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The Value of Nothing: Asymmetric Attention to Opportunity Costs Drives Intertemporal Decision Making

Daniel Read
Behavioural Science Group, Warwick Business School, University of Warwick, Coventry CV4 7AL, United Kingdom, daniel.read@wbs.ac.uk

Christopher Y. Olivola
Tepper School of Business, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213, olivola@cmu.edu

David J. Hardisty
Department of Marketing and Behavioural Science, Sauder School of Business, University of British Columbia, Vancouver, British Columbia V6T 1Z4, Canada, david.hardisty@sauder.ubc.ca

This paper proposes a novel account of impatience: People pay more attention to the opportunity costs of choosing larger, later rewards than to the opportunity costs of choosing smaller, sooner ones. Eight studies show that when the opportunity costs of choosing smaller, sooner rewards are subtly highlighted, people become more patient, whereas when the opportunity costs of choosing larger, later rewards are highlighted this has no effect. This pattern is robust to variations in the choice task, to the participant population, and to whether the choices are incentivized or hypothetical. We argue that people are naturally aware of the opportunity costs of delayed rewards but pay less attention to those associated with smaller, sooner ones. We conclude by discussing implications for theory and policy.

Data, as supplemental material, are available at https://doi.org/10.1287/mnsc.2016.2547.

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Introduction

Many of our most consequential choices involve trading off an outcome's magnitude against its timing. Should we accept a job offer right after graduating or invest in further education to earn more later? Should we consume now or invest to enable more consumption later? Do we socialize at the bar after work or stay overtime to save for that dream vacation? The ubiquity and importance of such *intertemporal* choices has spawned a rich literature (for reviews, see Frederick et al. 2002, Read 2004, Urminsky and Zauberman 2014). One key finding from this literature is that humans are generally impatient, often preferring smaller earlier rewards to larger delayed ones, even when waiting offers interest rates far in excess of those typically available to consumers (e.g., Frederick et al. 2002, Read et al. 2013, Olivola and Wang 2015). Impatience has been implicated in a wide range of suboptimal behaviors (Reimers et al. 2009), such as making insufficient provisions for retirement (Thaler and Benartzi 2004), exercising too little (Chabris et al. 2008), smoking too much (Bickel et al. 1999), and neglecting the damaging effects of current consumption choices on the environment faced by future generations (Hardisty and Weber 2009, Hardisty et al. 2012). Here, we propose a novel account of impatience based on the attention given to the opportunity costs of competing intertemporal choice options. Specifically, we argue that the opportunity costs of later consumption are naturally more salient, or given greater decision weight, than the opportunity costs of earlier consumption. This biases choices toward smaller, sooner rewards and away from larger, later ones. Consequently, highlighting the (already salient) opportunity costs of waiting longer does not affect patience, but highlighting the less salient opportunity costs of not waiting (as long) increases patience. We call this the *asymmetric subjective opportunity cost* hypothesis. In this paper, we test the predictions of this hypothesis and explore its generalizability through a series of studies. In doing so, we also explain a puzzling phenomenon known as the "Hidden zero effect" (Magen et al. 2008).

Table 1 Key Terms and Abbreviations Along with Their Definitions

Term	Definition
SS	The smaller, sooner option in intertemporal choice. This option produces a smaller outcome, but does so sooner; e.g., "Receive $100 today."
LL	The larger, later option. This option produces a larger outcome, but does so later; e.g., "Receive $150 in one year."
SS opportunity cost	The opportunity cost of choosing the *SS* option. This is the *LL* outcome that decision makers would forgo (at the time when the *LL* outcome would occur) if they chose the *SS* option.
LL opportunity cost	The opportunity cost of choosing the *LL* option. This is the *SS* outcome that decision makers would forgo (at the time when the *SS* outcome would occur) if they chose the *LL* option.
SS zero/*SS* nothing frame	Frame in which the *SS* option is described as offering zero (or nothing) at the time when the *LL* outcome would occur; e.g., "Receive $100 today *and* $0 *in one year*," or "Receive $100 today *and nothing in one year*." In other words, this frame only highlights the *SS* opportunity cost.
LL zero/*LL* nothing frame	Frame in which the *LL* option is described as offering zero (or nothing) at the time when the *SS* outcome would occur; e.g., "Receive $0 *today and* $150 in one year," or "Receive *nothing today and* $150 in one year." In other words, this frame only highlights the *LL* opportunity cost.
Explicit zero/Explicit nothing frame	Frame in which the *SS* option is described as offering zero (or nothing) at the time when the *LL* outcome would occur and the *LL* option is described as offering zero (or nothing) at the time when the *SS* outcome would occur. In other words, this frame highlights both the *SS* opportunity cost and the *LL* opportunity cost.
Hidden zero/Hidden nothing frame	This is the standard frame that is typically used in intertemporal choice problems. This frame does not explicitly mention the zero (or nothing) outcomes associated with each option. In other words, this frame highlights neither the *SS* opportunity cost nor the *LL* opportunity cost.
ASOC effect	The Asymmetric Subjective Opportunity Cost effect is the main implication of the asymmetric subjective opportunity cost hypothesis. The empirical result is that frames in which the *SS* zero (or *SS* nothing) is included increase patience, while frames in which the *LL* zero (or *LL* nothing) is included do not decrease (nor increase) patience.

Asymmetric Subjective Opportunity Cost Neglect

In the language of economics, the term "opportunity cost" is short for "you can't have it all." We have to choose something, and what we do not choose is the opportunity cost of what we do. More formally, the opportunity cost of an option is the value of its best alternative (where "value" incorporates all the consequences of that alternative). If your two best options (or your only options) are X and Y, and you can have only one of them, then the opportunity cost of X is Y, and the opportunity cost of Y is X. In a prototypical intertemporal choice, a smaller outcome that occurs sooner (denoted *SS*) is pitted against a larger one that occurs later (*LL*). In these two-option cases, the opportunity cost of *SS* is *LL* and the opportunity cost of *LL* is *SS*. Rational decision makers will choose the option with the lower opportunity cost: if the opportunity cost of *SS* exceeds that of *LL*, they will be *patient* and choose the larger but later option. (Table 1 explains key abbreviations used throughout the paper.)

However, much research has shown that people often neglect opportunity costs (Shafir and Thaler 2006), so that seemingly trivial or redundant reminders of opportunity costs can alter the perceived attractiveness of options and push people toward options that do not incur those costs (Frederick et al. 2009, Greenberg and Spiller 2016, Spiller 2011).[1] For instance, simply prompting consumers with the obvious fact that buying the cheaper of two products will leave them with "extra money" makes that cheaper product more attractive and increases their likelihood of purchasing it (Frederick et al. 2009). This observation led Frederick et al. (2009) to suggest that opportunity cost reminders have an asymmetric effect, in that they shift preferences toward the cheaper option, rather than the higher quality one. We interpret this as follows: in a straight choice between options, the quality given up by taking the cheaper option is naturally salient to consumers, but the money given up by taking the higher quality option is not. In a more recent paper, Chatterjee et al. (2016) observed two asymmetries: for experiential goods, such as holidays, highlighting temporal opportunity costs (but not financial opportunity costs) increases liking for the temporally cheaper good, whereas for material goods, such as computers, highlighting financial opportunity costs (but not temporal ones) increases liking for the financially cheaper good.

We propose that the tendency to discount the future stems in part from another asymmetry in opportunity cost neglect. Specifically, while people are naturally well aware of the opportunity costs of *LL* (forgoing an earlier benefit), they pay less attention to the opportunity costs of *SS* (forgoing a later benefit). This does not mean they do not "know" that choosing *SS* will mean

[1] The term "opportunity cost" is often used loosely to refer to any alternative to a given option, and not necessarily, as it is defined in economics, to the *best* alternative. In a two-alternative forced choice, however, the option forgone is the opportunity cost of the option taken even by the strict economic definition.

Table 2 The Four Core Zero Frame Conditions and Their Opportunity Cost Implications

		SS opportunity cost	
		Implicit	Explicit
LL opportunity cost	Implicit	Hidden zero: $100 today OR $150 in one year	*SS* zero: $100 today and $0 in one year OR $150 in one year
	Explicit	*LL* zero: $100 today OR $0 today and $150 in one year	Explicit zero: $100 today and $0 in one year OR $0 today and $150 in one year

they would not get *LL*—any more than they do not "know" that buying the cheaper of two products will leave them with money to spare—but rather that this knowledge is underweighted in their decision making. The opportunity cost of *SS*, therefore, plays a smaller role in intertemporal decision making than the opportunity cost of *LL*.

This proposed asymmetry in intertemporal opportunity cost salience leads to the following predictions: When the opportunity costs of *LL* are highlighted, patience will be unaffected, since these costs are naturally salient; but if the opportunity costs of *SS* are highlighted, patience (or choices of *LL*) will be increased. We tested these predictions by employing framing manipulations that subtly highlight the opportunity costs of *SS* and/or *LL* in standard intertemporal choice tasks.

These standard tasks involve choices between smaller, sooner (*SS*) and larger, later (*LL*) payments such as "$100 today OR $150 in one year." Patience is measured as the propensity to choose *LL*. In the example just given, the opportunity cost of choosing *LL* is that you will miss out on receiving $100 today, while the opportunity cost of choosing *SS* is that you will miss out on receiving $150 in one year. Magen et al. (2008) showed that providing a subtle nudge that draws attention to *both* opportunity costs made people more patient. They compared two ways of framing intertemporal choices, which they termed the "Hidden zero" and "Explicit zero" frames:

Hidden zero: $100 today OR $150 in one year;

Explicit zero: $100 today *and* $0 *in one year* OR $0 *today and* $150 in one year.

By emphasizing that each option will yield "$0" at the time its alternative pays off, the Explicit zero frame highlights the opportunity costs of *both SS and LL*. Magen et al. (2008) found that patience was increased by the Explicit zero frame—a phenomenon they called the Hidden zero effect. Similar results were earlier reported by Loewenstein and Prelec (1991, 1993), and later replicated by Radu et al. (2011), Wu and He (2012), Read and Scholten (2012), and Magen et al. (2014).

One question raised by the Hidden zero effect is why highlighting the opportunity costs of *both* options increases patience, rather than leaving it unchanged or even reducing it. One might have expected the two explicit opportunity costs would exert countervailing effects: Highlighting the opportunity cost of choosing *SS* through what we will call the "*SS zero*" (the later zero added to the description of *SS*) would favor patience, whereas highlighting the opportunity cost of choosing *LL* by including the "*LL zero*" (the earlier zero added to the description of *LL*) would favor impatience. The Hidden zero effect, in which highlighting both opportunity costs increases patience, suggests the *SS* zero must have more impact on patience than the *LL* zero. In fact, based on our theoretical account, we hypothesize a strong form of asymmetry such that the *SS* zero should increase patience while the *LL* zero should have no effect whatsoever on patience (not even a weaker effect).

In the studies reported below, we test this hypothesis by decomposing the Explicit zero frame into two frames that isolate each opportunity cost reminder:

SS zero frame: $100 today *and* $0 *in one year* OR $150 in one year;

LL zero frame: $100 today OR $0 *today and* $150 in one year.

The entire design is depicted in Table 2. We refer to the four frames described above and in Table 2 (Hidden zero, Explicit zero, *SS* zero, *LL* zero) as the *core frames*. In our studies, we find that the increased patience in the Explicit zero condition is entirely due to the *SS* zero. A similar finding was reported by Wu and He (2012) in an East Asian sample,[2] but we go beyond this result to show it is robust to variations

[2] We learned of Wu and He's (2012) excellent paper only after we had finished Studies 1–4 in this paper and completed a draft of this manuscript. Although Wu and He (2012) first demonstrated what we call the ASOC effect, this is not the focus of their paper (indeed, only one of their studies contains an *SS* zero frame).

in the magnitude, timing, sign, and nature of outcomes, and also that it generalizes to different, but theoretically equivalent, ways of highlighting the *SS* zero. Moreover, we show it is associated with differences in choice times in a manner consistent with our proposed theory: the *SS* zero substantially increases choice time, whereas the *LL* zero has little or no effect. This suggests the *SS* zero frame increases attention paid to information that people may not naturally consider, whereas the *LL* zero frame is already intuitively obvious and thus leads to no additional processing of opportunity costs.

