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The Right Moment

Context-Sensitivities, Ease of Retrieval, and Their Effects on Consumption

A dissertation submitted to the
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for the degree of

Doctor of Philosophy in Behavioral Decision Research

by

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Abstract

This dissertation integrates literature on optimization in sequence-based search and literature on affective forecasting and investigates one reason why consumers may be mistakenly oversaving things they own for the "right" moment. An initial survey of real-world consumer behavior documents the importance of the right moment in consumers' choices of when to use what they own. A complementary analysis of historical behavior then identifies systematic delays of everyday item use beyond opportunities that would have been highly beneficial, a signal that consumers may commonly be waiting for but failing to find the right moment for item use in everyday scenarios. A theory is then proposed to explain those and other initial findings as the consequences of a systematic bias, affecting optimization: namely, ease of retrieval. A pair of controlled experiments test the theorized mechanism as an explanation for mistaken oversaving on the parts of item owners. Cumulative results indicate that the right moment's relative ease of retrieval may be one direct cause of mistaken decisions to save rather than consume.

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The “Right” Moment: Context-Sensitivities, Ease of Retrieval, and Their Effects on Consumption

What do cabinets stocked with still pristine china, closets dotted with often expensive yet still unworn articles of clothing, and once great but now vinegary bottles of wine all have in common? In this paper I will argue that all of these phenomena stem from a common mechanism. In short, they all are rooted in the desire to ideally pair consumption and context.

The Problem in Everyday Terms

Many forms of consumption are context sensitive; that is, the value of consuming many a good or service depends on the details of the consumer’s context or state at the moment of consumption. For example, the value of wearing an article of clothing depends on the occasion to which one wears it; the value of using a free pass depends on the cost one escapes by using it (see Shu, 2008); and even the value of drinking a bottle of wine depends on the mood, the meal, and the company one keeps while drinking it. If well suited to the consumption episode, then a context can maximize the value of the consumption experience for the consumer; however, if inappropriate to or ill-fitted for the consumption episode, then a context can diminish or even negate the value that a consumption episode would otherwise offer. A professional sports team’s jersey is never as apt as when worn at the big game, but a free pass is pointless when all costs are negligible and a bottle of fine wine is wasted if used to wash down frozen pizza.

When potential consumers recognize that their intended consumption experiences are context-sensitive, it is only reasonable for those consumers to want to maximize their potential benefits, specifically by finding the ideal states or contexts in which to consume their items. Recognizing that the experience of drinking her cherished bottle of fine wine will vary widely on the basis of mood, meal, and company, the owner of that bottle should naturally desire to pop its cork on only the fairest of occasions.

However, the search for the very best occasion is an inherently complex and difficult problem. Sequences of future events are uncertain. The wine owner may preserve her bottle for an occasion that by chance will never arise (see Gaiter & Brecher, 2007). Even an unboundedly rational agent will not find the *ex post* best occasion for consumption all the time.

Human limitations and tendencies should only further complicate the problem. Having to accurately estimate expected payoffs, opportunity costs, and the likelihoods of finding better rather than worse alternatives quickly become unwieldy cognitive tasks for decision-makers who make judgments under the constraints of bounded reasoning and under the slants of biased perception. What a computer could quickly calculate to be a prime opportunity for consumption a human judge may labor to even recognize as beneficial, and what in reality is a rare possibility may mistakenly appear to be an imminent eventuality to a human judge. Consequently, striving to realize the best pairings but too often misjudging their likelihoods or qualities, potential consumers will err in ways in which unboundedly rational agents would not; and this pattern of human error may ultimately leave many once-viable items — especially many once-viable single-use items — underused.

The Goals of This Dissertation

I have three goals for this dissertation:

Goal 1: to provide new evidence that the above problem not only exists but moreover is common,

Goal 2: to develop a framework for structuring the problem as the consequence of one or more testable potential causes, and

Goal 3: to conduct a clear test of one potential cause.

To accomplish these goals, I describe preliminary evidence that owners of context sensitive items do tend to underuse, or oversave, in view of the right moment; expand that evidence with reports and documents from actual real-world consumers; construct in light of that evidence a theoretical model of the decision to use or save a context-sensitive item; and test one of the model’s several inputs as a potential driver of mistaken oversaving. Overall, I intend on demonstrating that people commonly oversave their context-sensitive items due to failed attempts at finding the ideal contexts in which to consume those items. Furthermore, their failures to consume at the right moment result from biased estimations of at fewest one fundamental input into their decisions to save or consume.

Finally, looking beyond what I accomplish in this dissertation, I note three interesting directions that this line of research can take in the future. Chief among those directions, I note, will be the construction of a general theory of all overpreparatory decisions as consequences of misjudging the future.

A Brief Note on Terms

Throughout this document, I refer to all physical, social, emotional, and other characteristics that surround a consumption episode and may affect its both actual and perceived utility as “contexts,” “moments,” or “occasions”; to the goods, services, credits, disclosures of information, and other entities whose consumption utilities may be affected as “items”; and to the utility-affecting pairings of items and contexts as “fits” or “matches”.

A Normative Model for Decisions of Whether to Consume or Preserve

In this first section, I provide a normative model of the decision to either save or consume a context-sensitive item by drawing on previous literature on optimization in sequence-based search (e.g., Bearden, Rappoport, & Murphy, 2006). Referring this model, I then provide preliminary evidence that actual decisions about the use of context-sensitive items typically deviate from the normative prescriptions in a consistent way: namely, that owners of context-sensitive items appear to regularly oversave their items in anticipation of the right moment.

Establishing a Foundation

Establishing a normative model of (what for brevity I will call) the decision to consume requires first establishing several important premises.

Context-sensitivity. First, items and contexts can be complementary: The marginal utility of consuming a particular item (e.g., a bottle of champagne) can be higher in particular contexts (e.g., in celebrations of good news) than in others (e.g., in dimly lit diners). Items whose marginal utilities do vary by context are *context-sensitive*.

Increasing fit increases marginal utility. Second, the size of a context-sensitive increase in marginal utility depends on how thoroughly the features of an item fit the features of the context.[1] The more thoroughly the features fit (i.e., the more features that are fit or the stronger each fit is), the larger the increase in marginal utility.[2]

The maximal fit may be implausible. Third, the ideal context in which to consume a particular context-sensitive item is the context whose features, if realized, would fit the item most thoroughly. In other words, the ideal context is the context whose features would maximize the marginal utility of consuming the item, if ever such a context became concrete. However, that ideal may be implausible and remain imaginary: Thorough, complex fits require thorough, complex conjunctions of multiple real-world variables (e.g., weather, place, mood, other people) whose joint likelihood of occurring just "right" may be vanishingly small.

Real contexts arise in series. Fourth, contexts that do become concrete arise in series. The members of this series are drawn from a common distribution, whose features may or may not be known to the item's potential consumer.

The best contexts in series are *ex ante* optimal. Fifth, in any series of contexts, the optimal context in which to consume (i.e., the context in which the item owner should consume) is the context whose features are *expected* to maximize the marginal utility of consuming the item, not the context whose features would have maximized that utility in retrospect. So, optima are determined from an *ex ante*, not *ex post*, perspective.[3]

Finding the *ex ante* optimum is not a problem for owners of fully durable items. Sixth, determining the optimal context in which to consume a context-sensitive item is important only to owners of less than fully durable items. Fully durable context-sensitive items, which may be used over and over again without diminishing returns

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[1] Fitting a feature can mean (1) providing an element that fills a gap or responds to a call, as would a wedding cake at a wedding; (2) providing an element that harmonizes with what is already present or expected, as would red coloring on Valentine's Day; or (3) providing an element that does both, as would red velvet wedding cake at a wedding on Valentine's Day.

[2] I understand fit as the proximity of an item-context pairing to the ideal version of that pairing along all its available features, or dimensions. The greater the distance from the ideal on any dimension, the worse the fit and, consequently, the lesser the increase in the marginal utility of the item.

[3] The reader may note, I rely on a distinction between (1) what would be the optimal alternative if it ever became real from (2) what is the optimal alternative in a set of two or more real options. The earlier kind of optimal I call "perfect" or "ideal." The later kind of optimal I continue with calling "optimal," in keeping with conventions around naming *ex ante* and *ex post* optima.

(e.g., wine glasses), should be used in every context that arises indiscriminately, because no use instance ever entails a disadvantage in future use. Less than fully durable context-sensitive items, on the other hand, do entail disadvantages in future use; each partially non-durable (e.g., a knife that becomes dull, a dress whose first use is considered more important than any subsequent use) or fully non-durable (e.g., single-use bottles of wine) item will diminish in the utility that it can provide after each use. Consequently, only owners of less than fully durable context-sensitive items should have to make decisions about whether to consume or preserve what they own.

Because single-use items diminish in this way to the greatest extent, they provide the strongest case for an owner’s selectivity. Consequently, I will focus on single-use items in this dissertation.

The Normative Model of When to Consume

Based on the six preceding premises, a normative model of the decision to either consume or preserve a single-use context-sensitive item at any arisen context i becomes essentially the comparison of the expected benefit from *consuming* the item in i with the expected benefit from *preserving* the item for a subsequent context j in i’s series. In making this comparison, the item owner should simply choose the alternative — i or j — with the greater expected benefit.

Let N represent the length of the series of observed contexts.

Let B represent the set of all k possible fitting contexts for the item.

Let each i be independently drawn from B with likelihood p_i*, so that* $\sum_{i=1}^{k} p_i = 1$.

Let w_i *represent the overall benefit from consuming the item in the ith context.*[4]

Finally, let c represent the cost of keeping the item available for use.[5]

[4] This benefit includes both the avoidance of any disutility $v_i \leq 0$ from not consuming in the ith context (e.g., regret, fear of missing out) and the achievement of any utility $u_i \geq 0$ from consuming in the ith context: $w_i = u_i - v_i$.

[5] Commonly c may be negligible, as only infrequently are there objective costs to keeping an item available for use. However:

In the simplest case, in which $N = 2$; $B = \{i, j\}$; *and there is no uncertainty about* w_i, w_j, *or* c,

$$\textit{compare} \quad \underbrace{w_i}_{\substack{\text{the expected utility} \\ \text{from consuming the item} \\ \text{in the present context i}}} \quad \text{with} \quad \underbrace{p_i w_i + p_j w_j - c}_{\substack{\text{the expected utility} \\ \text{from preserving the item} \\ \text{for a future context j}}} \ .$$

Then, choose whichever is greater.

This basic decision rule, citing the context with the greater or greatest expected utility as the *ex ante* optimal choice, holds for series of any length *N*.

Optimal stopping. To fully extend the basic decision rule to series of length $N > 2$, I must refer to what previous literature has called optimal stopping rules, or prescriptions of when during an *N*-long series of opportunities a decision-maker should stop deferring and should choose the current alternative (Bearden et al., 2006; Freeman, 1983; Haggstrom, 1967; Vanderbei, 1980). Because these rules calculate their optimal stopping points from comparisons of expected utility like the comparison above, these rules represent the normative standards against which actual decisions to consume may be measured in series of length $N > 2$. I shall explain how these rules operate by walking through one classic optimal stopping problem here.

The Secretary Problem. The canonical optimal stopping problem is the Classic Secretary Problem (CSP; Freeman, 1983; Lindley, 1961; Bearden et al., 2006). In this problem, a person plays the role of an employer, looking to hire one ideal new secretary to her staff. This employer knows exactly how many applicants there have been for the role and knows also that, if she were to interview them all, she would be completely able to rank them unambiguously from best to worst. (Importantly, these two pieces of knowledge are the only information that the

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- in situations of constrained space, *c* may represent the opportunity cost of not being able to keep another item in addition to the item whose use is in question. This form of *c* may be familiar to game-players, whose hand limits can preclude their retaining new items until their old ones have been discarded or consumed.
- Additionally, for items whose qualities naturally change over time (e.g., fresh-cut flowers, wine, cheese), *c* may be non-negligibly either positive, indicating decline over time, or negative, indicating improvement over time.
- Finally, for consumers who eagerly or dreadingly await a particular future *j*, *c* may also be non-negligibly either negative or positive, respectively, to capture the subjective benefits or costs of anticipation.

employer has about the pool from which the candidates are being drawn.) The employer may interview any number of candidates she chooses before deciding to hire one, but she may select to hire only the candidate that she is currently interviewing. (This restriction means that all previously interviewed candidates must have been irreversibly rejected.) She will succeed only by selecting to hire the very best of all the candidates available. So, the question that she must answer is, "After how many candidate interviews should I stop and hire a secretary?”

Solving the CSP: Threshold rules and backwards induction. Though there may be ambiguity about the exact origin of the problem (see Freeman, 1983), Lindley (1961) presented the surprisingly simple solution to the CSP: Interview (and reject) N/e of the N total candidates available and then stop (i.e., select to hire) the very next candidate who is better than the best of the previously interviewed candidates. In this way, this solution operates as a threshold rule, establishing a threshold based on a subsample of the given series and then selecting the next candidate who exceeds that threshold after the subsample. This rule is the optimal stopping rule for the CSP, because it obtains the optimal candidate of the N total candidates with greater likelihood than that obtained by any other rule or method of solution.[6]

Lindley (1961) obtained the optimal stopping rule for the CSP through simple backwards induction, carefully considering the likelihood that any of the N independently valued candidates would be the best candidate overall and thereafter working backwards from the Nth candidate to generate a strategy viable at each stage of the game. Similar reasoning has been used to obtain the solutions to variations of the CSP that include the Cardinal Payoffs variant, in which success is not narrowly defined as selecting only the very best candidate of the N available candidates but rather more broadly defined by the quality of candidate eventually hired (Bearden, 2006), and the Multiple Secretaries variant, in which success depends on hiring not just one but several best candidates from an applicant pool (Vanderbei, 1980). The solutions of these two variants in particular are, respectively:

(1) to interview (and reject) the first $\sqrt{N} - 1$ of the N total candidates and then select to hire the very next candidate who is better than the best of the previously interviewed candidates (Bearden, 2006) and

[6] Technically, this statement was disproven by Gilbert and Mosteller (1966), who showed that a related but more complex formulation actually outcompetes the simple solution provided by Lindley (1961). However, the difference in the two solutions’ acuities is never more than one percent of all occasions; so, both may be considered quite excellent, if not optimal.

(2) to hire each additional candidate, after the first hire, only when that additional candidate is either:

a. better than all previously rejected candidates and better than any previously hired candidate or

b. better than all previously rejected candidates and late enough in the series to be necessary in order to meet the targeted number of hires (Vanderbei, 1980).

Achieving a normative solution to any* N > 2 *problem of when to consume via thresholds and backwards induction. The strategy of backwards induction can also provide the solution to any $N > 2$ version of the problem of when to consume, for this problem is structurally quite similar to the Cardinal Payoffs variant of the CSP. In both cases, the decision-maker stands to receive a benefit proportional to the quality of the opportunity eventually chosen.

However, unlike in the Cardinal Payoffs variant, the decision-maker in the problem of when to consume may know about the distribution from which all $N > 2$ available opportunities are being drawn. This knowledge allows the decision-maker to tailor his or her strategy to the distribution and define a threshold rule without reference to a subsample. The resulting declining threshold rule is high while the opportunities to consume are still many and then becomes low as the opportunities to consume become few (see the declining black dashed line in Figure 1 for illustration). Relative to a constant threshold rule, this declining threshold rule increases the likelihood that the decision-maker will find an aptly rewarding opportunity for consuming her context-sensitive item.

Though the form of this solution may be more complex than the form of the solution to the simple $N = 2$ version of the problem initially presented above, the logic producing each solution remains constant: The normative response to both problems results from careful comparison of the expected utility of the current opportunity with the expected utility of an alternative (i.e., future) opportunity. This comparison is what sets the quality threshold above which a decision-maker should consume and below which the decision-maker should preserve. (A full solution to the particular problem of when to consume tested in Studies 3a and 3b may be found in Appendix A.)

Beginning to Compare the Normative with the Descriptive

Given the normative solution to the problem of when to consume a single-use context-sensitive item, I argue that, while people may naturally set quality thresholds for triggering consumption, these thresholds are typically not optimal.

In a preliminary test, I asked 27 participants to each choose when in a series of 40 opportunities (drawn from a known and positively skewed distribution, ranging from 1 to 300 points) to consume a single-use context-sensitive item. Although the normative solution of this problem was to stop and consume at the 18th of the 40 opportunities (see Appendix A), a majority of the participants chose to stop and consume at later opportunities than that optimum (see Table 1 and Figure 2). Specifically, two-thirds of the participants mistakenly oversaved their point-sensitive fishing gear beyond the optimal fish. Several of these mistaken participants then referred to their own overly high threshold rules as their reasons for having chosen to consume so late (e.g., “I couldn't settle upon anything since I either worry about whether the fish is good enough or I wouldn't find a better fish.”, “I had several opportunit[i]es to select a fish with a higher score, but I kept pushing further to the end with the irrational hope of finding one closer to 300.”). According to these references, quests for the ideal fishing opportunity explain the participants’ choices to overlook objectively beneficial fish. These findings therefore constitute preliminary evidence of oversaving and suggest overly high thresholds as the cause of that mistake.

Data from Shu (2008) corroborate my findings: In her experiment, she asked 96 participants to each choose on which of a series of variably priced flights (drawn from a known, positively skewed distribution, ranging from $100 to $1000) to use a given free-flight voucher. Most enacted choices were again significantly later than the optimum. Moreover, those late choices again appeared due to overly high thresholds, set just in case the most valuable ($1000) flight might arise. That is, even though the normative strategy for her experimental task was sensitive to a change in the price of the second most valuable flight (from $750 to $500), Shu noted, the actual strategies used in the task appeared not to be; participants who had considered a second most valuable flight priced at $500 still followed just as high a threshold rule for voucher use as participants who had considered a second most valuable flight priced at $750. Shu took this lack of variation in behavior as evidence that both groups of participants had set quality thresholds for use exclusively in view of the unrealistically ideal flight for voucher use, rather than comprehensively in deduction from accurate measures of how likely that ideal flight and other flights for voucher use actually were to arise.

Together, these two similar sets of results provide clear preliminary evidence of mistaken overpreservation; in both tests, item owners deferred item usage beyond opportunities where it would be highly beneficial. Additionally, both sets of results suggest that overpreservation occurs when item owners attempt to maximize their returns by consuming at ideal opportunities only. Before investigating one reason why item owners may chase such ideal opportunities for consumption, I conducted two initial studies of real-world consumers, to gauge how common overpreservation for specifically the ideal opportunity might be as a phenomenon. I present the results from these two studies as additional evidence of overpreservation, at work in many domains of everyday behavior.

Study 1: A Survey on Reasons for Disuse

Overview

In this survey, I asked a sample of consumers to report on items that they owned but had never before used. Assembled, these consumers’ reports identify (1) how frequently the idea of the “right” moment (i.e., the perfect opportunity) may affect decisions of whether to consume in several item categories and (2) how comparable that effect of the “right” moment may be with the effects of other reported reasons for item disuse. In summary, these reported reasons provide additional motivating evidence that people’s predominant reason for never using what they own is indeed the “right” moment, or the idea that there will be a most fitting context in which to consume (that unfortunately seldom arises).

Line of questions. The survey specifically asked each respondent to provide three classes of information on any relevant item:

(1) basic ownership information (e.g., manner of acquisition, time since acquisition),
(2) strength-of-influence information (e.g., how strongly did the idea of the “right” moment contribute to your disuse of this item?, how strongly did item damage contribute to item disuse?), and

(3) ranking information (viz., where does each contributing reason for disuse fall relative to the others in terms of strength of influence?).

To structure participants’ responses, 13 possible reasons for disuse were provided, plus one fourteenth option for any additional reason participants might have had.[7] The 13 provided reasons were:

(i) the item had been lost,
(ii) the item had been forgotten,
(iii) the item had been damaged,
(iv) the item had expired or become obsolete,
(v) the item was rare,
(vi) the item was monetarily valuable,
(vii) the item was sentimentally valuable,
(viii) the item was (monetarily) costly to use,
(ix) the item was (physically) effortful to use,
(x) the item was not as good as available alternatives,
(xi) the item’s quality would diminish after the first use,
(xii) the participant was waiting for the right moment, and
(xiii) the participant was trying to avoid the wrong moment.

Of key interest in this study were participants’ responses to the final two reasons; I expected that both would be highly ranked for their strengths of influence in the sample.

Participants

One hundred forty seven alumni of Carnegie Mellon University (M_{Age} = 56.1, SD_{Age} = 14.43; 55% male; 91.0% White, 7.00% Asian, 3.00% Black, 2.00% Hispanic, and 1.00% Native American, with 4.00% of participants

[7] All 13 provided reasons resulted from a brainstorming session with colleagues about possible and prevalent reasons for disuse.

selecting multiple racial categories) were recruited via e-mail, to complete an online survey.[8] (These 147 respondents were 29.4% of the 500 total alumni who had received the recruiting e-mail.)

Participating in the survey was entirely voluntary; participants were knowingly and willingly not compensated for their survey responses, except that if any had been interested he or she later received a statement describing the survey’s results upon their completion.

Method

Each participant responded to the survey in four stages.

Stage 1: Participants indicated which of 14 provided item categories contained items they owned but had never used. For each indicated category, participants were additionally asked to name what their particular item(s) were. The 14 provided categories were:

(i) clothing,

(ii) alcohol (including wine and beer),

(iii) tools and machinery (including vehicles and appliances),

(iv) electronics (including handheld devices [like cameras] and larger systems [like home stereos]),

(v) media (including books, music, and movies),

(vi) exercise equipment,

(vii) food and beverage (excluding alcohol),

(viii) decorations (including furniture and art),

(ix) credits and other earmarked savings (including gift certificates, vacation days, rainy-day funds, and other vouchers),

(x) jewelry,

[8] Demographic information is based on the responses of only 100 of the 147 total participants, as 47 participants chose not to provide their years of birth, genders, or racial groups.

(xi) personal care items (including cologne and fragrances, makeup, and other beauty supplies),

(xii) rooms and other domestic spaces (including patios, pools, and fireplaces),

(xiii) access (to a particular location or particular attraction), and

(xiv) other, which each participant could specify.[9]

(For simplicity, each of these 14 categories will be referred to by its first word only from this point forward.)

In the second through fourth stages, each participant answered further questions about one item, randomly chosen from the items that he or she had named in the initial stage.[10]

Stage 2: Participants provided basic ownership information on their individual items (e.g., how they had come to acquire those items, how long ago the acquisitions had occurred). The final two questions in this stage introduced the first two possible reasons for disuse: lost and forgotten. Participants provided strength-of-influence information on these two reasons at this stage.

Stage 3: Participants provided strength-of-influence information on the next nine of the remaining 11 given reasons for disuse. For each of these reasons, participants specifically provided (1) the extent to which the target quality (e.g., rare, effortful to use, damaged) characterized the item and (2) whether that quality had contributed to the item’s disuse.

Stage 4: Participants provided strength-of-influence information on the final two given reasons for disuse (viz., waiting for the right moment and trying to avoid the wrong moment) and then presented any other reason not already captured by the survey. For the right moment and the wrong moment, each participant specifically reported (1) how important item use during the moment in question was to him or her, (2) what exactly that moment would be, and (3) whether the idea of that moment had contributed to the item’s

[9] These fourteen categories were finalized via discussion with colleagues about the types of item that may be most affected by overpreservation.

