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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.

en 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 develpment 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 examned *what (if any) developmental experiences are needed for these biases to emerge in e 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 ore sociological. Much of the original and most important work on human cognive biases emerged from the fields of social psychology and behavioral economics. hough 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 uch insight into the way that a cognitive mechanism operates in its adult state by udying 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 nate 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

Thankfully, this is changing—at least in the field of social cognition. More and more social psycholosts 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.

cite 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 tourt, 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 hen use this information when computing the likelihood that one of these particuar 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

make a numerical estimate that he or she cannot, for whatever reason, compute xactly. Consider the problem of guessing the number of restaurants in New York ity. Are there more or less than 1000 restaurants in the Big Apple? What's your xact guess? If you're like most participants, the number you guessed for the above uestion would be slightly less than if I had asked you whether there were more or ss than 10,000 restaurants, and slightly more than if I had asked whether there were ore or less than 100 restaurants. As Kahneman and Tversky were the first to point ut, decision-makers tend to make numerical estimates such as these by first coming p with an initial guess (the "anchor"), and then adjusting up or down until the final uess seems more reasonable. Unfortunately, the size of the anchor often influences ow far an estimator is able to adequately adjust—with smaller anchors leading smaller final judgments than larger anchors. Interestingly, anchors are effective ven when it's clear that they are truly arbitrary. Tversky and Kahneman (1974), for xample, observed anchoring effects even when participants got their initial guess by inning a random number wheel. Such results suggest that anchor points influence ture judgments even in situations in which the anchors themselves are unrelated the question.

2.4 *Reference Dependence and Loss Aversion*

he final heuristics we'll discuss—and possibly the most well studied—occur in the omain of choice under uncertainty. Humans face choices that involve some element of uncertainty on a daily basis: send the e-mail now or do it later, heed mom's ving advice or ignore her, have the key lime pie or try the chocolate cake, and on. How do decision-makers navigate these risky decisions, and what information do they use to decide between risky options? Decades of work in economics nd game theory have converged upon what (until very recently) was considered n accurate descriptive account of all human decision-making, which we'll refer here as the expected utility maximization account. This descriptive account of uman decision-making originally developed out of a normative account of how dealized rational decision-makers should behave. Normatively speaking, rational ecision-makers should reason about potential options in terms of their objective onsequences—their expected payoffs. Under this view, deciding between two risky ptions should simply come down to computing the expected payoff of each option mes the odds of receiving that payoff. Traditional descriptive theories of human hoice have thus represented actual human decision-making in this way, simply as process of utility maximization.

Describing human decision-making in terms of expected utility maximization ontinues to hold considerable appeal for neoclassical economists for a number of easons. First, the process of utility maximization can offer quantifiable solutions to nany kinds of choice under uncertainty, everything from mate selection to deciding hat percentage of each paycheck to set aside for retirement. Second, utility maximiation is easy to formalize with the typical mathematical tricks and tools classically vailable to economists. Finally, utility maximization follows elegantly from intuitive deas about rationality and rational choice. For these reasons, people have naturally ssumed that this intuitively plausible normative theory of choice under uncertainty

should also serve as an accurate *description* of human choice behavior. Unfortunately, despite its intuitive appeal, utility maximization has become less and less favored among psychologists, mostly because it fails to adequately explain how human decision-makers go about making risky decisions. As Tversky and Kahneman (1981, 1986) were the first to observe, humans make choices that systematically differ from what rational choice and utility maximization models might predict. Rather than evaluate choices in absolute terms, human decision-makers often seem to anchor their choices to an arbitrary *reference point*, their current state or situation. They then treat the outcome of a decision differently, according to how it is framed relative to that reference point. Kahneman and Tversky used this reference dependence approach to develop their famous model, prospect theory, which mathematically delineates how subjects represent value as a function of their reference point. As prospect theory further outlines, people do not evaluate choices linearly relative to their reference point anchor. In one classic example, Tversky and Kahneman (1981) presented subjects with the following problem, along with one of the two following sets of solutions:

> Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:
>
> If Program A is adopted, 200 people will be saved [72%]
> If Program B is adopted, there is a 1/3 probability that 600 people will be saved, and a 2/3 probability that nobody will be saved [28%]
> Which of the two programs would you favor?
> If Program C is adopted, 400 people will die [22%]
> If Program D is adopted, there is a 1/3 probability that nobody will die, and a 2/3 probability that 600 people will die [78%]
> Which of the two programs would you favor?

