PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B

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Review

Intangibility in intertemporal choice

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Since the advent of the discounted utility (DU) model, economists have thought about intertemporal choice in very specific terms. DU assumes that people make *explicit trade-offs* between costs and benefits occurring at different points in time. While this explicit trade-off perspective is simple and tractable, and has stimulated productive research, it does not provide a very realistic representation of a wide range of the most important intertemporal trade-offs that people face in daily life. If one considers the most important and commonly discussed examples of intertemporal choices, a striking pattern emerges: in almost all cases, early outcomes tend to be concrete (e.g. purchasing this latte), but later outcomes tend to be much less tangible (e.g. the unknown item that could have been purchased later with the money spent on this latte). We propose that people rely on anticipatory emotions as a proxy for intangible outcomes when trade-offs are implicit. This paper reviews neuroeconomic evidence that has begun to elucidate the role of anticipatory emotions in decisions involving intangible outcomes. Although most progress has been made in the domain of spending and saving, we discuss how the existing neuroeconomic research could be extended to other domains where trade-offs are ill defined.

Keywords: neuroeconomics; behavioural economics; intertemporal choice; tangibility; consumer behaviour

> The qualities most useful to ourselves are, first of all, superior reasons and understanding, by which we are capable of discerning the remote consequences of all our actions, and of foreseeing the advantage or detriment which is likely to result from them; and, secondly, self-command, by which we are enabled to abstain from present pleasure or to endure present pain, in order to obtain a greater pleasure or to avoid a greater pain in some future time. In the union of those two qualities consists the virtue of prudence, of all the virtues that which is most useful to the individual.
>
> Smith (1759 [1981]), pp. 271–272, *Theory of moral sentiments*.

1. INTRODUCTION: THE EXPLICIT TRADE-OFF PERSPECTIVE

Ever since Ramsey (1928) and Samuelson (1937) laid out the basis of what has come to be known as the *discounted utility* (*DU*) model, economists have thought about intertemporal choice in very specific terms; the model has, in effect, become a lens through which all intertemporal trade-offs are viewed. As with most lenses, however, the lens of DU can distort as well as clarify. In this paper, we argue that DU has established an archetypal image of intertemporal choice that bears little resemblance to most of the important intertemporal choices that people engage in, with the result that economists and decision researchers have been effectively blinded to a wide range of important factors entering into intertemporal choice.

DU assumes that people make *explicit trade-offs* between costs and benefits occurring at different points in time. Dieters, for example, are seen as making a 'tradeoff between immediate gustatory pleasure and future health consequences' (Smith 2004, p. 386). When consumers make spending decisions, 'willingness to pay…reflects how much individuals would be willing to give up in other things to obtain this outcome. It is an explicit tradeoff that defines willingness to pay' (Bockstael *et al.* 2000, p. 1387). Addiction is similarly conceptualized as the result of 'an explicit tradeoff between the rewards of current consumption and the expected costs of lower future utility including the detrimental effect of higher discounting' (Orphanides & Zervos 1998, p. 89).

This 'explicit trade-off' perspective has had a profound effect on empirical investigations of intertemporal choice. In virtually all such studies, subjects are faced with an explicit choice between one reward that is small and available earlier (e.g. an immediate payment of $10) and an alternative reward that is larger and later (e.g. $15 in a week). Walter Mischel's delay of gratification paradigm (Mischel *et al.* 1989) is structurally identical, though it has focused exclusively on the intertemporal choices of children (e.g. one marshmallow immediately or two marshmallows in 15 minutes).

While the explicit trade-off perspective has stimulated productive research and yielded important

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PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

insights, it does not provide a very realistic representation of a wide range of the most important intertemporal trade-offs that people face in daily life. If one considers the most important and commonly discussed examples of intertemporal choices, a striking pattern emerges: in almost all cases, early outcomes tend to be concrete (e.g. eating a snack, purchasing an item, taking a hit of an addictive drug), but later outcomes tend to be much less well defined or tangible (e.g. becoming obese, accumulating less savings, becoming addicted). That is, the consequences of taking or not taking immediate actions are not only delayed, but *intangible* as well. By tangible (and by extension, intangible), we mean the classic dictionary definitions: e.g. 'perceptible by the senses'; 'capable of being treated as fact'; 'having physical substance and intrinsic monetary value'; and 'capable of being perceived; especially capable of being handled or touched or felt' (WORDNET v. 3.0). In some cases, delayed consequences are intangible because the impact of current behaviour is imperceptible—e.g. eating a large meal has an imperceptible impact on one's future weight. In other cases, delayed consequences are intangible because they are difficult or impossible to imagine or because, while one knows that there will be some consequence, one is not entirely sure about what that consequence will be. This is the case for spending versus saving; the consequence of spending in the present is usually tangible, but one rarely knows exactly what any money one saves will eventually be spent on. In still other cases, the probabilistic nature of delayed consequences or uncertainty about when they will occur probably contributes to their intangibility. When consuming addictive substances, for example, it is unclear whether or when certain delayed costs will be incurred (e.g. going to jail, becoming addicted).

Tangibility and time delay are often confounded because they tend to go hand in hand; delayed outcomes are typically less tangible than immediate outcomes. However, this is not necessarily the case. For example, if one accepts a friend's invitation to go to a late movie, one might be able to better imagine one's exhaustion at work the following day than one's enjoyment of the movie; hence, one could argue that in this case, the more immediate outcome is less tangible. Although, as the example illustrates, tangibility and time delay are separable, most intertemporal choices in the real world confound tangibility and delay. Outside the stylized choices subjects are given in laboratory studies of intertemporal choice, the costs of immediate consumption tend to be not only delayed, but poorly defined and hence intangible as well.

