CHAPTER

4

The Evolution of Our Preferences: Insights from Non-human Primates

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OUTLINE

INTRODUCTION

Some of the most idealistic views of human psychology are – sadly – often the most empirically mistaken. One of the most striking cases of this involves the view that humans are rational decision-makers par excellence. Under this optimistic account, humans are rational beings, creatures that develops rational preferences and makes decisions that perfectly maximize such preferences. Unfortunately, recent empirical

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work suggests that humans often fail to live up to this optimistic view. Both in the lab and in the real world, humans appear to show a number of systematic biases that cause us to violate rational assumptions. We, for example, let context shape our preferences (e.g., Ariely & Norton, 2008), react differently to payoffs depending on how they're worded (e.g., Tversky & Kahneman, 1981), and change our future preferences to fit with our past behavior (e.g., Brehm, 1956).

In the past few decades, researchers have learned much about the many ways in which context can bias our decisions (see reviews in Ariely & Norton, 2008; Camerer, 1998; Kahneman, Slovic & Tversky, 1982). Unfortunately, although much is known about the nature of human decision-making biases, less work has examined the question of where these biases come from in the first place. How do adult consumers come to be motivated by sales and promotions? How do we end up overvaluing objects that we own, or altering our preferences to fit with our decisions? Do we learn these biased strategies? Or are these strategies experience-independent, emerging as a basic aspect of human decision-making? Additionally, are such biases unique to our own species, or are these strategies a more ancient part of our psychological make-up? In short, what are the origins of our biased valuation strategies?

The question of where biased decision-making comes from is important for several reasons. First, a better understanding of how human biases originate will allow researchers a deeper insight into the nature of how valuation processes work more generally. As with any human cognitive process, our decision-making strategies are shaped by the processes by which they developed. Second, understanding how biased decision-making emerges can provide researchers with hints about how to teach people to overcome these strategies. If decision-making researchers knew that some experiences were likely to promote choice biases, they could intervene in ways that might promote better decision-making. If researchers instead learned that our biases were experience-independent, and an inherent part of our evolved psychology, such findings would advise different types of policy interventions, such as those that try to circumvent the biases people typically exhibit (see Thaler & Sunstein, 2008 for this type of approach). For these reasons, developing a more informed science of the origins of human decision-making is critical both for the science and policy of human decision-making.

Thankfully, the last few years have seen the integration of work examining the origins of valuation biases, both from a developmental and evolutionary perspective. Here, we review some of this recent work, focusing on studies from our own lab examining how contexts affect decisions in both young children and capuchin monkeys.

We begin by examining the origins of choice-induced preference change and argue that children and primates share common mechanisms for re-evaluating a choice's value after a decision. We then go on to review recent work examining the evolutionary origins of framing effects on choice, discussing our recent work demonstrating that capuchin monkeys exhibit framing biases that are virtually identical to those seen in adult humans. We then conclude by exploring what these findings mean for the science of human decision-making and the implications this work has for policy.

HOW CHOICE CHANGES PREFERENCES IN ADULT HUMANS

Perhaps the earliest account of biased evaluation strategies was penned back in 600 BC. Around this time Aesop, an enslaved storyteller, wrote his famous fable about "The Fox and the Grapes." In the fable, a fox sees a delicious looking bunch of grapes that he soon realizes is inaccessible. Eventually, after unsuccessful attempts to get the grapes, the fox decides not to extend any more effort. Soon after this decision, his evaluation of the grapes abruptly changes – the fox remarks that the grapes are probably not ripe and questions why he would need to eat "sour grapes" at all.

In the current century, our biased evaluations have been subject to scientific documentation. Since the early 1950s, researchers have identified numerous methodological situations in which choices, actions, and decisions compel participants to change what were otherwise strong prior evaluations (see review in Ariely & Norton, 2008; Harmon-Jones & Mills, 1999). To take a few examples, participants who are induced to espouse a preference that conflicts with their current attitudes will change their attitudes to fit with the preference they were forced to espouse (e.g., Bem & McConnell, 1970; Elliott & Devine, 1994; Linder, Cooper & Jones, 1967; Steele & Liu, 1983). In addition, making participants work harder on a disliked task leads them to evaluate that task as more enjoyable (e.g., Aronson & Mills, 1959).