Study 1

In Study 1 we investigated the asymmetric subjective opportunity cost hypothesis by testing the core frames described above along with one further frame. The core frames provided a test of the proposed asymmetry: highlighting the opportunity cost of *SS* will increase patience (regardless of whether the *LL* opportunity cost is also highlighted), but highlighting the opportunity cost of *LL* will have no effect (in either direction) on patience (regardless of whether the *SS* opportunity cost is already highlighted). The main empirical implication of the asymmetric subjective opportunity cost hypothesis is what we will label the ASOC (Asymmetric Subjective Opportunity Cost) *effect*: relative to the Hidden zero frame (with no opportunity costs explicit), the *SS* zero frame (with the opportunity cost of choosing SS made explicit) will increase choices of *LL*, but the *LL* zero frame (with opportunity cost of choosing *LL* made explicit) will not; moreover, patience in the Explicit zero frame (which makes both opportunity costs explicit) will be the same as that in the *SS* zero frame (since only the *SS* zero has any effect). In summary, we began with the following predictions over the ordering of *LL* choice proportions across the four conditions:

$$SS \text{ zero} = \text{Explicit zero} > \text{Hidden zero} = LL \text{ zero},$$

or

$$SS \text{ zero} - \text{Hidden zero} > \text{Hidden zero} - LL \text{ zero}.$$

The latter prediction is the heart of the asymmetric subjective opportunity cost hypothesis and, as already mentioned, we repeatedly find that while the difference on the left of the inequality is positive (i.e., *SS* zero > Hidden zero), the difference on the right is essentially zero (i.e., *LL* zero = Hidden zero).

One additional frame was included to test the Magen et al. (2008) proposal that the Hidden zero effect occurs because the Explicit zero frame turns *LL* into an increasing sequence of payoffs (as in, "first you receive \$0, then you receive \$150") and *SS* into a decreasing one ("first you receive \$100, then you receive \$0"). Because researchers had already reported that people prefer increasing over decreasing sequences of earnings (e.g., Chapman 1996, 2000; Loewenstein and Sicherman 1991; Read and Powell 2002), it follows that the Explicit zero frame would produce more choices of the increasing *LL* sequence relative to the decreasing *SS* one.[3] Loewenstein and Prelec (1993) had previously tested this idea with nonmonetary choices. Their respondents chose between: "Dinner at [a fancy] French restaurant on Friday in one month" or "Dinner at [a fancy] French restaurant on Friday in two months." When the options were presented this way, only 20% preferred to delay the French restaurant dinner. However, when both options were turned into temporal sequences by adding a "zero" outcome (Decreasing sequence: "Dinner at [a fancy] French restaurant on Friday in one month *and dinner at home on Friday in two months*;" Increasing sequence: "*Dinner at home on Friday in one month and* dinner at [a fancy] French restaurant on Friday in two months"), many more preferred to delay the French dinner. Loewenstein and Prelec (1993, p. 93) observed that "[b]ecause people eat dinner at home on most nights anyway, the mere embedding of the French dinner in an explicit binary sequence [reminds the subject] that the choice is 'really' between complete sequences."

Radu et al. (2011) previously contributed evidence against the sequence hypothesis by showing the Hidden zero effect extends backward in time, to past outcomes. Here, we provided a more direct test of the sequence hypothesis for future outcomes via a "Middle zero" frame, which was like the Explicit zero frame, but with the zeros occurring halfway (in time) between the *SS* and *LL* outcomes:

Explicit zero: \$100 today and \$0 in one year OR \$0 today and \$150 in one year;

Middle zero: \$100 today and \$0 in *six months* OR \$0 in *six months* and \$150 in one year.

The Middle zero frame forms increasing and decreasing sequences, just like the Explicit zero frame, but because both options offer \$0 in six months (rather than today or in one year), it does so *without drawing attention to either opportunity cost*. The sequence hypothesis would predict greater patience in the Middle zero than in the Hidden zero frame and, more generally, that the five conditions would be ordered as follows (in terms of *LL* choice proportions):

$$\text{Explicit zero} = \text{Middle zero} > SS \text{ zero} = LL \text{ zero} > \text{Hidden zero}.$$

That is, *both* the *SS* zero frame (which turns *SS* into a decreasing sequence) *and* the *LL* zero frame (which

[3] Some studies also find preferences for decreasing or constant monetary sequences over increasing ones (e.g., Frederick and Loewenstein 2008, Gigliotti and Sopher 1997, Guyse et al. 2002, Manzini et al. 2010).

turns *LL* into an increasing sequence) would yield greater patience than the Hidden zero frame. Such an account would also predict that patience would be greater when both zeros are present (as in the Explicit zero and Middle zero frames), compared to when only one is. The asymmetric subjective opportunity cost hypothesis, on the other hand, does not differentiate between the Hidden and Middle zero frames, but *does* differentiate between the *SS* and *LL* zero frames, and so predicts:

SS zero = Explicit zero > Hidden zero = Middle zero = *LL* zero.

The Middle zero frame also permitted us to test yet another explanation for the Hidden zero effect: that making zero outcomes explicit increases the perceived size of the nonzero outcomes by contrast (e.g., Bateman et al. 2007). Increasing the perceived sizes of both nonzero outcomes, in this way, could produce a magnitude effect—the well-known finding that people are more patient when larger monetary amounts are at stake (first reported by Thaler 1981, and replicated extensively). This could produce two possible patterns of results, depending on whether the numerical contrast generated by a zero applies to both options (global numerical contrast) or only to the option associated with that zero (local numerical contrast: the *SS* zero makes the *SS* outcome appear larger and the *LL* zero makes the *LL* outcome appear larger):

Global numerical contrast: Explicit zero = Middle zero ≥ *SS* zero = *LL* zero > Hidden zero;

Local numerical contrast: *LL* zero ≥ Explicit zero = Middle zero > Hidden zero > *SS* zero.

Methods

Participants. Participants in this web-based study were recruited through Maximiles (http://www.maximiles.co.uk), an Internet service in which members earn points by completing surveys (see Reimers 2009 for additional details), which they can then exchange for prizes. Our sample consisted of 710 British residents (44% female; mean age = 46.7 years), who participated in exchange for Maximiles points. As with all studies in this paper, sample sizes were chosen to provide sufficient power to detect what we anticipated would be a modest effect size (as seems typical for this type of framing manipulation). Therefore, we always recruited at least 60 participants per between-subjects cell, which gave us 80% power to detect main effects of $d = 0.36$ or larger in our 2×2 designs (i.e., the four "core" frames tested throughout this paper).

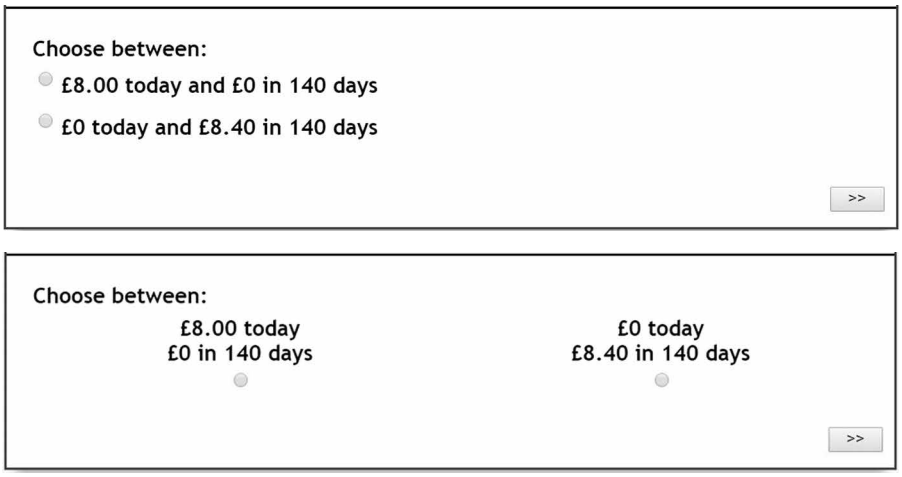
Procedure. Participants were randomly assigned to one of the four core frames, or to the Middle zero frame. They made 15 hypothetical choices between smaller, sooner (*SS*) payments available today, and larger, later (*LL*) ones, with each pair of options presented in the assigned frame. These choice items, shown in the top half of Table 3, were identical to those tested by Magen et al. (2008), except with payoffs in sterling (£). As Table 3 shows, these items are characterized by small payments (ranging from £2 to £8.70), and the fact that the *SS* option is available

Table 3 **Delay Lengths and Payoff Magnitudes for the 15 Items Drawn From Magen et al. (2008) (the "Magen Items"), and the 27 Items Drawn From Kirby et al. (1999) (the "Kirby Items")**

Smaller, sooner (*SS*)	Larger, later (*LL*)		Middle zero	
Amount	Amount	Delay (days)	Delay (days)	Subsets
Magen et al. (2008) items (the "Magen items")				
£2.00	£8.50	18	9	
£3.10	£8.50	7	4	
£3.30	£8.00	14	7	
£4.10	£7.50	20	10	*
£4.30	£7.50	22	11	*
£4.50	£7.70	28	14	*
£4.70	£5.40	92	46	*
£4.90	£5.80	42	21	*
£5.00	£7.20	34	17	*
£5.40	£8.00	30	15	*
£5.50	£7.50	61	31	*
£6.00	£8.50	46	23	*
£6.70	£7.50	119	60	*
£6.90	£8.70	102	51	*
£8.00	£8.40	140	70	
Kirby et al. (1999) items (the "Kirby items")				
$11	$30	7		
$14	$25	19		*
$15	$35	13		
$19	$25	53		*
$20	$55	7		
$22	$25	136		
$24	$35	29		*
$25	$30	80		
$25	$60	14		
$27	$50	21		*
$28	$30	179		
$31	$85	7		
$33	$80	14		
$34	$35	186		
$34	$50	30		*
$40	$55	62		
$41	$75	20		
$47	$50	160		
$49	$60	89		*
$54	$55	117		
$54	$60	111		
$54	$80	30		
$55	$75	61		
$67	$75	119		*
$69	$85	91		
$78	$80	162		
$80	$85	157		

Notes. Payments were in £ for UK studies and $ for U.S. studies. Items identified with an asterisk in the rightmost column were used in selected studies.

Figure 1 **(Color online) Example Screen Shot From Study 1, Showing the Vertical (Top) and Horizontal (Bottom) Presentations of Choice Questions in the Explicit Zero Framing Condition**



"today" (i.e., never delayed). From here on, we refer to these choice items as the "Magen" items.

The choice items were presented individually (i.e., one pair of options at a time), and their ordering was randomized for each person. Options were presented vertically (as Magen et al. had done; see the top part of Figure 1) for half the respondents, and horizontally (with *SS* appearing to the left of *LL*; see the bottom part of Figure 1) for the other half. This allowed us to test whether the Hidden zero effect was due to the visual alignment of payoffs across time in the Explicit zero (but not the Hidden zero) frame.

In all conditions, our measure of patience (the dependent variable) was the proportion of *LL* choices.