[10] If participants were willing, they could repeat the second through fourth stages two more times after the first time, in order to provide information on second and third items chosen in the same way as the first item. However, most participants — 63.3% — chose to provide information about only one item.

disuse. For the "other" option, participants were asked to explain the "other" reason(s) they intended. Finally, participants ranked all the reasons they had indicated had contributed to their items' disuse in order of strength of contribution.

Participants completed the survey by responding to standard demographic questions (e.g., age, sex) and then indicating whether they would be interested in (1) participating in a future study on the same topic or (2) receiving the results from this study.

(For the full survey, see Appendix B.)

Results

Table 2 presents the absolute and percentile frequencies of the 14 available categories of item in disuse in the sample. Of these 14 categories, the top four selected by participants were media (14.7%), alcohol (13.9%), credits (13.8%), and clothing (13.0%).

Table 3 then presents the absolute and percentile frequencies and the average ranks of the 14 available reasons for item disuse in the sample. Of these 14 reasons, the top three endorsed by participants were forgetting about owning the item (26.4%), waiting for the right moment to use the item (21.2%), and trying to avoid the wrong moment for using the item (13.8%). Of these three reasons, waiting for the right moment had the highest average rank for contributing to item disuse.

Digging deeper: The right moment. Table 4 presents a hand-coding of participant descriptions of right moments for item use across all 14 item categories. Suggesting that the majority of reported cases of item disuse in the sample arose in part because of concern with the right moment, the top four item categories that participants selected — media, alcohol, credits, and clothing — contained 59.6% of the cases citing the right moment as a reason for disuse in this sample.

The hand-coding separated participants' described right moments into four distinct categories:

Category 1: "Fitting Possibilities" including:

(a) special moments for special items (e.g., “it is a more specialized tool that can make certain woodworking operations less tedious with better quality,” “The right pairing of wine with food.”),

(b) moments forecast abstractly (e.g., “A summer cocktai[l] party would be a perfect time to use [the blouse].”), and

(c) moments that would otherwise be costly (e.g., “When the electricity goes off for an extended period of time”);

Category 2: “Certain Eventualities” (e.g., “When it gets cold and I need a warm shirt,” “When they're ripe,” “the specific event for which it was issued”);

Category 3: “Moments That Owners Can Make Happen” (e.g., “It'd be nice to wear them someday, maybe I should skip that latte in the morning :-)”); and

Category 4: “Other” (e.g., “Fresh asparagus, if properly stored, can be used for several days without being spoiled.”).

Of these four categories, “Fitting Possibilities” both has the most potential for generating the interesting overpreservative behavior at the heart of this dissertation and was the most endorsed in the sample, with 59.6% of the responses falling into this category.

Digging deeper: The wrong moment. Because many participant descriptions of wrong moments for use simply recapitulated the right moments for use, hand-coding participant descriptions of wrong moments focussed on counting how many wrong moments clearly pertained to a poor fit between context and consumption. Even conservatively excluding wrong moments due to risk of damage during use (e.g., “Wearing the dress during a messy activity”) and wrong moments due to lack of time for use (e.g., “No time to read”), more than half of the described wrong moments (i.e., 81 of the 156 described wrong moments) hinged on the idea of a poor fit between context and consumption (e.g., “Drinking it alone over a crappy meal or with no food.”, “Doesn't match outfit or occasion”, “In front of people it might offend.”). This percentage becomes larger, when the 35 participants who could not think of a wrong moment are also excluded.

Discussion

The results from this study support the claim that individuals desire to use many types of item in fitting contexts. “Waiting for the right moment” and “trying to avoid the wrong moment” were two of the most popular reasons why participants in this sample had never used items that they owned; only “forgetting about owning the item” was more common. Furthermore, of those three most popular reasons, “waiting for the right moment” was ranked highest for contributing to disuse. Complementarily, while clothing, alcohol, media, and credits were the item categories most associated to waiting for the right moment in the sample, each of the 14 provided item categories linked to at fewest one reported instance of “waiting for the right moment.”

More closely examining participants’ reports of what the right moments for item use would be showed, moreover, that many right moments matched well with those predicted by the theory laid out in this dissertation. Descriptions emphasizing fit, special qualities, abstract construals, and the costs of underpreparation represented more than half of the right moments reported (see Table 4). Additionally, though descriptions of right moments that are “Certain Eventualities” or “Moments That the Owners Can Make Happen” are not of particular interest in this paper, the relevance of these types of moments to the general concept of fit confirmed that nearly all participants reporting right moments had understood what a “right” moment is.

I consider these cumulative results to be evidence that the ideal pairing of consumption and context is a common, well-recognized, and important standard for owners of many types of item during decisions of whether to consume. Combining this evidence with the previous evidence of overpreservation, I suspect that owners of single-use context-sensitive items commonly hold themselves to ideal standards ultimately detrimentally. Decisions to wait for contexts to become ideal may lead potential consumers into mistakenly preserving their items indefinitely, or at least until the last moments possible for use before expiry.

Study 2: Parking at Duke

Overview

To complement the self-reported evidence from Study 1 and demonstrate that real-world consumers do tend to detrimentally preserve their context-sensitive items until the last moments possible for use before expiry, I conducted a second study of consumers, in one everyday domain: car-parking. I examined the car-parking patterns of registered bicycle commuters to Duke University and observed that those patterns regularly skewed towards the last available moments. Specifically I observed that, rather than consume their few single-use car-parking passes idiosyncratically every month, the bicycle commuters regularly consumed their passes collectively on the last dates each month. Because this regular tendency among the bicycle commuters to delay pass use until the last available moments could not be explained by the simultaneous weather patterns local to Duke University, this observation constitutes suggestive evidence beyond self-report that overpreservation for the right moment can occur in the real world.

Setting

Duke University’s Parking and Transportation Office offers a special registration to the University’s students, faculty, staff, and affiliates who plan on commuting to campus primarily by bicycle. As a perk of this registration, each registered bicycle commuter receives two free car-parking passes per month, so that on a maximum of two days each month he or she may drive rather than bike to campus.[11, 12]

Due to the imposed limit on the number of car-parking passes available to each registered bicycle commuter at any time and to the increased comfort of a car (vs. bike) ride to campus, bicycle commuters to Duke may naturally treat their two free monthly car-parking passes as special context-sensitive items, to be preserved for use only under special circumstances. The fact that the car-parking passes are available for use only twice each month encourages commuters, who may otherwise use their bicycles on any day, to be selective about when each parking pass is used. The fact that the speed and comfort of a car increasingly outperform the speed and comfort of a bike under increasingly dire, imaginable conditions (e.g., increasingly brief windows for arriving on time, increasingly inclement weather, the need to transport increasingly large objects or increasingly many people) promotes each commuter’s selectivity to focus on the most dire imaginable conditions (e.g., the worst weather days, the mornings of greatest hurry) as the ideal contexts for pass use.

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[11] Pass holders are aware, parking passes that are not used during their specified month expire at the end of that month and so do not accumulate.

[12] Members of the Duke community may of course drive their cars to campus on any day, but without parking passes have to find the room to park their cars amidst the few metered spots available. Given this constraint, few members are likely to commute by car without passes.

Altogether, the features of the choice environment provide a natural setting for investigating whether, given the choice, item owners regularly delay use of the superior alternative beyond opportunities where it would be highly beneficial.

Method

In search of regular delays of car-parking pass use beyond especially days of inclement weather, I explored the historical parking pass usage patterns of bicycle commuters to Duke University's campus over three recent years. I found regular spikes in parking pass use at the end of each month in those years and noted how those spikes failed to coincide with, or be explained by, spikes in inclement weather. These findings indicate the persistent influence of another common factor, delaying the bicycle commuters' parking pass use choices until the last possible moments before expiry. This other common factor could be the failure of commuters to find sufficiently ideal contexts for pass use earlier in the month than its very end, just prior to the passes' expiration.

Data. I acquired data on the parking pass use patterns of registered bicycle commuters to Duke University from the University's Parking and Transportation Office for the period from August 2012 through August 2015. Six hundred seven University affiliates were active parking pass users during that period: 233 faculty or staff members, 368 graduate students, and six undergraduates.[13] However, not all 607 commuters were active for the entire period (see Figure 3). Consequently, each commuter's individual record of parking pass use included only the dates of his or her active membership in the bicycle commuters' program: namely, only the dates between his or her first and last recorded dates of parking pass use. This exclusion of (1) all dates earlier than the first recorded date of pass use and (2) all dates later than the last recorded date of pass use from each commuter's record of parking pass use importantly prevented dates when the commuter might not have held available passes from entering into the statistical models as dates of deliberate pass disuse. Dates inside each commuter's range of activity were coded one if the commuter had chosen to use a parking pass on that date or zero if the commuter had chosen to not use a parking pass on that date.

[13] No other demographic information was available on these commuters.

I acquired data on the weather patterns of the greater Duke University area via Weather Underground, specifically from Raleigh-Durham International Airport’s detailed weather archives. The weather data contained daily inclemency summary measures like:

- accumulated rainfall in inches,
- mean temperature in degrees Fahrenheit, and
- maximal humidity in percentage of the air’s saturation

for greater Duke University area over the same three-year period as the parking data. Together these inclemency measures addressed the following dimensions of the weather throughout that period: temperature, dew point, humidity, barometric pressure, visibility, wind speed, gust speed, wind direction, accumulated precipitation, and cloud cover. Beyond these continuous measures, the weather data finally included binary indications of four major weather events that might have occurred on each day: fog, snow, rain, and thunderstorm.

Results

Descriptive analyses. Table 5 summarizes the usage history of the 7,779 total pairs of monthly parking passes available to active bicycle commuters between August 2012 and August 2015. Of the total number of passes available during that period, approximately 48.1% (61.3% of commuters’ first parking passes and 35.0% of commuters’ second parking passes) were used.[14]

Three histograms then illustrate the distribution of used parking passes as a function of the number of days until the end of the month: one general histogram of all parking passes (i.e., first and second together; see Figure 4) and two supplementary histograms of first and second parking passes individually (see Figure 5). These histograms show that parking pass use, especially second parking pass use, generally spiked on the very last days of the months in the data set.

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[14] Given the generally temperate climate around the Duke University campus and the reasonable assumption that bicyclists who register as bicycle commuters to the university do intend on commuting by bicycle more often than not, the seemingly high proportion of pass disuse in the data may not be surprising.

Two final sets of histograms demonstrate that the noted skew of parking pass use is not confined within any particular month or minor subset of months in the observed three-year period; end-of-the-month spikes in especially second parking pass use characterize most months and all years of the data (see Figures 6 and 7). The one notable exception is December, where a spike in parking pass use falls mid-month, before Winter Break begins for the University.

Inferential analyses. Having now shown through descriptions of the data that bicycle commuters to Duke University regularly tend to use their parking passes toward the ends of each month, I then tested whether coincident weather patterns could explain this tendency. Although improbable, it was possible that consistently inclement weather occurring at the ends of the months in the three-year period had promoted the observed spikes in parking pass use. To rule out this alternative explanation, I modeled the effect of the end of the month on whether a pass had been used while controlling for weather.

I specifically estimated a logistic regression model of daily parking pass use choices as function of an end-of-the-month variable. (Unless otherwise specified, each daily parking pass use choice was a binary variable, coded one when any parking pass — be it first or second — was used and zero otherwise, and the end-of-the-month variable was a simple indicator variable, coded one when the choice’s date happened to be the very last day of the month and zero otherwise.) I then included both inclemency measures (e.g., measures of temperature, humidity, precipitation) and temporal variables (e.g., day of the week, month of the year) as important covariates in the model. For completeness, all available inclemency measures were included, except where two or more measures correlated with one another at or above $r = .9$. (For an exhaustive list of all included inclemency measures, see Table 6.) Finally, to control for the non-independence of observations at the level of the commuter, I clustered standard errors by commuter.

Table 6 presents the results from the initial model of daily parking pass use choices as consequences of the last day of the month and other temporal and weather covariates. This initial model estimated more than a twofold increase in the odds of pass use on the very last date of the month, relative to any other date of the month (*odds ratio*

= 2.15, $p < .001$). This estimate means that, in general, pass holders may be more than twice as likely to use their parking passes on the last day of the month as on any other day, controlling for the month and the weather.

Because the preceding initial estimate may actually underrepresent the impact of the last day of the month onto parking pass use choices due to the intermittent months of inactivity in many commuters’ records, a revision of the initial model then estimated the effect of the last day of the month on parking pass use choices in only months in which parking passes had actually been used. Accordingly, this revision had all inactive months, in which no parking pass had been used, stricken from each commuter’s record prior to analysis. Table 7 presents the results from this revised model. The primary result is the estimated more than threefold increase in the odds of pass use on the very last date of the month, relative to any other date of the month (*odds ratio* = 3.10, $p < .001$). This estimate means that, in months in which pass holders do use their passes, pass use may be more than three times as likely to occur on the last day of the month as on any other day, controlling for the month and the weather.

Omitting December. Recalling that December was a clear exception to the pattern of parking pass use spikes at the end of the month, a second revised model then estimated the effect of the very last date of the month on parking pass use choices in all months but December. As expected due to the mid-month interference of Winter Break, the estimated odds ratio of parking pass use on the last day of the month to parking pass use on all other days of the month did indeed increase in December’s absence from 3.10 to 3.65 (still $p < .001$). This increase means that, in months in which parking pass holders do use their passes, pass use may actually be closer to three-and-a-half times than to just three times more likely to occur on the last day of the month than on any other day, controlling for the month and the weather.

More than just the last day. The three prior models provide initial evidence that inclement weather cannot explain bicycle commuters’ regularly preserving their car parking passes until the last available moment; even in the presence of several important weather and temporal covariates, the very last day of the month still registers a clear spike in active parking pass usage. Given this evidence, it may be the decline of available moments itself, driving the increase in usage at the end of the month. If so, then I would expect to see the several days leading up to the very last day of the month, and not just the very last day itself, also registering increases in parking pass usage over usage on all other days. Accordingly, using the same covariates and dependent variable as the revised model, six further models estimated the effects of the last two, three, four, five, six, and seven days of the month on parking pass use. The resultant estimates — all greater than 2 and significant at $p < .001$ (see Table 8) — demonstrate that the end of the month overall is a period of increased parking pass use and provide evidence that only under the increasing pressure of the closing month do commuters who are waiting to use their passes choose to use them.[15]

More than just limited experience. To demonstrate that the noted end-of-the-month effect on parking pass use is not driven by a lack of time or experience among the pass holders, a ninth version of the revised model then estimated the effect of the very last date of the month on the parking pass use choices of only those 337 commuters whose ranges of activity met or exceeded nine months, the length of one academic year (excluding three months of summer). The estimated odds ratio (3.35, $p < .001$) was practically consistent with the previous estimates calculated from the entire sample. This consistency suggests that the noted effect does not diminish with time or experience; both long- and short-term pass users appear three times more likely to use their passes on the last day of the month than on any other day of the month. (Indeed, restricting the sample even further, to include only those 161 users active for more than 18 months, still produces an estimated odds ratio approximately equal to 3 [3.18, $p < .001$].)[16]

Examining second parking pass use exclusively. Finally, estimated odds ratios based on only second parking pass use are also consistent with the previous estimates, based on the entire sample of passes: 2.98 when December is included (47197 observations from 562 commuters) and 3.44 when December is excluded (41647 observations from 558 commuters). These highly consistent results suggest that parking passes may be oversaved

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[15] An alternative way of statistically investigating this question of increased activity toward the end of the month took indicator variables of the second, third, fourth, fifth, sixth, and seventh from last days of the month individually as predictors of pass use choices (each while maintaining all other covariates). Each of these indicator variables was agnostic about (i.e., committed NA values to) the day or the few days in the month that followed the day indicated, so that it could not be argued that the spiking of pass use on the very last day of the month or on any day that followed the indicated day had carried a positive estimate to significance. While unsurprisingly this alternative way of investigating the question did estimate a lesser effect at each distance from the very last day of the month, each listed number of days from the end of the month still registered as having a significant positive impact on pass use choices (lowest *odds ratio* = 1.52, $p < .001$). By contrast, the first day of the month registered as having a significant negative impact on those same choices (*odds ratio* = 0.543, $p < .001$).

[16] Similarly, restricting the sample to only those 296 users who cumulatively used more than 20 passes, however long their ranges of activity, produces an estimated odds ratio approximate to 3 (3.41, $p < .001$). (For a histogram of the number of passes used by commuter, see Figure 8.)

regardless of whether there may be one or zero alternative passes still available to a commuter during any given month.

Discussion

Overall, the results from the analysis of the parking data in combination with the weather data show that item owners in one real-world scenario tend to oversave single-use, context-sensitive items. Bicycle commuters to Duke University regularly waited until the last available opportunities to make use of car parking passes that would have otherwise enabled them to avoid inclement weather, such as extremes of temperature or high amounts of rainfall, during their commutes. Because inclement weather cannot explain this end-of-the-month effect on parking pass use, another factor common to hundreds of commuters month after month must be able to explain it. As commonality rules out idiosyncratic factors that may also drive specific instances of pass use (such as a commuter’s need to transport large or cumbersome items to or from campus on a particular date and a commuter’s need to travel faster than a bicycle could take her on occasion), I attribute the end-of-the-month effect that I have identified in the data to the desire to consume at the right moment.[17] Admittedly, this attribution can be only speculative without direct access to what the commuters had intended or considered at each pass use decision point. However, the presented evidence that pass holders regularly drove their cars on days whose weather conditions were finer for biking than days on which commuters would have actually biked still provides an interesting real-world signal that overpreservation for the right moment exists outside the lab.[18]

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[17] The calendar’s function as a simple reminder not to forget that passes are both available and about to expire at the end of every month may also be a common contributor to the observed effect. However, the presented evidence that experience within the parking pass program — experience that would presumably decrease the need for a reminder of that kind — did not actually lessen the tendency to wait until the very end of the month to use the parking passes does not support that alternative explanation.

[18] It may be important to explicitly note here that, despite the compelling evidence in this study that real-world owners of context-sensitive items tend to overpreserve, it would still be inaccurate at this point to call that tendency to overpreserve a mistake on the parts of the item owners. Because of the lack of information on the item owners’ reasons for their choices and the related lack of a comprehensive objective standard against which to contrast choice behavior as either mistaken or not, Study 2 cannot substantially object to the claim that the bicycle commuters’ regular delays of parking pass use until the end of the month may have been rational. Consequently, Studies 3a and 3b, detailed below in the main text, were designed to provide complementary and clear evidence that decisions to preserve rather than consume context-sensitive items can be called mistakes.

One Cognitive Reason for Deviations from the Normative Model: Ease of Retrieval

Overview

Through the two previous studies, I have presented evidence that owners of context-sensitive items (1) commonly endorse the “right” moment as a leading standard for when to consume those items and (2) regularly delay consuming those items until the last moments possible before expiry. Together, this evidence suggests that suboptimal decisions to preserve rather than consume context-sensitive items occur because decision-makers have set overly high standards for initiating consumption, or in other words have fundamentally miscalculated the optimal decision rule.

In this section, I describe one reason why decision-makers may fundamentally miscalculate the optimal decision rule and consequently mistakenly overpreserve their context-sensitive items beyond beneficial opportunities for consuming them: ease of retrieval, or accessibility. I introduce this reason as an identified cause of the overestimation of likelihood and then explain how the overestimation of specifically the likelihood of obtaining the most fitting context for an item’s consumption (*p*) can bias a decision of when to consume toward an implausible, ideal future. This explanation entails two testable hypotheses about the origin of overpreservation as a retrieval-biased phenomenon in consumer behavior.[19]

How Ease of Retrieval May Lead to Overestimating p_j

Ease of retrieval is a familiar influence in the study of affective forecasting, or of the methods and pitfalls of human predictions of pleasant or unpleasant experiences (Gilbert & Wilson, 2009; Loewenstein, 1987; Morewedge, Gilbert, & Wilson, 2005). Affective predictions, or “forecasts,” require mental simulations of how future experiences could feel (e.g., “How much will I enjoy this sardine-flavored ice cream?”); and easily retrieved information (e.g., “Fishy flavors make poor confections.”) takes priority over relatively inaccessible information in supplying those simulations. This prioritization impedes accurate prediction whenever the easily retrieved information is not truly representative of the target experience. Consequently, ready images of an ideal, but

[19] Though this dissertation focusses on overpreservation as a “retrieval-biased phenomenon,” certainly there are other reasons why overpreservation may occur. In the conclusion, I acknowledge some of these other reasons as future directions for this research.

improbable, moment for consuming a context-sensitive item may be problematic for the item’s owners. Owners of context-sensitive items who easily retrieve the ideal contexts for their items’ consumption may inaccurately be encouraged to wait for future opportunities that are actually unlikely.

Phrased mathematically, ease of retrieval may bias estimates of p_j in the otherwise optimal decision rule:

$$\text{Consume now when} \quad \underbrace{w_i}_{\substack{\text{the expected utility}\\ \text{from consuming the item}\\ \text{in the present context i}}} \geq \underbrace{p_i w_i + p_j w_j - c}_{\substack{\text{the expected utility}\\ \text{from preserving the item}\\ \text{for a future context j}}} .$$

p_j represents the likelihood (p) of a particular future context (j) that is a better fit for the consumption episode in question than the present context (i). Overestimating p_j (i.e., believing a possible and more fitting context than the present to be likelier to arise than it really is) should result in more decisions to preserve rather than consume a context-sensitive item than should normatively occur.

Graphically, believing increasing item-context fits to be likelier to arise than they actually are may resemble the red prediction in Figure 9: Rather than predict in correspondence with the true distribution (in blue), the item owner predicts in correspondence with a distribution skewed in favor of the “right” moment, or the moment returning the greatest utility from consumption. Because of this skewed prediction, the item owner sets an overly high threshold in expectation of utility from consumption.

Two possible explanations of this mechanism. Two related streams of research in affective forecasting have documented skewed predictions due to biased subjective probabilities, as in Figure 9.

- One of these streams has shown that forecasters tend to predict positive or negative futures resembling respectively the best (Gilbert, Pinel, Wilson, Blumberg, & Wheatley, 1998; Kahneman, Krueger, Schkade, Schwarz, & Stone, 2006) or the worst (Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993; Morewedge, Gilbert, & Wilson, 2005) remembered or imaginable outcomes. For example, in 2005, Morewedge, Gilbert, and Wilson asked subway commuters to forecast how bad it would be if they were to miss their trains that day. In reply, these commuters predicted experiences that were on average as bad as other commuters’ *worst* remembered instances of the same event.

- The other of the two streams has shown that forecasters tend to overestimate the likelihoods both of rewarding (Krizan, Miller, & Johar, 2010; Massey, Simmons, & Armor, 2011; Vosgerau, 2010) and of painful (Risen & Gilovich, 2007; Vosgerau) prospects (see also Krizan & Windschitl, 2007): the more rewarding or painful, the greater the overestimation. For example, in 2010, Vosgerau asked lab participants to predict how likely they would be to either win or lose a die-based gamble. The participants collectively estimated that they were both more likely to win *and* more likely to lose than they truly were.

Both streams provide evidence that people can exaggerate how extreme the future is likely to be, and both streams have credited accessibility for driving this exaggeration.