That future rewards are not only delayed, but also less tangible is an insight that was, in fact, once prominent in the economics of intertemporal choice, and indeed was sometimes posited as *the* reason for why people discount the future. Thus, John Rae, who was the first economist to focus his attention narrowly on the problem of intertemporal choice, seemingly referred to the tangibility of immediately available rewards, and implicitly to the intangibility of delayed rewards, when he observed that 'the actual presence of the immediate object of desire in the mind by exciting the attention, seems to rouse all the faculties, as it were to fix their view on it, and leads them to a very lively conception of the enjoyments which it offers to their instant possession' (Rae 1834, p. 120). Even Böhm-Bawerk (1889 [1970], pp. 268–269), who played an important role in promulgating the explicit trade-off perspective, proposed an account of time discounting that seems to relate closely to the notion of tangibility. As he noted, 'we limn a more or less incomplete picture of our future wants and especially of the remotely distant ones'. However, the ascension of the explicit trade-off perspective has tended to eclipse consideration of factors such as tangibility, focusing attention instead on the types of factors that would be likely to play a role in decisions involving explicit trade-offs—e.g. the perception of time delays and feelings experienced during the delay period.

(a) *Dual processes underlying time discounting*

One of the indirect consequences of the popularity of the explicit trade-off perspective has been a blurring of what we will argue is a qualitative discontinuity between intertemporal choice in humans and other animals. As with humans, non-human animals can be run in experimental paradigms in which they choose between smaller earlier rewards and larger later rewards (although animals need to learn about the rewards through multiple trials, whereas humans can simply be informed of the contingencies).

One common view—held, it seems, disproportionately by those who come to the study of intertemporal choice from a background studying animals—is that the differences between animals and humans are merely a matter of degree: i.e. animals and humans share roughly similar mechanisms of time discounting. The main support for this perspective is that, while both humans and animals discount the future at dramatically different *rates*, both humans and animals display a common pattern of time discounting commonly referred to as 'hyperbolic time discounting'. As Monterosso & Ainslie (1999, p. 343) noted, for example, 'people and less cognitively sophisticated animals do not differ in the hyperbolic form of their discount curves'. Although some are agnostic about the underlying process, many advocates of the continuity perspective either explicitly or implicitly hold the view that hyperbolic time discounting is effectively 'hard-wired' into our evolutionary apparatus (e.g. Herrnstein 1997; Rachlin 2000). Hyperbolic time discounting predicts, and has often been used to explain, a pattern of behaviour known as intertemporal 'preference reversals'—e.g. choosing two oranges in eight days over one in a week, but also choosing one orange today over two tomorrow (Ainslie 1975).

However, the notion that humans and other animals 'do not differ in the hyperbolic form of their discount curves' is somewhat misleading. Although the general functional form of human and non-human animal discounting may bear some resemblance, the scale of the two are radically different. Even after long periods of training, our nearest evolutionary relatives have measured discount functions that fall in value nearly to zero after a delay of about 1 min. For example, Stevens *et al.* (2005) reported that cotton-top tamarin

monkeys (*Sanguinus oedipus*) are unable to wait more than 8 s to triple the value of an immediately available food reward. While such findings do not rule out the possibility that humans and animals discount the future similarly, we believe that the quantitative discontinuity is indicative of a qualitative discontinuity.

There is, in fact, considerable evidence that the time discounting of humans and other animals relies on qualitatively different mechanisms. Specifically, human time discounting reflects the operation of two fundamentally different systems: one that heavily values the present and cares little about the future (which we share with other animals) and another that discounts outcomes more consistently across time (which is uniquely human) (e.g. Shefrin & Thaler 1988; Loewenstein 1996). Although (some) animals display far-sighted behaviours (e.g. storing nuts for winter), these are typically pre-programmed and distinct from the type of spontaneous self-control observed in humans (e.g. deciding to go on a diet). The almost uniquely human capacity to take the delayed consequences of our behaviour into account appears to be directly attributable to the prefrontal cortex, the part of the brain that was the most recent to expand in the evolutionary process that produced humans (Manuck *et al.* 2003), and that is also the latest part of the brain to develop with age. Patients with damage to prefrontal regions tend to behave myopically, placing little weight on the delayed consequences of their behaviour (Damasio *et al.* 1994).

In perhaps the most explicit investigation of a dual-process account of intertemporal choice, McClure *et al.* (2004) examined the brain activity of participants while they made a series of intertemporal choices between small proximal rewards ($\$R$ available at delay d) and larger delayed rewards ($\$R'$ available at delay d'), where $\$R<\$R'$ and $d<d'$. Rewards ranged from \$5 to \$40 Amazon.com gift certificates, and the delay ranged from the day of the experiment to six weeks later. The purpose of this study was to examine whether there were brain regions that show elevated activation (relative to a resting-state benchmark) only when immediacy is an option (i.e. activation when $d=0$, but no activation when $d>0$) and whether there were regions that show elevated activation when making any intertemporal decision irrespective of delay. McClure *et al.* (2004) found that time discounting is associated with the engagement of two neural systems. Limbic and paralimbic cortical structures, which are known to be rich in dopaminergic innervation, are preferentially recruited for choices involving immediately available rewards. By contrast, fronto-parietal regions, which support higher cognitive functions, are recruited for all intertemporal choices. Moreover, the authors find that when choices involved an opportunity for immediate reward, thus engaging both systems, greater activity in fronto-parietal regions than in limbic regions is associated with choosing larger delayed rewards (figure 1). A subsequent functional magnetic resonance imaging (fMRI) study that replaced gift certificates with primary rewards (juice and water) that could be delivered instantly in the scanner replicated this pattern (McClure *et al.* 2007). Yet another study by a different set of authors (Hariri *et al.* 2006) found a similar pattern in a between- rather than within-subject study.

