange interaction. For the toys, the converse was true. Eighty-two percent of subjects (twenty-four of twenty-nine)[107] traded a bone for a bone. Seventy-nine percent (twenty-three of twenty-nine) traded a rope for a rope. This compared to 84% of subjects trading a bone for a rope and 90% of subjects trading a rope for a bone in the original exchanges. Therefore, for toys, maintaining the contrast to the result for foods, we find no significant evidence of an endowment effect. For toys, the interaction with the experimenter is apparently and very widely preferred over the object itself.

107. The sample size for the controls is slightly smaller than the sample size for the original experiment because several subjects were no longer available for testing. Specifically, several had developed age-related health problems, and several were moved to a chimpanzee retirement facility.

3. Willingness to Exchange: Potential Role of Distrust

Our third control investigated whether our data might reflect a generalized unwillingness of chimpanzees to trade foods, which might, for example, suggest that their reluctance to trade less-preferred food items for more-preferred food items in the original study was attributable to some distrust of the experimenter or other cause not attributable to the endowment effect. This was not the case. We ran two experiments to verify this.

First, we offered subjects the opportunity to trade a smaller piece of frozen juice for a whole stick. Thirty-five percent (ten of twenty-nine) of subjects were willing to make this trade. Problematically, however, the smaller piece of frozen juice was bite-sized (1.5 or 3 inches in length), which enabled immediate consumption, and consequently precluded subsequent trade. Consequently, in the second experiment, we ran the same study but with foods that could not be eaten rapidly (to help avoid potential complications from poor impulse control). Specifically, the chimpanzees were presented with the opportunity to trade a whole frozen juice stick (the same size as in previous tests) for a banana (which is a generally preferred food) of approximately the same length. Importantly, twenty-six of twenty-nine subjects (90%) exchanged on the first presentation and the remaining three did so on the second trial.

This indicates that our subjects were indeed willing, under the right circumstances, to exchange a lesser-valued food for a more-preferred one. The evidence we see of an endowment effect for foods, compared to toys, is not a generalized reluctance to trade away any valuable food. That is, while 58% of chimpanzees kept the juice stick when offered a trade for a peanut butter tube, only 10% kept it when offered a banana (and none kept it in their second trial). The subjects' willingness to give up the juice stick under this control condition indicates that the chimpanzees who kept an item in the endowment conditions of the original study did so because they preferred to keep it—and not out of concern that they would lose both commodities to an untrustworthy experimenter.

Indeed, the remarkable difference between exchange behaviors for food and exchange behaviors for non-food items, both in the original test and in the additional controls described here, further supports the conclusion that the frequent failure to exchange a less-

favored food for a more-preferred food was not due to a generalized inability or unwillingness to exchange, or to a lack of desire to interact with the experimenter. Instead, this was an active choice to maintain possession of the food item.[108]

B. Some Cautions

All studies have limitations. Our study has five worth noting.

First, corroboration never alone proves causation. This is a single study. While the data are consistent with each of our three predictions, they do not prove that the underlying theory that generated these predictions is necessarily correct. There may be other, better theories that generate these predictions.

Second, varying familiarity of objects may be an important confound. We have interpreted the difference in endowment effects between food and non-food conditions as likely reflecting the difference in the evolutionary salience between them. But other differences may be at work. For example, the observed differences might trace to variations between the objects other than the food/non-food distinction. Among the variety of possibly relevant distinctions (such as shapes, colors, or even consistencies of objects)

---

108. There are, of course, several additional explanations one might raise. However, several of the more likely possibilities do not explain the data as well as the evolutionary hypothesis. As one example, this effect cannot be attributed merely to chimpanzees' inability to delay gratification in situations involving food. Chimpanzees are known to delay gratification for food within their reach for at least 120 seconds, far longer than in the current study. Michael J. Beran, *Maintenance of Self-Imposed Delay of Gratification by Four Chimpanzees (*Pan troglodytes*) and an Orangutan (*Pongo pygmaeus*)*, 129 J. GEN. PSYCHOL. 49, 63 (2002). For another example, some models of the endowment effect predict it will be weaker for items that one consciously knows one cannot keep indefinitely (*see* Koszegi & Rabin, *supra* note 49, at 1134-35), which might arguably be the case for toys, as compared to foods. Yet, while this more deliberative explanation might theoretically have played some role in our subjects' responses, chimpanzees routinely keep what they have from humans, until they are ready and willing to give it up, a fact with which all of these chimpanzees have extensive experience. Finally, it is possible that some attribute of the items affects behavior. For instance, food may require extensive processing time, giving it more value upon acquisition because of these additional costs. On the other hand, toys may be valuable only for their novelty. Yet in our study, subjects were very likely to exchange toys for an identical toy, indicating that the novelty of the item was not particularly salient. If anything, the most obvious possibility is that subjects like the act of exchange, and that food outweighs the utility of the exchange interaction while objects have less utility than the interaction. While this is undoubtedly true, such reasoning begs the question that the evolutionary analysis explains, namely why chimpanzees prefer food over objects and interactions in the first place.