For extreme forecasts. In the former substream, accessibility has been credited specifically for tipping the quality of a prediction toward the extreme. If all predictions are based on remembered information about **similar** past events (Addis et al. 2007; Buckner & Carroll 2007; Dudai & Carruthers 2005; Hawkins & Blakeslee 2004; all as cited in Gilbert & Wilson, 2009) and extreme past events are more memorable than non-extreme past events, then extreme memories should outrank non-extreme memories as predictive substrates for the contents and tenors of future events (Gilbert & Wilson). In short, forecasters should tend to draw the future closer to the extreme than to the moderate outcome. Thus, it may not be surprising that subway commuters predicted a future experience of missing a train like their worst remembered instance of missing a train (Morewedge et al., 2005); they suffered from *impact bias*, the influence of extremity into the prediction of a positive or negative event.[20]

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[20] Though in truth the impact bias as exemplified should be said to affect the judgment of the benefit (*w*), not the likelihood (*p*), of a future event, in practice it may be more accurate to say that the impact bias always affects judgments of the expected benefit (*pw*). In scenarios in which the limits of the distribution are fixed and known to forecasters so that the impact bias cannot reasonably affect *w*, the bias may still affect *pw* via *p* in a way akin to the information perspective, presented in the main text below. Thus, I consider that the impact bias may affect judgments of benefit (*w*) when the distribution is not known, as in Morewedge et al. (2005), and judgments of likelihood (*p*) when the distribution is known, as in my completed studies, and consequently yield a skew like the one in Figure 9.

For misjudgments of likelihood. In the latter substream, accessibility has been credited in two related but separable ways.

The information perspective. In one way, researchers (e.g., Tversky & Koehler, 1994; Windschitl, Rose, Stalkfleet, & Smith, 2008) have assumed that forecasters base their likelihood judgments on two competing sets of information: the set of information favoring a given prospect’s occurrence and the set of information disfavoring that prospect’s occurrence. Because favoring information is typically more accessible than disfavoring information (see Klayman & Ha, 1987), forecasters tend to overrepresent favoring information relative to disfavoring information in judging likelihood. Consequently, forecasters tend to overestimate the likelihood that a given prospect will occur (and to underestimate any complementary likelihood). I call this information-based way of crediting accessibility for the overestimation of likelihood the *information perspective*.

The vividness perspective. In the other way, researchers (e.g., Risen & Gilovich, 2007; Vosgerau, 2010) have assumed that forecasters base their likelihood judgments on how vivid or otherwise arousing a given prospect appears. The more vivid or otherwise arousing a given prospect does appear, the more aroused a forecaster naturally feels as a result. Because forecasters commonly fail to correctly attribute this arousal to its true source, forecasters commonly misattribute arousal to likelihood (Vosgerau). Consequently, not only are increasingly vivid or otherwise arousing prospects increasingly accessible to forecasters (Risen & Gilovich), but also are such prospects judged increasingly likely by forecasters (Vosgerau). Ultimately, forecasters tend to overestimate the likelihood that a vivid or otherwise arousing prospect will occur (and to underestimate any complementary likelihood). I call this vividness-based way of crediting accessibility for the overestimation of likelihood the *vividness perspective*.

Comparing the two perspectives. From the information perspective, then, accessibility causes problems specifically where it intersects with confirmation bias: “[W]hen asked to imagine a specific behavior, such as giving blood, people focus too much on ways in which the behavior could occur and too little on ways in which the behavior might not occur (for reviews see Anderson, Krull, & Weiner, 1996; Koehler, 1991)” (Wilson, Wheatley, Meyers, Gilbert, & Axsom, 2000, p. 4; see also Krizan & Windschitl, 2007, p. 108-109). Consequently, when estimating how likely a given prospect is to occur, forecasters draw too heavily from the “will occur” pile and not heavily enough from the “won’t occur” pile. This tendency to overweight confirmatory evidence relative to disconfirmatory evidence translates into the tendency to overestimate how likely the prospect is to occur (and to underestimate how likely any complementary prospect is to occur).

From the vividness perspective, on the other hand, accessibility primarily acts as an early register of the degree of misattribution that may be expected in a likelihood judgment: In Risen and Gilovich’s (2007) work, increasingly painful prospects were increasingly quick to spring to forecasters’ minds and later were judged increasingly likely to occur. These sequential increases may be correlated, but ultimately separate (see Vosgerau, 2010). Forecasters may naturally overattend to vivid and arousing possibilities and, for similar qualities, may also overestimate how likely those vivid prospects are to occur.[21]

Ultimately, from either perspective, increasingly *outstanding* (i.e., confirmable and/or arousing) prospects are mistakenly judged increasingly likely to occur by forecasters. In the positive direction, this mistake in judgment has been known as the optimism bias, the desirability bias, or simply the effect of wishful thinking (Krizan & Windschitl, 2007; Massey et al., 2011); in the negative direction, as the pessimism bias or the undesirability bias (see Vosgerau, 2010). To maintain a unifying perspective here, I will refer to the mistake as simply the exaggeration of outstanding prospects’ likelihoods.

The Effect of Personal Investment

Further work on the impact bias and on the exaggeration of outstanding prospects’ likelihoods has shown that both mistakes increase in severity as the personal import of a prospect increases for forecasters. The more forecasters care about a potential future event, the more likely they are to overestimate the event’s expected extremity (*pw*).

[21] Though Risen and Gilovich (2007) had originally cast accessibility as mediator between painfulness (i.e., a form of arousing vividness) and overestimation — i.e., “We have suggested that aversive outcomes readily spring to mind, and because they are easily imagined, they are judged to be especially likely to occur.” (Risen & Gilovich, p. 19) — Vosgerau’s subsequent (2010) work contended that, when tested in concert with arousal, the ease of imagining a given prospect had no exaggerative effect on the subjective probability of the prospect. The unifying vividness perspective here considers how vividness can explain both sets of findings: Increasing vividness may increase both accessibility and arousal, while arousal may alone increase subjective probability.

Personal investment affecting the impact bias. Morewedge, Buechel, and Vosgerau (2013) showed that hockey fans who cared more than other fans about their favored team’s winning a game were more likely than those other fans to overestimate how happy they would be in response to that win.

Personal investment affecting the exaggeration of outstanding prospects’ likelihoods. Similarly, partisan sports fans (Massey et al., 2011; Simmons & Massey, 2012) and voters (Krizan et al., 2010) have reported increasingly high subjective probabilities of their favored teams’ or candidates’ winning given competitions. These increases were above those probabilities reported by neutral or undecided counterparts and, in the cases of the sports fans, this relative overestimation persisted even when forecasters were incentivized for accuracy.

Finally, Vosgerau (2010) showed that the exaggerative effective of arousal in particular hinges on having a stake in the uncertainty’s outcome: “[L]ikelihood judgments for the focal outcome were accurate when participants had no stake in the outcome but were too high when participants had a stake in the outcome” (p. 42).

Summary

Together — though the many above findings may paint an imperfectly defined picture of the true mechanism behind optimistic and pessimistic skews of objective probabilities — these findings on the impact bias and on the exaggeration of outstanding prospects’ likelihoods may account for the exaggerated nature (*pw*) of many predicted moments of consumption. Potential consumers who recognize and prioritize the context-sensitivities of items inherently imagine fitting opportunities for consuming those items. These imagined opportunities — whether due to biased draws from memory that inform subsequent predictions, biased draws from reasons why events should or should not occur, or the vivid and arousing natures of the events themselves — appear closer to the extreme than they normatively should, so that the expected benefit *pw* of consuming during a predicted opportunity is higher than it ought to be.[22] This overestimation of the future may become especially unrealistic, when potential consumers feel

[22] This expected benefit *pw* may be higher than it ought to be for both opportunities that are themselves inherently positive (e.g., holidays) and opportunities that are themselves inherently negative (e.g., hazards). Negative opportunities allow protective items (e.g., vaccines, “Get out of jail free” cards) to return benefits from consumption by mitigating the otherwise damaging outcomes. Owners of such context-sensitive protective items who imagine mitigating extraordinarily damaging outcomes may consequentially expect greater benefits from their protective items’ consumption than they should. In this way, expecting a higher than objective benefit from

especially invested in obtaining fitting opportunities — as many item owners who come to regard their context-sensitive items as special (e.g., the champagne owner) may naturally feel.

Ultimately, the item owner who keenly envisions her possible but extreme moment for consumption may be the worst at estimating how likely that moment is to actually occur. Her resultant misbelief, that that great future is more likely to occur than it actually is, should make her more likely to preserve rather than consume her context-sensitive item at any given opportunity than she truly should be. Mathematically expressed, this bias to preserve resembles a tendency toward the following inequality in the decision rule:

$$\underbrace{w_i}_{\substack{\text{the expected utility} \\ \text{from consuming the item} \\ \text{in the present context i}}} \quad < \quad \underbrace{p_i w_i + p_j w_j - c}_{\substack{\text{the expected utility} \\ \text{from preserving the item} \\ \text{for a future context j}}}$$

which takes as a premise that the future j appears more advantageous than the present i (i.e., that $w_j > w_i$) and which holds when the likelihood of obtaining j (p_j) appears sufficiently great for the expected advantage of consuming in j ($p_j [w_j - w_i]$) to exceed the cost of preserving until j (c).

Hypotheses

From this review of the literature I derive and plan to test the following two hypotheses.

Hypothesis 1: When experience increases the availability of an extreme opportunity for consumption, a potential consumer will become more likely to prepare herself for that opportunity — specifically, by preserving her context-sensitive item for it — than she normatively should be.

Hypothesis 2: When vividness increases the arousing nature of a possible opportunity for consumption, a potential consumer will become more likely to prepare herself for that opportunity — specifically, by preserving her context-sensitive item for it — than she normatively should be.

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consuming a context-sensitive item can apply to both hazards and holidays. (See Studies 3a and 3b in the main text for a demonstration of this fact.)

Studies 3a and 3b: “Getting Away with Gold”

Overview

In my previous two studies, I provided evidence that real-world consumers purposely may overpreserve their context-sensitive items for use in exclusively the “right” moments. In a preliminary test that preceded those two studies, I also provided introductory evidence that this purposeful tendency to overpreserve may be suboptimal, relative to a normative standard, and may result directly from the setting of an overly high threshold for initiating usage.

In Studies 3a and 3b, I provide coherent evidence from a pair of larger samples that (1) decisions to preserve rather than consume context-sensitive items may objectively be considered mistakes relative to a clear normative standard and that (2) one reason for making such mistakes may be the overestimation of the likelihood of the “right” moment’s occurrence. To provide this evidence, Studies 3a and 3b present a game-based paradigm as an experimental method for demonstrating that decisions to preserve rather than consume context-sensitive items can accurately be called mistakes and for testing my two hypotheses about why those mistakes occur. This game-based paradigm replicates the important structural features of a real-world decision about whether to consume or preserve a context-sensitive item, and asks each game player to ultimately make that decision. In this way, the game functions as a central design, variations of which may accumulate support for my theory.

Study 3a: Avoiding Losses while Getting Away with Gold

In this initial version of the game, participants, randomly assigned to one of four conditions, were tasked to choose when during a fixed series of three threatening encounters to shield themselves and guarantee protection of their starting number of points. Shields, as single-use context-sensitive items, were available for use only once during the series: ideally, once against the greatest expected point loss, or *ex ante* optimum, in the series. Any shield use after that *ex ante* optimum was consequently considered evidence of mistaken overpreservation.

Participants. Two hundred two participants were recruited from Amazon’s MTurk, to complete an online game and post-game survey. Participants were required to be 18 years old or older, were each compensated $1.00 for participating, and each had the opportunity to earn a performance-based bonus payment during the game.

Method. At the start of the task, each participant was randomly assigned to one of the four conditions in a 2 (*extreme vs. non-extreme experience*) x 2 (*vivid vs. non-vivid possibility*) design:

Condition 1: *extreme experience — vivid* (EEV),

Condition 2: *non-extreme experience — vivid* (NEV),

Condition 3: *extreme experience — non-vivid* (EENV), or

Condition 4: *non-extreme experience — non-vivid* (NENV).

Once assigned, each participant was given instructions on how to play the game. These instructions contained the experimental manipulation of vividness. Following the instructions, each participant played one practice round of the game. This practice round both acclimated the participant to gameplay and contained the experimental manipulation of experience. Following the practice round, each participant played one official round of the game. (Performance in this official round alone contributed to bonus payment.) Finally, each participant was asked to complete a post-game survey. (For a flowchart of this experimental design, see Figure 10.)

In order to properly describe the two manipulations, narrative and technical details about the game are provided first.

Narrative. The superficial narrative of this initial game cast players as heroes, attempting to escape from a vampire’s castle with treasure: namely, 100 gold coins. To escape from the castle with this treasure, each player needed to safely pass from the starting chamber to the outdoors, three chambers away.

Gameplay. Safely passing through the three intermediate chambers meant successfully avoiding or defending against threatened attacks by flying bats and/or the vampire along the way; in each chamber, every player encountered one of three possible threats: (1) a null threat in the form of an empty chamber, (2) a minor threat in the form of a flying bat (see Figure 11), or (3) a major threat in the form of the vampire (see Figure 12). The likelihoods of encountering these three threats were distributed over a six-sided die; according to this die, the player encountered the null threat, the minor threat, and the major threat with the respective likelihoods ½, ⅓, and ⅙ in each chamber (see Tables 9 and 10; more on the die in the “Encounters and manipulations” subsection below).

Actions and Consequences. When the player encountered a null threat, the hero was safe and automatically passed through the chamber without issue. However, when the player encountered a minor or a major threat, the hero was in danger and the player had to choose how to react. There were two options: (1) shield or (2) dodge.

- Choosing *shield* consumed the player’s one single-use defensive item (i.e., a garlic shield) in order to guarantee the hero safe passage by the given threat (be it bat or vampire).
- Choosing *dodge* enacted the player’s repeated-use evasive item (i.e., an artful dodge) in order to chance safe passage by the given threat (bat or vampire) with 1:9 odds of success.[23]

Whenever the player chose shield or happened to succeed a dodge, the hero avoided the threatened attack and retained all remaining gold coins. However, whenever the player happened to fail a dodge, the hero fell vulnerable to the attack and consequently dropped some remaining gold coins in order to hastily escape into the next space. The exact number of coins dropped depended on the attacker:

- When escaping a flying bat, the hero dropped between 20 and 40 gold coins.
- While escaping the vampire, the hero dropped between 50 and 70 gold coins.

Both ranges were inclusive of their endpoints and had uniform likelihoods, so that the expected loss to a bat was always 30 coins and the expected loss to the vampire was always 60 coins (see Table 9).[24]

[23] 10% was chosen as the likelihood of a dodge’s successful evading of any threat, because that frequency is both low enough that the defensive power of the shield clearly dominates it and yet not so low that it would seem practically useless to participants. In other words, 10% was chosen, so that participants would experience having another viable, but weaker, option than the shield at every stage in the game. Though not being tested within this dissertation, the handiness of such a lesser alternative may be an important premise for overpreservation to manifest [consider the experimental designs of Shu, 2008; see also the Future Directions].

[24] Coin losses suffered by players who happened to fail a dodge during gameplay were fixed at their expectations in order to minimize within-condition differences among players. Consequently, both players who successfully avoided minor and major threats and players who suffered those threats should have held the same beliefs about the effects of those threats in this experiment.

Ultimately, players were rewarded for however many gold coins their heroes successfully took from the castle, with an equivalent number of entries into a bonus lottery. After the completion of the experiment, this lottery awarded five $25.00 prizes to five distinct players who had completed the game.

Participants' instructions. Participants' instructions contained all the information given in the “Narrative” and “Gameplay” subsections, except the explicit calculations of expected losses (in Table 9). With the remaining information and the knowledge of the threats they would encounter, players could calculate their expected losses and thereby their optimal shield use choices at every encounter in the game.

Encounters and manipulations. Each player had six total encounters over the course of the game: three in the game's preliminary practice round and another three in the game's official round.

Manipulating experience. As noted above, each player was told that a six-sided die would determine each of the six threats she would encounter. Indeed, each player was asked to roll a virtual six-sided die before each encounter in the game, in order to determine the encounter's threat. The threat would be null when the die showed one, two, or three; minor, when die showed four or five; and major, when the die showed six (see Table 10, which participants were given).[25]

Yet, each player was not told that, while the die rolls would determine the threats as stated, all die rolls themselves had been fixed, in order to control the orders of threats she would encounter. This control allowed for the following manipulation of experience: While in the preliminary practice round all *extreme experience* (EE) participants encountered (in order)

- a minor threat,
- a null threat, and
- a major threat,

[25] Giving each player this image of material chance in determining outcomes was partially intended to lessen any sense of strategic rigging (e.g., experimenter's demand) or probabilistic bias (e.g., the Gambler's Fallacy) that may otherwise have been in the player's mind.

all *non-extreme experience* (NE) participants encountered (in order)

- a minor threat,
- a null threat, and
- another null threat.

This difference in the final threat encountered in the practice round tested Hypothesis 1.

Testing Hypothesis 1. Hypothesis 1 claimed, “When experience increases the availability of an extreme opportunity for consumption, a potential consumer will become more likely to prepare herself for that opportunity — specifically, by preserving her context-sensitive item for it — than she normatively should be.” Accordingly, I expected that altering participants’ samples of the known distribution of threats in the practice round, so that EE participants experienced the extreme of the distribution while NE did not in that round, would cause EE participants to overpreserve more than NE participants in the subsequent official round.

In order to capture this tendency to overpreserve on the part of the EE participants, all participants encountered the following order of threats in the official round:

Encounter 1: a null threat,

Encounter 2: a minor threat, and

Encounter 3: a null threat again.

The *ex ante* consumption optimum in this series was the second encounter, the minor threat (see Appendix A); all participants, regardless of condition, should have chosen to consume their garlic shields then. However, due to the preceding manipulation of experience, I expected that EE participants would be more likely than NE participants to *mistakenly* delay consuming their shields until the final encounter (where, unfortunately, that defense would be useless).

Manipulating vividness. Another manipulation varied how menacing the major threat appeared to be. This manipulation affected the image of the vampire participants saw during both the instructions and the subsequent gameplay: Participants in the *vivid* (V) conditions saw a more vivid, more arousing image of the vampire in their instructions and gameplay (see Figure 13) than participants in the *non-vivid* (NV) conditions saw in theirs (see Figure 12).[26] (Otherwise, the two visual experiences of the game were identical.) This difference in vividness tested Hypothesis 2.

Testing Hypothesis 2. Hypothesis 2 claimed, “When vividness increases the arousing nature of a possible opportunity for consumption, a potential consumer will become more likely to prepare herself for that opportunity — specifically, by preserving her context-sensitive item for it — than she normatively should be.” Accordingly, I expected that altering participants’ arousal, so that V participants were aroused more than NV participants, would cause V participants to then overpreserve more than NV participants in the official round. This expected difference would also be captured by participants’ choices in the second encounter of the official round; V participants would be less likely than NV participants to use their shields in that encounter.

2 x 2 expectations. Combining both manipulations’ predictions, I expected that EEV participants would be the most likely, and NED participants the least likely, of all four participant groups to overpreserve their shields in the official round.

A supplementary test of mediation. To fully support the mechanism posited by my theory, I planned a supplementary test of mediation, to detect whether a biased judgement of likelihood could account for the expected effect of either manipulation on participants’ shield-use choices. The biased judgment of likelihood I specified was each participant’s rating of how likely she was to encounter the vampire in the official round. Half of all participants made this rating, in particular between the practice and the official rounds. (For simplicity, having been randomly assigned to make this rating will be known as having been randomly assigned to the Likelihood [L] condition, while having been randomly assigned to skip the rating will be known as having been randomly assigned to the Non-Likelihood [NL] condition.) All L participants made their likelihood ratings on a 7-point Likert scale (from “Not at All Likely” to “Extremely Likely”). I expected that V and EE participants’ ratings would be higher on that

[26] The difference in arousal between the two images was checked by a between-subjects pre-test of several alternative vampire images. The two images most different on the dependent measure of arousingness were chosen for use in this experiment.

scale than NV and NE participants’ ratings, respectively. Observing those paired differences would mean that the two described manipulations had worked as theorized.

Post-game survey. A final post-game survey collected participants’ demographics and assessed participants’ general risk preferences (i.e., on a 7-point scale “How risk taking are you?”) and degrees of loss aversion (i.e., via a series of decreasingly positive gambles, drawn from Gächter, Johnson, and Herrmann [2007]).

Study 3b: Securing Gains while Getting Away with Gold

Because Study 3b used an almost identical design to Study 3a, the few differences between the two experiments will be documented here, before presenting the results from both experiments together.

Participants. Study 3b recruited another 202 participants from Amazon’s MTurk, to complete the online game and post-game survey. These participants also were required to be 18 years old or older, were each compensated $1.00 for participating, and each had the opportunity to earn a performance-based bonus payment during the game.

Method. As noted, Study 3b utilized an almost identical method to that of Study 3a. The few differences arose from how each Study framed the consequences of the game’s encounters: Whereas Study 3a framed each encounter as a chance for loss, Study 3b framed each encounter as a chance for gain. Consequently, unlike participants in Study 3a, participants in Study 3b:

- began gameplay with a zero-coin endowment and
- then had the opportunity to gain coins by successfully avoiding attacks throughout the game.

The respective numbers of coins available to be gained in encounters with the bat and the vampire in Study 3b were the same respective numbers of coins available to be lost in encounters with the bat and the vampire in Study 3a: In Study 3b, the expected gain from any encounter with a bat was 30 coins and the expected gain from any encounter with the vampire was 60 coins. Effectively, the reward structure was inverted.

In keeping with this inversion of the reward structure, the narrative of the game in Study 3b was also slightly altered. Rather than protect heroes against dropping some coins in hasty escapes from threats, shielding or successfully dodging enabled heroes to collect some coins otherwise guarded by threats.

These alterations to the method were not expected to change the pattern of results observed; I still expected EE and V participants to be less likely than NE and NV participants, respectively, to use their shields in the second encounter of the official round and I still expected participants' ratings of likelihood to mediate those differences. The only change in the results I did anticipate from Study 3a was a change in the magnitude of the observed effects. Specifically, because the potential losses of the game in the loss frame of Study 3a were likely to loom larger than the potential gains of the game in the gain frame of Study 3b, I expected that the magnitude of the observed effects in Study 3a could be larger than the magnitude of the observed effects in Study 3b. In other words, I expected that loss frame (LF) participants could be less likely than gain frame (GF) participants to use their shields in the second encounter of the official round. A planned comparison of the results from Study 3a with those from Study 3b would test for this expected difference in effect size.

Results from Studies 3a and 3b

Descriptive analyses. Table 11 summarizes the shield use choices of all 404 participants in the second encounter of the official round. Two main effects appear evident.[27]

Main Effect 1: In line with expectations, EE participants appear to have been less likely than NE participants, to use their shields in the second encounter of the official round.

Main Effect 2: Similarly, LF participants appear to have been less likely than GF participants, to use their shields in the second encounter of the official round.

No other main effects than those two appear evident.

[27] Two interactive effects also appear evident, but as these effects were not predicted and may be spurious I discuss them in Appendix C rather than in the main text. The one important note about these interactive effects here is that their inclusion in my statistical models does not erase the two noted main effects.

- Importantly, there appears to be no main effect of vividness, as V participants on average do not appear to have been any less likely than NV participants to use their shields in the second encounter of the official round.
- Additionally, there appears to be no main effect of likelihood, as L participants on average do not appear to have been any more or less likely than NL participants to use their shields in the second encounter of the official round.