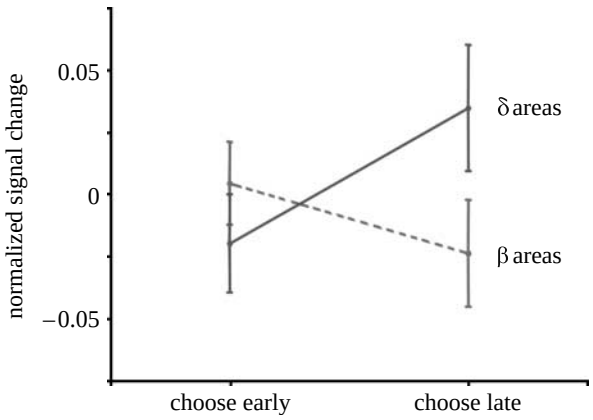

Figure 1. Activation in fronto-parietal regions (δ areas) and limbic regions (β areas) when choices involved an opportunity for immediate reward (McClure *et al.* 2004). δ areas include regions of visual cortex, premotor area, supplementary motor area, right and left intraparietal cortex, right dorsolateral prefrontal cortex, right ventrolateral prefrontal cortex and right lateral orbitofrontal cortex. β areas include the ventral striatum, medial orbitofrontal cortex, MPFC, posterior cingulate cortex and left posterior hippocampus. To assess overall activity among δ and β areas and to make appropriate comparisons, McClure *et al.* (2004) first normalized the per cent signal change (using a z-score correction) within each area and each participant, so that the contribution of each brain area was determined relative to its own range of signal variation. Normalized signal change scores were then averaged across areas and participants separately for the δ and β areas. The average change scores are plotted for each system and each choice outcome. Relative activity in δ and β brain regions correlates with participants' decisions involving money available today. There was a significant interaction between area and choice ($p<0.005$), with δ areas showing greater activity when the choice was made for the later option. Adapted from fig. 4 of McClure *et al.* (2004).

Humans have the ability to delay gratification, it seems, because we have a unique cognitive architecture that enables us to take account of delayed, and often intangible, future consequences of our current behaviour. In §2 we argue that the conscious experience of emotions is the mechanism that allows us to 'immediatize'—i.e. bring into the present in a form that has traction against other immediate motives—such delayed outcomes.

(b) *Emotions as the common currency*

One of the essential insights of more than a half-century of research on reward and punishment is that animals reduce multidimensional alternatives to a single common currency that facilitates comparison and substitution (McFarland & Sibly 1975; Shizgal 1997; Montague & Berns 2002). While discussions of common currency within neuroscience typically '[make] no reference to hedonistic experience' (Shizgal 1997, p. 198), following Rolls (1999), we propose that *emotion* serves as the common currency with which humans make intertemporal trade-offs. Rolls (1999) argued that emotions are experienced consciously, as feeling states (the famous problem of 'qualia') exactly because humans make the types of trade-offs they do. To trade off the immediate pain of a flu shot, for

example, against the potential reduction in misery from getting the flu requires some means of encoding how bad the two different outcomes are. The means for doing so, Rolls (1999, p. 251) argues, is consciously experienced emotions. As he writes:

> The view I suggest on such qualia is as follows. Information processing in and from our sensory systems (e.g. the sight of the colour red) may be relevant to planning actions using language and the conscious processing thereby implied. Given that these inputs must be represented in the system that plans, we may ask whether it is more likely that we would be conscious of them or that we would not. I suggest that it would be a very special-purpose system that would allow such sensory inputs, and emotional and motivational states to be part of (linguistically based) planning, and yet remain unconscious. It seems to be much more parsimonious to hold that we would be conscious of such sensory, emotional, and motivational qualia because they would be being used (or are available to be used) in this type of (linguistically based) higher-order thought processing.

Intertemporal choice, in this view, involves a balancing of two qualitatively different, but both immediate, affective influences: (i) immediate motivations to take specific actions based on immediate costs and benefits, and (ii) immediate emotions experienced as a result of thinking about the potential future consequences of our behaviour. Dieting, for example, might involve a competition between the immediate impulse to eat and the immediate guilt one would experience as a result of doing so. Saving might involve a trade-off between, on the one hand, the immediate pleasure of spending or pain of not spending, and, on the other hand, the immediate experience of guilt and fear if one spends and pride if one does not. Implementing far-sighted behaviour is not the same as choosing an apple over a banana because one prefers the former. It pits inherently different neural systems against one another.

(c) *Will power*

As Adam Smith noted in the opening quote, while 'discerning the remote consequences of all our actions' and 'foreseeing the advantage or detriment which is likely to result from them' is a necessary condition for deferral of gratification, it is not sufficient. In addition to recognizing and caring about the future consequences of our current actions, we also need to be able to control our behaviour in such a way as to implement the desired, often foresighted, line of behaviour. That is, far-sighted behaviour requires the extra element that Smith labelled 'self-command', which is also sometimes referred to as 'will power'.

The will power literature (see Baumeister & Vohs 2003 for a review) has consistently demonstrated that acting in a fashion contrary to the immediate impetus of emotional motivation (e.g. anger) or drive states (e.g. hunger) entails more than a purely cognitive evaluation that doing so is consistent with self-interest; it requires the exertion of a limited resource that is commonly referred to as will power. This research shows that, much as the energy exerted by muscles, will power is in limited supply (at least in the short term). The general experimental paradigm employed by Baumeister and his colleagues confronts participants with two successive, unrelated tasks that both presumably require will power. Behaviour on the second task is compared to a control group that did not perform the first task. The general finding is that exerting will power in one situation tends to limit people's ability to use it in a subsequent situation. For example, in one study by Vohs & Faber (2007), participants initially watched an audio-free video of a woman speaking. Words were also periodically presented at the bottom of the screen. Some participants were asked to perform the difficult task of focusing exclusively on the woman, ignoring the words. Others were given no direction about how to watch the video. All participants were then asked to state their willingness to pay for a variety of products. The participants in the restricted attention condition were willing to pay significantly more for the products than were the participants in the unrestricted condition.

Although the precise mechanisms underlying self-control are not yet well understood, recent work has found that exertions of will power deplete large amounts of glucose, which enables cerebral functioning (especially 'executive' processes) by providing fuel for neurons (see Gailliot & Baumeister 2007 for a review).[1] It may be the case that self-control involves maintaining attention on delayed consequences (or imagining delayed consequences) in a fashion that keeps anticipatory emotions active.

(d) *Summary*

Unlike the laboratory, the real world seldom offers clear information about the long-run costs of our immediate actions. Accordingly, the only trade-offs we can make are crude, at best. Few of us have a clue about whether, at a particular moment, we are saving or eating too much or too little. Few of us know whether it might make sense, perhaps at some later point in our lifespan, to experience the pleasures of heroin, even at the expense of becoming addicted. The benefits of delaying gratification are simply not tangible, and crudely trading off tangible immediate rewards against intangible delayed rewards is bound to lead to mistakes.

