LAURIE R. SANTOS AND VENKAT LAKSHMINARAYANAN

Innate Constraints on Judgment and Decision-Making?

Insights from Children and Nonhuman Primates

In this chapter, we explore the possibility that human judgment and decision-making heuristics may have an innate component. We first provide a brief review of this heuristic approach, exploring what little is known about the role of experience in the emergence of these biases over the course of human development. We then review how a comparative-developmental approach allows us to directly address which aspects of our heuristics are innate, universal, and evolutionarily ancient. We then adopt insights from comparative cognition to investigate origins of two classic judgmental biases—loss aversion and reference dependence. We present evidence that humans and nonhumans exhibit analogous judgmental biases previously thought to be uniquely human, and further argue that these shared behaviors result from a common and possibly innate ancestry. We end by postulating that examining the innateness of seemingly maladaptive behaviors such as reference dependence and loss aversion may provide insight into the psychological machinery that drives both accurate and biased decision-making.

1 Innate Constraints on Judgment and Decision-making? Insights from Nonhuman Primates

Infancy researchers who espouse a nativist view of human cognition are prepared for criticism from many different academic circles. Nevertheless, few nativists anticipated that one of the staunchest (and possibly most famous) rhetorical critiques of infants' early competence would emerge in a rather unlikely place. In 1997, *The Onion* published a scathing (albeit satirical) evaluation of nativist views, "Study Reveals: Babies Are Stupid."[1] The article reviewed a number of cognitive tasks on which babies perform quite poorly, including using a can opener to open baby food

1. Those readers who are unfamiliar with *The Onion* (http://www.theonion.com) are highly encouraged to add "America's Finest News Source" to their periodic Web surfing.

containers, reading a map to get back home, and finding ways to take shelter from downpouring rain. The review then concluded that despite the strong early competency claims of some infancy researchers, human babies are "so stupid it's not even funny."

The Onion's article is surely one of the few attacks on infants' early competence to be displayed proudly on a number of infant laboratory office doors. The parody works because of developmental researchers' newfound respect for infants' early cognitive capacities. Six month-old infants can't open baby food containers, but they have some understanding of support (Needham and Baillargeon, 1993), contact (Leslie and Keeble, 1987), and containment (Hespos and Baillargeon, 2001; see Baillargeon, 1994, 1995, for reviews). They can't read maps, but do understand how space and time constrain object motion (e.g., Spelke, 2000; Spelke et al., 1992). In contrast to what many believed only a few decades ago, infants' understanding of the world is pretty impressive. They have ideas about the way the physical and social world works, and their ideas are basically correct—they make accurate predictions about how objects and people behave even in the absence of much experience. The most agreed-upon conclusion of decades of infancy research is basically this: Shockingly enough, babies are pretty smart.

The same holds true for other subject populations whose abilities have been marshaled in support of innateness claims. Comparative researchers, for example, have amassed a wealth of evidence that nonhuman primates (hereafter "primates") seem to share many of the smart cognitive capacities that young infants develop early on—including an understanding of simple physical principles (see reviews in Tomasello and Call, 1997; Santos, 2004) and an appreciation of goals and intentions (see Lyons and Santos, 2006; Tomasello et al., 2005). Like human infants, primates also seem to be pretty smart. Our emerging picture of human cognitive origins, then—both developmentally and evolutionarily—seems to be one involving mostly smart capacities for reasoning about how the world works.

Infants' and primates' exciting cognitive competencies can easily give a novice researcher the idea that nativist views are synonymous with the following conclusion: Developmentally or evolutionarily *early-emergent* cognitive capacities necessarily equal *smart* cognitive capacities. After all, the cognitive capacities that have classically brought nativists and empiricists to blows have typically been relatively "smart" ones—they include, for example, claims about infants' "capacity" to "compute the numerical results of . . . arithmetical operations" (Wynn, 1992c, p. 750), their "theory of the physical world" (Spelke, 1988, p. 181), and so on.