Inferential Analyses. A simple logistic regression initially modeled the independent effects of all four experimental manipulations — experience, vividness, likelihood, and frame — onto shield use choices during the second encounter of the official round (see Table 12).[28] This model identified both the main effect of experience and the main effect of frame as statistically significant, in line with expectations: According to the model, the odds of shield use in the EE conditions were approximately one fourth of the odds of shield use in the NE conditions ($\exp(ß_{EE}) = 0.253$, $p < .001$) and the odds of shield use in the LF were approximately three fifths of the odds of shield use in the GF ($\exp(ß_{LF}) = 0.6$, $p < .05$). These estimates indicate respectively that:

- relative to not having encountered the vampire in the practice round, having encountered the vampire in the practice round reduced a participant’s likelihood of shield use in the second encounter of the official round and,
- relative to having to consider each encounter as an opportunity for gain, having to consider each encounter as an opportunity for loss reduced a participant’s likelihood of shield use in the second encounter of the official round.

Risk preferences and degrees of loss aversion. Examining the two supplementary measures of risk aversion and loss aversion in addition to the independent manipulations of experience, vividness, likelihood, and frame revealed only that the most loss averse participants were less likely to use their shields in the second encounter of the official round than the least loss averse participants were.[29] Specifically, participants who had

[28] Results from the fully interacted, 2 x 2 x 2 x 2 model appear in Appendix C.

[29] Data obtained on loss aversion from the series of six coin-flip gambles drawn from Gächter, Johnson, & Herrmann (2007) were converted into a 7-point Likert scale prior to analysis. Each point on this scale marked one turning point, at which some participants would no longer accept the chance of increased loss in all subsequent

scored 1, 2, or 3 on the 7-point Likert scale of decreasing loss aversion were about half as likely on average as participants who had scored 5, 6, or 7 on the same scale ($\exp(ß_{\text{Loss Aversion at 5, 6, or 7}}) = 0.552$, $p < .05$) to use their shields in that second encounter (see Table 13).[30]

Mediation. Three additional models tested whether the likelihood estimates provided by the 183 participants in the L conditions (85 from the LF and 98 from the GF) mediated the observed effect of experience on shield use choices (see Table 14 and Figure 14).

Mediation Model 1: Likelihood on Experience. The first model estimated the effect of experience on the likelihood estimates themselves (see column 1 of Table 14). As expected, this model found a positive relationship between the two variables: Whereas the average NE participant had estimated her likelihood of encountering the vampire in the official round as an approximately even chance (i.e., 4 on the 7-point scale), the average EE participant had estimated his likelihood of encountering the vampire in the official round as more likely than not (i.e., 5 on the same scale; $ß_{EE} = 0.748$, $p < .006$). Thus, having encountered the vampire in the practice round had raised subjective estimates of the likelihood of encountering the vampire in the official round.

Mediation Model 2: Decisions to consume or save on Likelihood. The second model estimated the relationship between the likelihood estimates and the subsequent shield use choices (see column 2 of Table 14). Also as expected, this model found a negative relationship between the two variables. Treated continuously, each unit increase on the likelihood scale corresponded with approximately a 20% decrease in the odds of optimal shield use ($\exp(ß_{\text{Likelihood}}) = 0.796$, $p < .01$). Categorically, participants who had viewed themselves as relatively likely to encounter the vampire in the official round (i.e., participants who had chosen 5, 6, or 7 on the 7-point Likert scale of subjective likelihood) had approximately one third of the shield use odds of participants who had viewed themselves

gambles. The resultant data were bifurcated at the median prior to inclusion in the model in order to best capture the apparent pattern in the simple crossplot of the data and shield use choices. This bifurcation isolated (in relative terms) loss averse, loss neutral, and loss accepting participants as three distinct groups. No differences from loss neutrality on either side emerged.

A similar bifurcation of the risk aversion data was not available.

[30] Data from the 15 participants whose responses to the six coin-flip gambles violated monotonicity (nine participants in the loss frame and six participants in the gain frame) were excluded from this analysis. Data from five additional participants who had failed to complete responding to the six coin-flip gambles (two in the loss frame and three in the gain frame) were also excluded from this analysis. Only data from the remaining 384 participants (193 in the loss frame and 191 in the gain frame) contributed to this estimate.

as relatively unlikely to encounter the vampire in the official round (i.e., participants who had chosen 1, 2, or 3 on the 7-point Likert scale).

Mediation Model 3: Decisions to consume or save on Experience in the presence of Likelihood. The final model estimated the effect of experience on shield use choices within the presence of the likelihood estimates. Should this estimate be meaningfully lesser than the estimate made without the presence of the likelihood estimates, the hypothesized mediation would be found.

Within the presence of the likelihood estimates, EE participants had approximately 30% of the shield use odds of NE participants ($\exp(ß_{EE}) = .296$, $p < .001$). Without the presence of the likelihood estimates, EE participants had approximately 26% of the shield use odds of NE participants ($\exp(ß_{EE}) = .264$, $p < .001$). The unexpected comparability of these two estimates suggests that the likelihood estimates had not fully mediated the observed difference of EE from NE participants’ shield use choices.

However, prompted by the earlier two models’ expected findings, a closer examination of the data then revealed that the suggested failure of the final model to support the hypothesized mediation had actually rested on some puzzling data: namely, the shield use choices of NE participants (see Figure 15). Whereas the shield use choices of EE participants had clearly followed from their likelihood estimates (i.e., EE participants who had reported high estimates of the likelihood of encountering the vampire in the official round then had understandably oversaved their shields in that round), the shield use choices of NE participants clearly had not followed from their likelihood estimates (i.e., NE participants, regardless of how likely they had estimated encountering the vampire in the official round to be, then had oddly used their shields at roughly a common rate). This insensitivity of the shield use choices of NE participants to their own likelihood estimates calls into question the validity of the likelihood estimates as measures of the subjective beliefs of the NE participants: Why should any NE participant who highly expected encountering the vampire in the official round be as likely to use her shield in the second encounter of that round as another NE participant who scarcely expected encountering the vampire?[31]

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[31] One possible explanation of this puzzling behavior is that NE participants’ prior experience with a bat in their practice round overrode any competing concern with the vampire during the second encounter of the official

This question of apparent insensitivity to relevant, self-generated likelihood estimates can explain why the final model failed to support more than what appears to be a moderated mediation (see Figure 15).[32] Whatever the answer to the question, a statistical test that relies halfway on completely non-correlated data has practically no chance of detecting a full effect, despite the supportive pattern of the other half’s data. So, whether all the NE participants had updated their subjective beliefs about the vampire by the decision point of the official round, had never actually taken their reported subjective beliefs seriously, or had acted in concert across the likelihood spectrum for a third reason, their common insensitivity precludes clear support for the full mediation hypothesized here.

Discussion. These initial experiments, testing my theory about one cause of mistaken overpreservation in the context of an online game, have provided evidence in support of my hypotheses. Participants who had experienced the extreme outcome of the distribution in the practice round of the game — although it was the rarest outcome — tended to have higher estimates of the likelihood of experiencing that extreme outcome again in the subsequent official round of the game than participants who had not experienced the same extreme outcome in the practice round. This heightened estimation may have consequentially altered behavior in that official round, in that participants who had experienced the extreme outcome of the distribution in the practice round of the game also tended to then mistakenly overpreserve their single-use items in the subsequent official round. While a complete mediation of item use choices by likelihood estimates was not available due to the puzzling behavior of NE participants (whose choices appeared insensitive to likelihood), the appearance of a causal chain in the behavior of EE participants is suggestive evidence that a complete mediation may yet exist. Ultimately, despite the lack of a complete mediation in the present data, the clear direct effects of experience and frame on behavior were found, beyond any similar effects due to risk aversion or loss aversion.

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round. Thus, NE participants may have used their shields against the official round’s bat reflexively, in a way similar to the way in which EE participants appeared to save their shields for use against an official-round vampire.

[32] A model of shield use choice as the effect of an interaction between experience and likelihood estimates does find the interaction to be a significant predictor of shield use ($\exp(ß_{EE \times Likelihood}) = .679$, $p < .05$). EE participants who had viewed themselves as relatively likely to encounter the vampire in the official round (i.e., EE participants who had chosen 5, 6, or 7 on the 7-point Likert scale of subjective likelihood) had relatively low odds of optimal shield use.

Though no parallel system of effects was found for the manipulation of vividness in these experiments, I do not discount the possibility that such effects may be observed under a different manipulation of vividness from the one used here. Though pretests of the images used to manipulate vividness here did find a significant difference in their capacities for arousal, it is still possible that in the context of the game this difference was eroded by, for example, divergent attention or a focus on strategy. Vividness may yet be shown to increase people’s overpreservative tendencies through overestimating the likelihoods of vivid, arousing outcomes.

Future experimental directions. Given the success of this experimental design at identifying one cause of overpreservation in behavior, future variations of this design may be able to detail these initial findings not only by disentangling some codirectional factors producing them but also by replicating them in other scenarios than the vampire’s castle. Along these lines, two particular variations appear useful.

One of these two variations would focus on disentangling two codirectional factors producing the noted overpreservative effect in participants’ choices. These codirectional factors are (1) the severity of that threat’s potential damage and (2) the category of the threat itself. To be clear, coupling these factors in the experiments above was less a confounding than a compiling of two directionally identical manipulations, since each of the manipulations could still generate the identical effect — albeit perhaps to a lesser degree alone than with its partner. So, one useful variation of the initial experiment would decouple the two manipulations, to more tightly if less strongly test for the overpreservative effect in participants’ shield use choices. For example, this variation could contrast the described EE condition against a new EE condition in which the threats were fixed to deal comparatively either more or less damage. In this variation, while the earlier condition’s major threat could deal near the major threat’s maximal damage (near 70%), the other condition’s major threat could deal near the major threat’s minimal damage (near 50%).[33] Given this difference in damage dealt to participants, I would expect that participants in the “high damage” condition would overpreserve more than participants in the “low damage” condition. The

[33] These discrepant levels of damage could be displayed to participants even who use their shields to successfully defend against these major threats; these defensive participants could witness how much damage their avatars would have suffered had they not used their shields in defense.

extent of such a difference between the two conditions would demonstrate how impactful absolute utility, relative to categorical utility, is onto decisions to consume.

The other of these two variations would focus on replicating the findings of the initial two studies in a new scenario. Ideally, this new scenario would not only depart from the vampire’s castle but also lend itself more naturally toward the frame of gains than the vampire’s castle did. As a scenario, the vampire’s castle naturally encouraged each participant player to adopt a defensive posture, executing self-protective actions in the faces of potential threats. Conceptually, this defensive posture better aligns to the potential for loss in the frame of losses than to the potential for gain in the frame of gains, as few events in games or in the real world actively earn a person rewards for defending well against threats. Consequently, a new scenario, naturally emphasizing the potential for actively earning rewards, (e.g., a gemstone mine, wherein participants attempt to capture the most valuable gems) may be a better test of the overpreservative effect in the domain of gains than the vampire-based scenario of the two completed experiments. This attentive preclusion of possible friction of the frame on the narrative of the experiment is important at least in the context of this paper, because the idea of the right moment primarily points toward the advantageous consumption of an item yielding bonus utility within a fitting context.

Further variations of the above design, in order to address further aspects of the core experiment — including especially the promise of a complete mediation — may join these two possible variations and the completed experiments as parts of a larger research package on this topic, with the intention of generating a case that factors inducing mistaken overestimations of likelihood cause the mistaken overpreservation of context-sensitive items for the “right” moments.

Direction for Future Work: Study 4 — “Rain on My Commute”

Overview

Following the direction to add support for my theory through variations of Study 3’s paradigm, I close this dissertation with a detailed proposal of one new experiment, testing specifically whether real-world events may predict virtual decisions to save or consume a context-sensitive item. Thematically, this proposal will weave together the threads of Studies 2 and 3 in taking advantage of natural events for experimental purposes. The aim is not only to replicate the conceptual findings of the previous studies but also to extend their application clearly to such everyday influences on decisions to save or consume as whether or not it may be raining.

At a high level, the proposed design will translate the structural features of Studies 3a and 3b away from the vampire’s castle and into two new scenarios: one a weather-based scenario like that of Study 2 and the other a load-based scenario that I will explain below. Participants, who will be recruited specifically during a severe weather event (viz., a heavy rainstorm), will be randomly assigned to one of those two scenarios as conditions, and will then be asked to play the online game. As in Studies 3a and 3b, the ultimate direction of this game will be for each participant to choose when during a series of three discrete opportunities to consume a context-sensitive item. Whereas in the vampire’s scenario this item was threat-sensitive and guaranteed protection against a minor or major threat, in the two new scenarios the item will be rain- or load-sensitive, respectively, and will guarantee protection against light or heavy rainfall or light or heavy weight. While in all scenarios the right moment for item use may be the severe event (i.e., the major threat, the heavy rain, the heavy weight), in all games the *ex ante* optimal moment for item use was and will be the mild event (i.e., the minor threat, the light rain, the light weight). Consequently, just as in Studies 3a and 3b, in-game decisions to preserve the item beyond the optimal moment will be considered mistaken decisions to oversave the item for the right moment. Newly, the participant’s real-world setting, not simply an artificial manipulation, may be a key driver of any difference in the proportion of mistaken decisions between conditions: Because of the real-world accessibility of heavy rain in the weather-based scenario, I expect that Weather participants will mistakenly overpreserve more than Load participants.

Participants

One hundred participants will be recruited from Amazon’s MTurk, to complete an online game and post-game survey. Recruitment will take place specifically during a heavy rainstorm in Washington, D.C. So, participants will each be required to be located in Washington, D.C., as well as to be 18 years old or older; will each be compensated $0.70 for participating; and will each have the opportunity to earn a performance-based bonus payment during the game. (Washington, D.C., has been chosen as a prerequisite for participation in this experiment for purposes of control; at present, Washington, D.C., is the smallest selectable region in the United States via

Amazon's MTurk and therefore is the most suitable of all U.S. selectable regions to ensuring that all recruited participants will be subject to the same weather events.)

Method

Each participant will be randomly assigned at the beginning of the experiment to one of two conditions. In the "Rain" condition, the gameplay narrative will be weather-based. In the "Load" condition, the gameplay narrative will be weight-based. Once assigned, each participant will be given instructions on how to play her version of game. Following these instructions, each participant will play one official round of the game and may earn a bonus payment on the basis of her gameplay. Finally, each participant will be asked to complete a post-game survey. (For a flowchart of this experimental design, see Figure 16.)

Narratives. The superficial narrative of the game in the "Rain" condition will cast players as commuters, attempting to plan their next three days of transport to work while minimizing the amount of time they will spend outside during rain. To avoid being outside during especially heavy rain, each commuter will have the option of securing a car for transport to work. Otherwise, each commuter will default to walking to work on foot.

The superficial narrative of the game in the "Load" condition will cast players as couriers, attempting to plan their next three days of work while minimizing the weight of the packages they will have to carry. To avoid carrying especially heavy packages, each courier will have the option of securing a car for work. Otherwise, each courier will default to working on foot.

Gameplay. Securing a car in either scenario will mean either successfully asking a neighbor to borrow a car or reserving use of the employer's private car in advance of the anticipated workday. The likelihood of benefitting from the car (i.e., the likelihood of rain in the weather-based scenario or the likelihood of a large or weighty package in the load-based scenario) will be distributed, as in Studies 3a and 3b, over a six-sided die. According to this die, the player will encounter no, light, or heavy benefit from a car with the respective likelihoods ½, ⅓, and ⅙ on each of the three days (see Tables 15 and 16).

Actions and consequences. When the player encounters an event offering no benefit from a car, the commuter or courier is effectively safe and will automatically complete the workday on foot without issue. However, when the player encounters an event offering light or heavy benefit from a car (viz., light or heavy rainfall in the weather-based scenario or a light or heavy large package in the load-based scenario), then the commuter or courier is effectively in danger and the player will consequently have to choose how to react. As in Studies 3a and 3b, there will be two options: (1) shield or (2) dodge.

- Choosing *shield* will consume the player’s one single-use protective item (i.e., a private car) in order to guarantee either the commuter safe passage through the rain or the courier safe carriage of the large package (be it light or heavy).
- Choosing *dodge* will enact the player’s repeated-use evasive item (i.e., a borrowed car) in order to chance safe passage or carriage with 1:9 odds of success.

Whenever the player chooses shield or happens to succeed a dodge, the commuter or courier will remain fully happy that workday and the player will avoid losing points in the game. However, whenever the player happens to fail a dodge, then the commuter or courier will feel unpleasant at work and the player will consequently lose some points in the game. The exact number of points lost will depend on the heaviness of the instigating event:

- When commuting through light rain or carrying a light large package without a car, the player will lose between 20 and 40 percent of her initial number of points.
- While commuting through heavy rain or carrying a heavy large package without a car, the player will lose between 50 and 70 percent of her initial number of points.

As in the previous studies, both ranges are inclusive of their endpoints and have uniform likelihoods, so that the expected loss to the light event will always be 30 percent of initial points and the expected loss to the heavy event will always be 60 percent of initial points (see Table 5).[34]

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[34] Point losses suffered by players who happened to fail a dodge during gameplay were fixed at their expectations in order to minimize within-condition differences among players. Consequently, both players who

Ultimately, players will be rewarded for the percentages of their initial points that still remain at the end of the game, at a rate of $0.02 per remaining percentage point.

Participants’ instructions. As in Studies 3a and 3b, participants’ instructions will contain all the information given in the “Gameplay” and “Narratives” subsections, except the explicit calculations of the expected losses. With the remaining information and the knowledge of the events they may encounter, players will be able to calculate those expected losses as well as their optimal shield use choices at every encounter in the game.

Encounters and manipulation. Each player will have three total encounters over the course of the game: the three in the game’s official round. (Unlike participants in Studies 3a and 3b, participants in this study will not complete a practice round.)

As in Studies 3a and 3b, each player will be told that a six-sided die will determine each of her encounters’ events and will be asked to roll a virtual six-sided die before each encounter in order to determine its rainfall or load. Unbeknownst to each player, however, all die rolls will have been fixed in advance, in order to control the order of events each player will encounter. Consequently, all participants will encounter the following three events in order:

Encounter 1: a null event (i.e., no rainfall or no large package),

Encounter 2: a light event (i.e., light rainfall or a light large package), and

Encounter 3: a null event again.

This order of events will allow for the capture of any tendency to mistakenly overpreserve in either condition: The *ex ante* optimum in both conditions’ series is the second encounter (i.e., the light event; see Appendix A) so all participants, regardless of condition, should choose to consume their single-use private cars then. Consequently, any preservation of the private cars beyond then will constitute evidence of a mistake.

Manipulating experience. The planned difference in how relevant the participants’ current real-world weather is to their gameplay will test Hypothesis 1. Hypothesis 1 claimed, “When experience increases the

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successfully avoided light and heavy events and players who suffered those events should have held the same beliefs about the effects of those events in this experiment.

availability of an extreme opportunity for consumption, a potential consumer will become more likely to prepare herself for that opportunity — specifically, by preserving her context-sensitive item for it — than she normatively should be.” Accordingly, when real-world experience increases the availability of heavy rain, Rain participants should become more likely than Load participants to mistakenly preserve rather than consume their context-sensitive single-use items in the second encounter of the game. Because all participants will be completing the experiment during a heavy rainstorm, I expect that more Rain participants than Load participants will mistakenly delay consuming their private cars until the game’s final encounter (where, unfortunately, that protection would be useless).

If found, this expected cross-over of influence from real experience to virtual decision-making would add robustness to the finding that experience can induce item owners to mistakenly oversave (Studies 3a and 3b) and would demonstrate that mistaken oversaving can also occur in a naturalistic (vs. fantastic, or vampiric) scenario.

Post-game survey. A post-game survey will finally collect participants’ demographics, assess participants’ general risk preferences (i.e., on a 7-point scale “How risk taking are you?”) and degrees of loss aversion (i.e., via a series of decreasingly positive gambles, drawn from Gächter, Johnson, and Herrmann [2007]), and ascertain whether participants will have directly experienced either the concurrent rainstorm or any concurrent heavy carrying prior to or during gameplay.

Expected Results and Discussion

As suggested, I expect that the results of this proposed experiment will corroborate the findings of the previous studies on item owners’ tendencies to mistakenly preserve rather than consume their context-sensitive items. Observing that Weather participants mistakenly overpreserve more than Load participants in this study would be additional evidence that the accessibility of the right moment (here via experience) is one cause of mistaken decisions to oversave.

More than a conceptual replication in a naturalistic setting, I also expect the results from this new study to extend previous findings by demonstrating an interplay between simple everyday influences and decisions to save or consume. Observing that Weather participants do indeed mistakenly overpreserve more than Load participants in this study would be evidence that even local, natural events can bias decisions to save or consume through the channels of accessibility. In this way, this proposed experiment may be considered a test of the strength of the identified effect of experience on decisions, with the expected results showing the effect’s robustness within the course of an everyday item owner’s experience.

General Discussion

Throughout this dissertation I have argued that the idea of the right moment is a pervasive and systematic influence on consumer behavior. As a result of this influence, context-sensitive item owners, who hope to maximize their returns from consumption, tend to pursue only the most fitting contexts for consuming rather than saving their items. By rejecting rather than accepting alternatives to the most fitting right moment, these item owners often detrimentally forego ready opportunities for benefiting from their items in favor of the unlikely possibility of benefitting the most. When foregoing such ready opportunities can be objectively estimated as the poorer of the two options, item owners’ detrimental choices to save rather than consume can be accurately called mistakes. The mistaken oversaving of context-sensitive items (longer than they ought be saved) may be an underacknowledged phenomenon in consumer behavior.

Sequentially, my argument has proceeded by first offering some initial evidence that this phenomenon of mistakenly oversaving for the right moment not only exists but moreover is common in the real world. This evidence was obtained:

(1) in pilot research, which introduced the finding that context-sensitive item owners tend to mistakenly delay consumption til the last of a finite sequence of opportunities;

(2) in a survey of real-world item owners, who highlit the tendency to wait for the right moment as a leading reason for never having yet used their saved items; and

(3) in an examination of archival data, which not only supported via a large field sample the finding that context-sensitive item owners tend to delay consumption until the last available opportunities but also

suggested that experience may be insufficient for such item owners to learn that their delays often detrimentally overlook relatively beneficial experiences.

My argument then proposed a theoretical model for structuring the decision to save or consume as a precise trade-off between the expected utilities of those two options. Comparing these expected utilities results in a simple decision rule about whether to save or consume at any given moment. By applying the logic of an optimal stopping rule to that simple decision rule, I extended the result to cover decisions over sequences of opportunities. Ultimately, the rule held that, whenever the expected utility of saving for the right moment should fail to exceed the expected utility of consuming at the present opportunity, it would be a mistake to save rather than consume. My argument then described one reason why owners of context-sensitive items may often fail to follow that simple decision rule: namely, the overestimation of how likely the right moment is to arise. Drawing on previous findings in affective forecasting, I attributed this overestimation to ease of retrieval and hypothesized that the easily retrieved right moment should erroneously encourage context-sensitive item owners to save when they should consume. Supporting this hypothesis, my argument then provided evidence that item owners violate the optimal decision rule by mistakenly oversaving in a pair of controlled experiments. In the experiments, participants to whom the right moment was available both reported greater estimates of how likely they were to obtain the right moment in the future and more frequently mistakenly oversaved their context-sensitive items for the future than other participants. Future directions can extend this finding, by testing whether the exogenous availability of the right moment in participants’ real-world circumstances would similarly affect decisions to save or use in a fictional decision scenario. Assembled, my argument and the evidence supporting its points develop one plausible explanation of oversaving as a common mistake in consumer behavior.