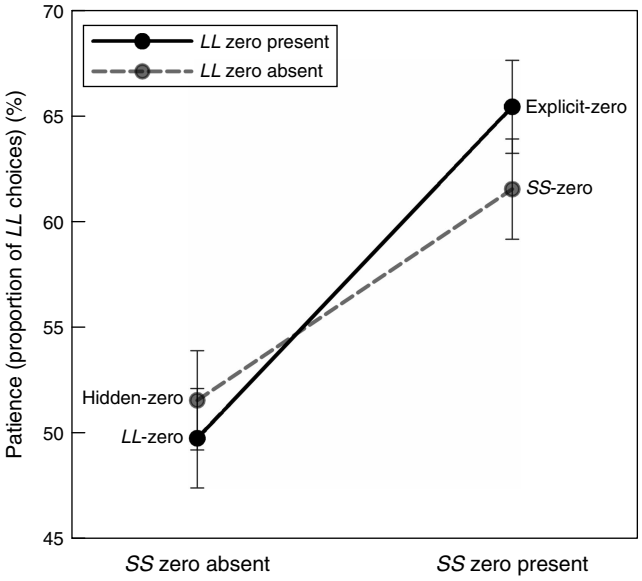
Results

Patience was unaffected by whether options were presented vertically or horizontally. This was confirmed by a 5 (zero frame) by 2 (presentation format: vertical versus horizontal) ANOVA, which revealed neither a main effect of format ($F(1, 700) = 0.21$), nor a frame by format interaction ($F(4, 700) = 0.63$). The main effect of zero frame was, however, highly significant, $F(4, 700) = 9.74$, $p < 0.0001$, $\eta_p^2 = 0.05$. We, therefore, collapsed across presentation format (vertical versus horizontal) and focused our analyses on the zero frames.

First, we examined the Middle zero frame: Patience was virtually identical across the Middle zero and Hidden zero frames (51% versus 52% *LL* choices, $t < 0.27$). This rules out the sequence-preference and numerical contrast explanations, which both predict greater patience in the Middle zero frame, but not the asymmetric subjective opportunity cost hypothesis, which does not predict a Middle zero effect.

Next, as depicted in Figure 2, we compared patience in the four core frames. We obtained the original finding of much greater patience in the Explicit zero than the Hidden zero frame (65% versus 52% *LL* choices, $t(282) = 4.31$, $p < 0.0001$, $d = 0.51$). Consistent with the asymmetric subjective opportunity cost hypothesis, however, this was entirely attributable to the *SS* zero. As predicted, patience did not differ between the *SS* and Explicit zero frames, both of which yielded greater patience than the *LL* and Hidden zero frames (which did not differ). A 2 (*LL* zero: present versus absent) by 2 (*SS* zero: present versus absent) ANOVA confirmed the main effect of *SS* zero ($F(1, 561) = 30.65$, $p < 0.0001$, $\eta_p^2 = 0.05$), whereas there was no effect of *LL* zero nor an interaction (both ps > 0.2).

Figure 2 **Mean Level of Patience (Proportion of *LL* Choices), as a Function of Zero Framing, in Study 1**



Notes. The horizontal axis indicates the presence or absence of the *SS* zero; the solid line indicates the presence of the *LL* zero and the dotted line indicates its absence. Error bars represent +/− 1 SE.

Discussion

The results of Study 1 support the asymmetric subjective opportunity cost hypothesis. Relative to the standard Hidden zero condition, patience increases when options are framed to highlight how choosing *SS* entails forgoing a later reward, but it is unchanged when the frame highlights how choosing *LL* entails forgoing an earlier reward. In addition, our results ruled out the two alternative explanations for the "Hidden zero" effect that we discussed above: sequence-preference (Loewenstein and Prelec 1993, Magen et al. 2008; see also Radu et al. 2011) and numerical contrast (Bateman et al. 2007). Finally, the results ruled out two additional explanations that were later brought to our attention: "averaging," and "similarity." The "averaging" account (e.g., Anderson 1974, Troutman and Shanteau 1976) suggests that a choice option may be evaluated as the average of its components, and therefore that adding a "zero" to an option with positive payoffs makes it less attractive. This account would not predict the absence of an *LL* zero effect (contrary to what we found). Furthermore, an "asymmetric averaging" account (whereby averaging is only applied to the *SS* option) would not predict a null effect in the Middle zero condition (contrary to what we found). The "similarity" account suggests that adding zeros to both options makes them appear more similar, which might increase random responding (Franco-Watkins et al. 2006, 2010). However, similarity would predict that the proportion of *LL* choices would be closer to 50% in the Explicit zero condition, yet we observed the opposite (see Figure 1). Furthermore, similarity would not predict a null effect in the Middle zero condition (contrary to what we found).

Studies 2–5

In Studies 2–5 we investigated the generalizability of the asymmetric subjective opportunity cost hypothesis by changing the sizes (Study 2) or signs (Study 4) of the payoffs, by adding delays (Study 3), and by using an alternative wording to highlight the opportunity costs (Study 5). The choice items presented in Studies 2–5 were subsets of the 42 depicted in Table 3. In Study 2, we used the 27 choice items devised by Kirby et al. (1999), and which have been widely used in studies of delay-discounting (e.g., Chabris et al. 2008, Luo et al. 2011, Myerson et al. 2014, Scholten et al. 2014, Torres et al. 2013). These "Kirby" items (presented in the bottom half of Table 3) involve larger payoffs than the "Magen" items (top half of Table 3) and were originally developed to test the magnitude effect—the tendency for patience to increase as both the *SS* and *LL* payoffs are increased by a common multiplicative constant. The Kirby items are known to be reliable and to have high external validity (Myerson et al. 2014).

Studies 3—5 used subsets of the Magen and/or Kirby items (items identified with an asterisk in the rightmost column of Table 3). The "*Magen subset*" comprised the 11 items from the original Magen items that showed a strong Explicit zero effect (but not necessarily the strongest ASOC effect) in Study 1. This was mainly done to avoid using items that yielded a clear ceiling or floor effect (i.e., items for which almost everyone chose the *SS* option or the *LL* option, across all frames). The "*Kirby subset*" comprised seven Kirby items chosen from among those that showed the strongest Explicit zero effect in Study 2.[4] Participants in Study 3 completed the 11-item Magen subset, while those in Study 4 completed the seven-item Kirby subset. Participants in Study 5 were presented with both subsets together (i.e., a total of 18 items).

As in Study 1, our main dependent variable was the proportion of "patient" (*LL*) choices. In these studies (and all future studies we report), we specifically recruited individuals who had not previously participated in any of our zero-framing studies.

Study 2

Study 2 tested the generality of the ASOC effect using the Kirby items, which also allowed us to investigate whether the effect is moderated by outcome magnitude. One possibility, for instance, is that when small payoff amounts are on the table, the effect is particularly prominent because it is a relatively trivial matter to ignore the *SS* opportunity cost, but as outcome magnitude increases, the *SS* opportunity cost becomes increasingly salient. In this case, payoff size would moderate the ASOC effect. Alternatively, the effect might be robust to variations in payoff size.

The Kirby items form nine sets of three choices (triplets) in which the *SS* outcome is transformed into the *LL* one by a common linear growth rate, ranging from 0.016% to 25% per day. One *SS* outcome in one triplet is relatively small (ranging from £25 to £35), one is medium (£50 to £60), and one is large (£75 to £85). Within each triplet, the delays are approximately the same. For example, the following triplet has a growth rate of 0.25% per day:

Small: £25 today OR £30 in 80 days;
Medium: £49 today OR £60 in 89 days;
Large: £69 today OR £85 in 91 days.

[4] In Study 1, the 11 items in the Magen subset showed a Hidden zero effect (difference in choice proportions between the Explicit and Hidden zero frames) ranging from 13% to 26%. The remaining four Magen items showed a difference of 5% or less. In Study 2, 13 of the 27 Kirby items showed a Hidden zero effect of 15% or greater, and we chose seven of these items at random, for an average effect of 21%. When selecting items for both of these subsets, we did *not* consider the magnitude of their *SS* zero effect (i.e., we only selected them based on the magnitude of their Hidden zero effect).

Table 4 **Mean Level of Patience (Proportion of *LL* Choices), as a Function of Framing Condition and Payoff Magnitude Category in Study 2**

	Payoff magnitudes				
Zero frame	Small	Medium	Large	Average	*N*
Explicit zero	54%	59%	62%	58%	68
SS zero	54%	59%	60%	58%	64
LL zero	39%	46%	47%	44%	66
Hidden zero	38%	41%	46%	42%	64
Average [total]	46%	51%	54%	51%	[262]
Kirby et al. (1999)	35%	41%	46%	41%	60

The magnitude effect predicts that, within each triplet, patience will increase with outcome magnitude.

Participants were 262 British residents recruited via Maximiles and paid in points (57% female; mean age = 45.3 years).

Results. We conducted a 2 (*SS* zero: present versus absent) by 2 (*LL* zero: present versus absent) by 3 (payoff magnitude: small, medium, or large) mixed factorial ANOVA, where magnitude was the within-participant factor. Table 4 displays the mean patience for each framing condition and magnitude category.

There was a strong magnitude effect, with more patience for larger outcomes, $F(2, 516) = 63.13$, $p < 0.0001$, $\eta_p^2 = 0.20$. Paired-sample t-tests revealed that patience was greater for medium than small magnitudes, $t(261) = 7.61$, $p < 0.0001$, $d = 0.47$; and greater for large than medium magnitudes, $t(261) = 3.61$, $p < 0.0005$, $d = 0.22$. Table 4 also shows the equivalent means (proportion of *LL* choices for each magnitude category) from the control group in Kirby et al. (1999, see their Table 4), illustrating how close the results in their study were to those in our Hidden zero condition.

We also obtained the ASOC effect: a main effect of *SS* zero, $F(1, 258) = 31.54$, $p < 0.0001$, $\eta_p^2 = 0.11$, but no effect of *LL* zero ($F(1, 258) = 0.30$). The three-way interaction between payoff magnitude, *SS* zero, and *LL* zero, was marginally significant ($F(2, 516) = 2.78$, $p = 0.06$, $\eta_p^2 = 0.01$), but no other interactions approached significance (all ps > 0.2). We conducted separate 2 (*SS* zero) by 2 (*LL* zero) ANOVAs for each payoff magnitude level and obtained a robust main effect of *SS* zero in all three cases:

Small: $F(1, 258) = 31.73$, $p < 0.0001$, $\eta_p^2 = 0.11$;
Medium: $F(1, 258) = 31.97$, $p < 0.0001$, $\eta_p^2 = 0.11$;
Large: $F(1, 258) = 23.90$, $p < 0.0001$, $\eta_p^2 = 0.08$.

Moreover, at no magnitude level was there a significant effect of *LL* zero nor an *SS*-by-*LL* interaction (all ps > 0.3). Overall, these results provided another clear demonstration of the ASOC effect, while also showing that it holds over a range of outcome magnitudes.

Study 3

In Studies 1 and 2, the *SS* option was always available immediately (i.e., today). Such immediate availability has a special status in theories of intertemporal choice, which often incorporate a "present bias" (e.g., Ainslie 1975, Böhm-Bawerk 1890, Laibson 1997, Olivola and Wang 2015), or a disproportionate weighting of present outcomes relative to delayed ones.

In Study 3 we investigated whether the ASOC effect also shows a present bias, in that the opportunity cost of *LL* is chronically salient only when the *SS* outcome is available immediately. If so, then if *SS* is delayed, the information contained in the *LL* zero will cease to be redundant, and it will exert its own effect—specifically, decreasing patience. We will call this the present-biased asymmetric subjective opportunity cost hypothesis. This hypothesis fits with the Radu et al. (2011) discussion of the Hidden zero effect, which they conceptualize as resulting from the Explicit zero frame shifting attention away specifically from the present.

An alternative hypothesis is based on the view that what we call "present bias" is really an "earliest option" bias, even when that earliest option is not available immediately (Scholten and Read 2006; see also Read 2001, Masatlioglu and Ok 2007). Kable and Glimcher (2010) referred to this as the "as soon as possible" or "ASAP" effect. The key idea is that when evaluating options, people disregard the common delay to *SS* and *LL*, and consider only the interval separating *SS* and *LL*. In contrast to the present-bias asymmetric subjective opportunity cost hypothesis, the "ASAP" asymmetric subjective opportunity cost hypothesis predicts the same pattern of preferences whether *SS* is available today or is delayed.

We compared the four core zero framing conditions, both when *SS* is available today (*Today-SS* frames) and when it is delayed (*Delayed-SS* frames). For the Delayed-*SS* frames we maintained the time interval between outcomes by adding a constant additional delay to both *SS* and *LL*. The ASAP asymmetric subjective opportunity cost hypothesis predicts the standard pattern of preferences for both the Today-*SS* and Delayed-*SS* frames:

SS zero = Explicit zero > Hidden zero = *LL* zero [as observed in Studies 1 and 2].