These mistakes need not exclusively be in the direction of too little self-control. Although the self-control literature tends to focus on individuals afflicted with insufficient self-control, problems of excessive self-regulation and excessive far-sightedness are not uncommon. Indeed, tellingly, for many problems attributable to insufficient self-control, one can identify a parallel problem driven by excessive self-control (e.g. obesity versus anorexia, spendthriftiness versus tightwaddism, impulsivity versus rigidity). Given the difficulty of rationally trading off delayed intangible costs and benefits against immediate tangible ones, it is not surprising that mistakes tend to occur in both directions.

In addition to the mistakes that arise from relying on crude emotional proxies for delayed rewards, it is also worth noting that, to the extent that self-control invokes immediate negative emotions, it can be extremely costly (Loewenstein & O'Donoghue 2006).

Avoiding temptations (that we deliberatively want to avoid) often requires the unpleasant experience of negative emotions such as guilt or anxiety. Moreover, when self-control fails, it is often only after one has attempted, in vain, to apply will power. In these situations, we essentially pay twice for our misbehaviour: we not only endure the material negative consequences of indulgence (e.g. increased weight or debt), but we also fail to fully enjoy the indulgence itself, since we feel guilty about failing to resist it.

The rest of this paper discusses evidence for, and ramifications of, the observation that intertemporal choice, in fact, rarely involves explicit trade-offs. Section 2 discusses the single application for which we have the best evidence of how decision makers deal with the lack of tangibility: the problem of spending and saving. Section 3 discusses an additional application, dieting, though the evidence is more preliminary. Section 4 shows how similar considerations can play a role in domains other than intertemporal choice, and focuses specifically on the phenomenon of charitable giving. Section 5 concludes.

2. SPENDING AND SAVING

Suppose at age 50 you access one of the ubiquitous 'retirement calculators' that are available on the websites of financial institutions, which informs you that, to retire in the material comfort you are accustomed to, you will need to salt away a nest egg of $500 000. Unfortunately, at present, you are only $20 000 of the way towards meeting that goal. Hours later you find yourself feeling hot and sleepy and right in front of a Starbucks coffee shop. Will you order the $4.25 iced latte? How will you decide?

According to the standard economic perspective, the price of the latte captures its opportunity cost (whatever alternative reward the unspent money would have financed). People presumably treat the situation as an explicit choice between the immediate pleasure of consuming the latte and the pleasure that would be enjoyed as a result of greater spending in the future were it foregone (Becker *et al.* 1974).

Behavioural research, however, suggests that many people do not spontaneously interpret prices in terms of opportunity costs. For example, Frederick *et al.* (2007) asked participants whether they would (hypothetically) be willing to purchase a desirable video for $14.99. The researchers simply varied whether the decision not to buy it was framed as 'not buy this entertaining video' or 'keep the $14.99 for other purchases'. Although the two phrases represent equivalent actions, the latter highlights the pleasure that is foregone by purchasing the video. Frederick *et al.* (2007) found that drawing attention to opportunity costs significantly reduced the proportion of participants willing to purchase the video, suggesting that many participants were not spontaneously considering opportunity costs. Similarly, Jones *et al.* (1998) asked participants to assume that they recently received an unanticipated windfall of $15 and to decide whether to use that money to buy a new CD. Half of the participants were encouraged to list 5–10 alternative uses of the money, whereas the other half were not encouraged to think about opportunity costs. Consistent with Frederick *et al.* (2007), participants encouraged to think about opportunity costs were significantly less likely to buy the CD.[2]

If prices do not deter spending through a deliberative consideration of opportunity costs, then what role do prices play in spending decisions? Prelec & Loewenstein (1998) proposed that people rely on negative emotions—specifically, a 'pain of paying'—as a proxy for deliberative consideration of opportunity costs. The pain of paying protects us from overconsumption primarily because it transforms intangible costs (vague notions of what will be foregone at some unknown point in the future) into tangible costs (in the form of immediate, visceral pain).

The pain of paying can presumably explain a wide range of phenomena, from the preference for flat-rate, zero marginal cost payment schemes that make it feel as if one is consuming for free (see Train 1991 for a discussion of the 'flat-rate bias'—the tendency for consumers to pay more for such plans) to the preference for paying for services, such as access to parklands, through taxes rather than user fees to the tendency to spend more when using credit cards than when using cash (Prelec & Simester 2001; Soman 2003). Until very recently, however, no empirical research had directly examined the role of the pain of paying in real spending behaviour.

In a project with Brian Knutson, Elliott Wimmer and Drazen Prelec (Knutson *et al.* 2007), we conducted the first study to examine the neural basis of spending and saving—an experiment in which participants chose whether or not to purchase a series of discounted consumer goods while having their brains scanned with fMRI. The main focus of the study was on whether people, in fact, rely on an anticipatory pain of paying to deter their spending. In each trial of our SHOP (save holdings or purchase) task, participants were initially shown a good that could be purchased, followed seconds later by its price, and finally by the opportunity to indicate whether or not they would like to buy the good at the offered price. The participants were initially given $20 to spend and were told that one of their decisions would ultimately be randomly selected to count for real. Once the brain scanning concluded, the participants were given a questionnaire that asked them to indicate how much they liked each product and how much they would be willing to pay for it.

Consistent with prior research suggesting that nucleus accumbens (NAcc) activation increases as anticipated gains and self-reported happiness increase (Knutson *et al.* 2001), we found that the extent to which participants reported liking a product correlated positively with NAcc activation when the product was initially presented. The difference between willingness to pay and price (i.e. consumer surplus) correlated positively with activation in the medial prefrontal cortex (MPFC), another dopaminergic target along the mesolimbic pathway. Activation in both regions positively correlated with actual purchasing decisions; NAcc activation began to predict purchasing decisions as soon as participants saw the product, and MPFC activation most strongly predicted purchasing decisions