Contributions

By proceeding in this way, my argument has offered several novel contributions to the study of consumer behavior (CB). First, by assessing the reasons reported by a sample of real-world item owners, this dissertation provided evidence that delaying consumption for the right moment is a common and conscious choice in everyday CB — even across a variety of item categories. Second, by then assessing the tendencies of bicycle commuters to save rather than consume their free car-parking passes each month, this dissertation also provided compelling real-world evidence that oversaving exists and realistically describes everyday CB. Third, by developing a simple theoretical model of a decision to save or consume, this dissertation has allowed for the establishment of benchmarks against which to compare decisions to save as potential mistakes. Following this allowance, fourth, this dissertation pursued a systematic study of one reason why mistaken decisions to oversave might occur and has provided evidence that one reason — namely, the overestimation of the right moment’s likelihood — might be a key driver of those mistaken decisions. Finally, in proposing a final experiment for reproducing the identified effect, this dissertation has offered a useful intersection between field and lab methods that may underscore both the overestimation of the right moment’s likelihood as one cause of oversaving and the operation of the idea of the right moment in the real world as a common influence on CB.

Future Directions

Looking forward, this dissertation has thereby established a foothold for the further examination of the problem of oversaving in CB. As Shu (2008) first suggested, item owners can be both present-biased and undersave and future-biased and oversave and both biases may be equally problematic. As I have begun to show here, which of the two saving biases occurs may result from the features of the item and the perspective of its owner. Abetted by limitations on an item’s use, context-sensitivity, or the ability of a context to affect a consumption experience, sets the stage for oversaving by pointing toward a most advantageous pairing of context and consumption. From this starting point, I see three additional directions for further study.

The first direction adheres most closely to the experimental work completed in this dissertation. Two additional inputs into the theoretical model remain as two potential sources of error leading to mistaken decisions to oversave: (1) the relative utility gained from consuming a context-sensitive item at the right moment instead of the current alternative moment and (2) the relative costs of saving the item for the right moment instead of consuming it at the current alternative moment. In theory, both the overestimation of the earlier input and the underestimation of the latter input should also result in a bias toward saving rather than consuming a context-sensitive item. Experimentation designed to test each input as a possible driver of mistaken decisions to oversave would be valuable next work in validating the theoretical model as an accurate, simple (1) understanding of a decision to save or consume and (2) outline of where and how that decision can deviate from optimality.

The second direction for future work steps back and considers another reason than the three cognitive reasons for oversaving that are implicated by my theoretical model: namely, an affective reason, owed to having functional alternatives to the potentially saved item. In general, having functional alternatives to the potentially saved item (e.g., having bottles of table wine as alternatives to a bottle of fine wine) may grant item owners the affective freedom to not regret missing out on either the present or the future opportunity for consumption. This affective freedom from potential regret would arise from knowing that even just one alternative could readily capture at least some of the benefit of whichever opportunity the focal item does not.[35] On its own, this affective freedom from potential regret may not encourage item owners to systematically either save or consume their context-sensitive focal items. However, because item owners may systematically (1) fixate on the possibility that the future will be more fitting than the present for focal item use and (2) simultaneously overlook the possibility that the present may be more fitting than the future for the same purpose, alternatives may stand in for focal items more often in the present than in the future in practice. Essentially, item owners with biased perspectives on their trade-offs between present and future may be “strategically” replacing especially superior focal items with inferior alternatives more often in the present than they should. Consequently, having alternative items may also promote oversaving, and understanding the operation of this strategic influence on decisions to save or consume could develop a more comprehensive view of oversaving than studies of the cognitive biases alone.

Finally, a third direction for future research steps fully back to the idea of searching for an ideal pairing of context and consumption and supposes that a bias like oversaving may also result from the mirrored circumstance, in which a hopeful consumer may be considered to own a context and be searching for an ideal item with which to pair it. To illustrate this circumstance, consider for example a hiker, packing for an upcoming camping trip through a nearby mountain range. In preparing for the trip, the hiker considers all the possible contexts in which she could find

[35] Initial evidence of this pressure-alleviating effect of having alternatives may have already been seen in the less stringent way in which Duke bicycle commuters appeared to hold onto the earlier of their two monthly car-parking passes in Study 2.

herself (e.g., hungry, wet, cold, stung by a bee) and desires to equip herself accordingly with relevant context-sensitive items (e.g., food, dry clothes, kindling, anti-histamine drugs). Given the relative benefits and costs of carrying each item and the likelihoods of each corresponding context she anticipates, there does exist an optimal subset of items for the hiker to actually pack within the set of all possible items she could pack. However, as in the original circumstance discussed throughout this paper, any misestimation of a fundamental input into her choice to pack or not pack each item could promote overpacking. Specifically, for example, any overestimation of the likelihood of her being stung by a bee could lead to her mistakenly overpacking anti-histamine drugs into an already heavy bag in advance of her hike. In general, this mistaken overacquisition denotes the choice to take on or acquire an item in preparation for an anticipated context, despite the fact that the expected costs of acquisition outweigh the expected benefits of possession. Theoretically and experimentally addressing such mistakes in acquisition would expand research on the general phenomenon of overpreparation by not only providing a superficially distinct phenomenon as a conceptual sibling to the mistakes in consumption that are discussed throughout this dissertation, but also providing a useful scenario in which to address the underestimation of costs (e.g., the costs of acquiring and carrying) as another possible cause of those mistakes.

Given the theoretical and practical importance of all three described future directions for this work, I consider all three exciting and worthwhile next steps for this line of research. I look forward to these directions' insights into an understudied aspect of consumer behavior, wherein individuals mistakenly overprepare themselves for the future.

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Table 1

Descriptive Statistics of Data from the Preliminary Test

Median stopping index	37
Mean stopping index	28.2
Percentage of stopping indices less than optimal	22.2
Percentage of stopping indices greater than optimal	66.7
Percentage of stopping indices equal to optimal	11.1
Percentage of stopping indices equal to last	29.6

Note. The *ex ante* optimal stopping index of this test is 18.

Table 2

Frequencies of Item Category Endorsements in Study 1

Category	Absolute frequency	Percentage in sample
Media	92	14.7
Alcohol	87	13.9
Credits	86	13.8
Clothing	81	13.0
Food	75	12.0
Personal	58	9.3
Jewelry	31	5.0
Electronics	23	3.7
Decorations	23	3.7
Tools	19	3.0
Access	16	2.6
Exercise	14	2.2
Rooms	10	1.6
Other	9	1.4

Table 3

Frequencies and Ranks of Reasons for Disuse in Study 1

Reason	Absolute frequency	Percentage in sample	Rank	Number of rankers
Forgotten	96	26.4	7	39
Right moment	77	21.2	2	33
Wrong moment	50	13.8	12	29
Relative quality	33	9.1	3	18
Effortful to use	28	7.7	4	16
Other	22	6.1	1	8
Rare	12	3.3	8	9
Monetarily valuable	9	2.5	11	8
Lost	9	2.5	14	4
Sentimentally valuable	7	1.9	9	7
Costly to use	6	1.7	5	5
Damaged	6	1.7	10	5
Changed quality after first use	5	1.4	6	5
Expired	3	0.8	13	2

Note. The number of participants who ranked each reason for disuse is included in this table, because that number (1) differs from the absolute frequency with which each reason was endorsed in the sample (see Table 2) and (2) may in many cases be prohibitively small to trust the ranking. Small numbers arose in the rankings because of both participants who had selected only one reason for disuse in the first stage of the survey (and could therefore not provide relative rankings of reasons) and (2) participants who had failed to complete the survey through the ranking question (which was last).

Table 4

Hand-coded Categories of Right Moments in Study 1

Item Category	Fitting Possibilities	Certain Eventualities	Moments That Owners Can Make Happen	Other	Total	Percentage
Alcohol	18	3	1	0	22	15.6
Clothing	12	8	0	2	22	15.6
Credits	14	7	1	0	22	15.6
Media	9	5	0	4	18	12.8
Personal	4	11	0	0	15	10.6
Food	6	8	0	0	14	9.9
Tools	5	1	0	0	6	4.3
Decorations	2	2	0	1	5	3.5
Electronics	4	0	0	1	5	3.5
Jewelry	4	0	0	0	4	2.8
Rooms	4	0	0	0	4	2.8
Exercise	1	1	0	0	2	1.4
Access	0	0	0	1	1	0.7
Other	1	0	0	0	1	0.7
Total	84	46	2	9	141	
Percentage	59.6	23.2	1.3	6		

Table 5

Numbers of Available Parking Passes Used and Not Used by Bicycle Commuters between August 2012 and August 2015

	Used	Not Used	Total
First Passes	4766	3013	7779
Second Passes	2725	5054	7779
All Passes	7491	8067	15558

Table 6

Effects of Temporal and Weather Variables on Whether a Parking Pass Was Used

```
Logistic regression                               Number of obs   =     194600
                                                  Wald chi2(30)   =    1126.12
                                                  Prob > chi2     =     0.0000
Log pseudolikelihood = -28778.007                 Pseudo R2       =     0.0930

                                   (Std. Err. adjusted for 607 clusters in UserID)
```

Pass	Odds Ratio	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
1.last_day	2.15365	.1492019	11.07	0.000	1.880205	2.466864
Year						
2013	.7059278	.0473737	-5.19	0.000	.6189242	.8051616
2014	.6494941	.0495701	-5.65	0.000	.559256	.7542926
2015	1.113119	.0992603	1.20	0.229	.9346253	1.325702
Month						
August	1.294081	.1145037	2.91	0.004	1.08804	1.53914
December	1.110684	.0939247	1.24	0.214	.9410422	1.310908
February	.9133197	.0652025	-1.27	0.204	.7940629	1.050487
January	.8136926	.0592237	-2.83	0.005	.7055157	.9384564
July	.9089057	.0736464	-1.18	0.238	.7754397	1.065343
June	1.019226	.0825286	0.24	0.814	.8696554	1.194521
March	.8271897	.0485849	-3.23	0.001	.7372416	.9281119
May	1.04985	.0694455	0.74	0.462	.9221928	1.195178
November	1.25162	.0945733	2.97	0.003	1.079332	1.451409
October	1.341073	.1076795	3.65	0.000	1.145794	1.569634
September	1.506954	.1191696	5.19	0.000	1.290586	1.759595
1.Weekend	.0085873	.002107	-19.39	0.000	.0053089	.0138903
1.Thunderstorm	.9082817	.043043	-2.03	0.042	.8277182	.9966865
1.Snow	.8971303	.0646006	-1.51	0.132	.7790443	1.033116
1.Rain	1.238236	.0472903	5.60	0.000	1.148933	1.334481
1.Fog	1.115639	.0480429	2.54	0.011	1.025341	1.21389
Mean_TemperatureF	.9876003	.0019282	-6.39	0.000	.9838284	.9913868
Max_Humidity	.9947666	.0022058	-2.37	0.018	.9904527	.9990994
Mean_Humidity	1.007341	.0023425	3.15	0.002	1.00276	1.011943
Mean_Sea_Level_PressureIn	.7254061	.0616871	-3.78	0.000	.6140401	.8569702
Mean_VisibilityMiles	1.009691	.0130919	0.74	0.457	.9843549	1.03568
Min_VisibilityMiles	.9852851	.0059181	-2.47	0.014	.9737539	.9969528
Max_Wind_SpeedMPH	1.00387	.0040146	0.97	0.334	.9960323	1.011769
Mean_Wind_SpeedMPH	1.012608	.0070955	1.79	0.074	.9987967	1.026611
PrecipitationIn	1.208787	.0330109	6.94	0.000	1.145788	1.27525
WindDirDegrees	.9996346	.0001324	-2.76	0.006	.9993752	.9998941
_cons	1727.965	4506.218	2.86	0.004	10.41733	286624.6

Note. The constant (“_cons”) term in this model represents the year 2012 and the month April in the data. As numerically the first year and alphabetically the first month respectively, they were taken by default as the reference levels for their respective variables during estimation.

Table 7

Effects of Temporal and Weather Variables on Whether a Parking Pass Was Used during Only Months of Active Use

```
Logistic regression                         Number of obs   =     103105
                                            Wald chi2(30)   =    1078.40
                                            Prob > chi2     =     0.0000
Log pseudolikelihood =  -23971.74           Pseudo R2       =     0.1069

                              (Std. Err. adjusted for 607 clusters in UserID)
```

Pass_X	Odds Ratio	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
1.last_day	3.101967	.2365289	14.85	0.000	2.671358	3.601989
Year						
2013	.9097694	.0445385	-1.93	0.053	.8265328	1.001388
2014	.8541806	.0443991	-3.03	0.002	.7714458	.9457884
2015	1.047352	.0615561	0.79	0.431	.9333936	1.175223
Month						
August	1.461505	.0929259	5.97	0.000	1.290265	1.655471
December	.9759934	.060723	-0.39	0.696	.8639488	1.102569
February	.826153	.0479262	-3.29	0.001	.7373627	.925635
January	.7608412	.044895	-4.63	0.000	.6777463	.854124
July	1.104124	.0639042	1.71	0.087	.9857169	1.236754
June	1.184537	.0683953	2.93	0.003	1.057792	1.326469
March	.7481682	.0374628	-5.79	0.000	.6782304	.8253178
May	1.133021	.0543331	2.60	0.009	1.031382	1.244677
November	1.022631	.0542763	0.42	0.673	.9215977	1.134741
October	1.175081	.062008	3.06	0.002	1.059621	1.303122
September	1.257603	.0730606	3.95	0.000	1.122258	1.40927
1.Weekend	.0083374	.0020446	-19.52	0.000	.0051558	.0134824
1.Thunderstorm	.9779761	.0499741	-0.44	0.663	.8847738	1.080996
1.Snow	.9568185	.0714968	-0.59	0.555	.8264657	1.107731
1.Rain	1.257993	.0502809	5.74	0.000	1.163206	1.360505
1.Fog	1.153933	.0521536	3.17	0.002	1.05611	1.260816
Mean_TemperatureF	.9857515	.001932	-7.32	0.000	.9819722	.9895454
Max_Humidity	.9941957	.0022633	-2.56	0.011	.9897696	.9986415
Mean_Humidity	1.006831	.0024759	2.77	0.006	1.00199	1.011696
Mean_Sea_Level_PressureIn	.6799502	.0610756	-4.29	0.000	.5701893	.81084
Mean_VisibilityMiles	1.022578	.0138554	1.65	0.099	.9957796	1.050098
Min_VisibilityMiles	.9846034	.0062088	-2.46	0.014	.9725093	.9968479
Max_Wind_SpeedMPH	.999048	.0041322	-0.23	0.818	.9909817	1.00718
Mean_Wind_SpeedMPH	1.013888	.0073985	1.89	0.059	.9994905	1.028493
PrecipitationIn	1.26164	.0386248	7.59	0.000	1.188163	1.33966
WindDirDegrees	.9994932	.0001377	-3.68	0.000	.9992234	.9997632
_cons	24025.66	66166.72	3.66	0.000	108.7588	5307455

Table 8

Estimated Increases in Likelihood of Pass Use during the Last Week of the Month

	Estimated Increase	Clustered Standard Error
Last Day	+3.11 times	0.232
Last Two Days	+2.95 times	0.170
Last Three Days	+2.50 times	0.123
Last Four Days	+2.40 times	0.107
Last Five Days	+2.30 times	0.095
Last Six Days	+2.16 times	0.086
Last Week	+2.07 times	0.079

Note. Each of these estimates was obtained in the presence of the same covariates as listed in Table 7.

Table 9

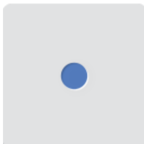
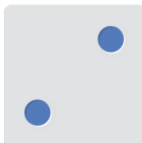
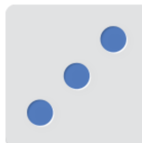
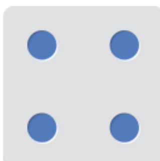
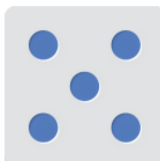
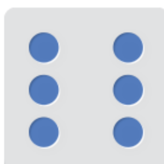
Distributions and Expectations of Threats in Studies 3a and 3b

Threat	Likelihood of threat’s occurring	Range of possible damage inflicted by threat, if it occurred	Distribution of likelihood over range of possible damage	Expected cost of threat, if it occurred	Expected cost of threat in general
Null threat	1/2	—	—	0 points	0 points
Minor threat	1/3	20% to 40% of total starting points	Uniform	(20% + 40%)/2 = 30% of total starting points	10% of total starting points
Major threat	1/6	50% to 70% of total starting points	Uniform	(50% + 70%)/2 = 60% of total starting points	10% of total starting points

Note. Participants in Studies 3a and 3b did not explicitly receive any of the information presented in the greyed columns.

Table 10

Graphical Translation of Likelihoods of Threats onto the Faces of a Six-Sided Die

Die face	Threat result
 or  or 	Null threat
 or 	Minor threat
	Major threat

Note. This table was presented ‘as is’ to participants in Studies 3a and 3b upon every die roll.

Table 11

Percentages of Participants Using Their Shields at the Ex Ante *Optimum in Studies 3a and 3b*

	Loss Frame		Gain Frame	
	V	NV	V	NV
EE	18.3% (20.0%)	20.0% (9.1%)	30.9% (40.0%)	32.6% (30.8%)
NE	51.7% (50.0%)	52.4% (68.4%)	54.4% (39.1%)	70.5% (66.7%)

Note. Parenthetical percentages represent the 183 participants in the L condition, who were asked to rate how likely they were they were to encounter the vampire in the official round.

Table 12

Results from Initial Logistic Regression of Shield Use Choices on All Four Independent Manipulations in Studies 3a and 3b

	Dependent variable:
	factor(Encounter..2..1)
factor(ConditionE)Extreme	-1.374^{***}
	(0.218)
factor(ConditionL)Likelihood	−0.115
	(0.217)
factor(ConditionV)Vivid	−0.250
	(0.219)
factor(Frame)Losses	-0.511^{**}
	(0.217)
Constant	0.729^{***}
	(0.253)
Observations	404
Log Likelihood	−249.170
Akaike Inf. Crit.	508.340
Note:	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Note. Standard errors are presented parenthetically below the coefficient estimates in the table.

Table 13

Results from Logistic Regression of Shield Use Choices on All Four Independent Manipulations and Loss Aversion Measures in Studies 3a and 3b

	Dependent variable:	
	factor(Encounter..2..1)	
	logistic	
	(1)	(2)
factor(ConditionE)Extreme	-1.336^{***}	-1.349^{***}
	(0.223)	(0.225)
factor(ConditionV)Vivid	−0.272	−0.286
	(0.224)	(0.225)
factor(ConditionL)Likelihood	−0.114	−0.120
	(0.222)	(0.223)
factor(Frame)Losses	-0.484^{**}	-0.503^{**}
	(0.222)	(0.223)
Loss.Aversion	0.116^{*}	
	(0.069)	
factor(Loss.Aversion.Condensed)Loss Neutral		0.258
		(0.320)
factor(Loss.Aversion.Condensed)Loss Willing		0.597^{**}
		(0.267)
Constant	0.324	0.563^{**}
	(0.332)	(0.265)
Observations	384	384
Log Likelihood	−237.651	−236.539
Akaike Inf. Crit.	487.302	487.077
Note:	*p<0.1; **p<0.05; ***p<0.01	

Note. Standard errors are presented parenthetically below the coefficient estimates in the table. “Loss.Aversion” is a reversed scale; increases on the scale represent decreases in actual loss aversion. “Loss Neutral” and “Loss Willing” represent two of three increasingly loss averse categorical divisions of that scale, with the most loss averse division as the referent category represented in the constant term of the second model. “Loss Neutral” indicates the middle place on that scale.

Table 14

Results from Four Models, Testing the Mediation of the Relationship between Experience and Shield Use Choices by Likelihood Ratings in Studies 3a and 3b

	Dependent variable:			
	Likelihood	factor(Encounter..2..1)		
	OLS	*logistic*		
	(1)	(2)	(3)	(4)
factor(ConditionE)Extreme	0.747***		−1.314***	−1.212***
	(0.264)		(0.322)	(0.328)
factor(ConditionV)Vivid	−0.227		−0.264	−0.314
	(0.264)		(0.319)	(0.324)
factor(Frame)Losses	0.322		−0.370	−0.328
	(0.265)		(0.321)	(0.325)
Likelihood		−0.229***		−0.177**
		(0.086)		(0.090)
Constant	4.120***	0.635	0.541*	1.288**
	(0.264)	(0.408)	(0.312)	(0.500)
Observations	183	183	183	183
Log Likelihood	−364.794	−119.788	−113.888	−111.941
Akaike Inf. Crit.	737.589	243.575	235.776	233.882

*p<0.1; **p<0.05; ***p<0.01

Note. Standard errors are presented parenthetically below the coefficient estimates in the table. “Likelihood” represents the likelihood ratings of participants in Studies 3a and 3b; they specifically rated how likely they were to encounter the *ex ante* optimum of the game in the game’s official round before that round began. These ratings are treated continuously in all three models, in absence of any theory predicting that unit increases on the rating scale would have a non-linear relationship to especially the tendency to use or save a shield.

Table 15

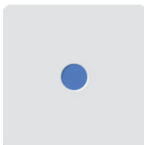
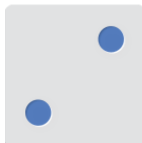
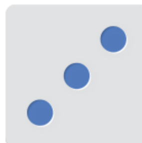
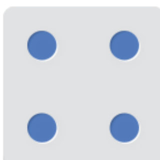
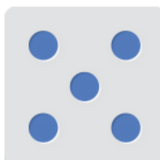
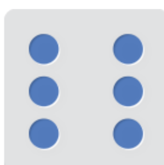
Distributions and Expectations of Events in Study 4

Event	Likelihood of event’s occurring	Range of loss suffered, if the event occurred	Distribution of likelihood over range of losses	Expected cost of event, if it occurred	Expected cost of event in general
No event	1/2	—	—	0 points	0 points
Light event	1/3	20% to 40% of total starting points	Uniform	(20% + 40%)/2 = 30% of total starting points	10% of total starting points
Heavy event	1/6	50% to 70% of total starting points	Uniform	(50% + 70%)/2 = 60% of total starting points	10% of total starting points

Note. The numbers in this table will not be altered from those used in Studies 3a and 3b (see Table 9). In the weather-based scenario of this study, the event will be rainfall; in the load-based scenario, the event will be a large package. Participants will not explicitly receive any information presented in the greyed columns.

Table 16

Graphical Translation of Likelihoods of Events onto the Faces of a Six-Sided Die

Die face	Event result
 or  or 	No event
 or 	Light event
	Heavy event

Note. This table is structurally identical to Table 10, used in Studies 3a and 3b. Other than substituting the name of the event in each scenario (i.e., “rainfall” in the weather-based scenario and “large package” in the load-based scenario), this table will be presented ‘as is’ to participants in Study 4 upon every die roll.