The present-biased asymmetric subjective opportunity cost hypothesis, however, predicts the standard pattern for Today-*SS* (just as in Studies 1 and 2), but predicts the following pattern for Delayed-*SS*:

Delayed-*SS*: *SS* zero > Explicit zero $\gtreqless$ Hidden zero > *LL* zero.

The present-biased asymmetric subjective opportunity cost hypothesis does not predict a specific relationship between the Explicit and Hidden zero

conditions, because the two zeros would influence choice in opposite directions.

Methods. A new sample of 281 British residents (58% female; mean age = 46.6 years) was recruited through Maximiles and paid in points. Respondents were randomly assigned to one of the four core frames.

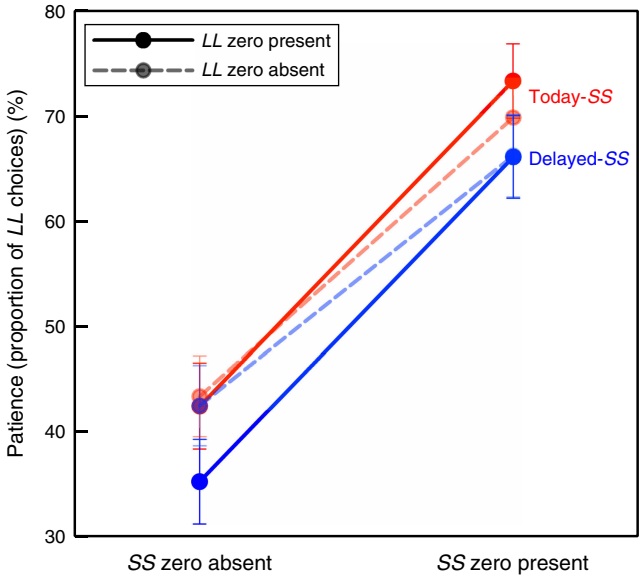
We created a Delayed-*SS* version of each choice item in the 11-item Magen subset by adding the original *LL* delay to both the sooner and later options. For example,

Today-*SS*: £5.50 today OR £7.50 in 61 days;
became,
Delayed-*SS*: £5.50 in 61 days OR £7.50 in 122 days.

Thus, we produced a set of 22 choice items, comprising 11 Today-*SS* and 11 Delayed-*SS* items, which we presented as a single block of items (randomly ordered).

Results. As Figure 3 shows, the *SS* zero effect was fully replicated for both Delayed-*SS* and Today-*SS* conditions. We computed patience separately for the Delayed-*SS* and Today-*SS* conditions and conducted a 2 (*SS* zero) by 2 (*LL* zero) by 2 (*SS* timing: Today versus Delayed) mixed factorial ANOVA, with *SS* timing as the repeated measure. The ANOVA revealed main effects of *SS* timing and *SS* zero (and an interaction between *LL* zero and *SS* timing), but no interaction between *SS* zero and *SS* timing (nor a main effect of *LL* zero, nor an *SS*-by-*LL* interaction). The effect of *SS* timing was that patience was greater when *SS* was available today than when it was delayed[5] (57% versus 52%), $F(1, 277) = 19.32$, $p < 0.0001$, $\eta_p^2 = 0.07$. The effect of *SS* zero was as predicted: Average patience was much higher when the *SS* zero was explicit than when it was not (69% versus 41%), $F(1, 277) = 57.10$, $p < 0.0001$, $\eta_p^2 = 0.17$. In short, these results support the "as soon as possible" version of the asymmetric subjective opportunity cost hypothesis.

Figure 3 **(Color online) Mean Level of Patience (Proportion of *LL* Choices), as a Function of Zero Framing, for the Today-*SS* (Red Lines) and Delayed-*SS* (Blue Lines) Conditions, in Study 3**



Note. Error bars represent +/ − 1 SE.

Study 4

In Studies 1–3, we focused on intertemporal choices between gains. In Study 4, we investigated how zero framing influences choices for losses. There are well-established and robust differences between intertemporal choices for losses and gains, the most prominent being that people are more patient when choosing among losses (the "sign effect," Thaler 1981).

Expressing patience in losses versus gains entails different choices. To illustrate, consider an intertemporal choice between gains, as presented in the Explicit zero frame:

SS: Receive £10 today and £0 in one year;
LL: Receive £0 today and £20 in one year.

Greater patience means more choices of *LL*. Now imagine these payoffs are reflected into the loss domain, with the same Explicit zero frame:

SS: Pay £10 today and £0 in one year;
LL: Pay £0 today and £20 in one year.

Now, greater patience will entail choices of *SS*: a preference to pay less sooner rather than more later. A more patient decision maker, therefore, will be more likely to choose *LL* for gains, and *SS* for losses.

The asymmetric subjective opportunity cost hypothesis is that people become more patient when reminded that choosing *SS* means forgoing a larger but later reward, but not when reminded that choosing *LL* means forgoing a smaller but sooner reward. A similar logic can be applied to losses. Adding a zero to the *LL* (i.e., impatient) option does not decrease patience because the information conveyed by the *LL* zero is redundant (people are naturally well aware that choosing the later loss means they won't have to suffer the sooner loss). By contrast, the *SS* zero focuses attention on the relatively underappreciated fact that choosing *SS* means not having to pay more later. Making the *SS* zero explicit should, therefore, lead to greater patience both for gains and losses, meaning more choices of *LL* for gains and *SS* for losses.

An alternative hypothesis suggested by Hardisty et al. (2013) is a variant of the "as soon as possible"

[5] This result is inconsistent with the conventional wisdom that adding a front-end delay increases patience. In fact, the evidence concerning this effect is mixed and our results are not unusual (see data and discussion in Andreoni and Sprenger 2012, Read et al. 2012, and Sayman and Öncüler 2009).

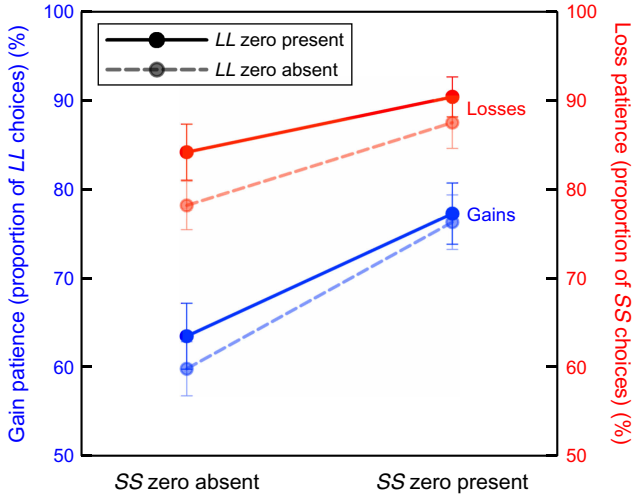
hypothesis discussed in Study 3. Hardisty et al. argued that people want to expedite both gains *and* losses. Since expediting a gain entails what we call "impatience," and expediting a loss entails "patience," this produces the sign effect. The corresponding interpretation of the *SS* zero effect would be that it disrupts this impulse, and so pushes people to favor more delayed options (gains or losses). In contrast to the asymmetric subjective opportunity cost hypothesis, this alternative account would predict opposing effects of the *SS* zero on patience for losses and gains because choosing the more delayed option reflects greater patience for gains but greater impatience for losses.

Methods. A new sample of 326 British residents (52% female; mean age = 47.3 years) was recruited through Maximiles (and paid in points).

Each participant was presented with numerically identical choice items twice: both as gains (receiving a payment) and as losses (paying a bill). The loss and gain items were presented in separate blocks, with block order counterbalanced across participants.

Results. Figure 4 presents the average level of patience in each condition. As explained above, while patience for gains was the proportion of *LL* choices, patience for losses was the proportion of *SS* choices. We conducted a 2 (*LL* zero) by 2 (*SS* zero) by 2 (payoff sign: gains versus losses) mixed factorial ANOVA, where payoff sign was the repeated measure. The ANOVA revealed a main effect of sign, $F(1, 322) = 56.40$, $p < 0.0001$, $\eta_p^2 = 0.15$, showing the expected effect of greater patience for losses (84% *SS* choices) than gains (68% *LL* choices).

Figure 4 **(Color online) Mean Level of Patience (Proportion of *LL* Choices), as a Function of Zero Framing, for Monetary Gains (Blue Lines) and Monetary Losses (Red Lines), in Study 4**



Note. Error bars represent +/ − 1 SE.

There was also an ASOC effect for both gains and losses. This was reflected in a main effect of *SS* zero, $F(1, 322) = 24.67$, $p < 0.0001$, $\eta_p^2 = 0.07$. Although there was a marginally significant interaction between payoff sign and *SS* zero ($F(1, 322) = 3.06$, $p = 0.081$, $\eta_p^2 = 0.01$), when we examined the simple effects (i.e., separately analyzing loss and gain trials) we found only a main effect of *SS* zero for both gains ($F(1, 322) = 20.15$, $p < 0.0001$, $\eta_p^2 = 0.06$) and losses ($F(1, 322) = 7.38$, $p < 0.007$, $\eta_p^2 = 0.02$). The main effects of *LL* zero and the *SS* × *LL* interactions never reached significance (all $ps \geq 0.12$).

Study 5

With the exception of Loewenstein and Prelec (1993), all previous studies (including those reported above) that demonstrated the effect(s) of making intertemporal opportunity costs explicit via a subtle framing manipulation (Magen et al. 2008, 2014; Radu et al. 2011; Read and Scholten 2012; Wu and He 2012) did so by reminding people that they would receive a "0" payoff now (if they chose *LL*) or later (if they chose *SS*). Therefore, one might be concerned that these effects are due specifically to the presence of the number zero. To rule out the possibility that this is literally an asymmetric *zero* effect—as opposed to an asymmetric *opportunity cost* effect—we conducted a study in which the term "nothing" was substituted for the £0.

Study 5 also provided additional tests of the "averaging" and "numerical contrast" accounts considered in Study 1. Arguably, any effect involving the mathematical averaging or contrasting of attributes should be stronger if those attributes are formatted in the same way (e.g., "£25" and "£0") rather than differently ("£25" and "nothing"). Therefore, the "averaging" and "contrast" accounts suggest the effect of highlighting the *SS* opportunity cost should be weaker in the "nothing" condition.

Methods. We recruited 341 British residents from Maximiles ($N = 341$; 48% female; mean age = 47.7 years), who were paid in points. Two participants were excluded because they failed to answer any of the choice items, leaving a final sample of 339.

The procedures were the same as in previous studies, except that we substituted "nothing" for the zero ("£0"), so that examples of the four core frames used in this study were as follows:

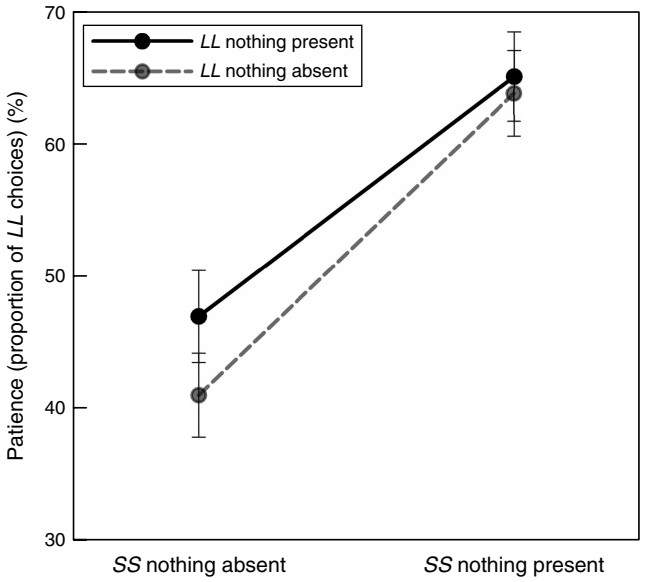
Hidden nothing: Receive £25 today OR Receive £35 in 29 days;

LL nothing: Receive £25 today OR Receive nothing today and £35 in 29 days;

SS nothing: Receive £25 today and nothing in 29 days OR Receive £35 in 29 days;

Explicit nothing: Receive £25 today and nothing in 29 days OR Receive nothing today and £35 in 29 days.

