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Toward an interdisciplinary science of consumption

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Scientific perspectives on the drive to consume were presented in Ann Arbor, Michigan, at the conference entitled "The Interdisciplinary Science of Consumption: Mechanisms of Allocating Resources Across Disciplines." The meeting, which took place May 12–15, 2010 and was sponsored by Rackham Graduate School and the Department of Psychology at the University of Michigan, included presentations on human, primate, and rodent models and spanned multiple domains of consumption, including reward seeking, delay discounting, food-sharing reciprocity, and the consumption and display of material possessions across the life span.

Keywords: consumption; resource allocation; neureconomics; hoarding; decision making

Introduction

In a single half-hour of news, one can view segments about the rising rates of obesity, the devastating failure of our financial markets, and a woman who hoards. All of these stories have one thing in common: they are effects of *maladaptive* resource-allocation decisions.

Food, money, and material goods are necessary for survival. We have highly evolved and conserved mechanisms for making such important decisions—a capacity that is highly similar and perhaps homologous across mammalian species. For example, the same brain regions in the mesolimbocortical system are active in a diverse array of consumptive environments, including during single-cell firing in rats and monkeys to food rewards,[1] lesion studies of animal food hoarding,[2,3] hoarding in frontal patients,[4] functional imaging of people gambling or shopping,[5,6] and PET imaging of compulsive hoarders.[7]

However, this very makeup, which may have been adaptive in ancestral environments, also predisposes us toward the negative consequences of consumption, as we fall victim to the temporary and immediate rewards that abound in our society, such as unhealthy prepared foods, credit cards with high interest rates, and material luxuries that we cannot afford and are not environmentally sustainable. In this environment of plenty, we struggle to maintain a balance. And the problem is likely to get worse before it gets better. For example, consumable products that are rewarding are readily available, offer quick solutions to common problems, and are marketed in ever-sophisticated ways to tap our evolved propensities toward short-term reward (e.g., "no money down" programs with exorbitant interest rates for new furniture and plasma televisions). Second, the consequences of consumptive behavior are often hard to perceive because they are temporally and physically distant,[8] taking place in an unforeseen future or a distant location, such as in poorly regulated factories that maintain poor working conditions for laborers and destroy natural resources. The Nobel Prize–winning efforts of Al Gore and the current financial crisis have brought the issue of maladaptive consumption to the forefront of national politics. Academia needs to rise to the occasion to confront this issue and to develop unified models that can directly address the multiple negative consequences of this applied, social problem.

Given the significant problems in our society associated with consumption across domains (food, money, material goods), the devastating effects on health, finance, and the environment, and the preponderance of existing basic science knowledge, the time is ripe to form an interdisciplinary community

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interested in the study of consumption. To facilitate cross-disciplinary interaction and to search for common themes across domains, the term *consumption* is broadly construed as any process by which resources are acquired and/or processed, whether they are truly ingestible or only conceptually consumed, like material goods.

Many fields are already investigating pieces of this puzzle, but this is usually accomplished without any knowledge or direct study into the commonalities across species or domains. For example, marketing researchers study behavioral and neural mechanisms of choice using experimental designs almost identical to those used by other researchers to study pathological human compulsive hoarding. Economists have long studied resource-allocation decisions, such as tradeoffs between short- and long-term gains (intertemporal discounting), giving to one's self versus another (trust games), or between one's self and the community (the commons problem), and they have directly studied the power of possession upon people's psychology and behavior (the endowment effect). All of these are highly relevant to consumption but are typically not directly associated or studied in the context of similar phenomena in the food hoarding of animals, human pathological compulsive hoarding, or public policy issues of consumption and the environment. Research in neuroscience, neuroeconomics, and decision theory is currently focused on identifying the neural substrates of reward, decision making, and utility calculation—studies that are highly influential, often cited, and find consistent neural regions implicated in the processing and decisions about rewards (e.g., frontal and ventral striatal regions). However, there are other reasons for acquiring and saving that are more psychological—even existential—than have yet to be considered in these fields. For example, like the bowerbird, which decorates his nest with feathers and shards of glass to attract mates, people acquire objects to display wealth and their unique character (and often for the purpose of attracting a mate!). Some subjects even explicitly report *status* as a reason for possessing a prized object.[9] Similarly, the strongest motivations to keep possessions are stimulated by things that remind people of their past, a former self, or a social relationship.[10,11] However, these aspects of consumption are rarely discussed or rigorously tested by economists and neuroscientists, and even within marketing and psychology, when they are discussed, they are not integrated conceptually with issues in animal behavior or pathological human behavior.

As evidence for the lack of centralized research on consumption, there is no term in psychology that refers to decisions about resources, and there is almost no psychological/neuroscientific research on decisions to acquire or discard material goods. *Acquisitiveness* is a term used by psychologists, but a search of this term in PsycInfo[a] reveals only 71 articles since 1887, only 13 of which are particularly germane to the topic, and most of which were written in the early 1900s (e.g., Cameron[12]). The term *hoarding* is used by animal and human researchers, but with very different connotations. *Resource-allocation decisions* is a term used by economists, but usually only for a specific scenario in which people keep money or give it to a stranger. There is a field called "material culture" (aka "material goods"), but articles on this topic are mainly restricted to anthropological and sociological treatments (a search of the term *psychology* in the *Journal of Material Culture* resulted in 40 articles since the journal's inception in 1996).[b]

To begin to address this gap in the academic literature, a conference entitled "The Interdisciplinary Science of Consumption: Mechanisms of Allocating Resources Across Disciplines" was held on May 12–15, 2010 at the Rackham Building on the University of Michigan central campus. The conference focused on mechanisms of resource-allocation decisions, such as acquiring and discarding important resources (e.g., money, food, material goods), with a specific goal to examine whether there really are deep commonalities in the mechanisms for such decisions across fields, species, and domains. The speakers were preeminent researchers from across fields, including marketing, economics, neuroscience, psychology, public policy, neuroethology, and animal behavior. The speakers were selected because their work informs the proposed unifying neurobiological and psychological model in which different forms of consumables or resources are assumed to be processed through largely shared

[a]http://www.apa.org/pubs/databases/psycinfo/index.aspx
[b]All data from June 2011.

neurobiological systems. The neurobiological systems were assumed to be those that evolved to motivate animals toward natural rewards that fulfill homeostatic needs, such as food and mates, but that could later be activated by artificial rewards and items that cannot be directly consumed, such as drugs and goods. More than a hundred people attended the academic portions of the meeting, with substantially more at the public lectures, producing a highly engaged audience of faculty and graduate students that attended all sessions together, discussed the themes over meals, and developed a narrative of discussion points throughout the meeting. In this way, the conference was like a large version of a "working meeting," where all attendees focused on a common goal of applying their expertise to a single, unified model of resource decisions. Below, we provide more detailed information on important components and themes of the meeting, organized by the order in which invited speakers presented their own work, followed by appendices that list members of the organizing committee and sources of funding for the meeting.