Despite the fact that the expected outcomes were identical between conditions (on average, 200 people will live in all conditions), subjects had different preferences across the different conditions. Subjects presented with the first two options tend to find the safe gain [program A] preferable to the risky gain [program B], indicating that saving 200 people with certainty is more appealing than the risky possibility of saving all 600. Subjects presented with the second two options seemed to think just the opposite; they preferred to take the risky loss [program D] rather than the certain loss [program C]. In this and many other experimental scenarios, subjects' decisions appear to be heavily dependent not only on how they perceive their options relative to a reference point, but specifically on whether those options are seen as losses or gains relative to that reference point. As observed in the Asian disease problem above, the disutility that subjects associate with losses tends to be greater than the utility associated with equal-sized gains. This phenomenon leads to a kink in the value curve described by prospect theory, with prospective losses looming larger than similar-sized prospective gains. This function leads to the heuristics of *loss aversion*, in which people act in ways that avoid losses more than they act in ways that seek equal-sized gains.

Kahneman, Tversky, and colleagues also predicted an unusual consequence of loss aversion: Individuals who would otherwise be happy to exchange two items of

equal value may instead choose not to—because of loss aversion, the disutility of losing an item may appear to be much greater than the utility of gaining one of equal value. A striking demonstration of this consequence is a phenomenon called the endowment effect (see Kahneman, Knetsch, and Thaler, 1990), in which a subject's willingness to pay for a particular good is smaller than his willingness to accept payment for that same good. In one example, Kahneman and colleagues (1990) gave half of a group of participants one coffee mug each and examined their willingness to trade or sell this new mug. The researchers observed that coffee mug owners demanded a larger price to sell their mugs than non-owners were willing to pay to buy or trade for the mugs. Becoming an owner thus seemed to change one's valuation of an object—because losing an owned object is framed as a loss, it is treated as more costly than the gain of a similarly valued object.

The heuristics and biases introduced above have been well studied and worked out in adult subjects. We now turn to the question of how these biases originate. Could some aspects of these heuristics be constrained innately? More specifically, do these heuristics develop early in human ontogeny, as one might expect if they arose without the need for experience, via innate mechanisms?

3 The Development of Cognitive Heuristics

Developmental psychologists have long been interested in how and why children make poor decisions, typically from the applied perspective of finding ways to improve children's (and often adolescents') decision-making by teaching them to utilize more normative strategies. Despite this widespread applied interest in the development of decision-making, shockingly little empirical work has been devoted to the mechanisms that children *actually* use to make decisions, and even less work has focused directly on examining children's use of cognitive heuristics (see J. E. Jacobs and Klaczynski, 2002, 2005). In addition, the existing empirical work exploring children's decision-making has emerged out of developmental traditions quite different from that of core knowledge and nativist approaches (e.g., Piagetian or information-processing approaches). Thus, little work to date has directly addressed the role of decision-making experience in the development of heuristics and biases, or the question of when such biases appear in the first place.

To date, the heuristic which has received the most empirical attention from developmental researchers is that of representativeness. Do children, like adults, use representative rather than base rate information when making judgments about group membership? To address this question, J. E. Jacobs and Potenza (2001) compared six-, eight-, and eleven-year-olds' performance on a judgment task to that of undergraduate controls. Participants of all ages were presented with information about different individuals and then asked to choose which of two groups had that person as a member. One example was presented as follows: "In Juanita's class, 10 girls are trying out to be cheerleaders and 20 are trying out for the band. Juanita is very popular and very pretty. She is always telling jokes and loves to be around people. Do you think Juanita is trying out to be a cheerleader or for the band?" As in this example, some scenarios provided participants with both base rate information about the two groups

and individuating information about the individual in question. Jacobs and Potenza observed that when individuation information was present, children's choices fell prey to the representativeness heuristic just as adults' did. Even six-year-olds tended to incorporate normatively irrelevant representativeness information into their decisions about social groups. Importantly, however, participants' use of the representativeness heuristic seemed to increase rather than decrease with age.