the most likely potential confound is familiarity. These specific dog toys were novel objects.

We think it unlikely that the toys were sufficiently novel for novelty alone to drive the observed differences. The toys are similar to other introduced objects the chimpanzees have encountered during their regular enrichment activities. Specifically, they have encountered many small plastic/rubber toys, similar to (but not) the bone, and they have regular exposure to rope toys, though not to this particular rope toy. Moreover, the subjects manifested no obvious predilections as a consequence of novelty—such as extended periods of examination before deciding whether to trade.

Third, the strength of subject preferences may be a significant confound. It is possible that the observed difference in endowment effects between food and non-food items reflects variation in the strengths of the preferences within classes (where a class comprises either food items or non-food items). That is, those who prefer peanut butter to juice, or vice versa, may have much stronger absolute and relative preferences than corresponding preferences for bone or rope toys.

It is not exactly clear how one would disentangle the strength of the preference between within-class objects from the difference in strength of preference between food and non-food classes. One possibility we have considered would involve establishing the price of one unit of an item (say, a single grape) in the currency of another item (say, six slices of cucumber). This could be revealed by incrementally increasing the units of the less preferred item until the aggregated units of that item caused a switch in preference to them.

However, there are some practical problems with this. If we did not give the preferred item to the subject immediately after he gestured for it, we would undermine the pattern we have established, introducing (for the chimpanzee) a new and significant risk, i.e., that expressed choices will be unfulfilled. If, on the other hand, we give the preferred item after each increment, satiation with (or desire for diversity among) consumed food items could confound interpretation of subsequent choices. This could theoretically be avoided by making each incremental increase on separate days. But this is impractical, given the time required—thirty to sixty minutes—to run a single session with each chimpanzee.

Fourth, our subjects are captive animals. It is of course possible that our chimpanzee subjects are behaving differently than they would under more natural conditions (although this particular facility works very hard to maintain a natural social environment and sufficient enrichment). For practical reasons, it would be extremely difficult to eliminate this potential confound. Moreover, we find it no more limiting than, say, the common use of college students in human studies, rather than representative samples of the species.

Fifth, evolutionary salience is a continuous variable, and one that potentially varies by context. (For example, the evolutionary salience of an apple when one is starving is arguably different than when one is sated.) This creates some potential challenges.

In addition, time-shifted rationality suggests that there will sometimes be inclinations that cut in opposite directions, the net of which is not always clear. For example, ascribing a single measure of evolutionary salience to, say, a hunting permit—wherein the permit is evolutionarily novel, while hunting is evolutionarily salient—may yield substantial difficulties. Similarly, while the evolutionary relevance of status signaling is quite clear, the currency of status changes with context. So, for example, a motor vehicle is not very evolutionarily salient, on one hand, because it is a new invention, built of new materials. On the other hand, cars (like houses, clothing, and watches) are pretty reliable, visible indicators of access to resources and have thus become signals of status. At present, we would estimate that this nets out such that high-status goods (many of which are high-wealth goods) would generally generate larger endowment effects, on average, than goods less associated with resources and status. But further work needs to be done to provide our hypothesis with greater precision respecting such goods.

V. CONNECTIONS

We explore two kinds of connections that link our hypothesis to the work of others.

A. Connections to Other Endowment Effect Experiments

We do not provide here any exhaustive account of where our evolutionary salience hypothesis does or does not connect to, explain, or differ from existing endowment effect studies. There are many hundreds of them, with virtually every one having a unique methodology, and analyzing them on the metric of our hypothesis simply requires a separate undertaking. Instead, we offer in this section a few thoughts on how our hypothesis connects to some of the extant literature.