The allocation of food and aid in primates

The conference opened with an evening public lecture by Frans de Waal, a primatologist from Emory University and the director of the Living Links Center, who was introduced by his colleague, John Mitani. De Waal reviewed the evidence from his own laboratory research and from the anecdotal and experimental evidence across mammalian species for a sense of fairness, cooperation, and altruistic aid.[13] This work demonstrates that social mammals such as primates, elephants, and dolphins understand when another is in pain or need, and often act spontaneously to help, even in the absence of any immediate rewards to the giver. In addition, primates in particular have been shown to possess a sense of fairness and reciprocity, sharing food with those who have shared with them in the past, previously groomed them, or with whom they share a bonded, positive relationship (Fig. 1). These situational factors indicate that the animals utilize affective feeling states associated with the current need situation or the potential partner to make decisions about

Figure 1. Chimpanzee food sharing. Food sharing in chimpanzees is typically a peaceful affair in which individuals share, particularly with those with whom they share a bonded relationship (genetic or friendship) or to reciprocate for prior food sharing or grooming. In this photograph from the Yerkes Field Station, the female at the top right possesses the leafy branch as the female in the lower left reaches tentatively for a share. Photograph taken by Frans B. M. de Waal and reproduced with permission from Royal Society Publishing, Figure 2 (p. 2715) in Ref. 14.

giving. This work was a particularly useful start to the conference, because it established a key theme to which we would return throughout: evolved mechanisms for making decisions about resources critically rely upon social-affective states. Such states not only inform individuals of problems that need to be addressed, but also inform the decider about the level of security in the environment and the perceived utility of targets of consumption to which we may be driven. Many of the subsequent talks provided independent evidence that emotional security, particularly that which is established in the early home environment or social group, is a significant mediator of the type or level of consumption that an individual selects.

The neural bases of decisions to obtain rewards

In the first of four sessions, we explored the neural bases of decisions to obtain goods that give rewards. Antoine Bechara (professor of psychology and neuroscience at the University of Southern California and professor of psychiatry at McGill University) spoke first about the role of the insula (a brain region that represents internal, somatic, and affective states) in human addiction, particularly for smoking. Bechara used a two-system view to argue that most research on addiction focuses upon the role of an impulsive, automatic system involving the amygdala and striatum or a more reflective system in the prefrontal cortex that controls urges and makes planned, reasoned decisions. However, Bechara pointed to the insula as a region that can maintain poor impulse control in the face of addictive substances by conveying affective signals of craving that override the rational system and its ability to control behavior.[15] With Naqvi *et al.*, Bechara studied patients who previously smoked and then quit without effort subsequent to a stroke that damaged their insula (Fig. 2).[16] For example, one man started smoking at the age of 14 and was up to 40 unfiltered cigarettes per day when he suffered a stroke at the age of 28, after which "[his] body forgot the urge to smoke." He simply no longer had the urge and did not have trouble resisting after that. Across 19 patients with damage to the insula and 50 with lesions not affecting the insula, 16 smokers quit without effort immediately after the damage, 12 of which were insula lesion patients. The majority of lesion patients who smoked quit immediately, while the majority of noninsula lesion patients did not. Bechara suggests that the insular cortex (particularly the anterior insula) represents interoceptive signals that signal "urges," such as those that occur in response to cues of reward during homeostatic imbalance or deprivation, which in turn can "hijack" the more reflective control decision-making systems in the prefrontal cortex, biasing individuals toward the impulsive, unreflected, and powerful urge to consume characteristic of true addiction.[15]

This work is highly convergent with that of Terry Robinson (Elliot S. Valenstein Collegiate Professor of Behavioral Neuroscience and professor of psychology at the University of Michigan), who also presented work on the role of reward cues during addiction, which he studies through biopsychological animal models. Robinson used Pavolvian conditioning methods to demonstrate individual differences in the response to conditioned cues that a natural (unconditioned) reward is coming. In animals who are "sign tracking," a neutral stimulus that predicts a natural reward obtains an incentive salience that is inherently rewarding, motivating, and attended to; in contrast, in individuals who are "goal tracking," the conditioned stimulus predicts the reward but does not confer its own motivating incentive properties, allowing the animal to focus on the goal after delivery of the cue (Fig. 3).[17] Thus, for example, a sign-tracking rat who learns that an illuminated bar predicts the receipt of food through a chute to the left will attend to the bar during the delay, pressing it and investigating it while waiting for the food, whereas the goal tracker notes the light and then attends directly to the chute through which the food will be delivered.[18] These individual differences represent two bimodal peaks in the distribution and profoundly reflect the neurobiology of the individuals and their response to cues of reward. For example, sign trackers are more impulsive, more prone to explore a novel environment, reinstate drug seeking more quickly after extinction from the cue, but also reduce consumption in the absence of the cue.[19] These traits are associated with greater engagement of mesolimbic dopaminergic reward circuitry associated with the cue, greater sensitivity to dopamine agonists, greater dopamine release in the accumbens, and greater dopamine release in response to the cue after the association is learned, which does not occur in goal trackers.[20,21]