Interestingly, children's choice results suggested that they tended to employ individuating information more in the social domain than in the nonsocial domain. The authors speculated that there may be some domain-specific differences in the development of the use of this heuristic, with representativeness strategies first developing for use in social judgments and gradually extending to other domains of decision-making. This is an interesting possibility, particularly from a nativist perspective, as it suggests that at least some heuristics and biases may have features that are specialized for particular kinds of computational problems and domains of reasoning. Further work in this area could definitely profit from exploring the even earlier developmental origins of this interesting domain-specific difference in the use of reasoning heuristics.

In addition to representativeness heuristics, children also seem to employ something like an availability heuristic, particularly when investigated in the context of hindsight bias. Bernstein and colleagues (2004) presented three-, four-, and five-year-olds and adults with a visual display in which a hidden image gradually got clearer. On half the trials, participants were asked to guess the object's identity. On the other half of the trials, participants were told the object's identity and asked to say at what point another naive person would be able guess what the object was. Participants of all ages grossly overestimated other people's ability to see the objects. When information about the object's actual identity was available, both children and adults made errors, incorrectly guessing higher frequencies of object detection. These results indicate that children as young as three years of age may utilize the same availability information as adults to determine unknown likelihoods, and in doing so, may experience a hindsight bias.

Children also seem to be susceptible to anchoring effects. H. D. Smith (1999) demonstrated that nine-, eleven-, and thirteen-year-olds' answers to addition problems can be affected by the order in which the numbers are presented, just like adults in the original Kahneman and Tversky studies, with smaller first numbers anchoring smaller answers than larger first numbers. In a second study, Smith observed that eight- and ten-year-olds' guesses about the number of jellybeans inside a clear container is affected by which number is used as an anchor. Children as young as eight years of age thus also seem susceptible to the same anchoring effects as human adults.

In contrast to representativeness, availability, and anchoring, there is less evidence that young children experience reference dependence and loss aversion when making decisions. Reyna and Ellis (1994), for example, presented preschoolers and older children with a gambling task in which payoffs were framed either as gains (a number of small toy balls to be won) or as losses (a deduction from toy balls that children had already been given). Children were then presented with options that, as in the Asian disease problem described earlier, differed with regard to their riskiness. In contrast to adults' performance, children's risk preferences did not seem to change based on the way the problem was framed—the youngest children preferred

the same option no matter whether they were gambling over gains or losses. Other studies of children's choice behavior, however, *do* reveal the signatures of both reference dependence and loss aversion (particularly when a risky choice is no longer involved). Harbaugh et al. (2001), for example, explored whether children exhibit a common signature of loss aversion, the endowment effect. He presented six-, eight-, and ten-yearolds with a trading task in which subjects were endowed with a particular toy and then asked if they would like to trade that toy for an alternative toy of equal value. As with adults, children were less willing to trade when they were made owners of an object. Like adult participants, children also seem to value an object more when they are made its owner; they seem to treat an object that they can sell or lose as more valuable than an equally priced object to be bought or gained.

Taken together, then, there is some evidence that heuristic-based approaches to decision-making emerge relatively early in human development. Although the full developmental pattern is by no means clear from the available data, there is growing evidence that children exhibit heuristic reasoning from a rather young age (but see Reyna and Ellis, 1994, for an exception). By the time they are three, children have begun to employ heuristics that lead them to make systematic judgment and choice errors. Unfortunately, however, most of the available evidence on children's reasoning to date involves older children who have already had considerable experience making decisions and establishing choice preferences. A better approach to exploring the early origins of cognitive biases would, of course, involve testing younger participants, preferably infants who've had far less experience making decisions and establishing preferences. A second problem with the present results concerns the verbal tasks used to explore children's decision-making. As cognitive developmentalists have known and struggled with for some time, a child's performance on verbal tasks is often constrained not only by his underlying cognitive competence, but also by the kind of task on which he is being tested. Indeed, this is true both for situations in which children perform poorly but have adequate competence—such as object search tasks in which toddlers fail to reveal the true core understanding of objects (see discussion in Santos, 2004)—and for situations in which they seem to perform well but actually lack certain cognitive competence—such as when young English-speaking children use and produce grammatically correct inflections before they completely understand past tense morphology (e.g., Marcus, 2001).[5] For this reason, developmentalists have begun to incorporate nonverbal tasks that circumvent some of the problems associated with verbal task demands. Such nonverbal tasks can also be more easily adapted to younger prelinguistic subject populations. To our knowledge, no such tasks have yet been developed to study judgment and decision-making developmentally.