One of the most striking examples of decisions affecting our evaluations, however, is a phenomenon researchers refer to as a choice-based preference change (Brehm, 1956; Lieberman, Ochsner, Gilbert & Schacter, 2001; Lyubomirsky & Ross, 1999; Steele, 1988). In one famous account of this phenomenon, Brehm (1956) presented participants with a set of household items and asked them to rate each item based on how much they liked it. After performing these ratings, participants were given a choice between two of the items. The two items picked for this choice phase were not random. Instead, Brehm forced participants to make what might be considered a difficult choice, choosing between two objects that they had already rated equally. After making this enforced choice, participants were asked to re-rate all items. Brehm found that participants changed their ratings post-choice in several ways. He first found that the item participants had chosen increased in value relative to the other items. More surprising, however, was what happened to the non-chosen item – it substantially decreased in value. Rejecting an object thus appeared to change people's future preferences.

The phenomenon of choice-induced preference change has now been documented across a number of real-world and experimental situations (see review in Egan, Bloom & Santos, 2010). Indeed, in just the last few years, researchers have begun learning more about the robust nature of this phenomenon. Sharot, Velasquez and Dolan (2010), for example, have observed that choice can affect preferences even in cases that involve extremely subtle or "blind" choices. For example, they presented participants with a cover story which led them to think that an arbitrary choice between two strings of symbols represented a true "subliminal" choice between different vacation options. Participants later decreased their valuation of vacation options they thought they had chosen against. In this way, choice-based preference change can occur even in cases where participants only think they made an intentional choice. Additionally, Lieberman and his colleagues (2001) observed that choice-based preference changes occur even under situations of cognitive load and bad memory. Taken together, this work suggests that choice-induced preferences can be elicited even without rich working memory resources, and even in the absence of a true choice being made.

Although psychologists have learned much about the nuanced nature of choice-based preference changes, little work to date had addressed the origins of these cognitive processes. In spite of over fifty years of work on this phenomenon, we know little about how these biases first start to emerge. Do choice-based preference reversals require experience before they develop? Or are these strategies a more fundamental part of the way we establish preferences and make decisions?

THE ORIGINS OF CHOICE-BASED PREFERENCE REVERSALS

To get at the origins of choice-based preference reversals, Egan, Santos and Bloom (2007) decided to explore whether similar phenomena could be observed in two populations that lacked the kinds of experience that adult humans have with choices and their consequences. In their first set of studies, they explored whether four-year-old children would switch their preferences after making a choice between two equally-preferred options. Adapting the original design by Brehm (1956), they presented children with novel stickers and examined whether the children's preferences for these stickers changed after they had made a decision. Each child was first asked to rate the stickers and then, after he or she had given ratings, to choose one of two possible stickers to take home. However, the two stickers presented at this stage were ones to which the child had just given equal ratings. In this way, the researchers were able to set up a choice situation between two equally preferred stickers. After the child had made a choice between the two stickers, he or she was then asked to make one additional decision – they had to choose between the sticker that they had just rejected in the first choice, and a novel sticker that they had originally rated as equal in value to the rejected sticker. If children, like adults, derogate options that they are forced to choose against, then they should prefer the novel sticker in this second choice. Egan and colleagues observed exactly this pattern of performance – children rejected the sticker they had chosen against in the first phase, suggesting that their choice against this sticker in the initial decision resulted in a change of preference. Importantly, this effect seemed to hold only in cases where children made their own decision. In a control condition, where the experimenter made the initial decision between the two stickers, children showed no subsequent change in preference for the rejected sticker. In this way, a child's commitment to a decision seems to affect future preferences in much the same way as occurs in adults.