Figure 5 **Mean Level of Patience (Proportion of *LL* Choices), as a Function of "Nothing" Framing, in Study 5**



Note. Error bars represent +/ − 1 SE.

Results. Figure 5 displays results for all conditions. As in the "zero" studies, patience was increased by the *SS* nothing, but not by the *LL* nothing. A 2 (*SS* nothing: present versus absent) by 2 (*LL* nothing: present versus absent) ANOVA confirmed a main effect of making the *SS* nothing explicit, $F(1, 333) = 38.36$, $p < 0.001$, $\eta_p^2 = 0.10$, and revealed no other significant effects (both ps > 0.20). Therefore, the ASOC effect does not depend (specifically) on the presence of the number zero. Furthermore, the results of this study do not support the "averaging" or "contrast" accounts, since replacing "£0" with "nothing" does not weaken the effect.

Study 6

In Study 6 we replicated the core conditions, using an incentive compatible procedure in which participants received payments based on the choices they made (e.g., Cubitt et al. 1998). Magen et al. (2008) had also tested the Hidden zero effect with real payments and while it survived the test, it did so with a substantially lower effect size. This makes it important to replicate the ASOC effect with "real" choices.

An additional measure elicited in Study 6 (and the two studies that follow it) was choice time (i.e., the time spent deliberating and choosing). Choice time is frequently used to gain additional insight into the decision-making process (Billings and Scherer 1988, Rubinstein 2013). According to the asymmetric subjective opportunity cost hypothesis, when the *SS* zero is made explicit, people will be alerted to a consideration they would otherwise neglect. Since such additional thinking should take time, we anticipated longer choice times in the presence of the *SS* zero.

Methods

Participants. Participants were 301 Stanford University students (61% female; mean age = 21.3 years) recruited with the understanding they would be paid with an Amazon gift certificate, the value of which would depend on their choices.

Procedure. To remind participants their choices had real monetary consequences, we asked them to provide their email addresses after they read the following instructions:

> The 15 questions on the following pages involve choices between amounts of money you could receive at different times. We will randomly select one of your choices and pay you the amount indicated by your choice, at the time indicated by your choice. In all cases, you will be paid in the form of an Amazon gift certificate, which will be delivered to you via email. Please enter the email address here at which you would like to receive your payment.

All payments, even those made on the day of the experiment, were delivered by email to ensure there were no differences in transaction costs between immediate and delayed payments (see Andreoni and Sprenger 2012). An explanation of this procedure was also included on the consent form.

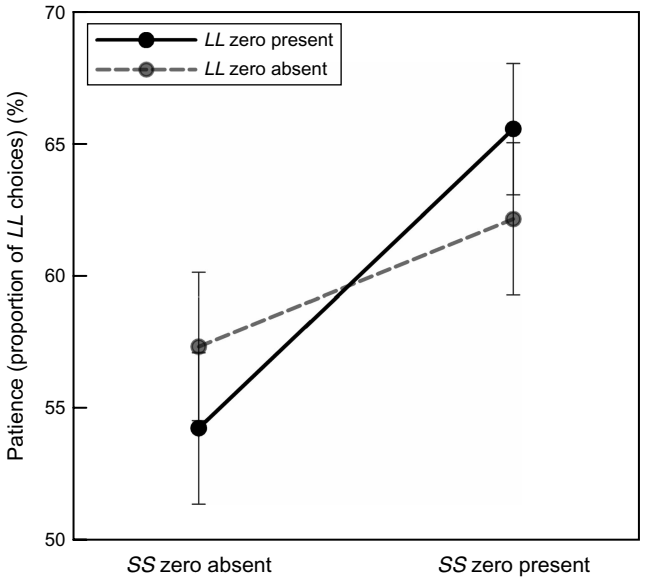
As in Study 1, participants were presented with all 15 Magen choice items (Table 3, top half). They were assigned to one of the four core zero frames, and choice time was measured as the time between when the options appeared on the screen and when participants submitted their choice.

Each participant was paid according to a random choice mechanism: One of the 15 choice pairs was selected at random, and the option chosen for that pair was paid out with an Amazon.com gift certificate for that amount available on the chosen date. For example, if the randomly selected choice pair was "$5.50 today OR $7.50 in 61 days," and the participant had chosen "$5.50 today," then an Amazon gift certificate for $5.50 was immediately emailed to her. If, instead, she had chosen "$7.50 in 61 days" a certificate for $7.50 was automatically sent by Amazon 61 days later.

Results

Choices. Figure 6 presents mean patience in each condition. These show the ASOC effect, with patience

Figure 6 **Mean Level of Patience (Proportion of *LL* Choices), as a Function of Zero Framing, in Study 6**



Note. Error bars represent +/ − 1 SE.

increased by the *SS* zero, but not by the *LL* zero. A 2 (*SS* zero: present versus absent) by 2 (*LL* zero: present versus absent) ANOVA confirmed a main effect of making the *SS* zero explicit, $F(1, 296) = 9.21$, $p = 0.003$, $\eta_p^2 = 0.03$, and no other significant effects (both ps > 0.19).

Table 5 compares the mean patience levels in Studies 1 and 6 with those obtained by Magen et al. (2008) for hypothetical versus real choices. Although the Hidden zero and *SS* zero effects were reduced when choices involved real money, both remained highly significant. The effect size (η_p^2) was reduced from 0.05 in Study 1 to 0.03 in Study 6—although it should be emphasized that the two studies differed in other ways, including the country in which they were administered and the nature of the sample (members of the public in Study 1; students in Study 6).

Table 5 **Mean Level of Patience (Proportion of *LL* Choices) for Hypothetical and Incentive-Compatible Choices, as a Function of Zero Framing Condition, in Studies 1 and 6, and in Magen et al. (2008)**

	Experiment			
	Hypothetical		Incentive compatible	
Zero frame	Study 1	Magen et al.	Study 6	Magen et al.
Explicit zero	64%	59%	66%	71%
SS zero	61%		63%	
LL zero	47%		55%	
Hidden zero	50%	38%	56%	59%
Hidden zero effect (Explicit minus Hidden):	14%	21%	10%	12%
SS zero effect : (*SS* minus *LL*)	14%		8%	

Choice times. Choice times were right-skewed, so we log-transformed them prior to analysis and averaged them across all 15 items for each participant. To provide interpretable descriptive statistics, we exponentiated the mean logs to get geometric means in standard time units.

Consistent with the view that only the *SS* zero increased consideration of (otherwise neglected) information, choices took significantly longer when the *SS* zero was explicit. It took an average of 3.8 seconds to choose in the Hidden zero frame and 4.2 seconds in the *LL* zero frame, compared to 4.8 seconds in the *SS* zero frame and 5.0 seconds in the Explicit zero frame. A 2×2 ANOVA, with average log-transformed choice time as the dependent variable, revealed a main effect of *SS* zero, $F(1, 297) = 42.9$, $p < 0.001$, $\eta_p^2 = 0.13$, as well as an effect of *LL* zero, $F(1, 297) = 34.9$, $p = 0.03$, $\eta_p^2 = 0.02$, but no interaction, $F(1, 297) = 0.6$. Note that the effect size was much larger for the *SS* zero than for the *LL* zero ($\eta_p^2 = 0.13$ versus $\eta_p^2 = 0.02$, respectively). The small effect of *LL* zero on choice times likely occurred because merely adding zeros lengthens the written description of the choice options and thus gave participants a little more to read. The difference in choice times between the *SS* zero and *LL* zero conditions, therefore, measures the relative increase in decision deliberation due to the presence of the *SS* zero while holding reading time relatively constant (since both the *SS* and *LL* zeros contribute similarly to word length). This paired contrast shows that choice times were 0.6 seconds longer in the *SS* zero frame than in the *LL* zero frame, $t(150) = 3.0$, $p < 0.01$, $d = 0.5$.

In summary, the *SS* zero leads people to spend more time deliberating, while the *LL* zero has only a negligible effect on deliberation time. This is consistent with our theory that the *SS* zero highlights information people were not previously attending to, while the *LL* zero highlights information that is naturally obvious to them (so that making it explicit has no effect on their deliberation process).

In our final two studies (Studies 7 and 8) we go beyond the "zero" and "nothing" frames and conceptually extend the idea of asymmetric attention to opportunity costs. In particular, we show that the predictions of the asymmetric subjective opportunity cost hypothesis hold when we use a completely different method for highlighting opportunity costs (Study 7), as well as for more naturalistic decision scenarios and nonmonetary outcomes (Study 8).

Study 7

So far, we have tested the asymmetric subjective opportunity cost hypothesis by providing people with subtle framing "nudges" (adding "£0" or "nothing"

to the choice options). The hypothesis, however, generalizes to other ways of making opportunity costs explicit. In Study 7 we provided even clearer opportunity cost reminders: entire separate sentences, appearing below the choice options, that explicitly reminded participants what they would be giving up with each choice option (e.g., "Remember: If you choose $100 today, you will receive nothing in one year"). We predicted these explicit reminders would have effects analogous to the more implicit ones, so that patience in the four conditions would be ordered as follows:

SS reminder = Explicit reminder > *LL* reminder = Hidden (or "No") reminder.

Method

Participants. We recruited two new samples of British residents: one from Maximiles ($N = 339$; 48% female; mean age = 48.5 years) and a second from Prolific Academic (http://www.prolific.ac; $N = 397$; 55% female; mean age = 30.2 years). Maximiles respondents were paid in points, while Prolific Academic respondents were paid £0.80. We excluded five respondents (four from Maximiles and one from Prolific Academic) who answered none of the choice items. Our final sample thus consisted of 731 participants.

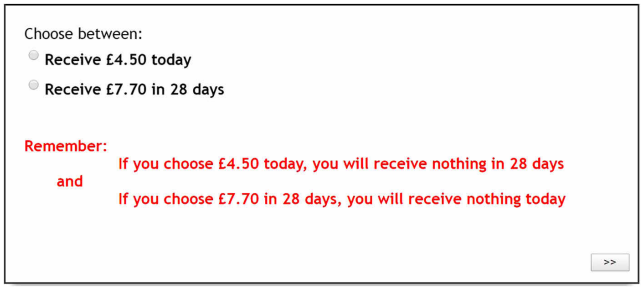
Procedure. For choices, we used the Magen and Kirby subsets in Table 3 (i.e., 18 choice items in total). The choice options themselves were always presented in the standard Hidden zero frame but, depending on the condition, were accompanied by a "reminder" that mapped onto the four core frames. This reminder appeared below the choice options, in bold red letters (see Figure 7) for the three non-Hidden conditions. To illustrate, consider the choice: "£4.10 today OR £7.50 in 20 days." The three possible reminders were as follows:

SS reminder: "Remember: If you choose £4.10 today, you will receive nothing in 20 days."

LL reminder: "Remember: If you choose £7.50 in 20 days, you will receive nothing today."

Explicit reminder: "Remember: If you choose £4.10 today, you will receive nothing in 20 days and if you choose £7.50 in 20 days, you will receive nothing today."

Figure 7 **(Color online) Screen Shot Showing the Explicit (Dual) Reminder Condition in Study 7**



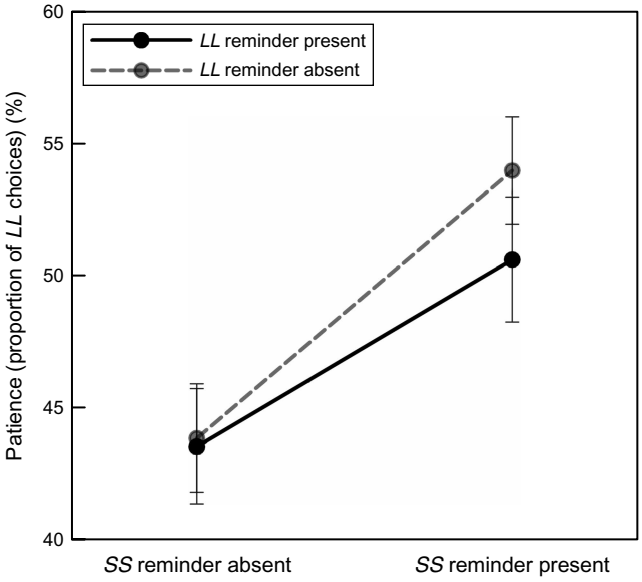
The Hidden reminder condition was identical to the Hidden zero condition in previous studies, with no reminders presented. A screenshot in Figure 7 shows how both reminders were displayed in the Explicit reminder condition.