5. Of course, the idea of "competence" is bit strange when thinking of the development of decision-making biases and heuristics. In this case, children may perform well on verbal tasks (i.e., make more normative, more accurate judgments) because the verbal tasks are able to mask children's genuine decision-making strategies that would otherwise lead to errors on nonverbal measures with fewer task demands.

4 Evolved Biases?: Comparative Evidence for Cognitive Heuristics

As reviewed above, relatively little work has addressed the question of cognitive biases in human infants and young children. Even less work has explored whether these biases are present in closely related primate species.

In order to deal with this oversight, we and our colleagues have begun a research program to explore how captive capuchin monkeys make decisions and choices under uncertainty. Our goal is to develop a dependent measure similar to that used in a number of human experiments: a measure of preference. Unfortunately, the preference measures most typically presented to adult humans involve monetary preferences—surveys in which subjects are offered choices between different monetary gambles or questions about how much they would be willing to pay for one choice over another.

To get around this problem, we began by training our capuchin subjects to use a token economy (see Brosnan and de Waal, 2003, 2004; Liv et al., 1999; Westergaard et al., 1998; Westergaard et al., 2004, for similar token methodologies). Our goal in using this token economy was to set up a system in which we could observe monkeys' preferences by examining how much they would be willing to pay for different risky choices. During training, monkeys were presented with a "wallet" of small metal tokens and were reinforced for exchanging these tokens with an experimenter (see figure 15.1 for photos of the trading setup). Once monkeys understood the exchange task, we explored whether they used this token system in some of the same ways that humans use money in their own economies. In particular, we explored whether subjects paid attention to the "price" of different kinds of food and whether they, like humans, would switch their preferences if the prices changed.

To do so, we presented monkeys with an experimental market situation in which they could choose to spend their tokens to buy different kinds of goods. They were given a small wallet of tokens upon entering the testing chamber. Two experimenters stood outside the testing chamber, and each of them offered a different kind of food. Monkeys could see each of the experimenters' offers, and could therefore decide whom to buy from. Once monkeys made their decision, they simply handed

FIGURE 15.1 A capuchin, MayDay, engaged in a trading task. Monkeys receive their wallet of tokens (A) and then deliver the tokens to an experimenter (B-D) to signal their preferences.

one of the two experimenters a token, and that experimenter then handed over the ood that he had promised. Monkeys could thus spend their token budget any way hey wished—purchasing food from either of the two experimenters, depending on heir preferences. Monkeys were initially allowed to spend their money on two types of food that they liked equally—apples and grapes—which were sold by two different experimenters at equal prices (one token for one medium apple chunk or one grape). Once monkeys got used to the price that each experimenter charged, we ntroduced what economists refer to as a "price shock"—basically a sale on one of the two goods (e.g., the price of one experimenter's good was cut in half, such that one token now bought two items). If monkeys' spending preferences, like those of human consumers, were dependent on the price of the individual goods, then they should change their pattern of purchasing, switching to buying more of the cheaper good. Our subjects did just this, indicating that the monkeys' token economy shared at least some of the rational features of human economies.