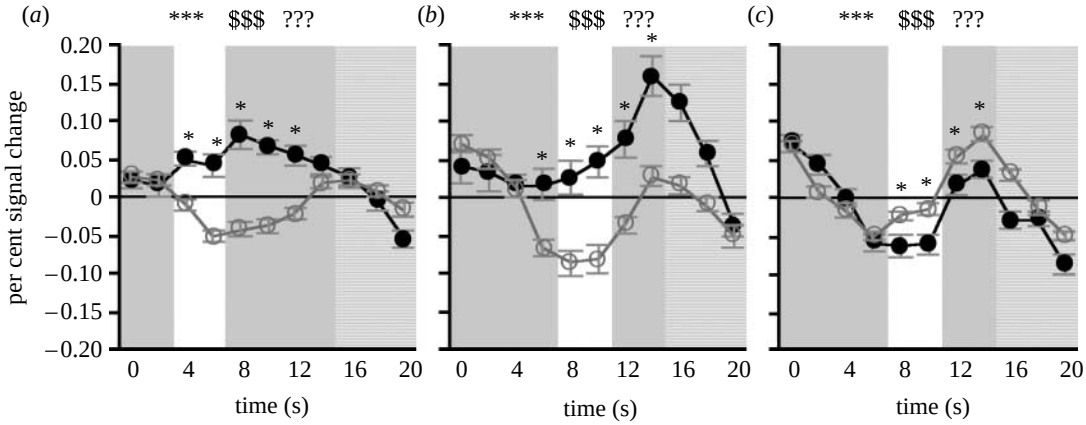

Figure 2. Time courses within volumes of interest in Knutson *et al.* (2007). (*a*) Bilateral NAcc activation time courses for trials in which products were subsequently purchased (filled circles) versus not purchased (open circles). (*b*) Bilateral MPFC activation time courses. (*c*) Right insula activation time courses. White bars indicate the period in which divergence was predicted; a triple asterisk indicates the product period; a triple dollar sign indicates the price period; a triple question mark indicates the choice period; all lagged/shifted right by 4 s; $n=26$; $^{*}p<0.05$; error bars $=\pm$s.e.m. Adapted from fig. 2 of Knutson *et al.* (2007).

during the price period (figure 2*a*,*b*). Most importantly in terms of the pain of paying, however, we found that activation in the insula during the period when subjects first saw the price correlated negatively with purchasing decisions (figure 2*c*). Insula activation has previously been observed in connection with aversive stimuli such as disgusting odours (Wicker *et al.* 2003), unfairness (Sanfey *et al.* 2003) and social exclusion (Eisenberger *et al.* 2003). These results support the idea that when the delayed costs of immediate indulgence are not explicitly represented (as in, e.g. McClure *et al.* 2004), but rather implicitly captured by prices, participants appear to rely on an anticipatory pain of paying to deter their spending, rather than strictly on a deliberative consideration of what is foregone by purchasing immediately.[3]

In other research conducted with Cynthia Cryder (Rick *et al.* 2008), we have been examining chronic behavioural consequences of the pain of paying. As touched upon above, because people are not making explicit trade-offs, it is difficult to 'get it right' and it is easy to get it wrong in either direction. In some cases, people do not experience enough pain, anxiety or guilt for their own good. This leads to a pattern of excessive spending and insufficient saving among people commonly (although somewhat oddly) referred to as 'spendthrifts'.[4] In other cases, 'tightwads' experience too much pain, which leads them to spend too little as well as to fail to enjoy that which they do purchase.

To measure individual differences on this dimension, we developed a 'spendthrift–tightwad' scale that divides respondents into one of three categories based on their scale responses: 'tightwads' spend less than they think they should; 'unconflicted consumers' spend about as much as they think they should; and 'spendthrifts' spend more than they think they should. These traits correlate strongly with self-reported pain of paying. Tightwads generally report feeling the pain of paying intensely, unconflicted consumers typically feel a moderate amount of pain prior to spending and spendthrifts generally feel little pain. Surprisingly, given all the media attention to the problem of excessive spending, we found that 'tightwaddism' was more common than 'spendthriftiness'. In our sample of over 13 000 respondents, tightwads outnumbered spendthrifts by a 3 : 2 ratio (24% versus 15%).

Spendthrift–tightwad scale scores predict several spending-related behaviours. For example, spendthrifts who use credit are three times as likely to carry debt as tightwads who use credit (60% versus 20%). Spendthrifts are twice as likely as tightwads to have less than \$10 000 in savings (52% versus 24%), and tightwads are twice as likely as spendthrifts to have more than \$250 000 in savings (28% versus 12%), and these differences persist after controlling for income.

However, individual differences in the pain of paying are not all-powerful determinants of spending behaviour. We find that tightwads and spendthrifts behave most similarly when situational factors diminish the pain of paying. In one study, for example, we (Rick *et al.* 2008) asked tightwads and spendthrifts whether they would (hypothetically) be willing to pay \$5 to have DVDs shipped to them overnight, rather than waiting four weeks. We simply varied whether the cost of shipping was framed as a '\$5 fee' or a 'small \$5 fee'. Although both phrases represent equivalent amounts of money, a 'small' fee presumably sounds less painful to pay. Since tightwads are most prone to experience the pain of paying, they were predicted to be most sensitive to the manipulation. Indeed, tightwads were significantly more likely to pay the small \$5 fee than the \$5 fee, but spendthrifts were completely insensitive to the manipulation.

In another study, we varied whether a \$100 massage was framed as utilitarian (recommended by a doctor to relieve back pain) or hedonistic (desired because you find massages enjoyable). Spendthrifts and tightwads were equally likely to rate the hedonistic massage as more painful to pay for than the utilitarian massage, but tightwads were more sensitive to the distinction. Tightwads were 46 per cent more likely to buy the utilitarian massage than the hedonistic massage; spendthrifts were only 29 per cent more likely to buy the utilitarian massage. The results of both studies suggest that situational factors that diminish the pain of paying diminish spending differences between tightwads and spendthrifts, by motivating tightwads to behave more like spendthrifts.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

While the above research focused on interventions that increase spending by tightwads, future research should examine whether there are interventions that simultaneously increase spending by tightwads and decrease spending by spendthrifts. Rick (2007) found that tightwads spend more when they are sad (relative to their spending in a neutral state) and that spendthrifts spend less when they are sad, but the effects were small.

Future research into the pain of paying should also attempt to establish a causal role for insula activation in purchasing decisions. Knutson *et al.* (2007) concluded that insula activation deterred spending, but the correlational nature of fMRI research made it impossible to rule out the possibility that not purchasing goods increases insula activation (though this alternative account seems less plausible than the proposed explanation). One way to obtain converging evidence would be to examine whether medications that reduce pain and anxiety (e.g. lorazepam; Paulus *et al.* 2005) generally increase spending and have a particularly strong effect on tightwads.