Results

Choices. We conducted a 2 (population: Maximiles versus Prolific Academic) by 2 (*LL* reminder: present versus absent) by 2 (*SS* reminder: present versus absent) ANOVA. The results, depicted in Figure 8, were as predicted by the asymmetric subjective opportunity cost hypothesis. There was only a significant main effect of the *SS* reminder ($F(1, 723) = 15.65$, $p < 0.0002$, $\eta_p^2 = 0.02$). Moreover, both populations individually showed the same pattern of a main effect of the *SS* reminder: (Maximiles: $F(1, 331) = 6.43$, $p = 0.012$, $\eta_p^2 = 0.02$; Prolific Academic: $F(1, 392) = 9.57$, $p < 0.003$, $\eta_p^2 = 0.02$), but neither a main effect of *LL* reminder nor an interaction.

Choice Times. As in Study 6, we log-transformed the choice times for each item before averaging them, and for descriptive statistics we report the geometric means of these averages. Participants in the Explicit reminder ($M_{\text{time}} = 5.2$ seconds) and *SS* reminder ($M_{\text{time}} = 5.1$ seconds) conditions took longer to make their choices than those in the Hidden reminder ($M_{\text{time}} = 4.6$ seconds) and *LL* reminder ($M_{\text{time}} = 4.9$ seconds) conditions. A 2 × 2 ANOVA with *SS* reminder and *LL* reminder predicting log-transformed choice times confirmed a main effect of *SS* reminder,

Figure 8 **Mean Level of Patience (Proportion of *LL* Choices), as a Function of the Reminder Condition, in Study 7**



Note. Error bars represent +/ − 1 SE.

$F(1, 725) = 3.1$, $p = 0.01$, $\eta_p^2 = 0.01$, but no significant effect of *LL* reminder, $F(1, 725) = 2.1$, $p = 0.15$, and no interaction, $F(1, 725) = 1.1$, $p = 0.30$. This again supports our view that the *SS* reminder, like the *SS* zero, provides people with something to consider (namely, the opportunity cost of choosing *SS*), that they would otherwise neglect. However, while a paired contrast between the *SS* reminder and *LL* reminder choice times was in the predicted direction, it was not significant, $t(362) = 0.9$, $p = 0.36$, $d = 0.1$.

In our final study (Study 8), we examine whether the ASOC effect applies to more realistic (i.e., less stylized) decision scenarios and to nonmonetary outcomes.

Study 8

The experiments reported so far focused on relatively stylized choices between smaller, sooner and larger, later amounts of money. Similarly, almost all previous studies of the Hidden zero effect have used stylized choices of this sort (Magen et al. 2008, 2014; Radu et al. 2011; Read and Scholten 2012; Wu and He 2012). The only exception of which we are aware is the single study by Loewenstein and Prelec (1993) in which participants chose between dining options. Yet, in their everyday lives, people have to consider a much wider range of intertemporal choices, and trade-offs between pure sums of money across time may be neither the most common nor the most consequential of these choices. Therefore, in Study 8 we examined whether the asymmetric effects of highlighting the *SS* and *LL* opportunity costs would be observed in a wider range of choices. We presented participants with choices between concrete and primarily nonmonetary *SS* and *LL* options. Choices included saving some lives now or more later, receiving some chocolate now or more later, purchasing a phone now or getting a discount later (the sole "monetary" scenario used in this study), having improved air quality now or later, and so on (see Table 6 for the summary of the scenarios used). Furthermore, many of these choice scenarios involved a full paragraph describing the situation, making them much richer than the simple monetary scenarios used in our earlier studies. For all scenarios, we constructed variations corresponding to the four core frames and then tested the asymmetric subjective opportunity cost hypothesis.

Methods

Participants were 318 undergraduate students (52% female, mean age = 19.7 years) at the University of British Columbia and Carnegie Mellon University. They completed the study in exchange for course credit. Participants were randomly assigned to one of the core frames (Hidden opportunity costs, *LL* opportunity cost, *SS* opportunity cost, or Explicit opportunity costs) and made choices for all 10 choice scenarios (summarized in Table 6), which were presented individually and in random order. Figure 9 shows screen shots from two of these scenarios.

Results

Choices. As in earlier studies, we collapsed across questions and calculated patience (the proportion of *LL* responses) for each participant. Overall, this showed the ASOC effect: participants chose *LL* more often in the Explicit (59%) and *SS* opportunity cost (59%) conditions than in the Hidden (49%) or *LL* opportunity cost (51%) conditions, $F(1, 314) = 12.2$, $p = 0.001$, $\eta_p^2 = 0.04$. An *SS* opportunity cost (present versus absent) by scenario interaction was found, suggesting that the effect of highlighting the *SS* opportunity cost was stronger in some scenarios than in others, $F(9, 306) = 3.2$, $p = 0.001$, $\eta_p^2 = 0.09$. Examining the choice results (summarized in Table 6) for each of the 10 scenarios individually, the ASOC effect was significant in six of them (see Table 6). These "successful" scenarios involved human lives, air quality, mass transit, chocolates, and movie downloads. Out of the four scenarios where the *SS* opportunity cost had no significant effect, three (chocolate truffles, phone discount, and music downloads) may have failed to yield a reliable pattern because of a ceiling effect due to a high baseline of *LL* responses (74% or higher in the Hidden opportunity costs condition). The fourth scenario (pollution free days) showed a (nonsignificant) change in the predicted direction. Other than differences in baseline *LL* responses leading to ceiling effects, we do not see any systematic differences between the scenarios that produced a significant *SS* opportunity cost effect and those that did not. In fact, every scenario that did not produce significant effects had a counterpart that did: the Belgian chocolates, financial gains (as in Studies 1–7), movie downloads, and air quality scenarios all showed the predicted effect. This moderating role of item-level ceiling effects is consistent with our earlier item-level analyses of the Magen and Kirby items (Table 3), which revealed that the ASOC effect is systematically weaker when the proportion of *LL* choices in the standard Hidden zero frame already approaches 100%.

Choice Times. As with our previous analyses of choice times, we analyzed the average natural logged choice times and report their geometric means. As expected, participants in the Explicit ($M_{\text{time}} = 13.0$ seconds) and *SS* opportunity cost ($M_{\text{time}} = 12.2$ seconds) conditions took longer to respond than participants in the Hidden ($M_{\text{time}} = 10.6$ seconds) and *LL* opportunity cost conditions ($M_{\text{time}} = 11.2$ seconds). There was a main effect of *SS* opportunity cost on choice time, $F(1, 314) = 11.1$, $p = 0.001$, $\eta_p^2 = 0.03$, no significant effect of *LL* opportunity cost, $F(1, 314) = 1.9$,

Table 6 Choice Options, Choice Proportions, and *p*-Values for the 10 Scenarios Used in Study 8

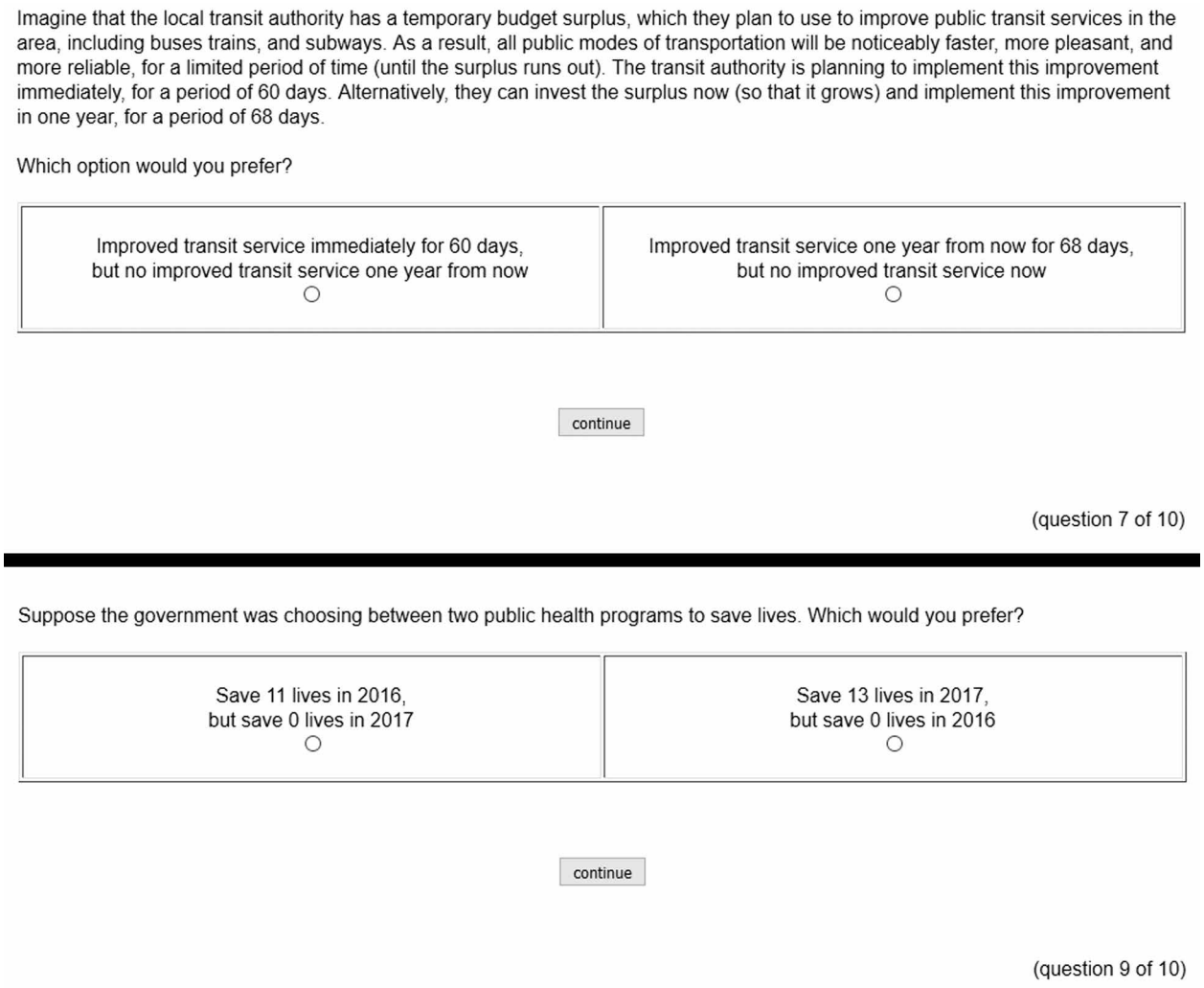
Scenario	Choice options	Proportion choosing *LL*	*p*-values
Lives saved (pollution)	... The government has to choose between two programs to control this pollution ... Save 100 lives now [but save no lives 25 years from now] or Save 200 lives 25 years from now [but save no lives now]	Hidden: 0.28 *LL* zero: 0.36 *SS* zero: 0.63 Explicit: 0.42	*SS* zero effect: < 0.001 *LL* zero effect: 0.25 Interaction: < 0.01
Chocolate truffles	Imagine you are participating in a focus group meeting that will last two hours ... Receive 2 truffles now [but nothing when the focus group ends] or Receive 3 truffles when the focus group ends [but nothing now]	Hidden: 0.86 *LL* zero: 0.71 *SS* zero: 0.72 Explicit: 0.81	*SS* zero effect: 0.66 *LL* zero effect: 0.53 Interaction: 0.02
Phone discount	Imagine that you decide to purchase a new phone ... Receive \$34 off the phone price today [but receive no discount in 30 days] or Receive \$50 off the phone price in 30 days [but receive no discount today]	Hidden: 0.74 *LL* zero: 0.83 *SS* zero: 0.70 Explicit: 0.82	*SS* zero effect: 0.58 *LL* zero effect: 0.03 Interaction: 0.80
Air quality	... Improved air quality immediately for 21 days [but no improved air quality one year from now] or Improved air quality one year from now for 25 days [but no improved air quality now]	Hidden: 0.20 *LL* zero: 0.36 *SS* zero: 0.42 Explicit: 0.43	*SS* zero effect: < 0.01 *LL* zero effect: 0.11 Interaction: 0.13
Mass transit	... Improved transit service immediately for 60 days [but no improved transit service one year from now] or Improved transit service one year from now for 68 days [but no improved transit service now]	Hidden: 0.24 *LL* zero: 0.38 *SS* zero: 0.36 Explicit: 0.50	*SS* zero effect: 0.02 *LL* zero effect: < 0.01 Interaction: 0.99
Belgian chocolates	Which would you prefer? Receive a box of 16 fine Belgian chocolates today [and no chocolates in one year] or Receive a box of 24 fine Belgian chocolates in one year [and no chocolates today]	Hidden: 0.36 *LL* zero: 0.30 *SS* zero: 0.45 Explicit: 0.52	*SS* zero effect: < 0.01 *LL* zero effect: 0.84 Interaction: 0.22
Music downloads	Which would you prefer? Receive 10 free music downloads of your choice now [and no free downloads in one month] or Receive 15 free music downloads of your choice in one month [and no free downloads now]	Hidden: 0.79 *LL* zero: 0.70 *SS* zero: 0.77 Explicit: 0.70	*SS* zero effect: 0.80 *LL* zero effect: 0.10 Interaction: 0.90
Lives saved (public health)	Suppose the government was choosing between two public health programs to save lives. Which would you prefer? Save 11 lives in 2016 [but save 0 lives in 2017] or Save 13 lives in 2017 [but save 0 lives in 2016]	Hidden: 0.51 *LL* zero: 0.48 *SS* zero: 0.65 Explicit: 0.60	*SS* zero effect: 0.02 *LL* zero effect: 0.44 Interaction: 0.85
Pollution free days	Which would you prefer? 11 extra pollution free days in 2016 [but no extra pollution free days in 2017] or 13 extra pollution free days in 2017 [but no extra pollution free days in 2016]	Hidden: 0.42 *LL* zero: 0.42 *SS* zero: 0.48 Explicit: 0.44	*SS* zero effect: 0.45 *LL* zero effect: 0.67 Interaction: 0.74
Movie downloads	Which would you prefer? Receive 5 free movie downloads of your choice now [and no free downloads in one year] or Receive 10 free movie downloads of your choice in one year [and no free downloads now]	Hidden: 0.47 *LL* zero: 0.60 *SS* zero: 0.69 Explicit: 0.71	*SS* zero effect: < 0.01 *LL* zero effect: 0.18 Interaction: 0.34