Our monkey market setup thus provided a methodology in which we could begin asking questions about monkey "irrationality"—their biases during choice under uncertainty. In particular, do monkeys set up their preferences as humans do—attending not just to how much food they get, but also to how much a potential offer varies in regard to an arbitrary reference point? To test this, we presented monkeys with a market in which the two trading experimenters provided the same kind of good—apples—but no longer automatically delivered the originally displayed number of food pieces (they sometimes gave more apples than they originally promised, and sometimes gave less). In this way, we were able to independently vary what monkeys were initially shown and what they eventually received in exchange for a token. Our goal was to see whether monkeys treated the initial offer as something like a "reference point," evaluating the amount of food they got later relative to that initial offer. Monkeys were given a choice between two experimenters. The first initially promised one piece of apple but, about half the time, delivered two instead of one. This experimenter therefore appeared to give a bonus relative to his initial reference point—monkeys started by thinking they would get only one piece of food, but sometimes they ended up getting two. The second experimenter, in contrast, always promised two pieces of apple but, about half the time, delivered only one piece. This experimenter thus seemed to give a loss relative to his initial reference point—around half the time, monkeys received less than they expected to get. Note that, on average, both of these experimenters delivered same number of apples; if monkeys chose between the two experimenters simply on the basis of how much food they got, then they should have chosen between the two experimenters at random. This was not, however, how the monkeys performed. Instead, all of our capuchin traders showed a whopping preference for the experimenter who delivered the bonus or gain relative to his initial offer. To explore the magnitude of this effect more specifically, we presented monkeys with a condition in which one trader always delivered what he initially displayed (he promised one and delivered one), while the second trader always delivered a loss (he always promised two and always delivered only one). Monkeys again robustly avoided the experimenter who gave them perceived losses. Moreover, we observed that increasing the number of losses delivered seemed to increase monkeys' aversion to a particular experimenter—they showed even stronger avoidance

of experimenters who delivered more frequent losses. Like humans in a number of different tasks, our monkeys were loss averse; they, too, avoided the experimenter who delivered a loss relative to his initial reference point.

In another study (Lakshminarayanan, Santos, and Chen, in preparation), we explored whether monkeys' loss aversion affected another aspect of their decision-making: the degree to which they are risk averse. As reviewed earlier, human subjects tend to become more risk averse when problems are framed in terms of potential losses (e.g., a certain number of people will die) than when they are framed in terms of potential gains (e.g., a certain number of people will be saved). To examine the same phenomenon in monkeys, we presented our monkeys with market options that varied in their riskiness. Monkeys could choose between a safe trader, who always did the same thing on every trial, and a risky trader, who varied what he did from trial to trial. In one condition, each of these two traders promised one piece of apple and delivered bonuses relative to their initial offer: the safe experimenter always delivered a small bonus of two apple pieces, whereas the risky experimenter sometimes delivered no bonus and sometimes delivered a big bonus of three apple pieces. Despite the fact that the two experimenters gave the same amount of food on average, the monkeys did not prefer them equally. Instead, our capuchin traders reliably avoided the risky experimenter—they consistently chose the smaller, safe reward over the larger, risky reward. We then compared how the monkeys performed when the same problem was framed in terms of losses rather than gains. Monkeys could choose between a safe trader and a risky trader, each of whom began by offering three chunks of apple. In contrast to the previous condition, however, the traders now delivered losses relative to their initial offers: The safe experimenter always delivered a small loss of one apple piece (resulting in an offer of two pieces), whereas the risky experimenter sometimes delivered no loss (resulting in an offer of three pieces) and sometimes delivered a big loss (resulting in an offer of only one apple piece). Interestingly, the monkeys switched their preference on this loss condition—when faced with losses, they became reliably more risk-seeking. They showed a robust preference for the risky experimenter, seemingly preferring a risky big loss to a more consistent small loss. Like humans, monkeys like risk differently, depending on how a problem is framed. Moreover, they seem to evaluate decisions involving uncertainty using the same features that humans do—whether their outcomes are framed as losses or gains relative to a reference point.

In a final study (Lakshminarayanan, Chen, and Santos, in preparation), we explored whether monkeys' loss aversion could potentially lead them to demonstrate an endowment effect. To test this, we first found two goods (fruit pieces and wheat cereal pieces) that the monkeys liked equally and thus purchased at equal rates. We then made each monkey subject an owner of one of two goods, and allowed the monkey to trade this good for the equally valued other good. If monkeys, like humans, come to value goods more when they become owners, then they should choose not to trade the good they own for other goods of equal value. This is exactly what we observed: Monkey owners were extremely reluctant to trade the good they owned.