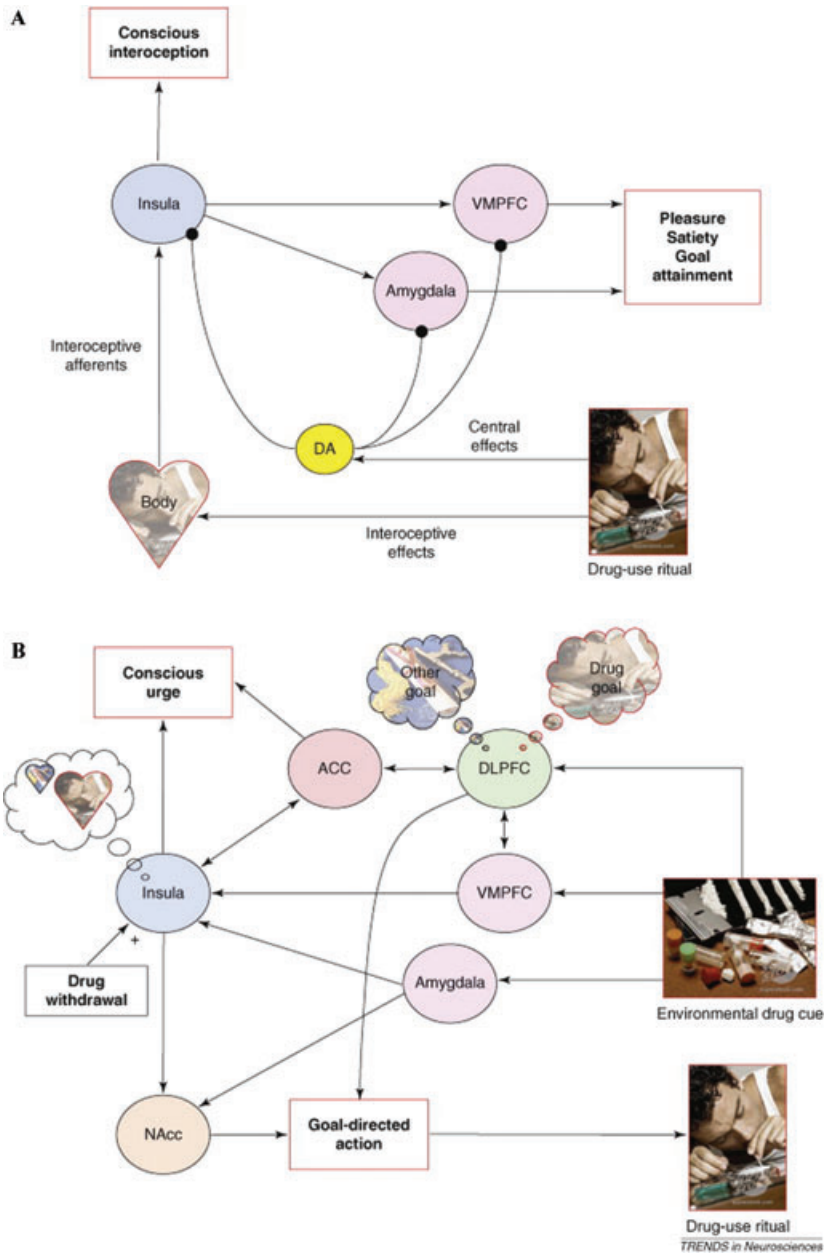

Figure 2. Schematic of the interoceptive functions of the insula during drug-seeking motivation. (A) Drug-use rituals produce interoceptive effects represented by the insula that produce the subjective qualities of the ritual, including conscious awareness of the drug's effects as well as the biological rewards (i.e., pleasure and satiety). Dopamine (DA) release from the drug's central effects may modulate the interoceptive rewards represented in the insula while causing the drug to become associated with pleasure, leading to future states of motivation and desire to obtain the drug. (B) Environmental cues associated with the drug, such as spatial contexts and drug paraphernalia, can reactivate the interoceptive representations in the insula via the VMPFC and amygdala, producing a subjective feeling of "craving" or a conscious urge to obtain the drug. This interoceptive representation feeds into the nucleus accumbens (NAcc), motivating actions toward the reward, while the dorsolateral prefrontal cortex (DLPFC) holds representations of the drug in mind and directs attention toward it, producing goal-directed actions toward the drug. The anterior cingulate cortex (ACC) additionally participates in the conscious feelings of urge through integrated representations of the insula's interoceptive states and the environmental cues of the drug, as well as by monitoring conflict associated with drug taking versus other goals. The insula may also mediate physiological signals associated with drug withdrawal that affect this process. Reprinted from Ref. 15, with permission from Elsevier.

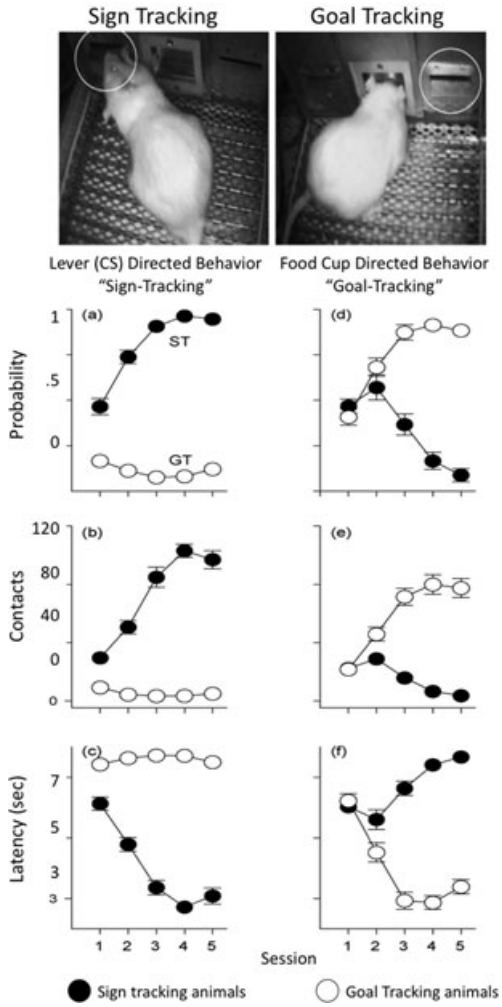

Figure 3. Behavior of sign-tracking versus goal-tracking rats during Pavlovian conditioning. The photograph at the top-left depicts a rat in a conditioning chamber in which the lever on the left illuminates (the conditioned cue) to predict the delivery of food in the door to the right (the unconditioned reward). The sign-tracking animals (depicted on the left of the photograph and with filled circles on the graphs) are more likely to interact with the lever in probability (A), number of contacts (B), and latency to contact (C), whereas the goal-tracking animals (depicted in the photograph on the right and with unfilled circles on the graphs) are more likely on each of these measures (D–F) to interact with the food cup to the right where the reward is actually delivered. Photograph reprinted from Ref. 17, with permission from Elsevier. Graphs reprinted from Ref. 18, with permission from Elsevier.