$p = 0.17$, $\eta_p^2 = 0.01$, and no interaction, $F(1, 314) = 0.0$, thus paralleling the choice data and replicating our two previous studies. A paired contrast between the *SS* opportunity cost condition and the *LL* opportunity cost condition was in the predicted direction but not significant, $t(158) = 1.3$, $p = 0.19$, $d = 0.21$. Although the time difference here (1.0 seconds) was larger than in Study 6 (0.6 seconds), the variance was also larger (2.3 versus 1.7)—because several scenarios in this study contained a long paragraph of text—so the difference is less reliable.

In sum, this study demonstrates that *SS* opportunity cost framing also influences choices between nonmonetary *SS* and *LL* options, such as human lives or mass transit quality.[6] Furthermore, our participants took longer to respond to *SS* opportunity cost framed scenarios (but not to the *LL* opportunity cost framed scenarios), indicating that the "future nothing" framing increases the salience of information that people may not naturally consider, while the "present nothing" framing may be intuitively obvious and therefore adds nothing new to the decision process.

[6] That the choices consist of *SS* and *LL* options may be critical. In two studies not reported here, participants chose between the *same* option now versus in the future (e.g., one chocolate now versus one chocolate in one hour), and these scenarios generally yielded null results. However, null results are difficult to interpret, and future research should explicitly compare *SS* versus *LL* scenarios with "same option" scenarios within the same study.

Figure 9 Screen Shots Showing Two of the Scenarios Presented in Study 8



Discussion

Our central thesis is that intertemporal choice is driven (among other things) by an asymmetric attention to opportunity costs. Although people are naturally (and chronically) aware that choosing the larger, later option means receiving (or incurring) nothing sooner, they are less attentive to the equally "obvious" fact that choosing the smaller, sooner option means missing out on (or avoiding) a larger outcome later on. Consequently, and as our studies repeatedly show, while people become more patient when reminded of the opportunity cost of taking something earlier instead of later, they are unmoved when reminded of the opportunity cost of taking something later rather than earlier. We called this the ASOC (Asymmetric Subjective Opportunity Cost) effect. It helps explain the tendency for human decision makers to be impatient and impulsive (e.g., why they often prefer smaller, sooner payoffs to larger, later ones that offer generous interest rates).

Our results are robust to many factors.[7] The ASOC effect occurs with horizontally and vertically presented

[7] As with any manipulation of this sort, there are boundary conditions and moderators that researchers need to keep in mind, such as the extent to which one option clearly dominates in terms of its payoff(s) and/or delay(s). Our item-level analyses of the Magen and Kirby items, as well as those used in Study 8, revealed that the ASOC effect is typically stronger when baseline *LL* preferences are closer to 50% (neither choice option clearly dominates in the standard Hidden zero frame), and weakens as they approach 100% (*LL* is already preferred by most people in the standard Hidden zero frame) or 0% (*SS* is heavily preferred in the standard Hidden zero frame). The dampening of the ASOC effect when most people already prefer *LL* merely reflects a ceiling effect. The dampening of the ASOC effect when *SS* is strongly preferred is potentially more interesting as it suggests (in line with our theory) that the impact of subtly reminding people that choosing *SS* means forgoing the *LL* payoff will depend on how much larger the *LL* payoff is compared to the *SS* payoff; clearly, highlighting the forgone *LL* payoff will have little or no impact when it is not much (subjectively) larger than the *SS* payoff. In sum, if one choice option clearly dominates (in people's minds), the ASOC effect is going to be weaker, as we would expect with such a subtle (and normatively irrelevant) manipulation.

choice options (Study 1), with outcomes of varying magnitude (Study 2), with immediate or delayed *SS* options (Study 3), for both gains and losses (Study 4), with real payoffs (Study 6), and for nonmonetary outcomes, such as lives saved or luxury chocolates (Study 8). Moreover, the effect is not restricted to the "zero" wording: we find the same pattern when the term "nothing" is substituted for the zero (Study 5) and when we remind people of the opportunity cost(s) in another, more explicit way (Study 7). In addition, we observed it in several different countries (not only in the United States and the United Kingdom, but also in India), and with both online and student samples.

We also found that choice time data were consistent with what we would expect from an effect driven by asymmetric attention to opportunity costs (Studies 6–8): Highlighting the *SS* opportunity cost increased the time participants spent deciding more than did highlighting the *LL* opportunity cost, which suggests the former (but not the latter) increased consideration of otherwise neglected information—namely, the forgone gains (or losses) associated with choosing *SS*. Our results also help elucidate the nature of the cognitive processes underlying the effect in other ways. For example, Radu et al. (2011, p. 366) proposed a "temporal attention hypothesis" to explain the Hidden zero effect, which has some similarities to our asymmetric subjective opportunity cost hypothesis. Specifically, they posited that the addition of zeros increases patience by shifting attention away from *immediate* gratification (i.e., focusing away from "*now*") and toward more distant periods in the past or future. According to their theory, the Hidden zero effect reflects a reduction in *present bias* specifically, rather than in delay discounting more generally. Yet we now know (from Study 3) that the Hidden zero effect occurs even in the absence of any immediate payoff option. This favors our asymmetric subjective opportunity cost hypothesis (which does not operate on the present bias parameter) over their temporal attention hypothesis (which does). A second difference between these theories is that their account places less emphasis on the asymmetry in salience that we have shown is critical to the effect. Indeed, they did not directly manipulate or test the asymmetry of attention to *SS* versus *LL* payoffs (or to their opportunity costs). A third difference is that their theory seems to focus on how people choose between immediate versus future (or past) *gains*, and does not generalize to trade-offs between sooner versus later *losses*. For example, Radu et al. (2011) explain (p. 366) that their "temporal attention hypothesis, suggests that explicit-zero framing increases patience by emphasizing the unpleasant distant consequences associated with present responding." Yet, when it comes to losses, impatience is associated with future responding (i.e., delaying a loss) rather than present responding. Therefore, in the domain of losses, intertemporal choices and their underlying cognitive processes do *not* "demonstrate [a] bias for immediate over temporally distant outcomes" (Radu et al. 2011, p. 380). In fact, as our Study 4 results show, the Explicit (or *SS*) zero frame also promotes patience in the loss domain by *increasing* (not decreasing) preference for the *SS* option.

In addition to the eight studies reported in this paper, we ran several that are not reported. Most were excluded because they were designed as pilot studies (we had no a priori intention of using their data), they tested another hypothesis that was unrelated to the current paper (e.g., the effect of adding more than one middle zero), or they contained an error (e.g., some payoffs were accidentally presented in the wrong currency). One concern with the exclusion of studies, however, is that experimenters may do so (even unintentionally) in a selective way that maximizes the likelihood of obtaining desired results (Ioannidis et al. 2014, John et al. 2012). In our case, the concern would be that the ASOC effect might disappear once we reintroduce these studies. To address this issue, we combined data across all 15 studies (reported and unreported) in which participants were exposed to the four core framing conditions without additional manipulations. Specifically, we combined all data from participants exposed to the four core treatment frames when these only involved monetary gains, and when the sooner option always occurred today. The resulting sample consisted of $N = 5{,}129$ individuals. We carried out our standard 2×2 ANOVA analysis, with patience as the dependent variable. The results mirrored our reported findings: Only the main effect of highlighting the *SS* opportunity cost was significant ($F(1, 5{,}125) = 211.56$, $p < 0.0001$, $\eta_p^2 = 0.04$), whereas there was no effect of highlighting the *LL* opportunity cost nor an interaction (both other $Fs < 0.5$). In fact, if we just consider the unreported studies ($N = 2{,}324$) we also obtain only a main effect of highlighting the *SS* opportunity cost: $F(1, 2{,}320) = 63.65$, $p < 0.0001$, $\eta_p^2 = 0.03$ (both other $Fs < 0.4$). Clearly, the main findings reported in this paper were not merely the product of selective reporting.

Table 7 shows the effect of highlighting the *SS* opportunity cost for all eight studies reported here, as well as for the unreported studies (aggregated). The table shows the mean and confidence intervals for its impact on patience, its proportional increase in patience (relative to the standard Hidden frame), and its effect size (Cohen's *d*). We can see that highlighting the *SS* opportunity cost consistently increased patience in all studies. By contrast, a similar study-by-study examination of the impact of highlighting

Table 7 **Summary of Results Obtained Across All Studies, Showing the Increase in Patience (Increased Proportion of *LL* Choices) When the *SS* Opportunity Cost is Highlighted (Compared to When It Is Not)**

	Increase in patience [95% CI] (%)	Proportional increase in patience (%)	Effect size *d*	Sample size *N*
Study 1	13 [8, 17]	25	0.47	565
Study 2	15 [10, 20]	35	0.70	262
Study 3	28 [21, 35]	69	0.91	281
Study 4	12 [8, 16]	17	0.59	326
Study 5	21 [14, 27]	47	0.67	339
Study 6	8 [3, 14]	14	0.34	301
Study 7	9 [4, 13]	19	0.29	731
Study 8	9 [4, 14]	18	0.39	318
Average [total] across 8 studies	14	30	0.54	[3,123]
Additional unreported studies	10 [7, 12]	22	0.32	2,324

Note. These comparisons are based on data from the four main framing conditions in each study (i.e., the Middle zero framing condition is excluded).

the *LL* opportunity cost showed that this latter effect was never significant (in *any* of our reported or unreported studies) and that its direction was inconsistent across studies (ranging from a 7% decrease to a 3% increase in the proportion of *LL* choices). Altogether, these results support our strong asymmetry predictions: there is a reliable and sizeable effect of highlighting the *SS* opportunity cost but no effect of highlighting the *LL* opportunity cost.