Table C1

Complete Estimates from the Fully Interacted (2 x 2 x 2 x 2) Model of Shield Use Choices on the Four Manipulations of Experience, Vividness, Likelihood, and Frame in Studies 3a and 3b

	Dependent variable:
	factor(Encounter..2..1)
factor(ConditionE)Extreme	-1.575^{**} (0.705)
factor(ConditionV)Vivid	−0.309 (0.645)
factor(ConditionL)Likelihood	−0.145 (0.676)
factor(Frame)Losses	-1.397^{**} (0.678)
factor(ConditionE)Extreme:factor(ConditionV)Vivid	−0.416 (0.919)
factor(ConditionE)Extreme:factor(ConditionL)Likelihood	−0.047 (0.926)
factor(ConditionV)Vivid:factor(ConditionL)Likelihood	−0.908 (0.873)
factor(ConditionE)Extreme:factor(Frame)Losses	1.410 (0.968)
factor(ConditionV)Vivid:factor(Frame)Losses	0.987 (0.847)
factor(ConditionL)Likelihood:factor(Frame)Losses	1.360 (0.940)
factor(ConditionE)Extreme:factor(ConditionV)Vivid:factor(ConditionL)Likelihood	2.133^{*} (1.237)
factor(ConditionE)Extreme:factor(ConditionV)Vivid:factor(Frame)Losses	−1.112 (1.257)
factor(ConditionE)Extreme:factor(ConditionL)Likelihood:factor(Frame)Losses	-2.913^{**} (1.445)
factor(ConditionV)Vivid:factor(ConditionL)Likelihood:factor(Frame)Losses	−0.698 (1.209)
factor(ConditionE)Extreme:factor(ConditionV)Vivid:factor(ConditionL)Likelihood:factor(Frame)Losses	1.115 (1.875)
Constant	0.956^{*} (0.526)
Observations	404
Log Likelihood	−240.521
Akaike Inf. Crit.	513.042
Note:	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Note. Standard errors are presented parenthetically below the coefficient estimates in the table.

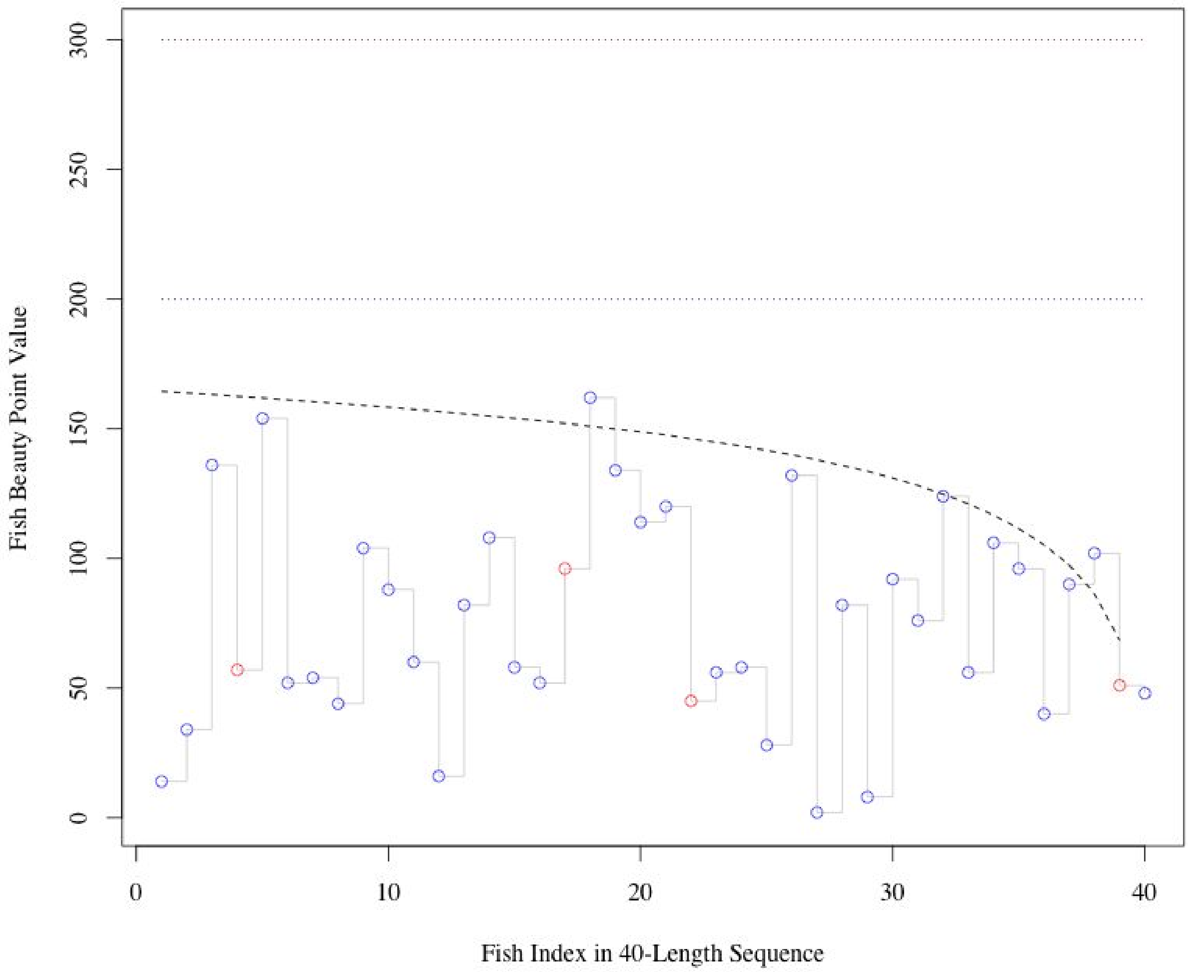


Figure 1. Plotted point values of opportunities (i.e., fish) in the preliminary test. Fish value points are color-correct, with blue points representing blue fish and red points representing red fish. The dashed black line is the normative threshold line, the first point above which is the *ex ante* optimal solution to the game. The dotted dark blue and dotted dark red lines above are respectively the perfect blue and the perfect red fish values *ex ante* possible in the game.

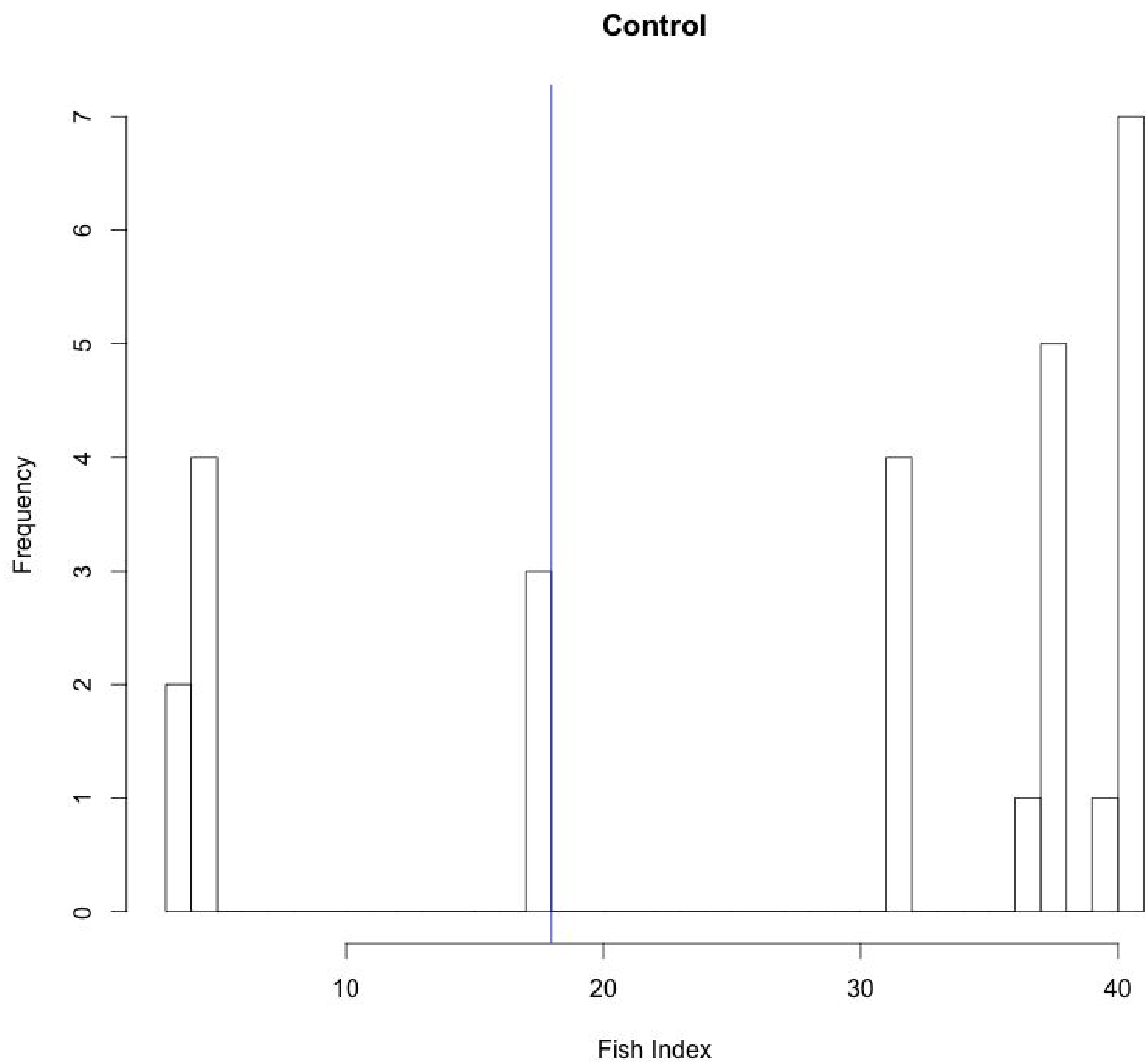


Figure 2. Histogram, illustrating the stopping indices of participants in the preliminary test. The stopping index of any participant was the cardinal number of the opportunity on which that participant had chosen to stop and consume his or her context-sensitive item. Stopping indices range from 1 to 40, because there were 40 opportunities available in the tested sequence. The stopping index of the *ex ante* optimal opportunity is given in blue.

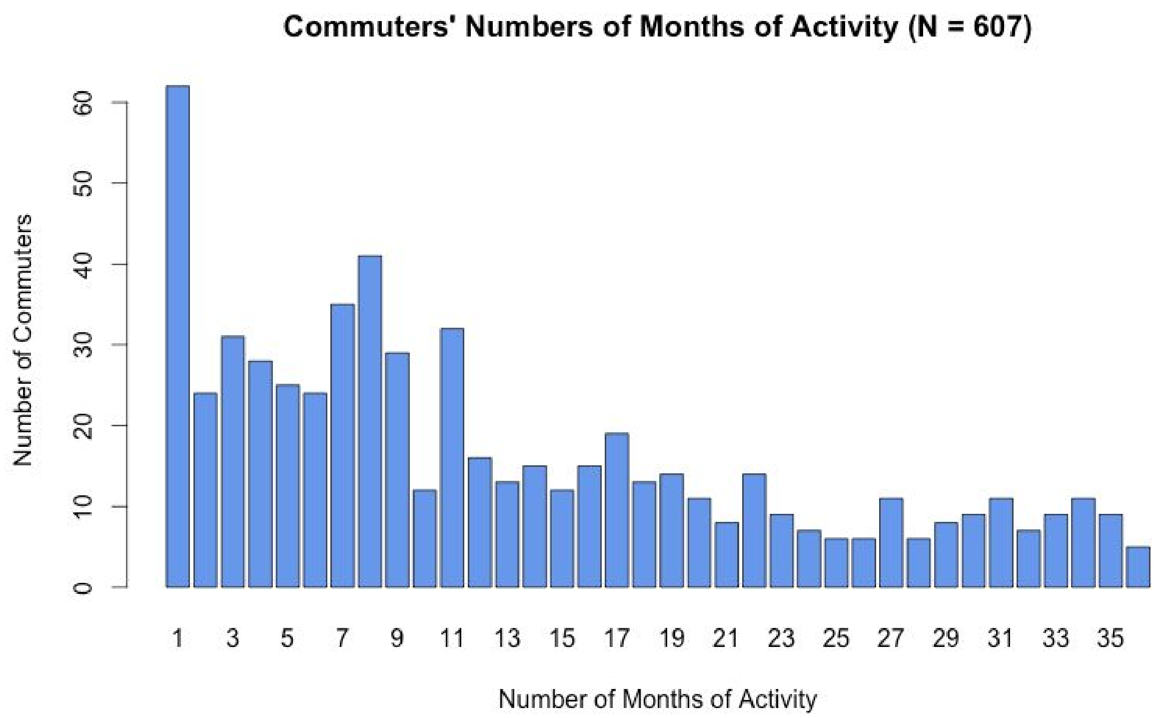


Figure 3. Histogram, illustrating the numbers of months of car-parking pass use activity of the bicycle commuters in Study 2.

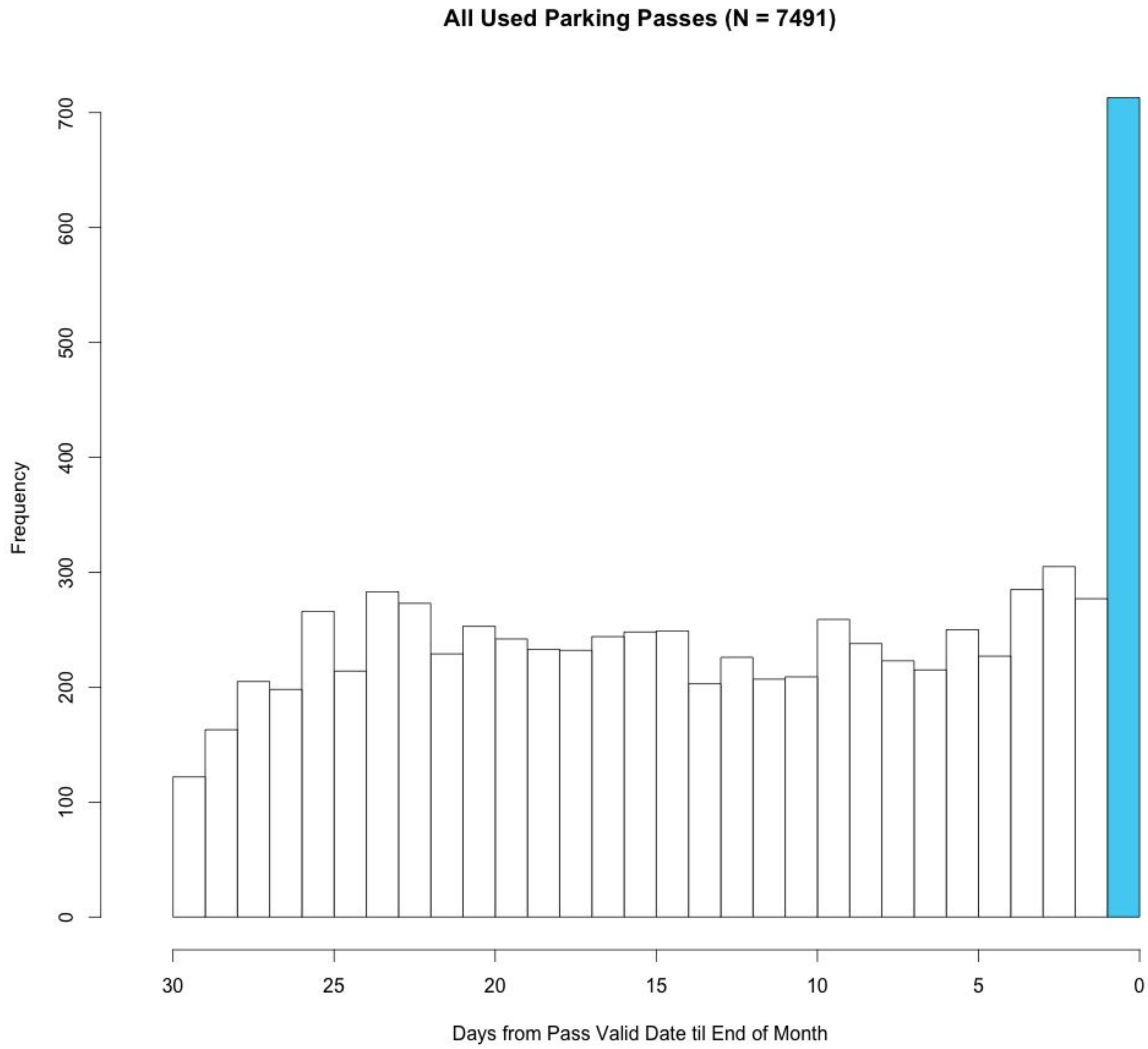


Figure 4. Histogram, illustrating the number of parking passes used in the data of Study 2 as a function of the number of days following use until the end of the month. The number of parking passes used on the very last day of the month is highlit blue as the modal number of parking passes used on any day of the month.

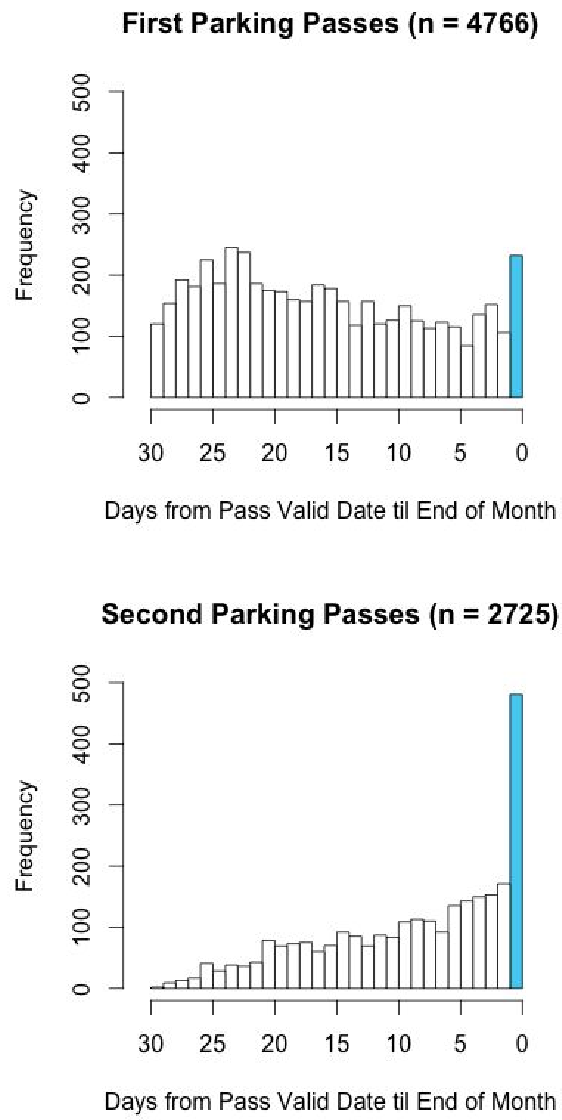


Figure 5. Two histograms, breaking down the number of monthly parking passes used in the data of Study 2 by order. Both first and second parking pass counts are shown as functions of the number of days following use until the end of the month. The numbers of first and second parking passes used on the very last day of the month are highlit blue for easy comparison.

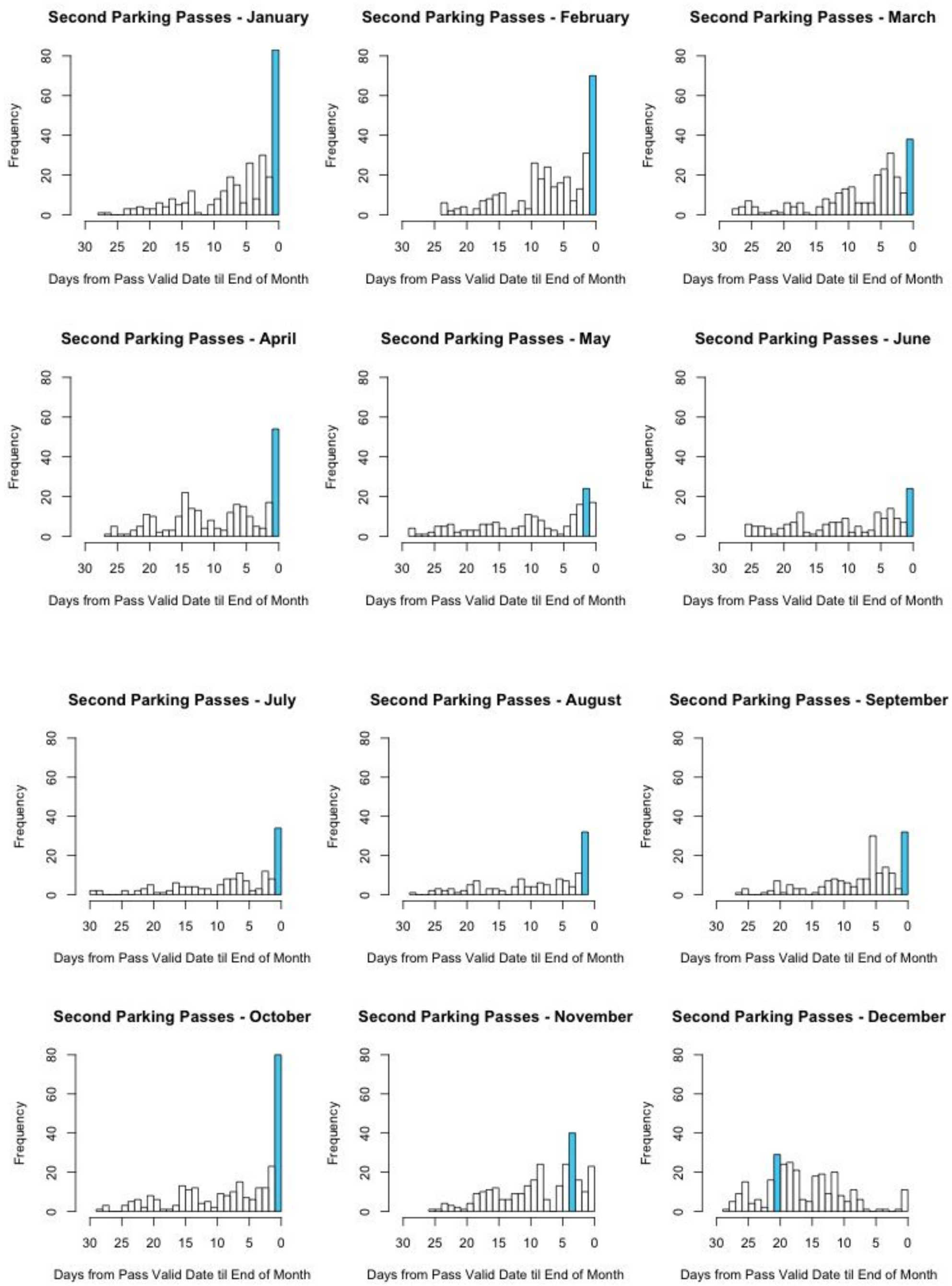


Figure 6. Twelve histograms illustrating the monthly numbers of parking passes used in the data of Study 2. The modal number of parking passes used each month is highlit blue for easy comparison across months.