Recall that our general view is that things closer to having survival and reproduction relevance (such as foods) will generally be more evolutionarily salient and, therefore, more likely to generate comparatively larger endowment effects than those things more distant from survival and reproduction relevance. In addition, our view suggests that, on balance, tangible things will be more evolutionarily salient than intangibles, and consequently more likely to generate comparatively larger endowment effects. And, among intangibles, those things with greater implications for survival and reproduction will yield greater effects than their counterparts.

We are not claiming that our theory would ultimately yield a way to quantify such things with precision. Instead, we suggest that evolutionary salience will be one of the factors explaining some of the variance in prevalence of and magnitudes in endowment effects. Of course (as should be clear by this point) in each case relevance for survival and reproduction is not measured in terms of current rationality, but is instead measured in terms of time-shifted rationality—such that it is not simply present circumstances, but estimated prior circumstances in which the brain initially evolved, that are relevant.

Consequently, our hypothesis may help to explain a number of existing patterns and puzzles that other researchers have discovered. Among them:

- An experiment, which its authors expected to reveal different endowment effect magnitudes for more and less familiar items (both of which happened to be food), found no such difference.[109]

109. *See* Bateman et al., *supra* note 16, at 502. The items were Coke and an uncommon

- A very recent meta-analysis of endowment effects concluded that the willingness-to-pay/willingness-to-accept gap was generally larger for goods with "intrinsic value" and for "health-related" goods than for other kinds of goods.[110]
- The same meta-analysis found that the disparity appears larger with actual ownership than hypothetical ownership.[111]
- A study showed endowment effects for individuals acting on their own behalf, yet virtually no endowment effect when individuals acted (abstractly) in an agency capacity on behalf of the shareholders of a business.[112]
- A study concluded that the magnitude of the willingness-to-pay/willingness-to-accept disparity appears to be greater for environmental improvements than for market items.[113]
- A study showed that coffee mugs generate an endowment effect, while inherently useless things (such as a token or IOU) that can be exchanged for (and are therefore abstractly equivalent to) the same mugs do not.[114]

B. Connections to Research on Brain Structure and Function

The time-shifted rationality perspective[115] suggests that various cognitive heuristics and biases may stem, in large measure, from evolved features of neural architecture, which yield behavior-biasing predispositions that are sometimes better adapted to ancestral conditions than to modern ones.[116] This suggests, in turn, that there will often be tension between brain function in different regions of the brain—those inclined toward the once-rational choice and those inclined (perhaps only after deliberate, self-conscious analysis) toward the more presently rational outcome. (Imagine, to illustrate, different networks within the same brain, one saying "go ahead, eat the tasty ice cream," and another saying "if you do, you'll get fat from ultra-concentrated calories, and we don't want that, do we?")

---

luxury brand of chocolates.

110. Sayman & Öncüler, *supra* note 5, at 306.
111. *Id.*
112. *See* Arlen et al., *supra* note 24, at 18-19.
113. *See* Irwin, *supra* note 16, at 452-53.
114. *See* Kahneman et al., *supra* note 11, at 1331-32.
115. *See* discussion *supra* Part II.B.
116. *See* discussion *supra* Part II.B.

A parallel example will illustrate. Among the suite of cognitive biases (of which the endowment effect is just one) is a bias sometimes described as an intertemporal choice anomaly. That bias is evident in a frequent and seemingly irrational preference to choose a smaller earlier reward over a larger later reward, when either choice is relatively near, but to *reverse* that preference for economically equivalent options that are more temporally distant. For example, people often choose x dollars over $x+y$ dollars, when given a choice between getting the former today or the latter in one week—but then choose $x+y$ dollars if given the choice between x dollars in (say) thirty weeks, or $x+y$ dollars in thirty-one weeks.[117] The choice is different, though in either case the one-week delay is the same.