This work is critical because it shows a clear way in which individuals may differ in their perception of stimuli (drugs, people, or goods, for example) and the rewards they expect to receive from them. Sensitivity to cue-induced motivation to obtain rewards can be highly explanatory of drug-addictive behavior and material consumption, as individuals are known to relapse in environments associated with prior drug taking and to show hedonic responses to cues like favored marketing brand images and even credit cards.

The conference was designed to investigate the role of such biological systems that clearly subserve the processing of natural, ingestible rewards, in the consumption of noningestible material rewards that can be purchased, hoarded, or displayed. Brian Knutson (associate professor of psychology and neuroscience, Stanford University) presented evidence for such crossover from his human neuroimaging work, finding that regions in the mesolimbocortical system produced unique signals of value and decision making while subjects made decisions to purchase material goods. With Rick *et al.*,[6] Knutson used his "SHOP" task to separately investigate the neural correlates associated with the passive viewing, pricing, and decision-making phases of material purchases (Fig. 4). He demonstrated that the nucleus accumbens (NAcc) is particularly involved during passive viewing of goods that people eventually purchase, implicating this region in processing the associated gains or rewards that motivate purchasing decisions. The insula responded particularly when subjects were presented with excessive prices and predicted subjects' susceptibility to the "endowment effect" (overvaluing products they own), perhaps reflecting a role for the insula in the anticipation of loss. Activity in the orbitofrontal cortex (OFC) declined with the insular response to excessive prices and pervaded during the decision phase, presumably because it integrates affective signals from regions like the NAcc and insula into an adaptive decision to obtain desired goods at their value. Thus, this work, along with that of Terry Robinson (see above), indicate that the same neural systems (particularly the dopaminergic NAcc and OFC) can mediate not only natural, unconditioned rewards like food or drugs, but also nonorganic, secondary, or learned rewards such as the cues that predict reward and material goods. Future work can investigate the origin of the rewards associated with material goods, dissociating perhaps signals associated with the predicted logistical benefits associated with an item (e.g., that addresses a current problem or need), the immediately available aesthetic qualities of the item (e.g., color, shininess, beauty),

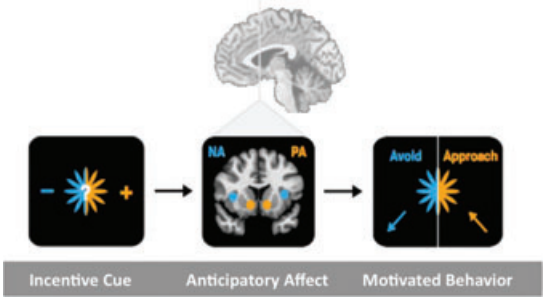

Figure 4. Knutson's anticipatory affect model. In the first phase, an incentive cue for an uncertain future outcome elicits activation in at least two brain regions (NAcc and anterior insula), which may correlate with the subsequent anticipatory affect response of either positive arousal (orange circles) or negative arousal (blue circles). In the final phase, the resulting overall signal (positive versus negative) then promotes the motivated behavior, which is either an approach (orange) or avoidance response (blue) to the cued outcome. For more information, see Ref. 22.

and the social rewards associated with obtaining a high-status item.

All three neuroscientific talks in the first session illuminated the general theme of the meeting, as they implicated overlapping neural systems between natural and material rewards, while providing novel details about the mechanism. In particular, the role of individual differences from Robinson's work in the response to cues of reward that maintain addictive behavior, as well as the role of the insula in Bechara and Knutson's work, represent mechanisms that are not common knowledge in the field, allowing us to form a more nuanced understanding of the underlying systems that can be exported to inform other domains.

The motivation to store versus use resources

In the second session, three presenters from different fields discussed how their work informs the development of the motivation to store versus to use resources. Bruce J. Ellis (professor of family studies and human development, John & Doris Norton Endowed Chair in Fathers, Parenting, and Families at the University of Arizona, Norton School of Family and Consumer Sciences) studies how human development, from a life history perspective, causes shifts in the bias toward risk-seeking behavior, such as drug abuse and teen pregnancy. Ellis' talk particularly emphasized how the transition into puberty affects the reallocation of one's resources, with individuals transitioning from focusing their childhood investments into somatic problems like maintaining health, increasing physical growth, and developing sociocompetitive competencies into more reproductive efforts in the body and behavior. During puberty, males and females both become interested in sex and competing for sex, but through different qualitative approaches that are consistent with an evolutionary view. Males become more risk seeking by displaying their abilities and risks as a sexual display, while females engage in female–female competition for higher quality males and attempt to build and benefit from social coalitions. These propensities interact with the level of security versus stress in one's environment, with less safe or secure environments predisposing individuals toward particularly short-horizon strategies such as greater risk seeking through dangerous behaviors and status signaling through expensive consumables.[23] Just as Wilson and Daly[24] characterized these features in *young male syndrome*, Ellis points to a possible corollary syndrome in psychosocially stressed females, characterized by early sexual maturation, impulsive mate choice, low-quality parental investment, single motherhood, and earlier and more conspicuous consumption of sexualized products. This presentation outlined themes that were particularly necessary to pull together research across the meeting, as the role of the environment and its level of security, as well as the role of mate signaling through consumption, appeared to be key determinants of behavior in subsequent talks, but was not yet addressed in the more neuroscientific framework around which the conference was organized.

For example, David Sherry (professor of behavioral and cognitive neuroscience, Department of Psychology at the University of Western Ontario) subsequently presented his work on the proximate factors that motivate birds to store seeds for the winter. He provided an overview of research from optimality models in which cache decisions are influenced by environmental and internal variables, including the size of a food patch, the abundance and variability of food, the cost of carrying energy reserves as fat, the time of day, and the risk of starvation. His own research showed neural specialization in the hippocampus for remembering the location of stored food. The hippocampus