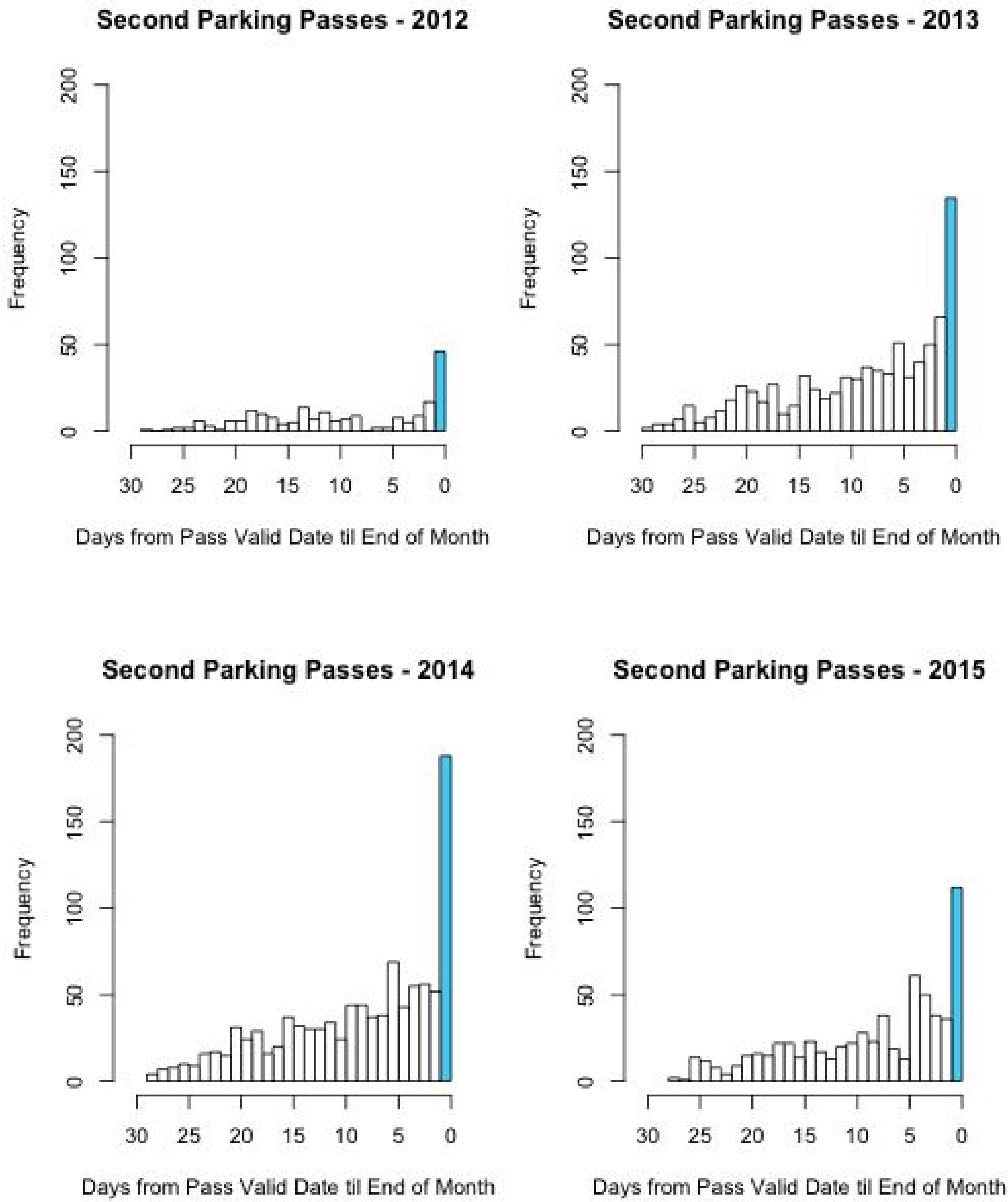


Figure 7. Four histograms illustrating the monthly numbers of parking passes used in the data of Study 2 by year. The number of parking passes used on the very last day of each month is highlit blue for easy comparison.

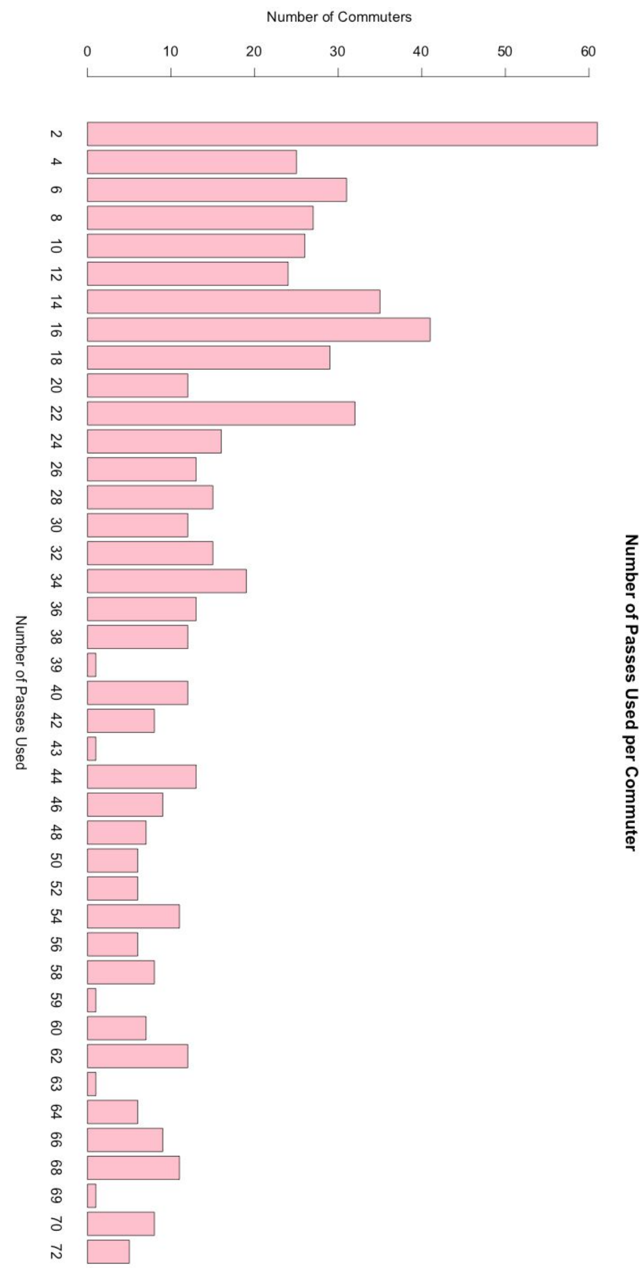


Figure 8. Histogram, illustrating the numbers of bicycle commuters who used between one (the minimum) and 72 (the maximum) number of car parking passes during the period of Study 2.

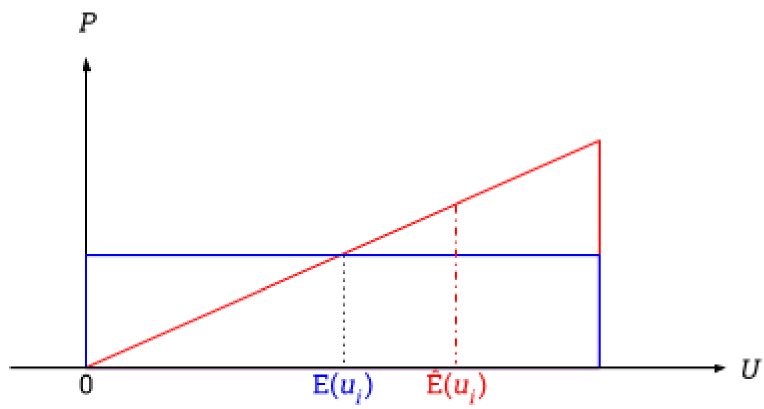


Figure 9. Simple graphical example of an unrealistically likely, positive prediction of an opportunity for consumption (in red) in contrast against the normative, positive prediction of that opportunity (in blue). In this contrast, the mistaken forecaster overpredicts the maximally positive possibilities and underpredicts the minimally positive possibilities. Consequently, the forecaster believes that the correct expectation of utility from consumption is higher than it actually is.

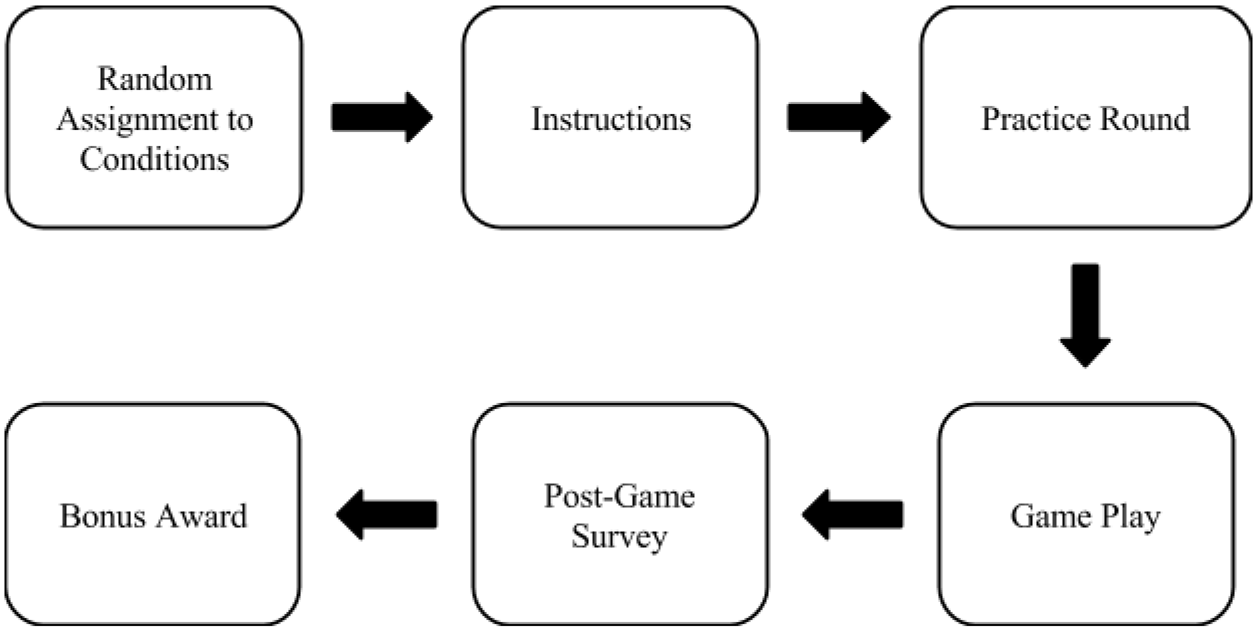


Figure 10. Flowchart of the experimental design of Studies 3a and 3b.

Figure 11. Graphical illustration of the minor threat, the flying bat, in Studies 3a and 3b.

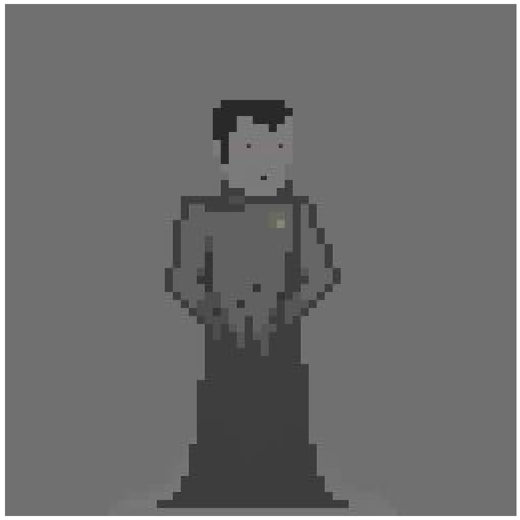


Figure 12. Graphical illustration of the major threat, the vampire, in Studies 3a and 3b.

Figure 13. Vivid graphical illustration of the major threat, the vampire, in Studies 3a and 3b.

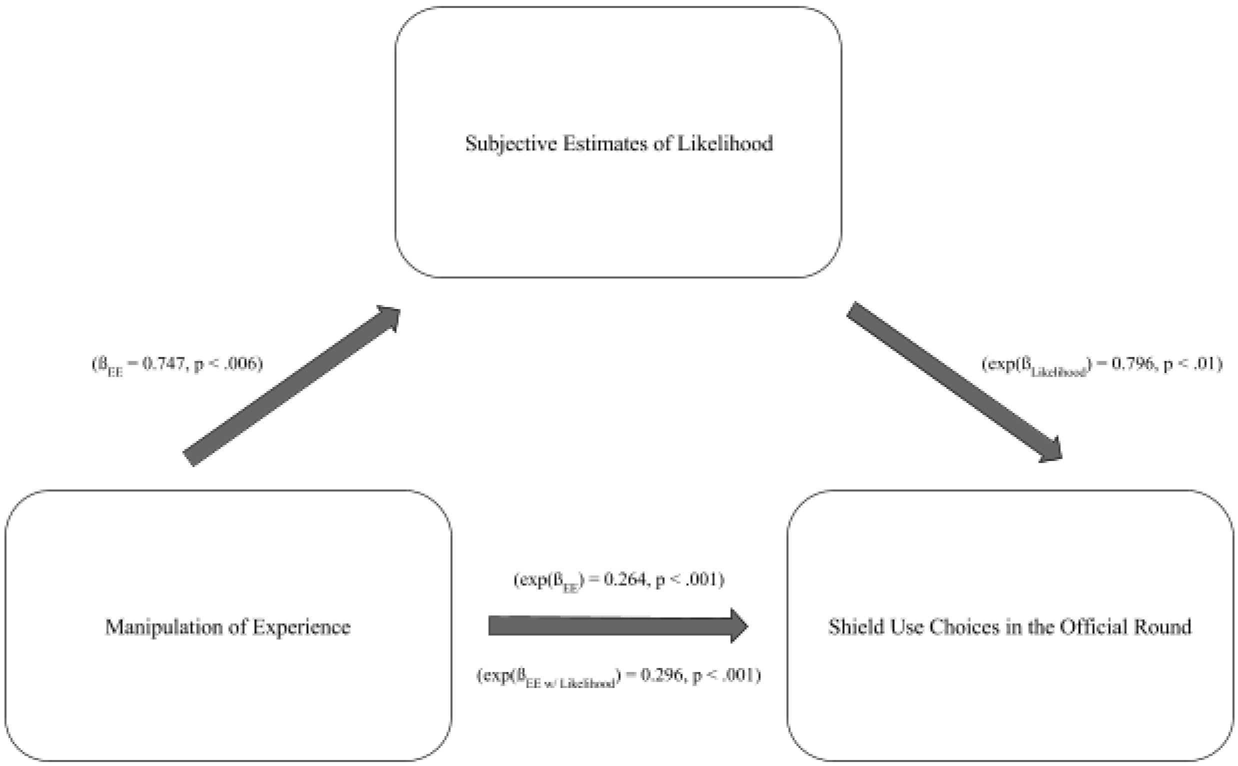


Figure 14. Mediation diagram and results, from Studies 3a and 3b

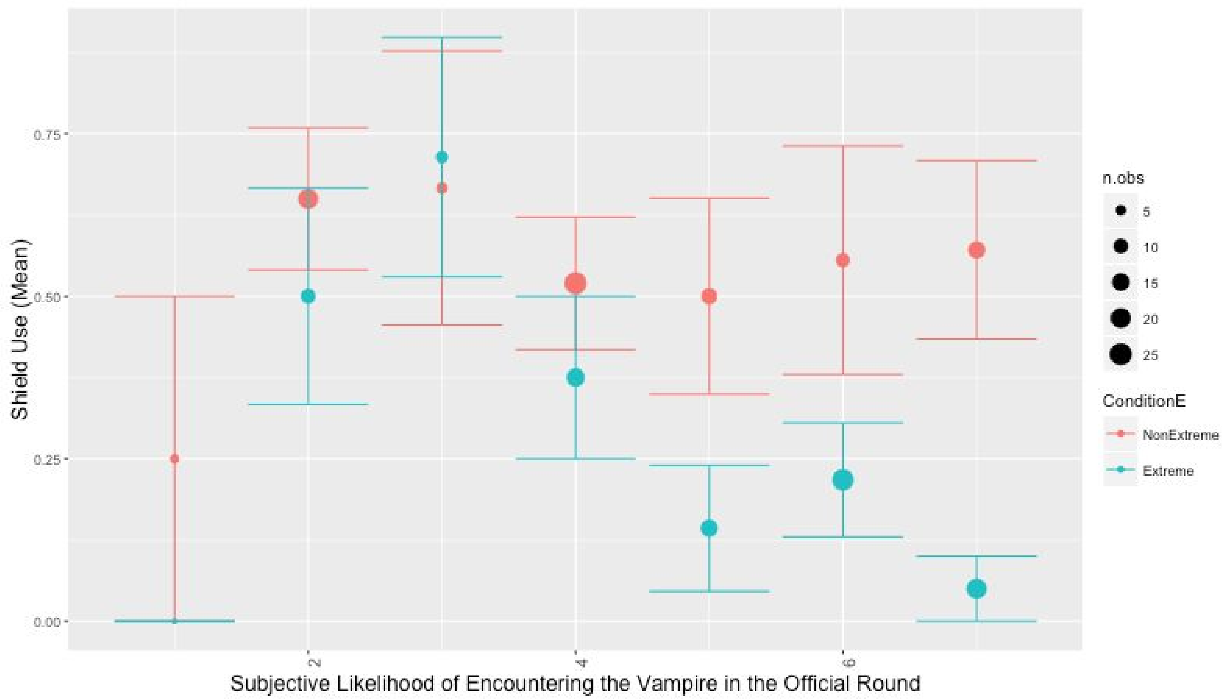


Figure 15. Illustration of a moderated mediation of the relationship between Experience and decisions to consume or save shields at the *ex ante* optimum in Studies 3a and 3b. The theorized mediator is the subjective likelihood of encountering that optimum in the official round of the studies. The apparent moderator may be a feature of the Experience condition.

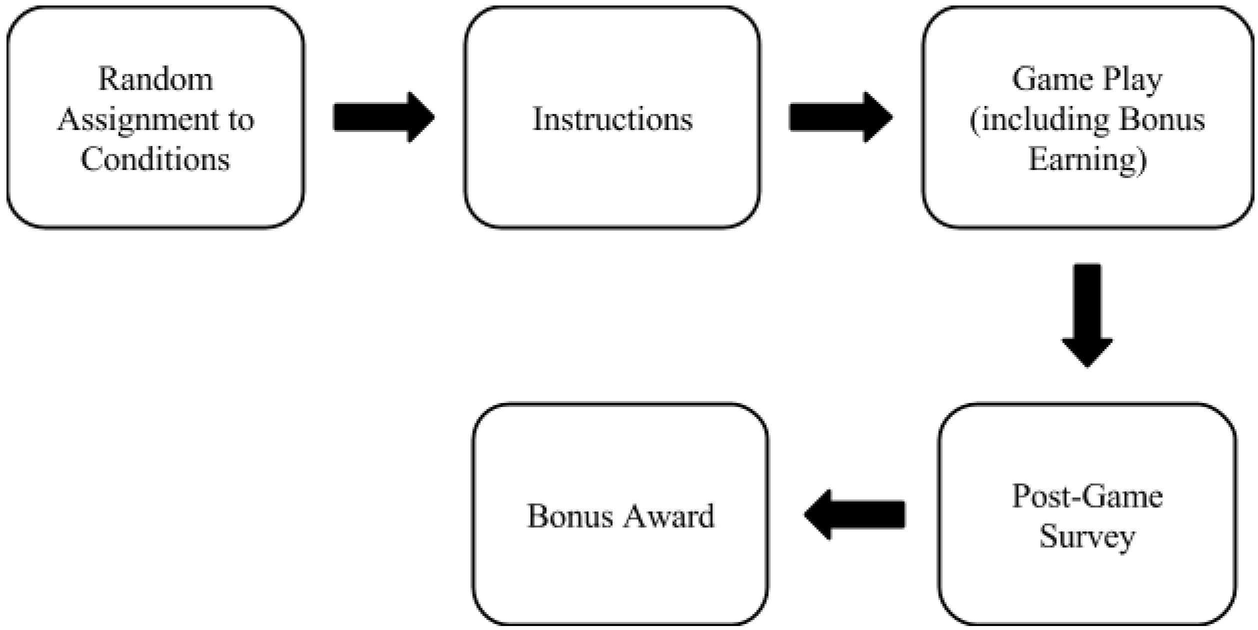


Figure 16. Flowchart of the experimental design of Study 4.

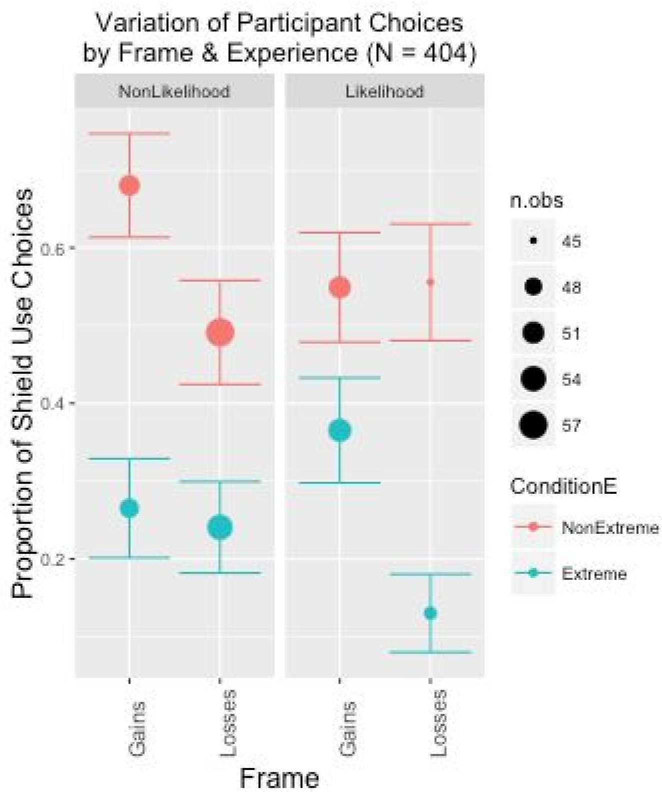


Figure C1. Illustration of a three-way interaction found among the experience, frame, and likelihood conditions in Studies 3a and 3b. The y-axis refers to the proportion of shield use choices at the *ex ante* optimum in the studies' common game.

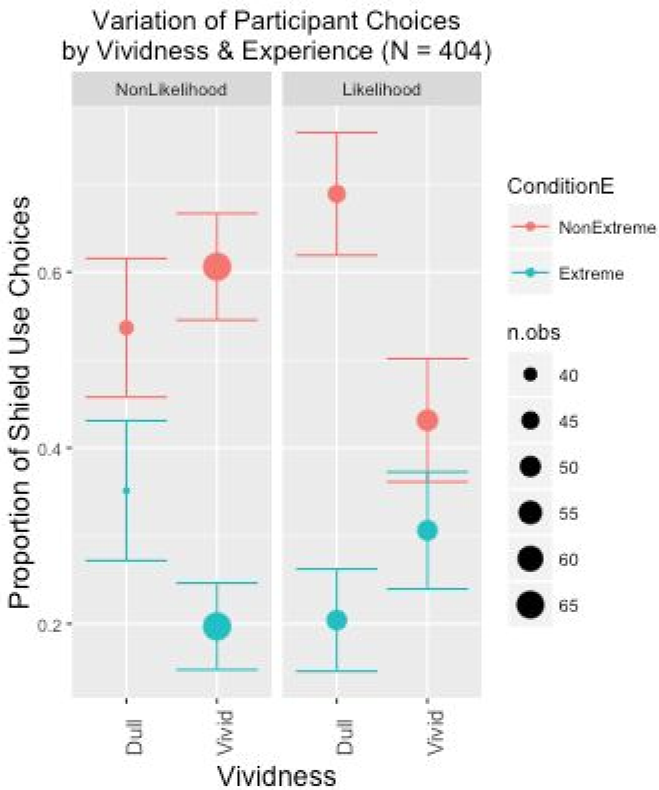


Figure C2. Illustration of a three-way interaction found among the experience, vividness, and likelihood conditions in Studies 3a and 3b. The y-axis refers to the proportion of shield use choices at the *ex ante* optimum in the studies’ common game.

Appendix A

This appendix describes the general process of optimally solving a problem of sequence-based search, like “on which of a sequence of *N* opportunities should a person consume a context-sensitive item?”

The normative solution to this problem begins with recognizing what information is available to the decision-maker about the given sequence of opportunities.