Reasoning from the time-shifted rationality perspective, Jones and Goldsmith proposed in a recent article that "temporal distance may allow the more deliberative parts of the brain greater latitude than it allows the more emotional parts, when confronted with more immediate temptation toward earlier gratification."[118] As the article went to press, researchers separately investigating the intertemporal choice phenomenon with brain scanning techniques (functional magnetic resonance imaging—fMRI) announced findings entirely consistent with the prediction. Specifically, they found that the limbic cortex (often referred to as the emotional center of the brain) is engaged in the preference for initial gratification, but gives way to less emotive and more analytical processing in the prefrontal cortex and to deferred gratification, as the time of reward recedes further into the future.[119]

The point of this example is that the hypothesis we articulate here—that evolutionary salience will modulate the presence of and magnitudes of endowment effects—grows out of the same life science perspective as the example just given, makes a parallel prediction (that different areas of the brain, perhaps these same

117. For more on this phenomenon, see Kris N. Kirby & R.J. Herrnstein, *Preference Reversals Due to Myopic Discounting of Delayed Reward*, 6 PSYCHOL. SCI. 83 (1995), and George Loewenstein & Drazen Prelec, *Anomalies in Intertemporal Choice: Evidence and Interpretation*, 107 Q. J. ECON. 573 (1992).

118. Jones & Goldsmith, *supra* note 1, at 450-51 n.136.

119. Samuel M. McClure et al., *Separate Neural Systems Value Immediate and Delayed Monetary Rewards*, 306 SCIENCE 503 (2004).

areas, are likely involved), and is equally amenable to investigation using brain scanning techniques. The fact that brain imagers have already found this phenomenon in other contexts of a cognitive bias increases the probability that similar neural phenomena underlie related biases, such as the endowment effect. For example, we anticipate that objects may, as a general matter, be cognitively processed in a meaningfully different way from abstractions and that this structural and functional brain difference may be what is generating observed variations in patterns and magnitudes of endowment effects.

That is, while a mug may be evolutionarily novel, for example, it is *less* novel than an *abstract right* to a mug, which can be traded for a mug not presently visible. We anticipate that the cognitive machinery that evaluates the mug is neurologically distinct from the cognitive machinery that evaluates the abstract right to the mug. And the parts of the brain evaluating such abstractions (generally, the prefrontal cortex) are far more recent, evolutionarily, than parts of the brain that would have long been involved in assessing the possible value of various tangible objects in the immediate environment.

CONCLUSION

We have here connected law to biology through economics, psychology, chimpanzees, and peanut butter. Why? Consider the context.

Western scholars are products of an educational system that long ago and artificially divided physical sciences, life sciences, and social sciences. Over time, as both knowledge and researchers accumulate, disciplines have tended to divide and sub-divide and further specialize—finding truths that are deeper, but also narrower and more isolated. It is now common for scholars within cognate disciplines to have sufficiently different training, knowledge, language, and methods that they cannot communicate effectively. And, though this balkanized structure may increase the supply of knowledge, it also increases transaction costs (including search costs and information costs) that often prevent our combining knowledge in useful ways.

In recent years, this has inspired many efforts to synthesize insights from different disciplines into a seamless web of knowledge, finding and making connections across increasingly large intellectual spaces. Some of these efforts have focused on breaking down barriers between the life sciences and the social sciences, including those between biology, psychology, and economics. And our work here adds to those efforts. Specifically, we have attempted to show—using a straightforward, exploratory, and potentially significant example—that combining life science and social science perspectives may help to provide theoretical foundation for and potential predictive power concerning various psychological traits relevant to law. In doing so, it may incrementally contribute to increasing the efficiency and effectiveness of law, by providing a deeper and more useful understanding of where law-relevant behavior comes from and why it manifests the way it does. To the extent that a deeper understanding of the human animal can aid law's efforts to pursue whatever goals society assigns it, biological perspectives are an essential part (though not the only essential part) of the picture.

Against that broader background, let us review the arc of this Article and summarize some important implications. Findings in behavioral economics are posing interesting challenges to the expected utility theory assumptions of neoclassical economics, which often underlie or influence legal approaches to social and economic problems. At the end of the day, differences between traditional economics and behavioral economics will reconcile (one way or the other), probably resulting in a more robust—if then also more complex—model of human behavior.

But in the meantime, the precise dimensions, patterns, and meanings of the various cognitive heuristics and biases inherent in behavioral economics—including the endowment effect—remain quite unclear. And this will likely continue, absent a much deeper understanding of the causes underlying these phenomena that might bring them together and help to make coherent sense of what are now simply a *seriatim* series of puzzling observations.