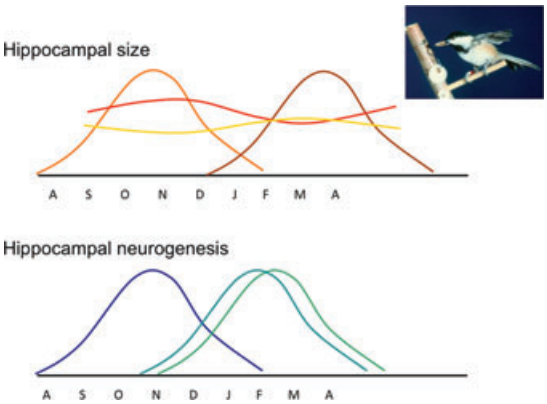

Figure 5. Changes in hippocampal size and neurogenesis over the months of the year in food-storing birds. The image to the top right depicts a black-capped chickadee, a food-storing bird. Letters on the *x*-axis represent the months of the year, from August to April. The seasonal pattern in the hippocampal size and neurogenesis is variable, as shown in this schematic illustration that summarizes the results of a number of studies.[25] For hippocampal size, one study shows a fall peak, one shows a spring peak, and others show no systematic seasonal change at all. Seasonal variation in neurogenesis is more reliably observed, though one study reports a fall peak and two others report peaks in mid-winter and spring. Figure and image provided by David Sherry.

exhibits not only greater size in storing versus nonstoring bird species, but also plasticity, including neurogenesis, across seasons in which food storing is and is not a priority (Fig. 5).[25] Contrary to what one might expect, factors such as day length, which correlate highly with the seasons in which food storing take place, do not causally produce changes in brain morphology. Rather, the actual storing behavior appears to dynamically affect the recruitment of new neurons into regions associated with memory for the locations of caches.

Studies of animal food storing are important to demonstrate the capacity for an evolved neural system, even in a nonmammalian species with a small absolute brain size, to optimize decisions about resources. Animals clearly integrate environmental and internal body state conditions to adaptively improve their chances of survival and reproductive success. Humans also keep stores of many different kinds that they create and maintain in order to satisfy perceived future needs, including bank accounts, investments, food pantries, and emergency supplies (and perhaps even stores of other things like social partners, memories, and ideas). Material goods appear to convey both the status and signaling functions discussed by Ellis, as well as the utilitarian future functions that are more associated with the storage of food in animals. For example, people keep books on the shelf both that reflect their identity and can be read in the future to abate boredom or to inform a particular problem. People also keep supplies for gift giving that can signal to someone that they care, to reciprocate a prior gift, and to signal their own wealth and largesse.

These fundamental resource decisions appear to be affected in compulsive hoarders, who acquire and fail to discard excessive numbers of items in their home to the point of distress, impaired daily living, and compromised safety. Randy Frost (Harold & Elsa Israel Professor, Department of Psychology, Smith College) is the world's leading expert on human compulsive hoarding, and his talk was attended by additional local public health workers and clinicians hoping to learn more about this disorder, which is very hard to treat. Frost discussed the diagnostic criteria for compulsive hoarding, which has largely been assumed heretofore to be a variant of obsessive compulsive disorder (OCD). However, Frost *et al.* are challenging this view, demonstrating that most hoarders do not have comorbid OCD, though some do, and many have comorbid depression, anxiety, and social phobia, which are not characteristic of OCD.[26–28] Additionally, SSRI medications that typically alleviate symptoms of OCD are less effective for compulsive hoarding, which responds better to cognitive-behavioral therapy (CBT) that is specifically designed to treat hoarding.[29] There were also significant themes of social and emotional trauma and anxiety in hoarders that resonated with the life-history strategy themes of Bruce Ellis. For example, hoarders experienced significant life-trauma events that appear to cause cognitions of worthlessness, mood dysregulation, and trouble inhibiting behavior, while they seek items that fulfill needs otherwise provided by bonded relationships with other people.[30] The role of sexual signaling through possessions in hoarders was discussed after the talk, because it played a prominent role in the life-history strategy approach espoused earlier. To date, there is no research specifically examining this, though a signaling motivation is consistent with many

hoarding behaviors and should be investigated further.

The evolution and psychology of monetary saving and material consumption

Consumption as pollution: why other people's spending matters

Robert Frank (Henrietta Johnson Louis Professor of Management and professor of economics at Cornell University) is the author of *Luxury Fever*[31] and *Passions within Reason*,[32] and is now more recently known for his work on the role of emotion in conspicuous consumption in modern Western society. His evening public lecture was highly convergent with that of the previous and subsequent speakers, encapsulating the emergent theme in which social display and sexual selection are considered major contributors to the drive to consume. Frank presented a view of modern consumption as a social comparative ratchet that increases exponentially over time. According to this view, people are less concerned about their absolute level of wealth and material excesses than they are with looking good relative to their neighbors and peers. Thus, once new, larger, and more luxurious goods are introduced into the market (e.g., mega-homes), a precedent is set that must be reached and exceeded by competing peers, who must subsequently purchase even bigger homes, establishing a new precedent for the scale of luxury, and on *ad infinitum*. Recent economic practices, such as giving people loans that they cannot afford to repay or zero percent–down mortgages, augment this natural progression by introducing new standards of living that individuals fight to attain despite the fact that they do not have the means or financial security to afford them. Moreover, such excessive conspicuous consumption is not sustainable for the natural environment. Frank recommended a taxation approach in which individual taxes are exempt for savings but luxury purchases are taxed at a progressive rate. The meeting's social and evolutionary speakers were also focused on social and sexual display (i.e., performing actions for the purpose of attracting social partners and mates) as the driving motivation behind the evolution of material consumption and, thus, Frank's talk provided a welcome level of detail on this important topic that needed to be integrated with the existing biologically based framework.

The development and psychology of economics

On the second full day of the meeting, in the third session, Paul Webley (director and principal, School of Oriental and African Studies; professor of economic psychology, University of London; and visiting professor, School of Psychology, University of Exeter) and Stephen Lea (School of Psychology, University of Exeter) traveled from the United Kingdom to present their work on the development and psychology of economics. Lea and Webley are well known for their theoretical piece in *Behavioral and Brain Sciences* entitled, "Money as tool, money as drug: the biological psychology of a strong incentive."[33] They argued in this piece that people are motivated to obtain money both as a tool and as a drug, again asserting a cross-domain mechanism for natural and artificial/symbolic rewards. At the meeting, Webley first presented his many, ingenious behavioral experiments with children to discover their changing concepts of money, saving money, and the factors that predict successful saving. He found that young children (by six years of age) have the concept of saving money, which they already associate with patience, control, and the virtuous delay of gratification; however, they do not like the process. Concepts of saving and behavioral strategies for saving are fully functional by 12 years of age, though because of the continued dislike of the painful process, children creatively attempt to attain their consumptive desires without saving. In one study, mothers and grandmothers had more influence over children's saving habits, but most of the variance is explained by overall parenting style rather than by any particular saving practice or discussion with the child. For example, authoritative parents raised children who were more future-oriented in general, saved more, thought saving was a good practice, found it easier to save and to resist temptation, and used saving as a way to obtain money—these factors appeared to benefit from a mediated effect of increased conscientiousness and self-efficacy in saving and a reduced feeling that saving was a struggle. Children of "overinvolved" parents had similar qualities overall but were less likely to use saving as a way to obtain money, instead negotiating with parents to borrow or obtain more. Webley concluded that the development of saving requires learning about what is valued, learning strategies and habits for saving, and acquiring self-knowledge that is necessary to plan for delayed gratification.