Taken together, then, capuchin monkeys trained in a token economy seem to exhibit decision-making behaviors analogous to those of humans. Across several

studies and situations, capuchins did not behave as rational, expected utility maximizing models would predict. Instead, like adult human participants, capuchins established preferences that were anchored to a particular reference point, and then evaluated their options differently, based on whether these options were framed as losses or gains relative to the reference point. We interpret these findings as evidence that capuchins (and probably other nonhuman primates) share the underlying decision-making heuristics that give rise to the "irrational" biases that are common in human choice. Such findings pose the possibility that the decision-making heuristics of humans and other primates result from homologous cognitive mechanisms that stem from a shared evolutionary history. Even without the benefit of common cultural experiences, humans and their phylogenetic ancestors may have exhibited similar preferences toward risk and cost because they employed similar evolutionarily constrained heuristics to simplify the process of making economic decisions.

5 An Innate Core Judgment System? Clarifications and Challenges

We began this chapter with the aim of examining the possibility that some aspects of human judgment and decision-making may have an innate component. In particular, we examined the claim that the decision-making heuristics used by human adults emerge in the absence of learning, pedagogy, and experience. To do so, we gathered existing data on cognitive heuristics in young children and nonhuman primates, two participant groups whose limited experiences make them ideal for evaluating innateness claims. Taken together, the existing evidence provides at least some suggestion that a number of heuristics emerge relatively early in human development; three-year-olds, the youngest children tested to date, display some heuristic-based reasoning on tasks analogous to those of adults. In addition, our own research has demonstrated that nonhuman primates display at least one of the heuristics important in human choice behavior—loss aversion.

With these findings in place, there is growing evidence that at least some aspects of human decision-making might emerge developmentally (and evolutionarily) earlier than psychologists may have originally suspected. We argue that the empirical stage is now set for a more extensive experimental investigation of the origins of human decision-making. As we mentioned earlier, the major dilemma facing researchers interested in the origins of cognitive biases is a methodological one. To date, only older children have been tested in decision-making studies, due in large part to the fact that few methodologies exist for asking younger children and infants about their decisions, choices, and preferences. Fortunately, such tasks can be creatively developed. Many classic adult decision-making tasks, for example, use participants' numerical guesses across different conditions as a dependent measure (see, for example, empirical demonstrations of the anchoring heuristic, Tversky and Kahneman, 1974). A number of nonverbal numerical tasks have already been developed to explore infants' numerical discrimination (e.g., expectancy violation procedures, search procedures, auditory discrimination tasks; see Feigenson et al., 2004, for review). These measures could potentially be adapted to measure the effects of

anchoring, even in young infants. Similarly, infant researchers could potentially adapt methodologies for exploring infants' statistical learning to assess infants' frequency estimates like those measured in empirical tests of representativeness and availability biases in adults. In these ways, infant researchers could potentially adapt existing nonverbal methodologies to develop paradigms to investigate infants' (and also nonhuman primates') decision-making.

The second challenge facing investigators interested in the origins of cognitive heuristics is a more theoretical one. If nonlinguistic primates (and potentially human infants) share the behavioral biases predicted by the use of cognitive decision-making heuristics, what does this mean for the representational structure of cognitive heuristics? Put another way, how can something as complex as a decision-making "rule" or heuristic be implemented nonverbally? We feel this second potential challenge truly highlights the importance of a comparative-developmental approach to the study of cognitive heuristics. Though nativist views are sometimes criticized on the grounds that they fail to specify exact mechanisms—or, as L. B. Smith (1999) put it, have "no specifiable and mechanistic meaning" (p. 133)—comparative-developmental evidence for particular abilities can actually *constrain* mechanistic explanations in ways that other empirical evidence cannot. Take, for example, claims for another purportedly innately postulated cognitive mechanism: the principles underlying our core understanding of objects (e.g., Spelke et al., 1992; Spelke, 2000). As mentioned in the introduction, both infants and primates seem to have some understanding of objects and their motions; they make correct predictions about how objects will behave and interact from an extremely young age. These predictions include, most notably, the expectation that objects will continue to retain their rigid boundaries and the expectation that objects will maintain a consistent path across time and space. When infants' early object competencies were first reported, the cognitive mechanisms driving such expectations were typically described in complex representational and mechanistic terms, such as a "theory" of object cohesion or a "principle" of spatiotemporal continuity (e.g., Spelke et al., 1992). The use of such high-level terms generated considerable controversy in the field of developmental psychology (see Scholl and Leslie, 1999a, for an elegant review), in part because it was difficult to imagine how an individual without language would actually represent such complex concepts. In the past few years, however, the proponents of higher-level views of infant competencies have amended their initially high-level explanations. Constrained by the ways that nonverbal creatures could represent a theory of objects, researchers who had postulated high-level cognitive mechanisms such as theories have instead pointed to ways that the normal operation of other perceptual and cognitive systems, such as those of object-based attention, could potentially give rise to principled-looking or theory-like expectations. (e.g., Scholl and Leslie, 1999a; Spelke, 2000; Feigenson et al., 2004). For example, the principle of cohesion, the idea that objects maintain their rigid boundaries, could potentially fall out of the actions of object-based tracking systems, which operate best on objects with rigid boundaries (e.g., van Marle and Scholl, 2003). In this way, an attentional constraint—the fact that tracking systems are object-based and fail to operate over nonrigid, non-object-like things—is able to give rise to an expectation of cohesion.