Egan and colleagues (2007) went on to explore whether similar choice-based preference changes occur in a non-human population: capuchin monkeys. Using a similar design to the one performed with children, they gave capuchins a choice between novel food objects: differently colored M&M candies. They first allowed the monkeys to make a choice between two colored M&Ms, and then gave the monkeys a subsequent choice between the color M&M that was initially rejected and a novel colored, but identical tasting, M&M. Just like children, capuchins preferred the novel M&M color in the subsequent choice, suggesting that the act of rejecting an option in the first decision caused them to dislike this rejected option subsequently. In addition, like children, monkeys only showed this derogation effect in cases where they themselves made the decision. In a control condition, in which monkeys were forced to choose one color by the experimenter, they showed no change in preference to the color they did not receive. In this way, both monkeys and children appear to share a characteristic human choice bias: they let their decisions affect their future preferences.

Having established that children and monkeys experience choice-induced preference changes, Egan and colleagues (2010) went on to explore the boundary conditions of this bias. For example, do children and monkeys require specific kinds of choices to experience preference reversals, or is the phenomenon of choice-induced preference changes just as robust in these populations as it is in human adults? To get at this issue, they explored whether children and monkeys would exhibit preference change even in a case in which the features they were choosing were less obvious. In one study, they gave children a "blind" choice that mimicked the one that Sharot et al. (2010) used with human adults. Four-years-olds were given a choice between different toys that were hidden under occluders. Thus children had to make this first choice blind to the options' features. After making this choice, the children were then given a second choice between the toy they had blindly rejected and another hidden toy. The authors observed that children continued to avoid the toy they previously rejected, even though they had no new information about the features of this rejected toy. These results demonstrate that choice-induced preferences are robust in children, just as they are in adults, operating even where initial choices were not based on any true preference (see Chen & Risen, 2009 for discussion of this issue).

Egan and colleagues (2010) explored whether similar effects hold for capuchins' choices. Monkeys were given an option to forage for different foods that were hidden in a bin of wood-shavings. Previously, the monkeys had learned that they could forage for one piece of food before they had to leave the testing area. Using this feature of the foraging task, the experimenters were able to engineer a situation where the monkey was led to think there were two different kinds of food (differently colored Skittles candy) hidden in the bin, when in reality there was only one kind of food. This set-up created a situation in which the monkeys believed they could "choose" between two colored Skittles, but in fact the one they found was the only one available. The question of interest was whether this simulated choice would be enough to drive a choice-based preference change. To examine this possibility, the authors then presented the monkeys with a subsequent choice between the Skittle that they thought they had previously "chosen" against, and a novel colored Skittle. Just as with children, capuchins continued avoiding the option they thought they had chosen against. In this way, both children and capuchins' choice-based preference changes appear quite robust – they operate even when the features of the choice options are unknown and in cases where the choices themselves are not actually real decisions.

Taken together, the results of children and monkeys in these choice studies suggest several important features about the origins of choice-based preference changes. First, the results suggest that preference changes can occur outside the context of adult human decision-making, and thus that this phenomenon may be a more fundamental aspect of human choice than we had previously thought. Choice-based preference biases appear to operate in populations that lack rich experience with decisions, as well as in populations who lack access to the kinds of complex decisions that adult humans typically make. Egan and colleagues have thus argued that choice-induced preference changes may be an evolutionarily-older aspect of decision-making than researchers previously thought. In addition, the results from children and capuchins suggest that choice-based preference changes are incredibly robust – in all populations, these biases occur in cases where a decision-maker thought they made a decision and were blind to their choice options. Finally, children's and capuchins' performance on these choice tasks suggests that it is unlikely that experience and training can be used to teach adult human decision-makers to overcome these biases, a point we return to in the final section of our chapter.

HOW FRAMING AFFECTS CHOICE IN ADULT HUMANS

A second domain where researchers have examined the origins of choice biases involves framing effects. Although classical economists may want to believe otherwise, real human decision-makers often make different choices depending on how a problem is described or framed. Indeed, subtle differences in how choice outcomes are worded can cause people to make sets of choices that violate standard economic assumptions such as preference transitivity and invariance (Ariely & Norton, 2008; Camerer, 1998; Kahneman et al., 1982; Kahneman & Tversky, 1979).

Consider, for example, a classic demonstration by Kahneman and Tversky (1979) where participants were presented with the following choices.