But what about those aspects of human cognition that are not as smart? Human cognition, though undoubtedly impressive, is certainly not without its faults. At the same time as researchers have made careers by showing that human infants and primates are smarter than we thought, a number of social psychologists have spent the past few decades showing that human adults are actually a lot dimmer than we thought. In both the laboratory and the real world, adults fall prey to a number of reasoning and decision-making errors (see Hastie and Dawes, 2001; Kahneman et al., 1982; Tversky and Kahneman, 1974). In solving relatively straightforward problems such as calculating coin-toss outcomes, guessing a country's population, or predicting whether others will share one's beliefs, adult participants fall prey to a

number of incorrect cognitive shortcuts that result in systematic reasoning biases. To take just a few examples, adult decision-makers tend to ignore statistically relevant information, such as base rates, and instead employ heuristics that take into account a particular instance's representativeness or emotional salience (Tversky and Kahneman, 1974). Similarly, decision-makers seem to evaluate their choices relative to arbitrary anchors (Tversky and Kahneman, 1974) and reference points (Tversky and Kahneman, 1986), rather than assessing choices in absolute terms. Across a number of domains, people tend to systematically ignore problem-relevant information and systematically overestimate the importance of problem-irrelevant information.

In this chapter, we speculate about the origins of these less smart cognitive mechanisms. How is it that educated, fully developed adult human decision-makers—organisms that are able to use can openers, read maps, and find umbrellas—fall prey to these numerous biases? More specifically, when and how did our species develop the imperfect cognitive heuristics that lead our decisions astray? Unfortunately, despite the decades of elegant research exploring the nature of human decision-making, little empirical research has addressed the origins of cognitive heuristics, either developmentally or comparatively. Moreover, relatively few researchers have speculated theoretically about the developmental experiences that might be required for these strategies to emerge over the course of human ontogeny or about the history of these heuristics over the course of human phylogeny.[2]

Here, we propose what is—admittedly—a somewhat radical view of the origins of human reasoning heuristics. Our proposal is that at least some components of the heuristics that lead us astray are built in innately. Put differently, we contend that the cognitive shortcuts that drive human judgment bias will emerge in the absence of much experience. We hypothesize that at least some aspects of decision-making heuristics should be structured like other "core" systems of knowledge (see Spelke, 2000; Hauser and Spelke, 2004). Such heuristics are likely to emerge early in human development (before much experience has taken place), and are likely to be evolutionarily ancient and thus shared with closely related primates (which make decisions in very different contexts than humans do).

We begin with a brief review of some human cognitive heuristics. We then review how a comparative-developmental approach—such as that used to study the origins of physical and social cognition (see reviews in Santos et al., 2002; Spelke, 2000, Hauser and Spelke, 2004)—can allow us to directly address which aspects of our cognitive heuristics are innate, universal, and evolutionarily ancient.[3] We

2. Although see the work of Gigerenzer and colleagues for a welcome exception (e.g., Gigerenzer and Goldstein, 1996; Gigerenzer and Selton, 2001; Gigerenzer and Todd, 1999).

3. Our review of the evolution of these heuristics, however, will not focus on the question of whether such heuristics are "adaptive"—whether they aided in human survival and reproductive success over phylogenetic time—but will instead review merely whether they are shared broadly with other primate species. Readers interested in this question of heuristic adaptiveness are encouraged to check out the work of Gigerenzer and his colleagues (Gigerenzer and Selton, 2001; Gigerenzer and Todd, 1999), who have provided a convincing case that the "biases" that result from heuristics may in fact be adaptive cognitive strategies over evolutionary time.

hen adopt insights from comparative cognition and review some of our lab's recent ork investigating the origins of two classic judgmental biases—loss aversion and eference dependence. We present evidence that one primate species—the capuhin monkey (*Cebus apella*)—exhibits judgmental biases previously thought to be niquely human, and further argue that this shared cognitive bias results from a ommon and possibly innate ancestry. We end by postulating that examining the nateness of seemingly maladaptive behaviors such as reference dependence and ss aversion may provide insight into the psychological machinery that drives both tional and irrational decision-making.