Stephen Lea addressed the value of the concept of hyperbolic discounting to explain major life economic choices such as saving, planning for retirement, credit abuse, and consumer debt. He pointed out that the vast majority of research on discounting (impulsively preferring an earlier smaller reward to a larger, later reward), which was performed with rats and pigeons, uses experimental delays on the order of seconds and is probably mediated by largely automatic, unreflected cognitive processes. In contrast, major life financial decisions, such as planning for a vacation or paying off a credit card debt, take place over the course of months to decades and often involve substantial explicit thought and planning, even when decisions go awry. Lea argued that to explain such long-term financial acts, we need to augment concepts of temporal discounting with "mental time travel," which is a human cognitive process in which people recall past events and envisage future events in the service of the decision. However, the processes enabling mental time travel may not allow people to compare values across time accurately, producing biases that reflect both the effects of hyperbolic discounting as well as the errors from mental time travel (e.g., optimism and availability biases).

The final talk of the third session by the author of this article, Stephanie D. Preston (Department of Psychology, University of Michigan), presented the overview of the meeting theme by demonstrating how the neural substrates and psychological mechanisms for resource hoarding were shared across species and domains. Evidence from prior experiments was presented from food storing in rodents and human compulsive hoarding, shopping, and gambling, all of which implicated the mesolimbocortical system, particularly the NAcc and OFC. Data from a neuroimaging study in her own lab were presented[34] that demonstrate a role for the OFC across consumption decisions (e.g., acquiring or discarding goods, for personal use or monetary profit). The NAcc may only be involved to the extent that participants are acquisitive, which potentially suggests that hoarders are like the "sign-tracking" rats of Terry Robinson (above), as they appear to view the cues of reward as rewarding themselves. Additional work in her lab confirmed that acquisitive tendencies are normally distributed in the population (Fig. 6) and are particularly associated with underlying differences in anxiety,[35] which

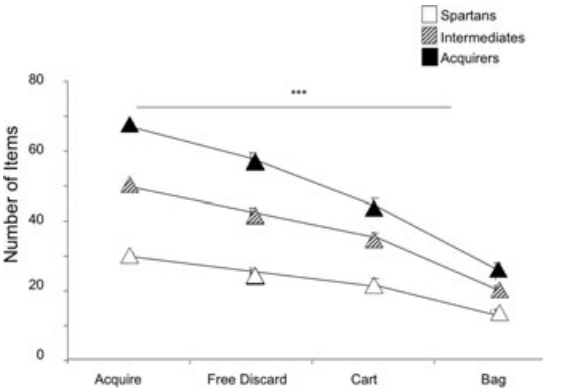

Figure 6. Normal, individual differences in acquisitiveness. Experimental data from the object decision task (ODT) divide subjects into three groups based on the number of objects that they acquire and keep across blocks of the task. Acquirers (those who take a lot but are not clinical hoarders) are presented in filled triangles, intermediates in hatched triangles, and Spartans in unfilled triangles. The blocks (on the *x*-axis) represent decisions to acquire as many hypothetical goods as one desires from a set shown one at a time, followed by an opportunity to cast off any acquired items that are no longer wanted, first without any pressure, and then after space constraints are introduced to fit items into a shopping cart and then a paper grocery bag.[35]

may adaptively provide individuals with resources that improve survival or reproductive success in environments perceived as uncertain or threatening.[36] However, the role of anxiety appears complex, with only a particular type of anxiety being involved that overlaps with, but is dissociable from, the anxiety of OCD.[26] Thus, the evidence again suggests that feelings of safety and security are critical drivers in the desire to consume; in addition, such drivers may directly enhance the perception of goods that satisfy such motivations.

Psychological and evolved underpinnings of the drive to consume

In the fourth session, human behavioral researchers presented information on the psychological and evolved mechanisms of risk preferences and the drive to consume. Kathleen Vohs (associate professor of marketing, McKnight Presidential Fellow, and Land O' Lakes Professor for Excellence in Marketing, Carlson School of Management, University of Minnesota) is a prolific social psychologist working in a department of marketing to examine the role of self-control to explain many real-world successes and failures to engage in desirable consumptive behavior (such as saving instead of spending, and

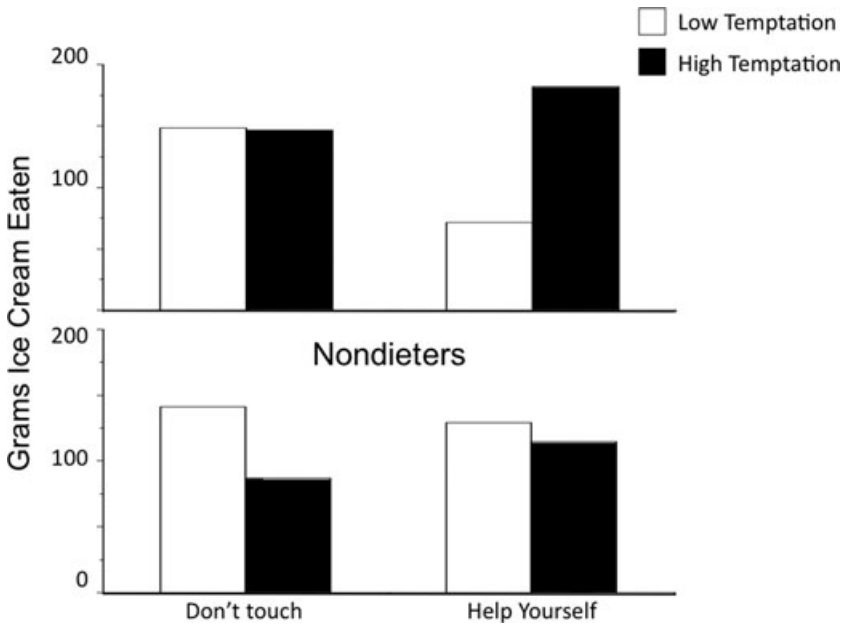

Figure 7. Chronic dieters: effects of self-regulatory depletion on ice cream consumption. Under conditions of high temptation, chronic dieters are particularly prone to eat ice cream when they can help themselves. Modified after Vohs and Heatherton.[37]