> You have been given $1000. You are now asked to choose between:
>
> **(A)** a 50% chance to receive another $1000 and 50% chance to receive nothing, or
>
> **(B)** receiving another $500 with certainty.

When presented with the above scenarios, 84% of participants choose the less risky option B. One might interpret this result as evidence that participants would rather have a certain payoff of $1500 than a risky payoff of either $2000 or $1000. However, such a conclusion would not fit with participants' performance when they are presented with a different framing of similar final outcomes.

> You have been given $2000. You are now asked to choose between:
>
> **(A)** a 50% chance to lose $1000 and 50% chance to lose nothing, or
>
> **(B)** losing $500 with certainty.

Here, participants again had a choice between a certain payoff of $1500 and a risky payoff of either $2000 or $1000, but now they showed exactly the opposite preference as they did in the original scenario. Here, more than half of the participants choose the risky gamble, avoiding the safe bet. In this, and a number of other studies (see Kahneman & Tversky, 1979; Kahneman et al., 1982; Tversky & Kahneman, 1981, 1986), people become more risk-seeking when their final payoffs are viewed as losses, than they do when their final payoffs are seen as gains. This bias – known as the *reflection effect* – demonstrates several features of how framing effects work. First, people tend to evaluate their choices not only in terms of the absolute value of their payoffs, but also based on how their payoffs compare to some arbitrary point or context, a value often referred to as a *reference point*. In this way, people view their choices as either gains or losses relative to their reference point. Second, people behave differently when they perceive payoffs as gains than they do when they perceive payoffs as losses. Specifically, they appear to work harder to avoid losses than they do to seek out correspondingly sized gains, a bias known as *loss aversion*. Loss aversion is evident in the above scenario insofar as people tend to take on more risk in an attempt to avoid experiencing any loss relative to their reference point.

Reference dependence and loss aversion lead to a number of inconsistencies both in the laboratory and in the real world. One phenomenon, thought to be due to these biases, is termed the *endowment effect*, a bias wherein ownership causes decision-makers to attach extra value to possessions (Kahneman, Knetsch & Thaler, 1990, 1991; Thaler, 1980). Consider two prizes of equal value – for example, a mug and a box of pens. When a participant is asked to evaluate these two prizes separately, he or she would likely consider them equivalent in value, and when asked to assign a cash value to each of these items, might rate them as being worth about the same – say, $5.50 each. Presumably, then, when they received one of these items as a gift, they would be just as likely to keep the item received as they would be to trade it for the equally valued alternative. In practice, however, when asked to give up the mug in exchange for the pen set (or vice versa), decision-makers only choose to make the swap about 10% of the time. When asked to estimate the cash value of the item in their possession, they tend to overvalue the owned object. Researchers have explained this tendency to overvalue possessions in terms of loss aversion. In order to trade an owned object, a decision-maker must give up (i.e., lose) that item in order to acquire another one. Since losses impact well-being more than gains, decision-makers demand more in order to give up an object than they're willing to pay to obtain one.

Similar framing effects appear to influence real-world decision-making when the stakes are higher than mugs and pens. One example is a problem economists have referred to as the "equity premium puzzle." When stocks are underperforming, investors tend to hold on to them longer than they should – they incur a chance of a large loss in order to have a chance to make back past losses. In contrast, investors tend to sell winning stocks early because this guarantees them a sure gain (Odean, 1998). The same biases between losing and gaining assets leads to asymmetries in the housing market, where homeowners are reluctant to sell their homes when doing so would be seen as a loss relative to purchase price (Genesove & Mayer, 2001).

Although there is substantial work exploring how framing effects wreak havoc on human decision-making, until recently little work had explored where these biases come from in the first place. One possibility is that framing effects reflect learned strategies, ones that are developed via experience with certain specific features of our markets. Alternatively, framing effects may reflect something more fundamental. Indeed, it is possible that framing effects may emerge even without human-specific experiences with markets and gambles. One way to distinguish between these two alternatives is to examine whether similar biases are present in individuals who lack experience with human-like markets. To this end we, and our colleagues, have begun exploring whether loss aversion and reference dependence are also evident in capuchin monkeys (Chen, Lakshminarayanan & Santos, 2006; Lakshminarayanan, Chen & Santos, 2008; Lakshminarayanan, Santos & Chen, 2011).