Before launching into our review, however, we must come clean to the reader bout a major impediment facing the enterprise we're about to outline: Unfortunately, t present there is relatively little work on the role of experience in the early devel-pment of cognitive heuristics and their resulting biases. Although much work has xplored whether specific experiences and training can improve adult cognitive iases (see Hastie and Dawes, 2001, for a review), extremely little work has exam-ned *what (if any) developmental experiences are needed for these biases to emerge in ne first place*. In addition, very little work to date has explored whether cognitive iases are shared with other closely related nonhuman species, as one might expect they were part of an innately constrained cognitive system that emerged early in rimate evolution. We see two reasons for this lack of evidence. The first reason methodological. Most work in the field of judgment and decision-making uses urvey-based verbal tests. Such tests are difficult to administer both developmentally particularly with young infants) and comparatively. Researchers interested in the arly origins of cognitive biases are thus faced with the difficult task of developing ew (probably nonverbal) methods in order to examine the role of experience in the evelopment of these cognitive phenomena. The second reason, however, is a bit nore sociological. Much of the original and most important work on human cogni-ve biases emerged from the fields of social psychology and behavioral economics. Though these two fields excel at tracking down and modeling the mechanisms that ive rise to human performance, they have tended to be less interested in the origins f the mechanisms they study.[4] This oversight is unfortunate, as researchers can gain nuch insight into the way that a cognitive mechanism operates in its adult state by tudying how that mechanism can and cannot be shaped by different cultural or evelopmental experiences.

For these reasons, we warn our readers that they should not expect to see a onvincing empirical case that adult cognitive biases are innate. We are confident, owever, that a convincing case for (or against) the claim that cognitive biases are nnate could potentially be made in the future. The question of whether human ognitive biases emerge in the absence of experience is ultimately—we believe—an mpirical one. Designing nonverbal measures of judgment and decision-making is ontrivial, but certainly not impossible. One goal of the present chapter, then, is to

[4] Thankfully, this is changing—at least in the field of social cognition. More and more social psychol-sts have become interested in the nature and origins of adult human social cognition (e.g., Olson al., in press).

BOX 15.1 A List of Common Cognitive Heuristics and Their Associated Biases

Interest in the nature of heuristics and biases originally began when Tversky and Kahneman (1974) proposed three reasoning heuristics:

- *Anchoring heuristic* (also known as the anchoring and adjustment heuristic): the tendency to start judgments from a particular (often arbitrary) value. The anchoring heuristic often results in a bias in which one fails to correctly adjust away from the initial "anchor" value.
- *Availability heuristic:* the tendency to overweight salient information when making judgments. The availability heuristic often results in a bias in which one overweights information that is more salient or "available." It is often thought to stem in large part from the constraints of perceptual and memory systems that lead certain types of information, but not others, to become salient. The availability heuristic is also thought to lead a number of other biases, including the *hindsight bias* (an error in which one believes that past events are more predicable than they actually are; also known as the "I-knew-it-all-along" bias).
- *Representativeness heuristic:* a tendency to make judgments based on representative characteristics rather than statistical information. The representativeness heuristic can result in a bias to neglect of the base rate (sometimes called *the base rate neglect bias*) and other problem-relevant information.

Kahneman and Tversky (1979) identified another important tendency that decision-makers use to make choices under uncertainty:

- *Loss aversion:* the tendency to avoid outcomes that are viewed as losses. Loss aversion results in a bias whereby one's inclination to avoid subjective losses is larger than one's inclination to acquire equal-size subjective gains (this bias is also termed the *reflection effect*). Loss aversion is also thought to result in a bias known as the *endowment effect*, in which one's willingness to sell a good that one owns is considerably less than one's willingness to buy an equally valued good that one does not yet own. Loss aversion was originally summarized and modeled under prospect theory, Kahneman and Tversky's descriptive framework for human decision-making under uncertainty.

xcite other primate and infant researchers about the possibility of a developmental udy of judgment and decision-making. We hope this chapter will serve to inspire me new research questions and set researchers on the path of developing methods get at these important issues.

It's also important to note that although the psychology of adult human heustics and biases is a rich and exciting field; it also one that is unfortunately far too rge to do to justice to in a chapter of this length. For this reason, we were forced to strict our review to only a small subset of the exciting work in the field of judgment nd decision-making. Additionally, we have chosen to review only those biases that ave been examined developmentally (often in older children) or comparatively, nd have kept most of our focus devoted to the few biases whose origins we and our olleagues have examined directly using comparative experiments.