withholding instead of bingeing). Vohs described her model in which self-regulation is like a muscle that can be depleted and built up slowly overtime. This control muscle reflects a general, limited resource that can be tapped to control impulses and desires but that also can be depleted by one task and then be deficient to permit self-regulation in a subsequent, unrelated task. Vohs demonstrated such effects across domains, including dieting, impulsive spending,[38] and interpersonal behaviors with romantic partners, friends, and strangers.[39] Across domains, the worst effects of depletion—for example, from a boring, frustrating, or challenging task—are achieved by those trying to control their subsequent behavior, because chronic exertion in their domain of interest (e.g., dieting) leaves them vulnerable to failures in will power (Fig. 7).[40] She similarly demonstrated the need for self-resources in decision making[41] and that such self-regulation makes time move more slowly,[42] and once depleted, people think less rationally.[40,43] She also suggested that self-affirmation may be a beneficial, efficient way to reduce the effects of depletion on performance.[44] As in the prior talks, the consistency with which one's mental resources affect decisions across domains (financial, social, dietary) suggests that a common underlying biological system is implicated across resource-allocation decisions. In addition, her work on the more controlled, rational cognitive system, which was alluded to by Bechara (above), helps to fill gaps in our understanding of how such control systems can actually permit successful control but also be impaired during decisions to consume.

Geoffrey Miller (associate professor, Department of Psychology, University of New Mexico) is an evolutionary psychologist who, like Robert Frank, emphasized the role of sexual selection in driving conspicuous consumption, popularized in his mainstream nonfiction book, *Spent: Sex, Evolution, and Consumer Behavior.*[45] In a collaboration with Griskevicius *et al.*,[46] Miller *et al.* found that romantic primes (e.g., attractive opposite-sex faces and writing about an ideal date), compared to control prime images, caused men, in particular, to increase spending for conspicuous consumption items that signal status and wealth (e.g., a new car, watch, holiday), while females increased spending on inconspicuous consumption items (e.g., medicine and household appliances) and were more likely to report giving in volunteer opportunities that would be publicly observed (Fig. 8). Offers of private help were more common in women than men but were not affected by romantic motives. Thus, males appear more likely to use status goods to signal their

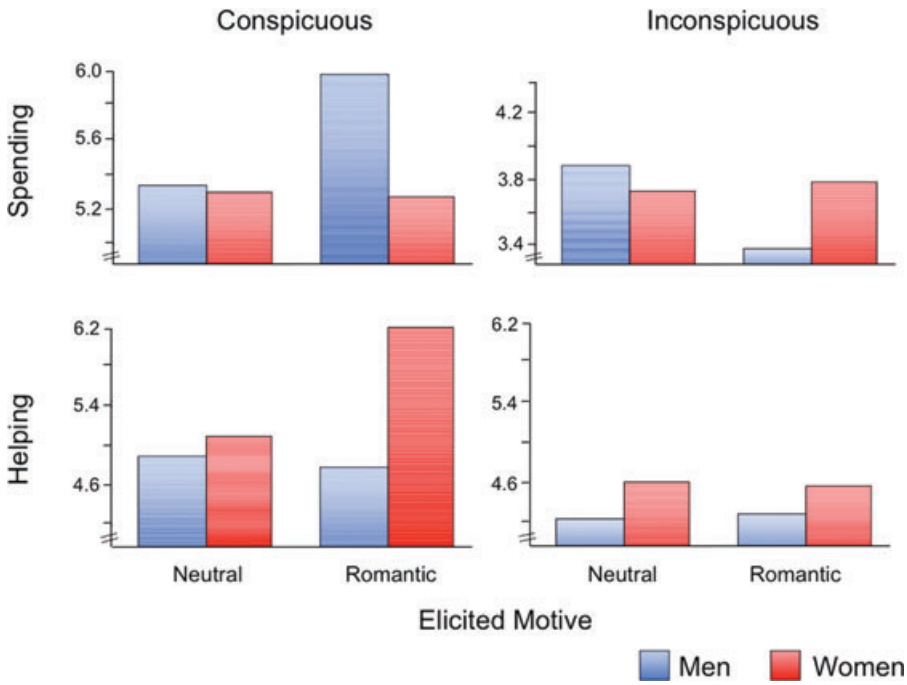

Figure 8. Effects of romantic or control primes on spending and helping behavior across conspicuous and inconspicuous conditions for males and females. Males (blue bars), in particular, increase conspicuous spending after romantic priming, whereas females (red bars) increase conspicuous helping and spending for inconspicuous items. Modified after Griskevicius *et al.*[46]

quality to females, while females are more likely to signal their beneficence and proper maintenance of domestic life. Such signals are thought to have evolved because they indicate actual enhanced fitness and thus the quality of the potential mate. But Miller argues that selection in early hominid history was particularly driven by displays of the "central six" mental traits (intelligence, openness, conscientiousness, agreeableness, stability, extraversion), which are evolutionarily conserved, heritable, stable, measurable, reliable, and attractive to others.[47] Thus, Miller believes that consumerist capitalism evolved because of the human instinct to display intelligence and personality, which can be normatively expressed through certain positions and products, along with social and historical factors.