Unfortunately, establishing framing effects in a population that does not naturally engage in economic transactions comes with formidable challenges. In the next section, we detail how we introduced our monkeys to a token-based market where they could buy and sell food rewards. We then detail how we used this market to establish whether capuchins share with humans irrational economic preferences such as loss-aversion, a reflection effect, and the endowment effect.

FRAMING EFFECTS IN CAPUCHIN MONKEYS

Our first task in exploring the nature of capuchin framing effects was figuring out a method that could be used with non-verbal subjects. To this end, we decided to train our monkeys on a novel fiat currency – a set of metal disc tokens – that they could trade with human experimenters for different kinds of food. Although establishing a fiat currency in monkeys may seem like a lofty goal, numerous previous studies had successfully trained primates to trade tokens with human experimenters (e.g., Addessi, Crescimbene & Visalberghi, 2007; Brosnan & de Waal, 2003; Westergaard, Liv, Chavanne & Suomi, 1998). After a short training period in which the monkeys learned how to use their tokens, we were able to place our capuchin subjects in an experimental market where they could buy food at different prices. In each experiment, monkeys entered a testing area where they were given a wallet of tokens. The tokens could be exchanged with one of two experimenters who each offered a different food reward. In this way, we allowed monkeys to reveal their preferences between the two options by spending more of their tokens on whichever option they preferred.

The initial experiments involving this experimental set-up were intended to establish that monkeys understood the market (Chen et al., 2006). We first explored whether the monkeys would buy more food from an experimenter who offered a greater reward at the same price. To do this, we gave the monkeys a choice between two experimenters who differed in terms of their average payoff. The first experimenter gave the monkeys an average payoff of one and a half apple chunks, while the second experimenter provided an average payoff of only one apple chunk. Like smart shoppers, our monkeys selectively traded with the first experimenter, suggesting that they both understood the market set-up and tried to shop in ways that gave them a better deal overall.

We then turned to the question of whether the same market could be modified to reveal the monkeys' preferences between two options that are equivalent but treated differently due to the nature of the frame (Chen et al., 2006). We first gave the monkeys a choice between two options that were, in terms of their overall payoffs, equivalent. The only difference between these two options was that one was framed as an opportunity for a gain while the other was framed as a possible loss. This was accomplished by having each experimenter begin the act of trading by holding a small dish that contained different amounts of food. We reasoned that the number of chunks displayed on the dish would serve as a reference point against which the monkeys might frame their decision. We could then vary whether what the experimenter offered seemed like a gain or loss relative to that initial reference point by having them add or subtract pieces of food from the number they initially displayed. In the first study, we gave monkeys a choice between an experimenter who framed his offer as a gain – he started with one chunk of apple but then half the time added an extra chunk – and an experimenter who framed his offer as a loss – he started by offering two chunks of apple and half the time removed one. If monkeys in this study simply computed overall expected value, then they would have no reason to form a preference between these two options. Instead, consistent with human performance, our monkeys showed a preference to trade with the experimenter who provided a possible gain and avoided the experimenter who provided a potential loss. Just as in human studies, our monkeys appeared to both frame their final payoff relative to an arbitrary reference point and to avoid options that were framed as losses relative to that reference point.

To explore whether this reference dependence and loss aversion also affected monkeys' risk preferences (e.g., Kahneman & Tversky, 1979; Tversky & Kahneman, 1981), our next experiment explored whether monkeys also exhibited a reflection effect when risky and safe options were framed differently (Lakshminarayanan et al., 2011). Specifically, we gave monkeys a choice between an experimenter who provided his reward consistently on every trial – he was a safe bet – and another experimenter – the risky experimenter – who provided a variable reward that was, on average, equivalent to that of the safe experimenter. In the first condition, both the safe and risky experimenters initially displayed three chunks of apple. The risky experimenter would subtract either nothing or two chunks from this initial display, thereby representing a risky shot at either three or one apple chunk. The safe experimenter, in contrast, always removed one chunk of apple from his initial display. The safe experimenter therefore represented a certain loss of a single apple chunk. When presented with this loss framing, monkeys were risk-seeking; they selectively chose to trade with the risky experimenter over the safe experimenter. We observed a different pattern of performance, however, when the same final payoffs were framed as gains instead of losses. Here, we presented monkeys with a choice between a risky and safe experimenter who both started out with one chunk of apple but added more. The risky experimenter would then either add nothing or add two chunks of apple, for an average final payoff of two chunks. The safe experimenter initially displayed a single apple chunk, but always added one chunk to this initial display. In contrast to how they performed with loss framing, monkeys were risk-averse when dealing with gains. Just like humans, capuchins exhibited a reflection effect: they were risk-seeking when their prospects were framed as losses and risk-averse when the same final outcomes were framed as gains.