The Empirical Origins of Cognitive Heuristics

sychologists' interest in heuristics and biases began with the influential work of ehavioral economists Daniel Kahneman and Amos Tversky. Kahneman and 'versky published a series of revolutionary articles in the 1970s that paved the way or the rise of the modern field of heuristics and biases. These early articles outned three of the best-known judgment heuristics—*representativeness*, *availability*, nd *anchoring*—and detailed their groundbreaking descriptive analysis of choice ehavior under uncertainty, known as prospect theory, which focused on another ell-known heuristic, *loss aversion* (Tversky and Kahneman, 1981, 1986). We outline ach of these four heuristics in turn.

2.1 *Representativeness*

he first heuristic identified by Kahneman and Tversky, the representativeness heustic (Tversky and Kahneman, 1974), comes into play when one attempts to decide ow likely it is that a particular example or instance is a member of a larger class of ems. Consider the problem of trying to determine the occupation of a well-dressed, miliar-looking woman sitting in the lobby of your conference hotel. How likely is that the woman is a graduate student, or someone from your high school, or a tourst, or a janitor? One way to solve this problem would be to figure out the statistical nformation that's necessary for the relevant likelihood estimations. One would, for xample, want to know the base rate of each category—the general prevalence of raduate students, janitors, tourists, and people from your high school. One could nen use this information when computing the likelihood that one of these particular categories was present at the conference hotel, and then use that information to uess which category you sampled when you ran into the familiar-looking woman.

Normal human participants, however, don't employ this type of reasoning. nstead of using base rate information, participants tend to guess based on the salient haracteristics of the sample they're considering. Faced with the problem above, nost adult decision-makers would automatically consider the most salient feature f the woman they've run into (namely, that she is in a conference location) and

then try to determine the larger class of people which best fits with this particular salient feature. Paying attention to a representative characteristic in this way might warrant the conclusion that this woman is in fact a graduate student, as the feature of sitting in the lobby at conference hotels tends to be a representative feature of graduate students. Such a representativeness strategy might be in error, however, if the conference in question happens to be in a popular tourist destination, where the base rate of tourists could be far higher than the base rate of graduate student conference attendees, or if the conference happens to take place in the small town where the decision-maker grew up, where the number of local high school alumni may far exceed the base rate of graduate students in town. For this reason, decision-makers' use of representativeness judgments can often lead them astray when base rate information differs across the categories of interest.

2.2 *Availability*

A second judgment shortcut that plagues adult decision-making is the availability heuristic (see Tversky and Kahneman, 1974). The availability heuristic is employed when one attempts to determine the likelihood of a particular event or to compare the likelihoods of two different events. Instead of using actual statistical information to determine the probability of a particular event, most decision-makers employ a shortcut in which they call to mind specific past instances of the event in question. Since more typical events are easier to remember than less frequent events, decision-makers can sometimes use the number of instances they come up with as a measure of the likelihood that the event in question will occur. For example, consider trying to determine which event is more likely to disrupt your next picnic: a thunderstorm or a hurricane. To solve this problem without exact weather statistics, you might try to recall instances in which picnics you know of were disrupted by thunderstorms or by hurricanes. If you're like most people, you probably know of more picnics that were disrupted by thunderstorms than by hurricanes, and thus you would likely conclude that picnics are more often rescheduled due to thunderstorms than to hurricanes.

While the availability heuristic works most of the time, it is subject to errors when the instances we're considering differ in their perceptual prominence, emotional salience, memorability, or familiarity. Consider one common bias of availability, known as the *hindsight bias* (aka the "I knew it all along" bias). The hindsight bias involves a tendency to see events that have already occurred as having been more likely to have occurred than events that have not yet occurred (e.g., "I should have known that a hurricane would disrupt my picnic. It was so obvious!"). Our higher likelihood estimations for events that have already occurred is undoubtedly due to the fact that such events are both emotionally and perceptually more salient—and thus more available—than events that did not occur. As a result, people mistakenly believe that past events should have been easier to predict than they actually were.

2.3 *Anchoring*

The final heuristic proposed in Tversky and Kahneman's original treatise is that of anchoring. Anchoring is frequently used in situations in which a person is required