Finally, note the complementary role that brain and behavioural research played in generating insight into how people control their spending. Prelec & Loewenstein's (1998) model, itself motivated by behavioural research, later inspired the neuroeconomic research of Knutson *et al.* (2007), which, in turn, motivated Rick *et al.*'s (2008) behavioural work. As noted above, subsequent research could generate further insight into the pain of paying by examining whether drugs that reduce pain and anxiety affect different consumers differently.

3. DIETING

In their brilliant chapter, 'Dieting as an exercise in behavioral economics', Herman & Polivy (2003, p. 473) noted that dieting is the example of an intertemporal choice most likely to be used to illustrate theoretical discussions of intertemporal choice, but ultimately concluded that 'dieting fails to fulfill the exemplar role it has been asked to play'. The main reason, translated into our terms, is that the benefits of eating are immediate and tangible, whereas the benefits of dieting are delayed and intangible. As Herman & Polivy (2003, p. 474) stated it:

> the difference in the reward structure facing dieters is crucial to understanding…why dieting may be more difficult than are normal delay-of-gratification situations. Mischel's subjects, for one thing, are guaranteed the delayed reward; they know that if they wait, they'll get their extra cookie. The dieter, however, has no such guarantees. She can resist that tempting plate of cookies, but there's no certainty that she will become slim as a result.

One reason why is that weight loss is only weakly related to consumption; the influence of factors such as metabolism and weight at the beginning of a diet can overwhelm the influence of food intake. Another factor interfering with the relationship between current restraint and future slimness is the behaviour of one's future selves. Restraint today is powerless to bring about slimness in the future if future selves cannot be trusted to restrain themselves.

Real-world dieters not only lack assurance that their restraint will bring about large delayed rewards (in the form of smaller waistlines), but they also have no idea when those rewards might come to fruition. Contrasting real-world dieting with the explicit trade-off paradigm, Herman & Polivy (2003, p. 474) noted, 'Mischel's subjects know how long they must wait. For the dieter, the process is normally slow; quite possibly, she could diet forever and still not reach her weight goal.' The weak relationship between any particular episode of restraint and future slimness, as well as the ambiguous definition of 'future', suggests that the delayed rewards dieters face are far less tangible than the explicitly defined rewards typically offered in the laboratory.

Given the intangibility of delayed rewards, the dieter presumably needs some way of immediatizing the costs of current indulgence (foregone slimness). Herman & Polivy (2003, p. 475) proposed that dieters weigh the pain of current restraint against the anticipated pleasure of improved future health, but speculated that indulging today is not necessarily a consequence of 'current pain exceeding future pleasure; it is more a matter of current pain exceeding the current (pleasurable) anticipation of future pleasure. Both of these hedonistic events occur in the present, virtually simultaneously, and may be directly compared on the same metric.' An alternative hypothesis, consistent with research on the pain of paying, is that dieters use negative emotions to immediatize the consequences of indulgence. Essentially, Herman and Polivy proposed that anticipatory pain motivates indulgence today, though the influence of that pain can be counteracted by pleasurable anticipation of future health. By contrast, our perspective suggests that anticipatory pleasure motivates immediate indulgence, though the influence of that pleasure can be counteracted by painful guilt.

To the best of our knowledge, remarkably little research has attempted to uncover how dieters immediatize the delayed consequences of indulgence. One exception is an exploratory study by Ellison *et al.* (1998) in which six anorexic women and six healthy women viewed several pictures of beverages of varying caloric content while having their brains scanned with fMRI. Some pictures were of 'labelled high calorie drinks (e.g. chocolate milkshake)', while others were of 'labelled low calorie drinks (e.g. still mineral water)' (Ellison *et al.* 1998, p. 1192). Ellison *et al.* (1998) reported that anorexic participants experience greater insula and amygdala activation across the entire experiment, but crucially the authors do not analyse whether the experimental manipulation (calorie level) moderates this difference. Clearly, more refined neuroscientific research is needed. Knutson *et al.*'s (2007) SHOP task, for example, could easily be modified to address dieting issues, by replacing products with liquid chocolate and other indulgences that could be delivered to participants having their brains scanned, and replacing price with nutritional information (e.g. number of calories). While many fMRI studies have examined how people react to

images of food, or while anticipating receiving liquid rewards, it is critical to examine how people decide whether or not to consume when faced with information about the health consequences of that consumption.

While the potential role of anticipatory guilt in dieting has yet to be determined, research has revealed that diets produce guilt, without any accompanying weight loss. Polivy & Herman (1992), for example, assigned a group of women who wanted to lose weight to an 'undiet' that allowed them to eat whatever they wanted. Although the undiet did not affect their weight, it did make participants less dissatisfied with themselves and less depressed.

Other research suggests that providing small but frequent tangible incentives for weight loss can improve self-control by introducing new visceral motivations that compete with a visceral drive to indulge. Mann (1972), for example, found that participants who deposited valuables with a therapist and signed contracts in which return of their possessions was contingent on progress towards pre-specified weight-loss goals lost tremendous amounts of weight: an average of 32 pounds. A recent study by Volpp *et al.* (in preparation) enrolled obese US veterans who wanted to lose weight in a weight-loss programme, the goal of which was to lose 16 pounds in 16 weeks. In one condition, participants are eligible for a lottery (expected value = $3) each day they are on track to meeting their monthly weight-loss target. In another condition, participants can deposit up to $3 of their own money each day, which the experimenters then double. Participants receive the doubled amount, plus a $3 bonus, each day they are on track to meeting their monthly weight-loss target. In a third (control) condition, participants are given no financial (tangible) incentives to lose weight. Thus far, participants in both financial incentive conditions are about twice as likely as participants in the control condition to have lost significant amounts of weight and to have met the monthly goal of losing one pound per week.[5]

4. BEYOND INTERTEMPORAL CHOICE: CHARITABLE GIVING

Although the standard economic perspective assumes that all intertemporal choices involve explicit trade-offs, the perspective does not assume that all explicit trade-offs occur in the intertemporal domain. Decisions regarding whether (or how much) to donate to charities are, analogously, presumably based on explicit trade-offs between our own well-being and that of others (though some gifts may not involve such a trade-off if they simultaneously increase the welfare of the recipient and give the donor a pleasant 'warm glow'). While the explicit trade-off paradigm has yielded insights into charitable giving, and has stimulated both behavioural and neural research (e.g. Andreoni & Miller 2002; Harbaugh *et al.* 2007), very few charitable decisions in the real world appear to be based on explicit trade-offs. In most cases, the benefits of retaining one's money, or the personal costs of donating, are much better defined than the benefits that donations confer on others (or the costs to others of not donating).