Researchers have provided a similar explanation for infants' principle of spatiotemporal continuity. A continued movement through time and space is an implicit assumption built into the mechanisms by which perceptual tracking mechanisms operate (reviewed in Scholl and Leslie, 1999a); thus, infants correctly view events with the expectation that objects will act in spatiotemporally consistent ways not because they have a theory about objects, but because that is how their visual system is built to track objects. In this way, a number of infant researchers have come to the conclusion that "the initial knowledge comprising the infant's object concept is best characterized in terms of this attentional interface between perception and cognition" (Scholl and Leslie, 1999a). The infant's object "principles" therefore simply fall out of the blind actions of peripheral perceptual and attentional systems.

We predict that future comparative-developmental studies of cognitive heuristics could constrain our understanding of judgment and decision-making in much the same way. If a "core system" of judgment does in fact emerge early, as we have suggested, the shortcuts observed may not be representationally rulelike at all—instead, like infant object concepts, their "principled" nature may simply fall out of the actions of other peripheral or attentional systems. Rather than possessing linguistically or propositionally structured heuristics (as has occasionally been implied for the adult decision-making system), infants and primates may instead possess attentional mechanisms whose normal operation results in shortcut-like processes observed in standard adult decision-making tasks. One could therefore test this prediction using a comparative-developmental approach; examining known limits of attention and memory constrain the operation of heuristics in a systematic fashion. In this way, a core system of judgment heuristics need not imply representationally complex cognitive structures, at least in the case of decision-making strategies. As with intuitive object principles, core judgment rules may emerge as a cognitively fortunate by-product of other constrained peripheral systems.

6 An Innate Core Judgment System: Final Thoughts

The goal of this chapter was to push a radical claim about the origins of human decision-making in order to generate theoretical and empirical interest in a comparative-developmental study of cognitive heuristics. Though it's likely our chapter has raised more questions than it has provided answers, we hope that, at the very least, it will open some new debates about the origins and experiences that give rise to some of our more (in)famous cognitive mechanisms.

16

CHANDRA SEKHAR SRIPADA

Adaptationism, Culture, and the Malleability of Human Nature

It is often thought that if an adaptationist explanation of some behavioral phenomenon is true, then this fact shows that a culturist explanation of the very same phenomenon is false, or else the adaptationist explanation preempts or crowds out the culturist explanation in some way. In this chapter, I show why this so-called competition thesis is misguided. I identify two evolutionary models, which I call the Information Learning Model and the Strategic Learning Model, which show that adaptationist reasoning can help explain why cultural learning evolved. These models suggest that there will typically be a division of labor between adaptationist and culturist explanations. I then show that the Strategic Learning Model, which has been widely neglected by adaptationist thinkers, has important and underappreciated implications for a question that has long been contentious in the behavioral sciences—the question of the *malleability of human nature*.

1 Introduction

A traditional family of explanations in anthropology and the social sciences explains people's behavior in terms of culture. For example, if you want to know why women in group A choose mates with this type of characteristic feature, while women in group B choose mates with that type of characteristic feature, the answer is that people socially learn their patterns of mate choice from others in their group, and these two groups simply differ in what patterns of mate choice are conveyed during this social learning process. We can call this family of explanations *culturist explanations*.

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