- When the available information is as little as it is in the CSP, a calibration period, during which the decision-maker subsamples the distribution by observing the first N / e opportunities in the sequence, is necessary. This subsampling allows the decision-maker to learn via experience about the distribution from which her *N* opportunities are being drawn.
- However, when the available information already includes information about the distribution, then this calibration period may be unnecessary.

In the solutions that I will detail in this appendix — namely, the solution to the problem posed in the preliminary test and the solution to the problems posed in Studies 3a and 3b — sufficient information about the distribution is available, so that a calibration period will not be included.

Solving the Preliminary Test

In the preliminary test, the sufficient information is specifically the exact structure of the distribution, enough to compute its expected value:

> The wild fish population comprised two colors: 90% of fish were blue, and 10% were red. Fish of these two colors existed on a range from 1 point to 300 points, with higher numbers of points denoting greater value to the participants. In this range, 70% of blue fish had between 1 and 100 points (inclusive), 25% of blue fish had between 101 and 150 points (inclusive), and the remaining 5% of blue fish had between 151 and 200 points (inclusive) while 70% of red fish had between 1

and 150 points, 25% of red fish had between 151 and 225 points, and the remaining 5% of red fish had between 226 and 300 points (with probability uniformly distributed within each interval).

With this information on the distribution from which the *40*-long sequence is being drawn, the first step toward optimally solving the problem of when to stop during that sequence is calculating the expected value of any single opportunity in the sequence. By taking the weighted average of both three-piece distributions that will contribute the sequence, I calculate this expected value as 68.4 (out of 300 possible points).

With this expected value, the second step toward solution is beginning the backwards induction process, by considering what the decision-maker should do if the *40*-long sequence were simply a *2*-long sequence. At the earlier of the two opportunities, the decision-maker knows that the expected value of the later opportunity is equal to the expected value of the distribution: here, 68.4. Knowing this fact, a rational decision-maker (with only one stop available to her) should choose to stop at the earlier opportunity only if its observed value were to exceed the later opportunity’s expected value. Making this choice is therefore simply following the basic decision rule outlined in the main text and picking the greater of the two available quantities. Strategically, if the decision-maker could not expect to do better by delaying than by consuming at the earlier of the two opportunities, then she should not attempt to do better by delaying than by consuming at that earlier opportunity, lest she not maximize her payoff.

With this strategy for a *2*-long sequence understood, the third step toward solution is considering how to adapt that strategy for a slightly longer sequence: namely, a *3*-long sequence.

- At the second opportunity in the *3*-long sequence, the decision-maker should behave exactly as she would behave at the earlier opportunity in a *2*-long sequence. At both points, the remainders of the sequences are identical, so the strategy should be the same.
- At the first opportunity in the *3*-long sequence, additional information must be known in order to proceed: namely, the expected value of the second opportunity. This expected value is necessary, so that the decision-maker can use the same value-maximizing strategy at the first opportunity as she will use at the second: comparing the observed value of the present opportunity with the expected value of the future set of opportunities and then choosing the higher payoff.

- The expected value of the second opportunity in the *3*-long sequence is different from the expected value of the distribution, because the decision-maker knows that at that second opportunity there will still be an option to delay and choose the final opportunity in the sequence instead. Given this option, the decision-maker must take into account the “safety net” of that final opportunity.
- The way to account for the influence of the third opportunity on the expected value of the second is to temporarily revise the distribution. This temporary revision occurs by changing all possible payoffs in the distribution that are less than the expected value of the third opportunity to the expected value of that third opportunity. In this case, all values in the distribution that are less than 68.4 become equal 68.4. This temporary revision accounts for the fact that the decision-maker knows that she will reject any second opportunity whose observed value is less than the expected value of the third opportunity. Because this rejection effectively means that all fish values 1 through 68 will function as 68.4, I temporarily replace them accordingly. I then calculate an expected value of the second opportunity equal to 86.5. Thus, in a *3*-long sequence drawn from the given distribution of fish values, a decision-maker should reject the observed value of the first opportunity only if it were not to exceed 86.5.

This same reasoning can be iterated to accommodate sequences of length *N*.

With the understanding now of how to extend the optimal decision rule (i.e., “choose the present only if it exceeds the future in expectation”) to sequences of *N*-length by iterative backwards induction, the fourth step toward solution is simply executing the iteration *N - 1* times. For the *40*-length sequence in the preliminary test, this iteration results in the following sequence of 39 expected values (with a dot after every five values, simply to enhance legibility): 164.4, 163.8, 163.2, 162.5, 161.9 • 161.2, 160.5, 159.8, 159.0, 158.3 • 157.5, 156.7, 155.8, 154.9, 154.0 • 153.1, 152.1, 151.0, 149.9, 148.8 • 147.6, 146.2, 144.8, 143.3, 141.7 • 140.0, 138.0, 135.9, 133.6, 131.0 • 128.1, 124.8, 121.1, 116.7, 111.5 • 105.3, 97.5, 86.5, 68.4. These values represent the declining threshold rule (graphed as a dashed black line in Figure 1) governing the optimal solution to the preliminary test’s problem of when to consume. According to this solution, any rational decision-maker at the first opportunity in the sequence should stop at that opportunity only if its value exceeded 164.4.

Applying this normative solution to the series of opportunities in the preliminary test — 14, 34, 136, 57, 154 • 52, 54, 44, 104, 88 • 60, 16, 82, 108, 58 • 52, 96, 162, 134, 114 • 120, 45, 56, 58, 28 • 132, 2, 82, 8, 92 • 76, 124, 56, 106, 96 • 40, 90, 102, 51, 48 (all graphed in grey, with color-correct points overlain, in Figure 2) — reveals that the *ex ante* optimal opportunity is the 18th (worth 162 points), because it is the first opportunity to exceed its related threshold value (151.0). (Because that same fish is also worth the maximum number of points in the series, it happens to also be the *ex post* best fish.)

Solving Studies 3a and 3b

The same process, used above to solve the problem of when to consume in the preliminary test, may be used to solve the problems of when to consume in Studies 3a and 3b. Those studies contain the following three 3-long sequences:

- the practice round's sequence for all *extreme experience* (EE) participants: a minor threat, then a null threat, and finally a major threat;
- the practice round's sequence for all *non-extreme experience* (NE) participants: a minor threat, then a null threat, and finally another null threat; and
- the official round's sequence for all participants: a null threat, then a minor threat, and finally another null threat.

I will provide the optimal solution for each sequence in turn. In doing so, I will recall the fact that, based on the given distribution of threats (see Table 5), the expected value of any threatening encounter in the experiment is 20 gold coins. Thus, the expected value of the third encounter in each sequence is 20 gold coins; and, by backwards induction, the expected value of the second encounter in each sequence is 30 gold coins. Consequently, the declining threshold rule governing the optimal solution to each of these three problems is the sequence of those two expected values: 30, 20.

The practice round's optimal solution for EE particpants. Participants in the EE condition first encounter a minor threat in their practice round. A minor threat has an expected value equal to 30 gold coins (see

Table 5). Comparing this expected value with the expected value of the next encounter in the sequence (also, 30), EE participants should be indifferent regarding shield use in that first encounter.[36]

EE participants then encounter a null threat in the practice round. This threat has an expected value equal to zero gold coins; in the loss frame of Study 3a, it’s harmless and, in the gain frame of Study 3b, it’s useless. So, EE participants who still have shields in the second encounter of their practice round should preserve their shields for the third encounter.

EE participants encounter a major threat last in the practice round. This threat has an expected value equal to 60 gold coins. Both because it is the last threat in the round and because its expected value is high, EE participants who still have shields should consume their shields during this final encounter in their practice round, to either avoid the loss or guarantee the gain.

So, the *ex ante* optimal solution for EE participants during their practice round is:

- indifference to shield use during the first encounter and,
- in the cases in which the shield still has not been used by the third encounter, definite shield use then.

The practice round’s optimal solution for NE participants. The leading two encounters of NE participants in their practice round are identical to the leading two encounters of EE participants in their practice round, so they have the same solution.

Following those two leading encounters, NE participants finally encounter a null threat in their practice round. As noted, this threat is either harmless or useless. So, NE participants who still have shields in this stage have effectively missed the *ex post* optimal threat on which to use their shields in this round: the first encounter.

[36] To be most comprehensive, each calculation of the expected values of the current and the next rounds in the noted solution should take into account the repeated-use item’s 10% likelihood of successfully thwarting each threat. Given this likelihood, an expected value equal to 30% of a player’s 100 total starting points should truly be an expected cost equal to 27% of the player’s 100 total starting points. However, because this cost adjustment equally affects both sides of the decision of when to consume the single-use context-sensitive item, it is omitted from these explicit calculations for simplicity. Explicitly accounting for the dodge never changes the optimal response.

The *ex ante* optimal solution for NE participants during their practice round is:

- indifference to shield use during the first encounter,
- no shield use in the second encounter, and
- indifference to shield use during the third encounter.

The official round’s optimal solution for all participants. All participants first encounter a null threat in the official round. Because this threat has an expected value of zero gold coins, all participants should preserve their shields for the second encounter in this round.

All participants then encounter a minor threat second in the official round. Because the expected value of this threat is equal to 30 gold coins, the expected value of this second encounter exceeds the expected value of the next, third and final, encounter (i.e., 20 gold coins). Consequently, all participants should consume their shields during this encounter.

The *ex ante* optimal solution for all participants during the official round is:

- no shield use during the first encounter and then
- definite shield use during the second encounter.

Appendix B

This appendix is a reproduction of the online survey that participants in Study 1 completed, reporting on reasons for never having used items they owned. (The parenthetical numbers next to the multiple choice options simply represent how the options were coded in the final data file.)

Introduction

In this research task, you will be asked to answer several questions about your ownership of items that you have not yet used. Please, answer these questions as accurately as you can. Remember, all of your responses are and will remain anonymous and confidential.When you are ready to begin, just advance to the next page.

1. Please, select any and all of the following categories in which you own an item that you have not yet used. For example, if you own a ring that you have not yet worn, then please select the category "Jewelry" from the list below. Note: Using an item may mean: wearing it (as in the case of Jewelry or Clothing), eating it (as in the case of Food & Beverage), living in it (as in the case of Rooms), spending it (as in the case of Credits & Other Earmarked Savings), watching or listening to it (as in the case of Media), or another definition beyond simply "using it" (as in the case of Tools & Machinery). So, please, answer accordingly.
    - Clothing (1)
    - Alcohol including Wine and Beer (2)
    - Tools & Machinery including Vehicles and Appliances (3)
    - Electronics including Handheld Devices (like Cameras) and Larger Systems (like Home Stereos) (4)
    - Media including Books, Music, and Movies (5)
    - Exercise Equipment (6)
    - Food & Beverage excluding Alcohol (7)
    - Decorations including Furniture and Art (8)
    - Credits & other Earmarked Savings including Gift Certificates, Vacation Days, Rainy-Day Funds, and Other Vouchers (9)

- Jewelry (10)
- Personal Care Items including Colognes and Fragrances, Make-Up, and other Beauty Supplies (11)
- Rooms & other Domestic Spaces including Patios, Pools, and Fireplaces (12)
- Access to a Particular Location or Particular Attraction (13)
- Other (14)

2. For each category that you've selected, please now specify what you own but have not yet used in the text box below the name of the category. In the "Jewelry" example from the previous page, you would specify the item "ring" by entering "ring" (without quotation marks) into the text box immediately below "Jewelry". If you happen to have more than one item in any category, please list the items in the relevant text box for that category and separate them with commas. For example, if you happen to have both a ring and a watch that you have not yet worn, please enter "ring, watch" into the text box for "Jewelry". If you happen to list any item bearing a specific name or title, such as a book or a movie, please make sure to include the general class of the item before specifying its name or title. For example, if you happen to have never read your paperback copy of War & Peace, please enter "book: War & Peace" into the text box for "Media".

   ***Please, note: Exhaustive lists of items are not necessary; a representative list of at maximum five items per category would work well.

3. The remainder of this task will ask you to answer questions about one to three of the items that you have just named. For each item, the questions will be divided into three groups: The first group of questions will focus on your history of owning the item. The second group of questions will focus on the qualities of the item itself. The third group of questions will focus on what is important about the item to you. Please, answer all questions as accurately and honestly as you can.

An item was at this point randomly selected from what the participant had listed.

Block 1: Questions about History of Ownership

4. How did you acquire the item?
    - I bought it for myself. (1)
    - I received it as a gift from someone else. (2)
    - I found and then kept it for myself. (3)
    - I inherited it. (4)
    - I made it. (5)
    - Other (6)
5. Please, explain exactly how you acquired it.
6. Is the time since you acquired it best thought of in terms of days, months, or years?
    - Days (1)
    - Months (2)
    - Years (3)
7. In those terms, exactly how long ago did you acquire the item?
    - {Sliding Scale}
8. When you acquired the item, how long did you think it would be until you used it? (Again, please, answer by first indicating whether the length of time is best thought of in terms of days, months, or years.)
    - Days (13)
    - Months (14)
    - Years (15)
9. When you acquired the item, how long did you think it would be until you used it? (Now complete your answer by moving the slider to the appropriate place on the time scale below.)
10. Were there certain circumstances in which you had expected to use it?
    - No (0)
    - Yes (1)
11. {If Yes to 12} What were those circumstances?

12. Thinking about the item now, do you think that you will use it?
    - No, Never (0)
    - Maybe (1)
    - Yes, Definitely (2)
13. {If not "No, Never" to 14} How long will it be until you use it? (As before, please, answer by first indicating whether the timeframe is best thought of in terms of days, months, or years.)
14. How long will it be until you use it? (Now complete your answer by moving the slider to the appropriate place on the time scale below.)
15. Since acquiring it, have you ever lost the item?
    - No (0)
    - Yes (1)
16. Finally, when choosing to use an item of its type, how often do you forget that you have the item available?
    - Never (1)
    - Hardly Ever (2)
    - Sometimes (3)
    - Most of the Time (4)
    - All the Time (5)
17. Why do you forget that you have the item available? (If you selected "Never" above, you may skip this question.)

Block 2: Questions about the Item Itself

18. How rare or unique is the item?
    - Not at all Rare or Unique (1)
    - Slightly Rare or Unique (2)
    - Somewhat Rare or Unique (3)
    - Very Rare or Unique (4)

- Extremely Rare or Unique (5)

19. Has the rarity or uniqueness of the item contributed to your disuse of it?
    - No (0)
    - Yes (1)
20. If Yes, how has it contributed?
21. How monetarily valuable is the item?
    - Not at all Valuable (1)
    - Slightly Valuable (2)
    - Somewhat Valuable (3)
    - Very Valuable (4)
    - Extremely Valuable (5)
22. Has the monetary value of the item contributed to your disuse of it?
    - No (0)
    - Yes (1)
23. If Yes, how has it contributed?
24. How sentimentally valuable is the item to you?
    - Not at all Sentimental (1)
    - Slightly Sentimental (2)
    - Somewhat Sentimental (3)
    - Very Sentimental (4)
    - Extremely Sentimental (5)
25. Has the sentimental nature of the item contributed to your disuse of it?
    - No (0)
    - Yes (1)
26. If Yes, how has it contributed?
27. How much money is required to use the item?

- No Money at All (1)
- A Small Amount of Money (2)
- A Moderate Amount of Money (3)
- A Large Amount of Money (4)
- An Extremely Large Amount of Money (5)

28. Has the amount of money required to use the item contributed to your disuse of it?
    - No (0)
    - Yes (1)
29. If Yes, how has it contributed?
30. How much physical effort is required to use the item?
    - No Effort at All (1)
    - A Small Amount of Effort (2)
    - A Moderate Amount of Effort (3)
    - A Large Amount of Effort (4)
    - An Extremely Large Amount of Effort (5)
31. Has the amount of physical effort required to use the item contributed to your disuse of it?
    - No (0)
    - Yes (1)
32. If Yes, how has it contributed?
33. How well does the item compare with alternatives that you also own or else can freely access for the same purpose?
    - Worst of All Alternatives (1)
    - Worse than Most Alternatives (2)
    - Middle of All Alternatives (3)
    - Better than Most Alternatives (4)
    - Best of All Alternatives (5)

- I Have No Alternatives (0)

34. Has the relative quality of the item among such alternatives contributed to your disuse of it?
    - No (0)
    - Yes (1)
35. If Yes, how has it contributed?
36. How good is the item during its second use?
    - 1: Completely Unusable (1)
    - 2 (2)
    - 3 (3)
    - 4: Just as Good as During Its First Use (4)
    - 5 (5)
    - 6 (6
    - 7: Far Better than During Its First Use (7)
37. Is there anything special about its first use?
    - No (0)
    - Yes (1)
38. Has the prospect of a change in quality after first use contributed to your disuse of the item?
    - No (0)
    - Yes (1)
39. If Yes, how has it contributed?
40. How damaged is the item currently?
    - Not at All Damaged (1)
    - Slightly Damaged (2)
    - Somewhat Damaged (3)
    - Very Damaged (4)
    - Extremely Damaged (5)

41. Has damage contributed to your disuse of the item?
    - No (0)
    - Yes (1)
42. If Yes, how has it contributed?
43. Finally, has the item become expired or obsolete since you acquired it?
    - No (0)
    - Yes (1)
44. Has this expiration or obsolescence contributed to your disuse of the item?
    - No (0)
    - Yes (1)
45. If Yes, how has it contributed?

Block 3: Questions about What Is Important to the Owner

46. How important is it to you that you use your item at the right moment?
    - Not at All Important (1)
    - Slightly Important (2)
    - Somewhat Important (3)
    - Very Important (4)
    - Extremely Important (5)
47. What is the right moment, or ideal situation, in this case? (Please, provide a right moment or ideal situation, even if using your item at that moment is not important to you.)
48. Has a desire to wait for the right moment contributed to your disuse of the item?
    - No (0)
    - Yes (1)
49. If Yes, how has it contributed?
50. How important is it to you that you avoid misusing your item at the wrong moment?

- Not at All Important (1)
- Slightly Important (2)
- Somewhat Important (3)
- Very Important (4)
- Extremely Important (5)

51. What is the wrong moment in this case? (Please, provide a wrong moment, even if avoiding misusing your item at that moment is not important to you.)
52. Has a desire to avoid the wrong moment contributed to your disuse of the item?
    - No (0)
    - Yes (1)
53. If Yes, how has it contributed?
54. Previously, you described a particular situation in which you had expected to use your item. The description that you provided is reproduced below. Could this situation be considered either the right moment or the wrong moment? Please, select each box below that applies.
    - The Right Moment (1)
    - The Wrong Moment (2)
55. Please, explain your previous response.
56. Looking back, do you think that you ever missed an opportunity to use the item at the right moment?
    - No (0)
    - Yes (1)
57. Below is a list of all the factors that you indicated have contributed to your disuse of the item. In a moment, you will be asked to rank these factors, according to their amounts of contribution. For now, please, just indicate at the bottom of this page whether anything other than these factors contributed to your disuse of the item. There is no need to rank the factors below at this time.
58. Did anything other than the factors listed above contribute to your disuse of the item?
    - No (0)

- Yes (1)

59. {If Yes} Please, explain this other factor here.
60. Now, please, rank all the factors that contributed to your disuse of the item by amount of contribution. Place the factor that has contributed the most at the top, with the remaining factors descending in contribution. In this way, Rank 1 becomes the greatest contributing factor, Rank 2 becomes the second greatest, Rank 3 the third, and so on.
61. Finally, which factor best explains why you have not used the item in the particular situation that you described previously (reproduced below)?

Closing Block 4

62. Are you willing to continue with participating by answering the same questions for another item?
    - No (1)
    - Yes (2)

If Yes to 62, recycle back to question 4.

If No to 62, proceed directly to final questions.

Thank you for all your responses. We appreciate the time and effort that you put into making them as accurate and honest as possible. Now, before you complete this task, we finally ask that you answer a few demographic questions about yourself.

63. In what year were you born? (Please, enter the year as a four-digit number.)
64. What is your sex?
    - Male (1)
    - Female (0)
65. What is your race?
    - Asian (including Indian and Filipino) (1)
    - Black (including African and Caribbean) (2)

- Hispanic/Latino (3)
- Native American (4)
- White (including Middle Eastern) (5)

66. Finally, if you have questions or comments about this survey, please, enter them here.
67. Thank you for participating! You have now completed this survey. You may exit or close this window at any time.

Appendix C

This appendix provides a more detailed look at the results of Studies 3a and 3b than the discussion in the main text provides. In particular, the following two interactive effects are detailed:

Interactive Effect 1: Relative to the gain frame (GF), the loss frame (LF) appears to have reduced the shield use choices of:

a. extreme-experience (EE) participants only in the likelihood (L) condition and
b. non-extreme-experience (NE) participants only in the non-likelihood (NL) condition (see Figure C1).

Interactive Effect 2: Similarly, relative to the non-vivid (NV) condition, the vivid (V) condition appears to have reduced the shield use choices of:

a. EE participants only in the NL condition and
b. NE participants only in the L condition (see Figure C2).

While neither of these effects was expected, their appearances in Table C1 prompted their investigation in statistical models of participants’ shield use choices.

A comprehensive multinomial logistic regression explored the data for interactive effects among the four experimental manipulations — experience, vividness, likelihood, and frame — onto shield use choices during the second encounter of the official round. This model identified two three-way interactions as respectively statistically and marginally significant: the interaction among experience, likelihood, and frame ($\exp(ß_{EE \times L \times LF}) = 0.054$, $p < .05$) and the interaction among experience, likelihood, and vividness ($\exp(ß_{EE \times L \times V}) = 8.44$, $p = .08$).[37] These estimates indicate that, relative to not having estimated the likelihood of encountering the vampire in the official round, having estimated that likelihood had shifted (1) for whom losses had then loomed larger than gains and (2) for whom vividness had then reduced shield use, respectively. Specifically, the loss frame had reduced the shield use of NE

[37] A revised model, testing for these two three-way interactions in particular, found both statistically significant ($\exp(ß_{EE \times L \times LF}) = 0.109$, $p < .02$, and $\exp(ß_{EE \times L \times V}) = 15.1$, $p < .003$).

participants in the NL condition but of EE participants in the L condition, while vividness had reduced the shield use of EE participants in the NL condition but NE participants in the L condition.

These interactive effects on shield use may have logical interpretations, dependent on the cuing of attention to the vampire by way of added emphasis on it. Being asked to consider the vampire explicitly (in order to estimate the likelihood of encountering it) could have simultaneously driven home the potential for loss, should the vampire appear again, for EE participants as it appeared inconsequential, loss or gain, for NE participants (who had not encountered it previously). Similarly, being asked to consider the vampire explicitly could have consequentially recalled its frightening visage for NE participants, who had perhaps not seriously considered the probability of encountering a vampire otherwise, at the same time as it appeared merely redundant to EE participants (who had encountered it before). This style of explanation, pointing toward a consequential reminding for participants that the vampire could be a costly or fearsome encounter, could apply to at fewest some of the cell-from-cell differences described by the three-way interactions.

However, because I see no obvious reason why having been asked to estimate the likelihood of encountering the vampire in the official round should have subsequently moderated how frame or vividness affected EE vs. NE participants as it appears to have in Table C1, I hesitate to trust these three-way effects as more than some noisy results from this specific sample. Fuller explanations of these effects than my initial, *post hoc* speculations should come only after replications of these effects in a follow-up to these two studies. Until that point, while it may be important to acknowledge that the noted interactive effects are potentially meaningful results that suggest that the two other experimental manipulations — likelihood and vividness — may have also mattered to participants in determining whether to consumer of preserve their single-use items, it is important to recognize that the presence of the interactive effects in the results does not erase the significance of the main effects described in the main text.