Because these trade-offs are ill defined and thus difficult to calculate with any precision, charitable giving is highly erratic and only loosely tied to the needs or the benefits realized by recipients. For example, people appear to be much more sympathetic when victims are tangible and identifiable than when they are abstract. Consider, for instance, the following scenario:

> *The Vintage Sedan*. Not truly rich, your one luxury in life is a vintage Mercedes sedan that, with much time, attention, and money, you've restored to mint condition. In particular, you're pleased by the auto's fine leather seating. One day, you stop at the intersection of two small country roads, both lightly travelled. Hearing a voice screaming for help, you get out and see a man who's wounded and covered with a lot of his blood. Assuring you that his wound is confined to one of his legs, the man also informs you that he was a medical student for two full years. And, despite his expulsion for cheating on his second year final exams, which explains his indigent status since, he's knowledgeably tied his shirt near the wound as to stop the flow. So, there's no urgent danger of losing his life, you're informed, but there's great danger of losing his limb. This can be prevented, however, if you drive him to a rural hospital fifty miles away. 'How did the wound occur?' you ask. An avid bird-watcher, he admits that he trespassed on a nearby field and, in carelessly leaving, cut himself on rusty barbed wire. Now, if you'd aid this trespasser, you must lay him across your fine back seat. But, then, your fine upholstery will be soaked through with blood, and restoring the car will cost over five thousand dollars. So, you drive away. Picked up the next day by another driver, he survives but loses the wounded leg.

As explained by Unger (1996) in his landmark philosophical volume 'Living high and letting die', the typical person finds the sedan driver's actions reprehensible. But before considering why, let us consider a second scenario:

> *The Envelope*. In your mailbox, there's something from (the US Committee for) UNICEF. After reading it through, you correctly believe that, unless you soon send in a cheque for $100, then, instead of each living many more years, over thirty more children will die soon. But, you throw the material in your trash basket, including the convenient return envelope provided, you send nothing, and instead of living many years, over thirty more children soon die than would have had you sent in the requested $100.

As Unger points out, this envelope problem presents a more serious moral transgression than the sedan problem for several reasons: more people are affected, less is required to help them, and their survival, not just their health is at stake. Nevertheless, people commonly view a lack of response to the sedan problem as morally wrong, yet view a lack of response to the envelope problem as morally acceptable. Unger outlines a list of potential reasons why the two problems are viewed differently, and concludes that the differences between the scenarios provide no moral justification to take action in the sedan problem but not in the envelope problem. Critically, however, the differences between the two problems are important psychologically.

Most centrally, the two scenarios are different in terms of psychological tangibility.

In the sedan problem, the victim is visible and tangible. Walking away means leaving a person to suffer who you have seen first hand, something very difficult (and blameworthy) to do. In the envelope problem, however, the victims are far away, unknown and abstract. It is difficult to imagine the victims, let alone empathize with their suffering. And, without the ability to imagine their need, it is nearly impossible to imagine how $100 can do any good. Therefore, you throw away the envelope with a clear conscience and, as described by Unger, with the blessing of your peers.

Many empirical studies also suggest that tangibility promotes generosity. Small & Loewenstein (2003), for example, found that people are more generous to identifiable victims than to abstract victims. To demonstrate this 'identifiable victim effect', Small & Loewenstein (2003) conducted a study in which several participants were each given $10 and privately assigned a unique identification number. Half (the 'victims') were then randomly chosen to lose the money, and each fortunate participant who kept their $10 could give any portion of their endowment to a victim with whom they were randomly paired. All that varied was whether each fortunate participant learned their victim's identification number immediately before or immediately after the decision to give. That is, from the fortunate participant's perspective, the target of their generosity was either determined or undetermined at the moment of choice. The manipulation was designed to unconfound identifiability and information about the victim, which are normally confounded in the real world. Although the manipulation was subtle, fortunate participants gave significantly more to determined victims than to undetermined victims.

Another finding at odds with the explicit trade-off paradigm is that people tend to be more sensitive to the proportion of lives saved than to the absolute number of lives saved (Baron 1997; Featherstonhaugh *et al.* 1997; Jenni & Loewenstein 1997; Friedrich *et al.* 1999; Small *et al.* 2007). For example, the possibility of saving 10 out of 100 people in imminent danger is more appealing and motivating than the possibility of saving 10 out of 1 000 000 people in danger. In the latter case, any effort to help may be perceived as a mere 'drop in the bucket'. The identifiable victim effect may be a special case of a preference for saving proportions. Identifiable victims limit our ability or motivation to attend to other victims, thus becoming their own reference group and receiving maximum sympathy.

These findings suggest that the extent to which one's donation is expected to produce tangible benefits is far more critical than the explicit trade-off paradigm would suggest. When victims are identifiable, it is easier to imagine those victims directly benefiting from any particular donation. When there are many victims, potential donors may fear that each victim will only receive some vanishingly small portion of their donation, merely producing a drop in each of several buckets. Similarly, the prospect of saving only a small proportion of a large pool of potential victims fails to motivate potential donors who need to believe their efforts will produce tangible benefits.

Other research suggests that campaigns that emphasize that they are close to reaching their fund-raising goal diminish the likelihood that donors will feel as if their efforts merely represent a drop in the bucket. List & Lucking-Reiley (2002), for example, found that donations are greater when potential donors learn that seed grants have provided two-thirds of the total amount needed than when seed grants have only provided 10 per cent of the total. One interpretation of this result is that the benefits of a donation are perceived as more tangible when a specific goal is neared—much as the baseball player whose hit moves the team ahead of the other team receives disproportionate credit.