Converging both the life history strategy themes from Ellis' presentation and the evolutionary psychology themes of Miller's presentation, Vladas Griskevicius (assistant professor of marketing, University of Minnesota McKnight Land-Grant Professor) presented a life-history strategy approach to understanding short- versus long-term strategies across socioeconomic groups. Griskevicius began with an evocative description of a man with a small income who works very hard in his job as a mechanic, yet spends up to $30,000 per year on lottery tickets. Such behavior appears risk seeking and irrational in the context of his other financial needs; but Griskevicius, like Ellis, used this case to portray the distinction between somatic and reproductive strategies for life investments. In this context, somatic strategies represent a longer horizon approach to improving physical health, longevity, and the accumulation of skills in situations where the environment appears secure, and reproductive strategies represent a shorter term strategy to compete for reproductive success in the present in situations where the environment appears risky and uncertain. Across many studies that utilize mortality primes from short newspaper articles about danger in society, Griskevicius *et al.* found that the fear of mortality causes bifurcating responses in individuals depending on their early (but not current) socioeconomic status (SES).[48] Individuals with early material and social support become risk averse when later primed to expect danger

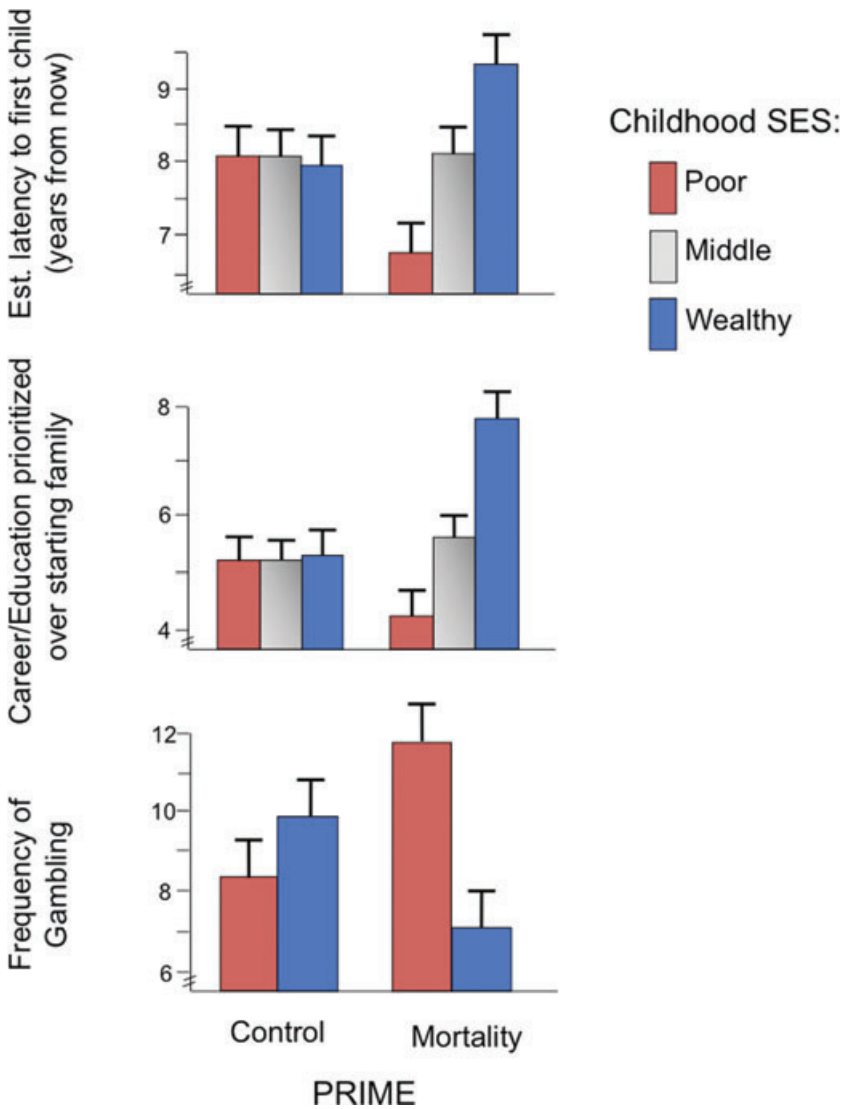

Figure 9. Effects of early childhood SES on the response to short- versus long-term planning strategy tasks. Participants from low childhood SES backgrounds (maroon) select the more immediate, short-term strategy, and those from high childhood SES backgrounds (blue) select the longer-term strategy (middle SES in gray bars). These effects generalize across decisions to predict the number of years before having one's first child (A), whether to prioritize starting a family or education and career (B), and whether to take an immediate smaller reward or to gamble for a longer-term, larger outcome (C). In graphs A and B, higher values on the *y*-axis represent greater slow, long-term investments, but in graph C, higher values represent greater immediate, fast-term investment. Modified after Griskevicius *et al.*[49]

or uncertainty, while those with early deprivation become risk seeking in the same later setting. These effects generalize across many measures, including the age at which people predict they will have their first child, the decision to start a family soon or to invest further in one's education or career, and the decision to take a smaller immediate reward versus a gamble for a larger, longer term benefit (Fig. 9). Even when individuals of low versus high childhood SES are exposed to the same cues of danger in the environment, those from a less enriched early environment switch into a faster, riskier strategy, while those from a more enriched environment switch to an even slower strategy. Thus, in a case such as that

of the man who spent his small income on lottery tickets, a life-history strategy approach assumes that he is not irrational, but rather exhibits an evolved strategic response to the combination of his early and current environmental conditions.

Summary

Ecologists study optimal models of animal food hoarding, financial analysts model stock trading, psychologists investigate decisions about reward (and impairments therein such as gambling and addiction), and clinical psychologists treat compulsive hoarding. Each of these domains captures the ways in which decisions are made to acquire resources in order to balance short- and long-term needs. Progress in each domain can be catapulted by a genuine attempt to identify common themes and incorporate models from one domain into another. For example, by understanding the evolution of animal food hoarding, clinicians and marketers identify environmental triggers for human acquisition, yielding strategies that take natural tendencies into account. By bringing researchers of compulsive hoarding and shopping (which are sex biased, but no one knows why) together with neuroscientists, we can understand the neurobiology of these intractable disorders. Interactions between marketing, business, or finance with neuroscience can improve the sophistication of neural theories of choice, which are increasingly popular. Moreover, all of these fields can contribute to the dialogue on public policy.

In just a few short days, with scholars engaged in a dialogue across these domains, we were able to identify multiple commonalities across the findings of researchers, all of which addressed a general model of consumption as an evolved response to perceived cues of reward and uncertainty that differ across individuals due to inherited and learned sensitivities and strategies.

Maladaptive consumption is a serious issue that produces environmental waste, unfair labor practices, and negatively affects human health. Subunits of local and federal government separately struggle to encourage monetary saving, reduce waste, increase recycling, and deal with compulsive hoarding. Through a careful comparison of the mechanisms underlying these seemingly disparate processes, a unified model of resource allocation can be created that benefits basic science as well as society.

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Conflicts of interest

The author declares no conflicts of interest.

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