We next explored whether framing led monkeys to show an endowment effect (Lakshminarayanan et al., 2008). Do monkeys also over-value objects they own and refuse to trade them for an equivalent good? To investigate this, we switched the monkeys' market by endowing them not with tokens but instead with one of two foods: either cereal or fruit pieces. We chose these two types of food as stimuli because the monkeys value them about equally. We could therefore use these equivalent goods to explore how monkeys' valuation changes when they own one of the foods. If monkeys valued owned foods just as much as the ones they didn't yet own, then we might expect them to keep about half the food and trade about half away for an equivalent food. Our monkeys, however, showed a very different pattern of performance – they overwhelmingly preferred to keep the food they owned. This pattern of results hinted that monkeys might experience something like an endowment effect, overvaluing objects that they own (see Brosnan, Jones, Lambeth et al., 2007 for a similar effect in chimpanzees). Nevertheless, a few key alternative explanations for this result demanded follow-up studies. One alternative was that monkeys chose to retain their food because they didn't understand how to trade foods like they did tokens. To rule this out, we endowed capuchins with the same foods as in the initial study but offered them the chance to trade these foods for a much higher valued alternative. When offered a much higher valued food, capuchins were willing to trade the food they owned, suggesting that monkeys understood that food could be traded like their tokens. A second alternative, however, was that monkeys refused to trade their endowed food not because of an endowment effect but because of the additional physical effort required for trading. To address this alternative, we estimated the physical cost of the transaction by calculating the minimum possible compensation capuchins required to trade a token, and then added this extra compensation to the equivalent food reward we had offered in our original study. Even when compensating for the cost of the transaction, our subjects were still willing to retain their endowed foods rather than trade them away. In this way, our capuchins' endowment effect persisted despite a transaction-cost compensation. Finally, we tested whether the observed endowment effect was due to temporal discounting; specifically, would monkeys still exhibit an endowment effect even when it took them more time to eat the endowed food than it would to trade it away? If the observed endowment effect was, in reality, because the food in their endowment took less time to eat than the food available for trade, then subjects should be willing to trade away their endowment if doing so results in a shorter time to obtain their payoff. Even when subjects were offered the opportunity to trade for a faster-to-eat food, they nevertheless refused to trade their endowed food. Taken together, our results suggest that capuchins exhibit an endowment effect even in cases in which we controlled for discounting effects and transaction costs.

In summary, capuchins' choice behavior in situations of framing mirrors that of humans in remarkable ways – they exhibit reference dependence and loss aversion, and such biases also lead them to overvalue objects they own and exhibit reflection effects. As with similarities between capuchins and humans in choice-based preference change studies, these framing results suggest a number of conclusions about framing effects in human decision-making – such effects are likely to be due to fundamental cognitive mechanisms, ones that are likely to be experience-independent, evolutionary ancient, and possibly harder to overcome than we'd like to think.

HOW STUDIES OF THE ORIGIN OF CHOICE BIASES INFORM ADULT HUMAN DECISION-MAKING

While we have recognized for centuries that our decision-making is reliably error-prone, only recently have we started to understand why humans exhibit these biased decision-making strategies. The previous sections have shown that adult humans share their preference biases with both children and monkeys, and thus are not unique in how their preferences are influenced by irrelevant factors, such as contextual information. Here, we will conclude by discussing how this comparative and developmental work can help explain why we might be so prone to these context effects.