There are important implications for law if the endowment effect is as real and robust as its proponents claim. It is therefore important to understand where the phenomenon comes from, why it appears when and as it does, and what, in particular, causes the

seemingly unruly variations in magnitudes of the effects that so many different studies, in different contexts, have described. Of course, science will not answer the normative question about whether the law *should* make any adjustments in light of endowment effects. But a greater understanding of the endowment effect would aid efforts to anticipate its appearance, evaluate its consequences, determine when to adopt accommodating, counterbalancing, or debiasing legal moves, and decide how best (if at all) to do so.

To date, however, the social science literature has cast about within itself for many explanations, including loss aversion. But none of these is satisfying. Each explanation is fundamentally ad hoc, with little prospect of understanding why the effect may appear when and as it does, and even less prospect of connecting the endowment effect to the various other cognitive heuristics and biases that researchers have identified. Specifically, we believe that the failure to make greater progress in understanding the endowment effect is in part symptomatic of a larger failure to more aggressively integrate social and life science perspectives on human behavior.

We therefore aspire to a more unified theory. And using a time-shifted rationality perspective, derived from evolutionary biology, we developed three novel predictions, the combination of which would emerge from no other known theory. We tested those predictions in chimpanzees, and report evidence consistent with those predictions.

First, and as predicted, the endowment effect appears to be present in chimpanzees (who, along with bonobos, are our closest living relatives). We believe we are the first researchers to have documented an endowment effect in non-human primates, and in chimpanzees in particular.[120] Second, and as predicted, the strength of the effect in chimpanzees varies across contexts. Third, and as predicted, the more evolutionarily salient stimuli (food items) resulted in a stronger endowment effect in chimpanzees than did less evolutionarily salient stimuli (toys). To our knowledge, we are the first researchers to have tested a theory-driven hypothesis about

120. One research team has recently begun to study whether five capuchin monkeys may exhibit an endowment effect. *See* Santos & Chen, *supra* note 83.

variations in the prevalence of endowment effects in non-human animals.

There are, as with all scientific experiments, important caveats. For example, the results of this experiment do not alone prove that the endowment effect definitively exists in all chimpanzees in all situations (although it does indicate the propensity for an endowment effect in the species). While our perspective does appear to pull together and make sense of some intriguing aspects of the existing endowment effect literature, our results do not prove that endowment effects will vary in humans according to the evolutionary salience of the items at issue. Nor do our results alone prove that the theory underlying the three predictions is accurate. There may be some other theory, not yet developed, that explains these data and more.

However, that the three predictions are supported is suggestive. It appears that chimpanzees do, under some conditions, exhibit endowment effects. And that they do so has at least five consequences. First, our results bear upon the existing debate over whether endowment effects are, as some have argued, mere artifacts of the language of experimental instructions and subject misunderstandings. The more species there are in which an endowment effect can be observed, the more likely it seems that the endowment effect is a meaningful phenomenon in humans.

Second, the results of our experiment increase the likelihood that there is a common evolutionary root to the endowment effect in humans, chimpanzees, and perhaps other species. Similar phenomena in different species can be the result of (1) evolutionary pathways held in common, through common descent, (2) different evolutionary pressures yielding similar results in distantly related species, or (3) similar evolutionary pressures that can independently generate similar phenomena in distantly related species. However, the more closely two species are related, all else being equal, the more likely it is that similar phenomena flow from an evolutionary history common to both species.

Third, and in turn, the results of our experiment suggest that further research inspired by evolutionary and time-shifted rationality hypotheses may help to uncover additional patterns in endowment effects in humans. Of course, evolutionary salience (or indeed any other single causal explanation) may not alone explain all

endowment effect data. However, it likely explains at least some of the observed variance in endowment effects.

Fourth, our experiment suggests that chimpanzees may be a very useful animal model for investigating the variety of other cognitive heuristics and biases known in humans, as they have been useful in investigating the evolution of many other primate (including human) behaviors. Reciprocally, it may be possible to first discover in chimpanzees some previously unknown heuristics and biases that might then also be tested for and identified in humans.

Fifth, and perhaps most importantly, this initial test of the evolutionary perspective on the endowment effect may help lead to a broader and scientifically coherent reconciliation of cognitive heuristics and biases, within a combined life-science/social-science framework of time-shifted rationality. In all, we believe that our experiment not only has revealed something new about chimpanzee attitudes toward property, but may also help to forge further connections between biology, psychology, and economics that are potentially useful for law.