It is also worth noting that the ASOC effect has now been demonstrated both with Western participants (our UK and U.S. samples) and East Asian participants (college students in China—see Wu and He 2012). Moreover, in two of our unreported studies we collected data from M-Turk participants in India ($N = 152$). It turns out these South Asian participants show a strong *SS* zero effect ($F(1, 148) = 46.15$, $p < 0.0001$, $\eta_p^2 = 0.24$), but no *LL* zero effect nor an interaction (both ps > 0.3). This suggests the asymmetric attention paid to opportunity costs in intertemporal choices may be a general human tendency rather than the product of (a particular) culture.

Of course, individuals (e.g., Nenkov et al. 2008, Strathman et al. 1994) and societies (e.g., Noguchi et al. 2014, Preis et al. 2012) vary in how frequently and intensely they focus on future consequences. Susceptibility to the effect of highlighting the *SS* opportunity cost should depend on an individual's baseline tendency to consider future opportunity costs (i.e., in the absence of explicit reminders). Our theoretical framework also predicts that individuals who are naturally attentive to future opportunity costs will be less affected by (or even immune to) manipulations that highlight the *SS* opportunity cost (in the same way that chronic awareness of immediate opportunity costs makes people unmoved by efforts to highlight the *LL* opportunity cost). In fact, Wu and He (2012) reported that individuals naturally inclined to focus on the future, or to consider future consequences, are much less affected by the Explicit zero and *SS* zero frames. The theoretical account laid out in this paper can, thus, accommodate existing evidence concerning the moderating effect of individual differences in future orientation.

While our studies have repeatedly demonstrated an asymmetry in the way people respond to manipulations that highlight intertemporal opportunity costs, the precise cause(s) of this ASOC effect remains a topic for future research. In particular, it is not clear whether the ASOC effect is due to changes in *awareness* of the *SS* opportunity cost (as we emphasize in this paper), changes in *evaluations* of the *SS* opportunity cost (e.g., perhaps people are naturally aware of it, but highlighting it makes them care more about it), or both (see Bartels and Urminsky 2015). The choice time data we reported suggest that the *SS* zero (or *SS* nothing reminder) makes information more salient to decision makers, which supports the *awareness* account. However, changes in *evaluation* could create or amplify choice conflict, which would also increase choice times. In this paper, we have emphasized the awareness account, because it more parsimoniously explains the choice time results. Furthermore, we have ruled out a number of alternate theories, including accounts based on sequence-preferences (see also Radu et al. 2011), numerical contrasts, averaging, and similarity.

Theoretical Links and Policy Applications

A variety of theories, models, and mechanisms have been proposed to explain why human decision makers discount future outcomes and, in particular, why we tend to be so impatient (e.g., Doyle 2013, Frederick et al. 2002, Read 2004, Soman et al. 2005, Urminsky and Zauberman 2014). Yet, to the best of our knowledge, none of these accounts have incorporated the mechanism examined in this paper: an

asymmetric attention to the opportunity costs associated with choosing sooner versus later outcomes. Our paper, therefore, contributes significantly to our understanding of intertemporal choice by identifying (and demonstrating the importance of) this previously overlooked mechanism. While we do not claim that asymmetric attention to opportunity costs explains all of the variance in intertemporal decision making, we believe it contributes a substantial portion of it, and therefore deserves greater attention from researchers.

Our results and the theoretical account we propose can be understood by looking at a distinction already familiar to early economists. In addition to core economic determinants of intertemporal preferences, such as interest rates and liquidity constraints, they also pointed to the effects of motivational and cognitive factors. Motivational factors include the "pure rate of time preference," or the different value placed on consumption as a function of it being delayed, with impatience reflecting a preference to receive a given level of consumption as early as possible.[8] Cognitive factors comprise the way those outcomes are conceptualized, with impatience reflecting a change in representation due to delay. Böhm-Bawerk (1890), for instance, proposed that distant outcomes are devalued partly because they are hard to imagine, so that when deciding between present and future there is an asymmetry between now and later:

> Provision for the future makes no inconsiderable demands on our intellectual strength; makes some demands, even, on our moral strength; and these demands are not equally met by men at all stages of civilization. *The present always gets its rights*. It forces itself upon us through our senses. To cry for food when hungry occurs even to a baby. *But the future we must anticipate and picture*. (p. 244, italics added)

Similar views have been aired by many others (e.g., Akerlof 1991, Fisher 1930) and have a modern parallel in theoretical approaches built on the concept of psychological distance (Pronin et al. 2008, Trope and Liberman 2010). Pronin et al. (2008), for example, demonstrated that the experiences and desires of our present self (the person we are now) are more accessible and naturally salient to us than those of our future self (the person we expect to be in the future), leading us to neglect the latter. They showed that manipulations designed to increase attention to the feelings and desires of the future self, or to reduce attention to the feelings and desires of the present self, led people to discount the future self less. Their results and the theoretical account they proposed thus dovetail with the ones in this paper. These accounts would suggest there is no need for an *LL* zero (or *LL* nothing reminder) to focus people on the opportunity costs of choosing delayed gains (or immediate losses), but there is a need for an *SS* zero (or *SS* nothing reminder) to focus them on the opportunity costs of choosing immediate gains (or delayed losses). In fact, we found the *SS* zero effect emerges even when *SS* is delayed, suggesting that it is often the earliest available option that gets its "rights," and not just options available immediately—a view consistent with recent neuroscientific evidence (Glimcher et al. 2007, Kable and Glimcher 2010).

The reliability and robustness of the ASOC effect suggests it can be used as a cheap but effective policy nudge: simply making future opportunity costs explicit will nudge people toward more patient choices. It is likely that for many intertemporal choices the delayed consequences of decisions are given little attention and possibly even none at all. How many people, for instance, when considering the purchase of a large TV, think about the consequences that purchase will have during their retirement, when their pension pot is reduced by several thousand dollars? Reminding them of those consequences (by highlighting the *SS* opportunity cost) is likely to make them at least more equivocal about the decision. Indeed, recent experimental evidence from the field supports the beneficial effects of reminders on savings behaviors (Karlan et al. 2016).

We end our discussion by placing what we have learned in a more formal context, showing how the ASOC effect can inform the modeling of intertemporal choice.

A (Slightly More) Formal Analysis

The standard delay discounting account of intertemporal choice proposes the choice between *SS* and *LL* is determined by weighing the discounted value of the sooner outcome (x_S), against the discounted value of the later one (x_L). For reasons that will become apparent, we call this account the "Neutral perspective" and summarize it as follows:

$$\text{Neutral perspective:} \quad SS \gtrless LL, \quad \text{if } v(x_S) \gtrless \delta v(x_L),$$

where $v(\cdot)$ depicts the value of the *SS* and *LL* outcomes, and the right-hand side shows how the value of x_L is weighted by a discount factor $\delta \leq 1$, which represents the impact of the interval separating the two options (or the ASAP effect, see Study 3 in this paper, and Scholten and Read 2006). The expression denotes that *SS* will be preferred to *LL* if the value of x_S exceeds the discounted value of x_L. Note that $v(x_S)$ shows no relative discounting, even if delayed, since

[8] The pure rate is separate from factors such as changes in the ability to enjoy consumption, or risk, or inflation, or increasing wealth—all of which can influence preferences for future over current consumption.

the interval preceding it is common to both outcomes and so cancels out.

While we have not tested a formal model of intertemporal choice, we will briefly sketch out the elements needed to accommodate the ASOC effect. We suggest that when making any choice, a person can look at the options from multiple perspectives, and her resulting decision will reflect an aggregation of those different perspectives. Framing changes how attention is distributed over these perspectives, and perhaps the total amount of attention allocated as well. One perspective is the neutral frame given above, but alternatives include treating one option (either the sooner or later one) as a reference point, from which the other option deviates. When the sooner option (*SS*) is the reference point, for instance, we would have:

SS reference point perspective:

$$SS \gtrless LL, \quad \text{if } v(x_S) \gtrless \delta v(x_L) - \varphi v(x_S),$$

where the addition of $[-\varphi v(x_S)]$ to the right-hand side of the inequality denotes that, in this representation, not receiving x_S at t_S is viewed as incurring a loss (when $\varphi > 0$), which reduces the attractiveness of *LL*. The *SS* reference point is the perspective most naturally facilitated by highlighting the *LL* opportunity cost. Similarly, if the later option (*LL*) is taken as a reference point then *SS* is disadvantaged as follows:

LL reference point perspective:

$$SS \gtrless LL, \quad \text{if } v(x_S) - \varphi\delta v(x_L) \gtrless \delta v(x_L).$$

Here, the addition of $[-\varphi\delta v(x_L)]$ to the left-hand side of the inequality quantifies the (time discounted) reduction in attractiveness of *SS* when not receiving x_L at t_L is viewed as incurring a loss (i.e., for values of $\varphi > 0$). This *LL* reference point perspective is the one most naturally facilitated by highlighting the *SS* opportunity cost. This proposal is similar to an earlier one by Loewenstein (1988) as an account of the delay-speedup asymmetry.

All three perspectives can emerge from any option description, and it is likely that they all play a role regardless of the frame chosen. If we denote the relative attention paid to each reference point perspective by the parameters a_S and a_L, which are normalized relative to the attention paid to the Neutral perspective,[9] then the choice between *SS* and *LL* can be conceptualized as a weighted average of the arguments provided by the three separate perspectives:

All three perspectives (nested):

$$SS \gtrless LL, \quad \text{if } v(x_S) - a_L\varphi\delta v(x_L) \gtrless \delta v(x_L) - a_S\varphi v(x_s),$$

$$\therefore \text{ if } (1 + a_S\varphi)v(x_S) \gtrless (1 + a_L\varphi)\delta v(x_L).$$

The impacts of highlighting the *LL* and *SS* opportunity costs are reflected in the attention parameters a_S and a_L, respectively. Our results suggest an asymmetric pattern, whereby a_S is unchanged by highlighting the *LL* opportunity cost and a_L is increased by highlighting the *SS* opportunity cost. This interpretation is also consistent with our choice time data in Studies 6–8. When a reminder of the *SS* opportunity cost was added, more time was spent deciding. By contrast, adding a reminder of the *LL* opportunity cost had a much smaller (or no) impact on choice times. This suggests the cognitive processing of the options changes, even if only quantitatively, when the *SS* reminder is added. We suggest the additional choice time represents extra time spent considering the opportunity cost of choosing the *SS* option. That is, the extra processing time is due to an increase in a_L—the attention given to the choice construal that makes *LL* the reference point.

Conclusion

People are often impatient, choosing smaller, sooner rewards. Our results suggest this may occur in (large) part because they do not give due weight to the future opportunity costs of these impatient choices (e.g., getting nothing later). Fortunately, when these opportunity costs are highlighted, people take notice and choose larger, later rewards more frequently, across a wide variety of situations (magnitudes, delays, gains and losses, real and hypothetical, monetary and nonmonetary). Therefore, it seems the salient prospect of a future nothing may hold some value for improving decision making in the present.

Supplemental Material

Supplemental material to this paper is available at https://doi.org/10.1287/mnsc.2016.2547.

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[9] This normalization assigns $a_N = 1$ to attention paid to the neutral frame, with total attention then given as $1 + a_S + a_L$. An alternative is to define total attention as unity and define $a_N = 1 - a_S - a_L$, which can simplify matters. However, our results suggest that total attention paid to the task varies from frame to frame, with more attention paid to the task when the *SS* opportunity cost is made explicit.

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