Comparisons across age and species often shed light on mechanisms that drive cognitive processing. In the case of cognitive errors, similarities across development and phylogeny demonstrate that common intuitive mechanistic explanations for why adults have these biases are not the most plausible. For example, it is often assumed that biases arise because adult decision-makers have grown up in a world of complex choices and economic options. This assumption cannot account for the fact that young children possess similar biases, despite far less experience with markets and choices. In addition, the fact that capuchins also show context-based preferences indicates that experiences unique to adult humans – having economic markets and wide ranges of choice options – are not required for the development of these biases. A second account of choice biases – one that has come up particularly when trying to account for framing effects – has argued that these tendencies are due to verbal task confounds. Under this account, verbal aspects of gambles presented in surveys induce subjects to attend to irrelevant aspects of the problem in ways that lead to framing effects. This interpretation, however, would predict that non-verbal populations would not exhibit identical framing effects. Comparative results showing framing in capuchins demonstrate that such effects cannot result from linguistic aspects of the task. Finally, some have hypothesized that choice biases result from rather sophisticated cognitive mechanisms. For example, some psychologists propose that a sophisticated self-construct is required for biases like choice-induced preference changes (e.g., Gawronski, Bodenhausen & Becker, 2007; Steele & Liu, 1983) and the endowment effect (e.g., Beggan, 1992; Gawronski et al., 2007). However, we have shown that capuchin monkeys – who very likely do not share a rich sense of self – also denigrate unchosen alternatives and over-value objects they own. These results make it unlikely that high-level cognitive explanations, involving a rich sense of self, can fully account for these biases. In this way, research on the origins of choice biases has narrowed the hypothesis space for how and why such biases occur in adult decision-makers.

In addition to constraining mechanistic interpretations of choice biases, the current work on monkeys' choice errors begins to allow researchers new ways to examine biases at the neural level. To date, neuroscientists interested in the nature of choice biases have had to study these phenomena in humans using functional neuroimaging techniques. Although these non-invasive techniques have provided important insights into the nature of choice biases (e.g., De Martino, Kumaran, Seymour & Dolan, 2006; Lee, 2006; Sharot, Martino & Dolan, 2009; Tom, Fox, Trepel & Poldrack, 2007), the nature of human neuroimaging techniques precludes studying choice biases at the level of individual neurons and circuits (but see Chapter 5 for a discussion of similar issues by De Martino). As such, researchers interested in understanding the nature of choice errors at the level of single neurons have faced a methodological challenge; indeed, such researchers could greatly benefit from developing primate model of these biases, one that would allow researchers to examine neural activity using more refined techniques (e.g., single-cell recordings). Having learned that monkeys' choice biases at the behavioral level are similar to those of adult humans, neuroscientists are now poised to develop just such a neurophysiological model of choice biases. In this way, learning more about the evolutionary origins of choice biases has potentially provided a new methodological window into which researchers can begin studying the neural bases of these biases.

A final insight that stems from studying the origins of choice biases concerns ways to overcome these biases. Because humans and capuchins are disposed to make choices in strikingly similar ways, it is likely that these two species' common ancestor – a species that existed approximately 35 million years ago – exhibited many of the same choice patterns. In this way, our choice strategies may be evolutionarily quite old.

This insight provides hints as to why such biases might be so pervasive in modern economies. Evolutionarily old strategies are often the trickiest ones to overcome – just consider our evolutionarily-selected predilections for sweets and aversion to snakes and spiders. The finding that choice biases may be similarly old suggests that policymakers would be well-served to incorporate an evolutionary perspective into their efforts to modify the behavior of human decision-makers through laws and incentives. The early emergence of choice biases hints that such biases might persist in the face of extensive economic exposure or market disciplining. Our origins approach therefore recommends that the optimal role of policy may be to work around these systematic errors rather than attempt to change them. Approaches like "nudging" consumers to avoid their choice biases (e.g., Thaler & Sunstein, 2008) or using framing effects to a consumer's advantage (e.g., Thaler & Bernartzi, 2004) may therefore be the only way to make the best of our rationally-inadequate evolutionary endowment.

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