Although tangibility is not an issue from the explicit trade-off perspective, the extent to which donations produce tangible benefits clearly influences giving. The precise mechanisms by which tangibility influences giving are still somewhat unclear, and neuroeconomic research could be informative. For example, neuroeconomic studies that vary the extent to which victims are determined at the moment of choice could examine whether negative affect (in the form of a pain of donating) prevents giving to undetermined victims or whether negative affect (in the form of guilt) promotes giving to determined victims. Alternatively, the extent to which victims are determined at the moment of choice may influence activation in regions diagnostic of pleasure: potential donors who can easily imagine their donations producing tangible benefits may experience more pleasure than potential donors who cannot easily conjure such thoughts.

5. CONCLUSIONS

In debates over the usefulness of mathematical modelling, one often hears the defence, against the attack that models are simplistic, that models are supposed to be simplistic; their benefit is in simplifying, and hence illuminating, aspects of reality. However, the same properties that enable models to illuminate reality also provide the means for models to distort reality. The explicit trade-off perspective, we believe, has had both of these effects. On the one hand, it has helped to identify a wide class of decisions, intertemporal choices, that share a common element: trade-offs of costs and benefits occurring at different points in time. Combining diverse types of decisions under the common heading of intertemporal choice, however, may have also obscured important aspects of reality by suggesting greater commonalities between decisions than might in fact exist. For example, the decision of how much to save and the decision of whether to act on one's road rage are both intertemporal choices (albeit both including an admixture of risk). However, the mechanisms underlying these two 'choices' are likely to be very different, and categorizing both as intertemporal choices may lead one to assume greater commonality than actually exists.

In this paper, we have argued that one way in which the current perspective has distorted reality is by blinding us to the fact that most intertemporal choices involve not only time delay but tangibility as well. Do people fail to take their medications because the costs of taking them are immediate and the benefits delayed,

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

or because the costs are tangible while the benefits are amorphous (particularly for so-called 'silent killers')? Do those who want to lose weight fail to diet effectively because the benefits of abstaining are delayed or because they are ill defined (due to metabolism, the uncertain behaviour of future selves and other factors only loosely related to consumption today)? Unwitting reliance on an explicit trade-off perspective, we believe, has tended to blind researchers, in each of these cases and many more, to the second set of considerations.

Tangibility is relevant for more than intertemporal choice, as hinted at by our brief discussion of its role in charitable giving. It is also relevant to decisions that transcend the individual. Thus, for example, McKibben (1999) in a newspaper article titled 'Indifference to a planet in pain' noted that the lack of a concerted response to global warming is in part a function of the problem's intangibility. As he writes, 'We don't yet feel viscerally the wrongness of what we're doing… How bad it will get depends on how deeply and quickly we can feel.' Understanding the role of tangibility in decision making is not only critical for the health and well-being of individuals, but may also be critical for that of the planet as a whole.

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ENDNOTES

[1]Low glucose levels (or poor glucose tolerance) have been linked to criminal behaviour (e.g. Rojas & Sanchi 1941; Virkkunen 1984), extreme impulsivity (e.g. Virkkunen *et al.* 1987) and alcohol abuse (e.g. Wright 1977; Linnoila & Virkkunen 1992). Correspondingly, consuming glucose can restore will power (e.g. Kissin & Gross 1968; West & Willis 1998). Gailliot *et al.* (2007), for instance, conducted a study in which participants initially watched the same video used by Vohs & Faber (2007), again varying whether or not participants controlled their attention. Some participants then received a drink rich in glucose; others received a placebo drink without glucose. Finally, all participants were given a difficult task to complete, with mistakes serving as a measure of self-control. Consistent with prior will power research, the participants who received the placebo drink made more mistakes if they initially completed the difficult attention-control task. Crucially, however, glucose eliminated this difference. These findings pose a challenge to economic models of decision making, which (implicitly) assume that we are always in the high-glucose condition.

[2]The failure to spontaneously make explicit trade-offs is by no means limited to spending decisions (e.g. Northcraft & Neale 1986; Okada & Hoch 2004). Legrenzi *et al.* (1993), for example, asked participants whether or not they wanted to see a particular film in a foreign city. The participants were allowed to ask the experimenters any questions they might have to help them make their decision. Their questions focused almost exclusively on the film itself, with very few pertaining to other options that were available to them (e.g. going out to dinner, going to a sporting event). Camerer *et al.* (1997) similarly found that many New York City cab drivers set daily income targets and therefore stop working earliest on their most profitable days (e.g. rainy days), when the opportunity cost of leisure is highest.

[3]It must be acknowledged, however, that as in all fMRI studies, this one is subject to the problems of inferring causation from correlational data, inferring the engagement of a particular cognitive or emotional response from activation in a particular brain region (Poldrack 2006), inferring actual brain activation from BOLD response and making sense of such indirect indications of activation.

[4]Referring to such consumers as 'spendthrifts' can be traced (at least) to Strotz (1955–1956, p. 165): 'An individual is imagined to choose a plan of consumption for a future period of time so as to maximize the utility of the plan as evaluated at the present moment…If he is free to reconsider his plan at later dates, will he abide by it or disobey it—even though his original expectations of future desires and means of consumption are verified? Our present answer is that the optimal plan of the present moment is generally one which will not be obeyed, or that the individual's future behavior will be inconsistent with his optimal plan. If this inconsistency is not recognized, our subject will typically be a 'spendthrift'.'

[5]Similar incentive programmes have decreased drug addicts' propensity to relapse. Stephen Higgins and collaborators have developed 'voucher-based reinforcement therapy' that essentially 'bribes' addicts to desist by frequently rewarding desistance with vouchers redeemable for retail goods (see Higgins *et al.* 2004 for a review). The therapy has successfully reduced relapse among users of several addictive substances, including cocaine (Higgins *et al.* 1991), opiates (Silverman *et al.* 1996; Bickel *et al.* 1997), alcohol (Petry *et al.* 2000), marijuana (Budney *et al.* 1991) and cigarettes (Roll *et al.* 1996; Roll & Higgins 2000). Similar to dieting, addiction is a domain in which neuroscience could shed much-needed light on the role of emotions experienced at the moment of choice.

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PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES