The Value of Time

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Ten studies are used to document that time is valued in accordance with a double-kinked value function. There is a zone of indifference for small time gains (losses), increasing marginal utility (disutility) for moderate time gains (losses), and diminishing marginal utility (disutility) for large time gains (losses). Moderate amounts of time exhibit increasing marginal utility (disutility) because larger blocks of time provide a more diverse set of usage opportunities. It is only when it is difficult to imagine how more (less) time would be beneficial (detrimental) that there is diminishing marginal utility (disutility) for time. Thus time valuation shows increasing marginal utility when there is a time deficit, but diminishing marginal utility when there is a time surplus. These findings have implications for how other resources might be valued.

Keywords: time, value function, marginal utility, resource valuation, riskless choice

Time is an inherently valuable resource that has an inherently malleable value. For example, consider the value of a block of time (e.g., an hour). The value of this time depends on its expected use (Graham 1981; Okada and Hoch 2004). An hour spent on a meaningful activity is more valuable than an hour spent on a meaningless one (Becker 1965). Likewise, completing more meaningful activities, in an hour, is more valuable than completing fewer meaningful activities (Becker 1965). Thus it should not be surprising that there are products designed to increase the effectiveness of time allocation (e.g., organizational tools), enhance the efficiency of time usage (e.g., technology), and extend the availability of time (e.g., life-extending fitness and health products).

Time is only one of many resources that have a malleable value. The value of financial resources (e.g., wealth), natural resources (e.g., food), social resources (e.g., social network), psychological resources (e.g., willpower), and physiological resources (e.g., metabolic energy) all depend on the opportunities for, and the context of, usage. Yet attempts to assess the value of these resources have often ignored anticipated usage opportunities, especially with respect to the value of an increase in the amount of the resource. For example, it is often assumed that units of a resource are uniform and that demand stays constant, so the next best use of each additional unit of the resource is declining. Thus resource abundance results in diminishing marginal utility: each additional unit of a resource has less value (Bernoulli (1738) 1954; Böhm-Bawerk 1891).

Time is a resource that violates one of the conditions that leads to diminishing marginal utility—namely, that demand stays constant. This violation occurs because the length of a block of time determines the activities that can be considered for its use. For instance, the value of 1.5 hours is likely to exceed the value of three 30 minute blocks because the former allows one to complete three 30 minute activities *or* one 1.5 hour activity. That is, larger

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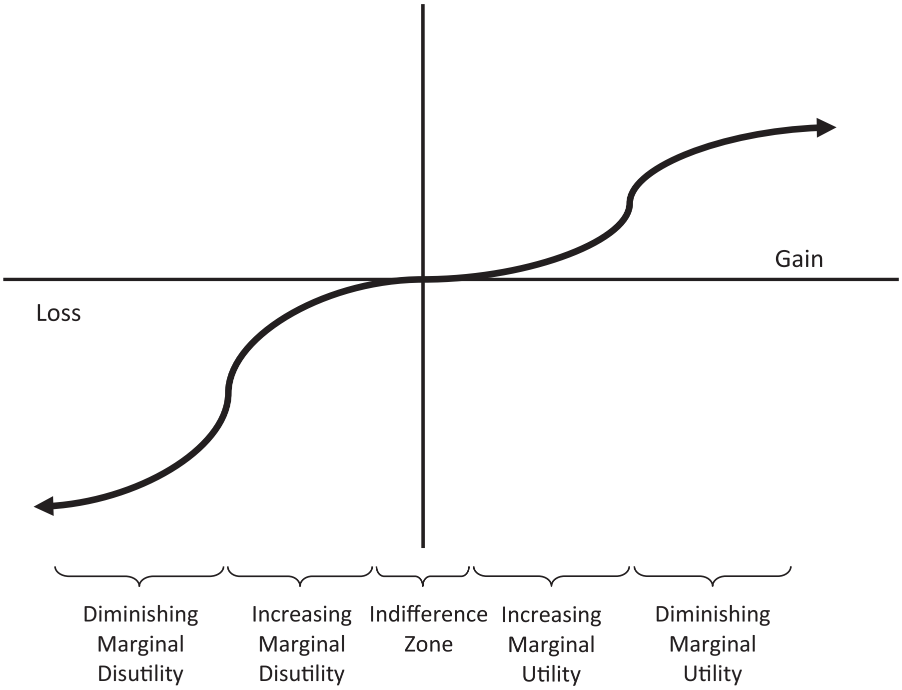
FIGURE 1

DOUBLE-KINKED VALUE FUNCTION



blocks of time should be more valued, on a per unit basis, because they allow one the flexibility to engage in more valued activities. The possibility of increasing marginal utility is especially pertinent to time because time cannot be saved and aggregated. Whereas people can save and aggregate some resources (e.g., money), so that each unit can be valued in accordance with its anticipated best use, this is not the case with time.

The preceding discussion suggests that time is a resource that has two opposing sources of valuation: (1) the increasing value associated with better opportunities for use and (2) the decreasing value associated with resource abundance, as is the case with any resource. We anticipate that the value accrued from better opportunities for use should be dominant as blocks of time increase from small to moderate sizes. That is, moderate blocks of time should be valued in accordance with increasing marginal utility. The value lost from resource abundance should be dominant as blocks of time increase from moderate to large sizes. That is, large blocks of time should be valued in accordance with diminishing marginal utility. The relative width of the increasing and diminishing marginal utility zones will depend on the relative strength of these two forces.

If time is valued in accordance with two opposing forces, then its valuation should be consistent with a double-kinked value function (figure 1) (Friedman and Savage 1948). A double-kinked value function assumes insensitivity at the reference level, followed by increasing and then diminishing marginal utility. That is, there should be an area of indifference for small units of time, increasing marginal utility (disutility) for moderate units of time, and diminishing marginal utility (disutility) for large units of time. We test this prediction using four multi-experiment studies. Initially, we test for increasing marginal utility (disutility) for moderate amounts of time. In study 1, we ask people how much time they would need to double their happiness (unhappiness) from gaining (losing) a certain amount of time. They report needing less than twice as much time (study 1). This result implies increasing marginal utility (disutility) for time gains (losses). In study 2, we ask people to provide a per unit value for time gains (losses). The per unit value of time increases as the stakes increase. Again, this result implies increasing marginal utility (disutility). Next, we show diminishing marginal utility (disutility) for large amounts of time (study 3). Finally, we investigate an implication of the double-kinked value function. Study 4 shows that people prefer to integrate (segregate) moderate time savings (losses) but segregate (integrate) large time savings (losses). We begin our analysis with a discussion of how people value resources.

RESOURCE VALUATION

Resource valuation has a history of study dating back to Adam Smith (1776). For this reason, much of our understanding of how people value resources is accepted knowledge (Horowitz, List, and McConnell 2007). Two of the most fundamental conclusions are that (1) a change in resources must surpass a perceptual threshold in order to have value, and (2) each additional unit of a resource will have less value than the last (i.e., diminishing marginal utility). We begin with a short review of the evidence supporting these two conclusions. Afterward, we discuss the more novel claim that resource valuation can exhibit increasing marginal utility.

Indifference Zone

A value indifference zone refers to inconsequential gains or losses in a resource. The claim of an indifference zone has its roots in psychophysical perception (Fechner 1987; Titchener 1899). Initial investigations into perception documented that stimulation must surpass a threshold in order to be perceived (Titchener 1899). Subsequently, threshold effects have been shown to be applicable to resource valuation. For example, there is considerable evidence that small amounts of money do not rise above a "caring" threshold (e.g., Gourville 1998; Gupta and Cooper 1992; Kalwani and Yim 1992; Kalyanaram and Little 1994). Gourville (1998) reported that listing a per day price (e.g., $.33), as opposed to a per year price (e.g., $120), is an effective sales tool because small amounts of money are trivial. Similarly, Kalyanaram and Little (1994) found that consumers were insensitive to small increases or decreases in price (also see Kalwani and Yim 1992), suggesting that an indifference zone also exists around relative changes in the amount of a resource.

Indifference to increases in the amount of a resource is not limited to the domain of money. People are not willing to pay more for small increases in the number of wildlife saved after an oil spill (e.g., saving "much less than 1% of the population" of birds versus "about 2% of the population" of birds) (Desvousges et al. 1992). People are unwilling to pay more for small increases in improving health (e.g., reducing risk from 20/100,000 to 15/100,000; Hammitt and Graham 1999) or safety (e.g., reducing risk from 150/100,000 to 100/100,000; Baron and Greene 1996; Jones-Lee, Loomes, and Philips 1995). Academics report that small increases in job status, from the lowest possible level, do not lead to more job satisfaction (an indicator of value) (Morrison et al. 2011).

Diminishing Marginal Utility

The concept of diminishing marginal utility (value) has its roots in Bernoulli's (1738/1954) solution to the St. Petersburg paradox. The paradox is that people are only willing to pay a small amount to play a game of chance with an infinite expected value. Bernoulli argued that there is a diminishing marginal utility for money and this, along with a person's current state of wealth, determines how much the person is willing to pay to play the game. Gossen (1854) formulized diminishing sensitivity in his first law of the theory of marginal utility, in which all goods and services are expected to show a decrease in marginal value with increasing units. Subsequently, diminishing marginal utility has become a foundational assumption to a number of theories of how individuals value resources (e.g., expected utility theory, von Neumann and Morgenstern 1947; prospect theory, Kahneman and Tversky 1979; information search theory, Stigler 1961; hedonic adaptation, Frederick and Loewenstein 1999; variety seeking, McAlister 1982; Simonson 1990).

Increasing Marginal Utility

Evidence for increasing marginal utility comes primarily from studies on risky choice. The most robust evidence involves people's willingness to accept small gambles (Friedman and Savage 1948; Markowitz 1952; Weber and Chapman 2005). For example, when presented with a choice between a certain $1 or 10% chance of $10, most people will accept the gamble. Expected utility theory accounts for this behavior by claiming that the subjective value of $10 is more than 10 times the subjective value of $1, so that the expected value of the $10 payout is greater than the value of $1. The inference is that the utility function for money must be increasing at an increasing rate. Similar behavior is observed in investing, job choices, and medical decision making (Friedman and Savage 1948).

A problem with the risky choice evidence for increasing marginal utility is that it assumes risk attitudes are determined by the utility function. This is a foundational assumption of expected utility theory. Yet this assumption ignores the fact that resource valuations, and resource-based decisions, occur in riskless contexts (e.g., welfare evaluation, income tax progressions, dynamic decision problems) (Tversky & Kahneman 1991; Wakker 1994). Nonexpected utility theorists address this issue by assuming that risky choices are a function of multiple factors (e.g., riskless utility, a person's willingness to accept or avoid risk, distortions in probabilities, elicitation procedures, etc.) (Wakker 1994). That is, utility (i.e., cardinal utility) can exist independent of a person's willingness to accept or avoid risk. The implication of this assumption is that a response to a gamble may reveal a person's beliefs about risk, or misinterpretation of probability, rather than insight into the shape of the underlying cardinal utility function. For this reason, the possibility that riskless resource valuation could show increasing marginal utility is open to debate. In fact, some models of riskless valuation reject this possibility completely. The reference-dependence model assumes increasing marginal utility is impossible in a riskless domain (i.e., the value function exhibits diminishing marginal [dis]utility) (Tversky & Kahneman 1991).

THE VALUE OF TIME

Time is a finite and perishable resource (Jacoby, Szybillo, and Berning 1976; Leclerc, Schmitt, and Dube 1995; Okada and Hoch 2004). Time cannot be stopped or stored. For this reason, the value of time is inherently tied to its use and misuse. People are aware that time is wasted, that time can be put to better use, that they often lack control over the allocation of time to activities, and that there are occasions where they are especially effective at using time (de Graaf 2003; Kimmel 2008; Menzies 2005). That is, people are aware that the value of time fluctuates.

One factor that influences the value of time is the size of a block of time (figure 1). First, people know that a block of time must be sufficient enough to have a meaningful use (i.e., there is a valued activity that could be performed with the time). That is, small amounts of time should have little value (see indifference zone in figure 1). Second, as the size of a block of time grows, its value should increase (more time is better) because there are (1) a greater quantity of activities can be performed and (2) better opportunities for usage. The first source of value, anticipating a greater quantity of activities, should increase value at a diminishing rate, assuming a person typically schedules activities from most to least valuable. Diminishing marginal utility is an indicator of resource abundance. The latter sources of value should increase utility at an increasing rate. More time creates the opportunity to schedule a better activity (e.g., 1.5 hours allows one to complete three 30 minute activities *or* one 1.5 hour activity, whereas three 30 minute blocks allows one to complete three 30 minute activities). Increasing marginal utility is an indicator of better opportunities for usage.

The relative importance of the opportunities-for-use factor (i.e., a focus on the quality of the activities) and resource abundance (i.e., a focus on the quantity of the activities) determine the width of the increasing and diminishing marginal utility zones in the double-kinked value function. Initially, increasing the size of a block of time should address the opportunities-for-use issue, so that there should be increasing marginal utility (disutility) for moderate amounts of time (see increasing marginal utility zone in figure 1). As the size of a block of time grows truly large, the value accrued from better quality activities should wane, and resource abundance should drive valuation (see diminishing marginal utility zone in figure 1). The width of the three zones (i.e., indifference, increasing, diminishing) should depend on the referent time (i.e., five minutes is trivial in a day but critical when every second counts).

RESEARCH PLAN

There are a number of potential approaches to studying the value of time. Notably, one could study time in context (e.g., the allocation of time to tasks) or out of context (e.g., the value of time, independent of a specific use). The advantage of studying time in context is that the activities performed with time are a significant contributor to the value of time—time is what you make of it. The disadvantage of studying time in context is its value is idiosyncratic to the activity being performed. Studying time out of context solves the "value-is-idiosyncratic-to-the-activity" problem. When time is studied out of context, people should be much more likely to consider prototypic activities when valuing different segments of time. Given these assumptions, we began our study of time using a noncontextualized setting. In study 1, time was valued relative to itself. In studies 2 and 3, time was valued in an unfamiliar context, so as to minimize the influence of contextualization on its value. In study 4, we relaxed these constraints and studied the value of time in a naturalistic, contextualized setting. The general discussion provides a fuller discussion of how time is valued in specific contexts as well as the factors that influence the width of the zones in the valuation function.

STUDY 1

Study 1 consisted of three variants of the same study. The overall goal was to provide evidence that the value function for moderate time gains (losses) shows increasing, rather than diminishing, marginal utility (disutility). The study used the magnitude estimation method, first introduced by Galanter and Pliner (1974). The method involves estimating how much time it would take to double the utility (disutility) experienced from an amount of saved (lost) time. In study 1a, people were asked how much time it would take to double the utility from saving or losing a unit of time (5, 15, 30, 60, or 120 minutes). Subsequent studies repeated the experiment using a within-subject manipulation of units of time (study 1b) and a choice-dependent measure (study 1c).

Study 1a

Design. The study used a 2 (Domain: gain vs. loss) × 2 (Type of Activity: pleasant vs. unpleasant) × 5 (Stake: 5, 15, 30, 60, 120 minutes) between-subjects design. The type of activity factor was included in the design because it was possible that the respondents would assume time gains were from an unpleasant task and time losses were from a pleasant task. Assumptions of this type could create increasing marginal utility (disutility) for time gains (losses). This alternative hypothesis could be ruled out by showing no influence of the type of activity factor.

Participants. Participants were 400 adults (34.3% female, median age = 28, median education = "some college") that were recruited through Mechanical Turk (MTurk) and paid a fee of \$.25. Participants were randomly assigned to one of the 20 conditions.

Procedure. Participants were told the experiment investigated how they would respond to gaining or losing time. The next sentence manipulated the domain and type of activity. Participants in the gain-pleasant (gain-unpleasant) condition were told, "'Gaining time' is defined as needing less time than expected to complete a pleasant (unpleasant) task" (see appendix A for an example of the gain-pleasant condition). Participants in the loss-pleasant (loss-unpleasant) condition were told, "'Losing time' is defined as needing more time than expected to complete a pleasant (unpleasant) task."

The remaining instructions were tailored to the gain or loss scenario. Participants were told that although the objective value of gaining (losing) 10 minutes is twice that of gaining (losing) 5 minutes of time, most people do not feel that way about the subjective value of time. Participants were told that some people needed to gain (lose) more than 10 minutes of time to double the happiness (unhappiness) they would experience with gaining (losing) 5 minutes of time, whereas other people needed less than double the time (see appendix A). After advancing to the next screen, participants were asked to indicate how much time they would need to gain (lose) to make them exactly twice as happy (unhappy) as gaining (losing) 5 minutes, 15 minutes, 30 minutes, 60 minutes, or 120 minutes.

Data Preparation. Each respondent was classified as having diminishing marginal utility, constant marginal utility, or increasing marginal utility for the time stake they were asked to judge. Diminishing marginal utility was indicated by a response that was more than twice the stake. For example, if a person said it would take 15 minutes of time to be twice as happy as 5 minutes of time, the person's value function would be relatively flat or concave. Increasing utility was indicated by a response less than twice the stake. For example, if a person said it would take 8 minutes of time to be twice as happy as 5 minutes of time, the value function would be relatively steep or convex. Constant utility was indicated by a response that was twice the stake.

Some participants provided illogical answers ($n = 0$, 5, 4, 15, and 15 in the 5, 15, 30, 60, and 120 minutes stakes, respectively) and were removed from the analysis. An illogical answer was a response that was less than or equal to the listed stake. For example, if a participant was asked how much saved time would make them twice as happy as 5 minutes of saved time, a response of 5 minutes or less was an illogical answer. It should be noted that had illogical answers been retained, they would have been classified as cases of increasing marginal utility. Thus removing these respondents was conservative with respect to the test for increasing marginal utility.

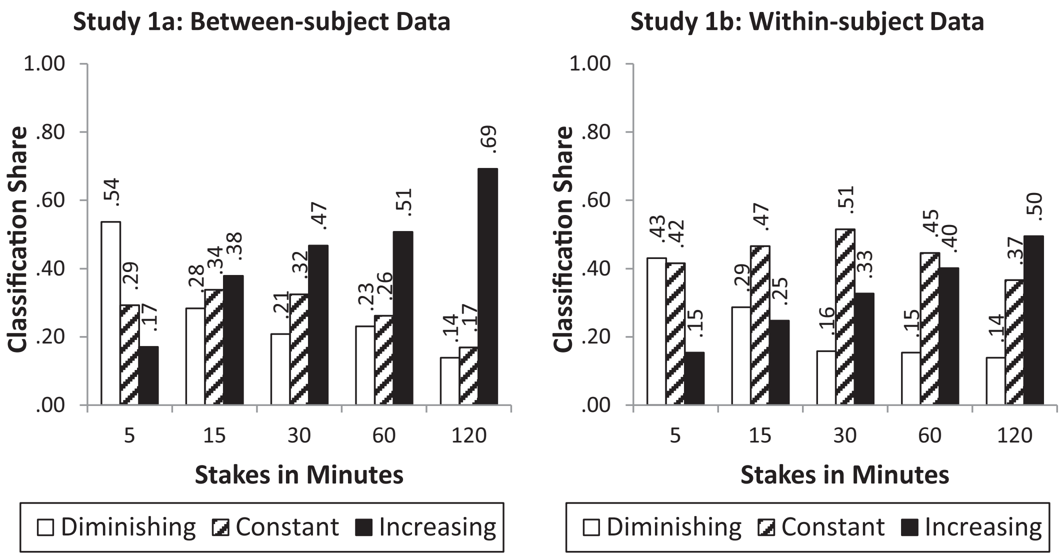
Results. The percentage of participants providing responses consistent with diminishing, constant, and increasing marginal utility are presented in figure 2. The data were analyzed using a multinomial logistic regression with domain (loss vs. gain domain), type of activity (pleasant vs. unpleasant), and stakes (5, 15, 30, 60, 120 minutes) as independent variables. The stakes variable was coded as a five-level ordinal variable. The increasing marginal utility classification was treated as the reference group, so that the constant and diminishing marginal utility classifications were compared to this group. Statistical tests have 2 degrees of freedom because these two dependent measure contrasts are jointly considered.

The fit of the fully estimated model was significant ($\chi^2(14) = 93.27$, $p < .05$). The analysis revealed no domain by type of activity by stake three-way interaction ($\chi^2(2) = .83$, $p > .05$). The domain by type of activity ($\chi^2(2) = .16$, $p > .05$), domain by stake ($\chi^2(2) = 1.17$, $p > .05$), and type of activity by stake ($\chi^2(2) = 1.02$, $p > .05$) two-way interactions were not significant. The domain ($\chi^2(2) = 1.80$, $p > .05$) and type of activity ($\chi^2(2) = .77$, $p > .05$) main effects were not significant. As predicted, there was a significant main effect of stakes ($\chi^2(2) = 22.21$, $p < .05$). A follow-up test showed that increasing marginal utility became more prevalent than constant marginal utility as stakes increased ($\chi^2(1) = 6.84$, $p < .05$). Increasing marginal utility also became more prevalent than diminishing marginal utility as stakes increased ($\chi^2(1) = 14.01$, $p < .05$).

The percentage of people classified as having increasing marginal utility was compared to the percentage classified as having diminishing marginal utility for each of the five stakes. There was more diminishing marginal utility ($\hat{p} = .54$) than increasing marginal utility ($\hat{p} = .17$) at the 5 minute stake ($z = 6.06$, $p < .05$), equivalent diminishing ($\hat{p} = .28$) and increasing ($\hat{p} = .38$) marginal utility at the 15 minute stake ($z = -1.41$, $p > .05$), and more increasing marginal utility than diminishing marginal utility at the 30 minute ($\hat{p}_{\text{diminishing}} = .21$, $\hat{p}_{\text{increasing}} = .47$, $z = -4.05$, $p < .05$), 60 minute ($\hat{p}_{\text{diminishing}} = .23$, $\hat{p}_{\text{increasing}} = .51$, $z = -4.01$, $p < .05$), and 120 minute ($\hat{p}_{\text{diminishing}} = .14$, $\hat{p}_{\text{increasing}} = .69$, $z = -9.18$, $p < .05$) stakes. Thus the aggregate value function shifted from diminishing marginal utility at small stakes (i.e., 5 minutes), as would be expected if there was an indifference zone, to increasing marginal

FIGURE 2

RESULTS OF STUDY 1A AND 1B



NOTE.—The classification share is the percentage of participants that exhibited diminishing, constant, and increasing marginal utility at each time stake. Participants who said it would take more (exactly, less than) than 2X minutes to double the value of a time stake were classified as having diminishing (constant, increasing) marginal utility.

utility (disutility) at moderate stakes (i.e., 30 minutes or more).

Study 1b

Study 1b repeated the study 1a procedure using a within-subject manipulation of stakes and procedural modification designed to enhance the accuracy of responses.

Design and Procedure. The study used a 2 (Domain: gain vs. loss) × 2 (Type of Activity: pleasant vs. unpleasant) × 5 (Stake: 5, 15, 30, 60, 120 minutes) mixed design with stakes as a within-subject factor. The order of the stakes was counterbalanced. This factor did not interact with the other factors and is not discussed further.

The procedure was the same as study 1a with one exception. Participants were queried after each response to make sure they had understood the question correctly. After each response, participants were asked, "You indicated that gaining [response] minutes would make you twice as happy as gaining [stake] minutes. Does this mean..." with the responses being (a) "Having [response] minutes would make you twice as happy as having [stake] minutes, (b) "Having [stake + response] minutes would make you twice as happy as having [stake] minutes, and (c) "Neither of the above is correct. I want to change my response."

Participants. Participants were 202 adults (36.6% female, median age = 30, median education = "some college") that were recruited through MTurk and paid a fee of $.50. Fifteen participants indicated they had provided an incorrect answer for one or more stake (i.e., they selected answer [b] or [c] when queried about the correctness of their response). Their responses were updated with the correct response. Nineteen of the 1010 responses were an illogical answer. These responses were retained in the main analysis because participants indicated this was their valuation in the query confirming their response. Critical test statistics are also reported with these responses excluded from the analysis.

Results. The percentage of participants providing responses consistent with diminishing, constant, and increasing marginal utility are presented in figure 2. The fit of the fully estimated model was significant ($\chi^2(14) = 125.68$, $p < .05$). The analysis revealed no domain by type of activity by stake three-way interaction ($\chi^2(2) = .81$, $p > .05$). The domain by type of activity ($\chi^2(2) = 1.67$, $p > .05$), domain by stake ($\chi^2(2) = 1.00$, $p > .05$), and type of activity by stake ($\chi^2(2) = .73$, $p > .05$) two-way interactions were not significant. The domain ($\chi^2(2) = .42$, $p > .05$) and type of activity ($\chi^2(2) = 2.35$, $p > .05$) main effects were not significant. As predicted, there was a significant main effect of stakes ($\chi^2(2) = 28.09$, $p < .05$;

$\chi^2(1)_{\text{without illogical}} = 25.20$, $p < .05$). A follow-up test showed that increasing marginal utility became more prevalent than constant marginal utility as stakes increased ($\chi^2(1) = 12.13$, $p < .05$; $\chi^2(1)_{\text{without illogical}} = 10.61$, $p < .05$). Increasing marginal utility also became more prevalent than diminishing marginal utility as stakes increased ($\chi^2(1) = 23.35$, $p < .05$; $\chi^2(1)_{\text{without illogical}} = 21.42$, $p < .05$).

The percentage of people classified as having increasing marginal utility was compared to the percentage classified as having diminishing marginal utility for each of the five stakes. There was more diminishing marginal utility ($\hat{p} = .43$) than increasing marginal utility ($\hat{p} = .15$) at the 5 minute stake ($z = 7.09$, $p < .05$), equivalent diminishing ($\hat{p} = .29$) and increasing ($\hat{p} = .25$) marginal utility at the 15 minute stake ($z = 1.01$, $p > .05$), and more increasing marginal utility than diminishing marginal utility at the 30 minute ($\hat{p}_{\text{diminishing}} = .16$, $\hat{p}_{\text{increasing}} = .33$, $z = -4.36$, $p < .05$), 60 minute ($\hat{p}_{\text{diminishing}} = .15$, $\hat{p}_{\text{increasing}} = .40$, $z = -6.33$, $p < .05$), and 120 minute ($\hat{p}_{\text{diminishing}} = .14$, $\hat{p}_{\text{increasing}} = .50$, $z = -9.24$, $p < .05$) stakes. Thus the aggregate value function shifted from diminishing marginal utility at small stakes (i.e., 5 minutes), as would be expected if there was an indifference zone, to increasing marginal utility (disutility) at moderate stakes (i.e., 30 minutes or more).

Study 1c

Study 1c repeated the study 1a procedure using a choice task as the dependent measure. For example, the value of a 5 minute gain was assessed by asking participants if, "Gaining 10 minutes of time would make me MORE THAN [EXACTLY] [LESS THAN] twice as happy as gaining 5 minutes of time." The advantage of this procedure was that responses were bounded by the choice category, so all data could be retained. The procedure was also an easier, albeit less precise, way for participants to express their utility for time.

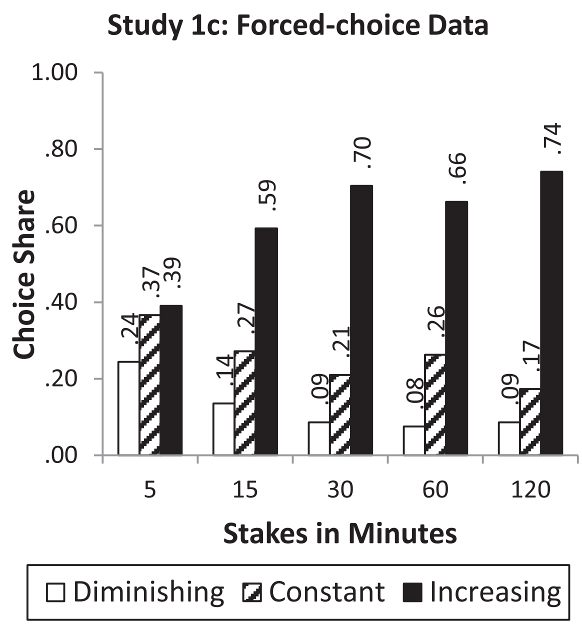
Design and Procedure. The study used a 2 (Domain: gain vs. loss) × 2 (Type of Activity: pleasant vs. unpleasant) × 5 (Stake: 5, 15, 30, 60, 120 minutes) between-subject design. Except for the change in the dependent measure, the procedure was identical to study 1a.

Participants. Participants were 405 adults (36.3% female, median age = 27, median education = "some college") that were recruited through MTurk and paid a fee of $.25.

Results. The choice shares are presented in figure 3. The data were analyzed using a multinomial logistic regression with domain (loss vs. gain domain), type of activity (pleasant vs. unpleasant), and stakes (5, 15, 30, 60, 120 minutes) as independent variables. The stakes variable was coded as a five-level ordinal variable. The "more than twice as happy" (increasing marginal utility) choice was

FIGURE 3

RESULTS OF STUDY 1C



NOTE.—In study 1c, the graph reports the percentage of respondents indicating that twice as much gained (lost) time will provide them more than twice as much happiness (unhappiness), twice as much happiness (unhappiness), or less than twice as much happiness (unhappiness). Choosing "less than twice as much happiness (unhappiness)" indicated diminishing marginal utility and choosing "more than twice as much happiness (unhappiness)" indicated increasing marginal utility.

treated as the reference group, so that choice shares of the "exactly twice as happy" (constant utility) and "less than twice as happy" (diminishing marginal utility) were compared to the "more than twice as happy" choice share.

The fit of the fully estimated model was significant ($\chi^2(14) = 37.17$, $p < .05$). The analysis revealed no domain by type of activity by stake three-way interaction ($\chi^2(2) = 2.62$, $p > .05$). The domain by type of activity ($\chi^2(2) = 1.44$, $p > .05$), domain by stake ($\chi^2(2) = 1.11$, $p > .05$), and type of activity by stake ($\chi^2(2) = 5.26$, $p > .05$) two-way interactions were not significant. The domain ($\chi^2(2) = .11$, $p > .05$) and type of activity ($\chi^2(2) = 2.13$, $p > .05$) main effects were not significant. As predicted, there was a significant main effect of stakes ($\chi^2(2) = 12.60$, $p < .05$). A follow-up test showed that the choice share of "more than twice as happy" (increasing marginal utility) increased relative to the choice share of "exactly as happy" (constant utility) as the stakes increased ($\chi^2(1) = 7.61$, $p < .05$). The choice share of "more than twice as happy" (increasing marginal utility) increased relative to the choice share of "less than twice as happy" (diminishing marginal utility) as the stakes increased ($\chi^2(1) = 5.74$, $p < .05$).

The percentage of people classified as having increasing marginal utility was compared to the percentage classified as having diminishing marginal utility for each of the five stakes. There was more increasing marginal utility than diminishing marginal utility at the 5 ($\hat{p}_{\text{diminishing}} = .24$, $\hat{p}_{\text{increasing}} = .39$, $z = -2.32$, $p < .05$), 15 minute ($\hat{p}_{\text{diminishing}} = .14$, $\hat{p}_{\text{increasing}} = .59$, $z = -7.79$, $p < .05$), 30 minute ($\hat{p}_{\text{diminishing}} = .09$, $\hat{p}_{\text{increasing}} = .74$, $z = -11.67$, $p < .05$), 60 minute ($\hat{p}_{\text{diminishing}} = .08$, $\hat{p}_{\text{increasing}} = .66$, $z = -10.65$, $p < .05$), and 120 minute ($\hat{p}_{\text{diminishing}} = .09$, $\hat{p}_{\text{increasing}} = .74$, $z = -12.94$, $p < .05$) stakes. Thus the aggregate value function showed increasing marginal utility throughout the range of stakes.

Discussion

Study 1 has three noteworthy findings. First, participants showed diminishing marginal utility (disutility) for small time stakes (e.g., 5 minutes in studies 1a and 1b). This result is consistent with an indifference zone in the value function (see figure 1). Second, participants showed increasing marginal utility (disutility) for moderate time stakes. This result is consistent with an increasing marginal utility zone in the value function (see figure 1). Third, increasing marginal utility (disutility) was observed for time gains (losses) using different dependent measures (e.g., estimated value, choice) and data collection procedures (e.g., between subject, within subject). The percentage of participants that exhibited increasing (constant) marginal utility was smaller (greater) in the within-subject design, suggesting this is a more conservative procedure for investigating increasing marginal utility (disutility).

STUDY 2

Study 1 assessed the value of time by asking people to estimate how much time it would take to double the happiness (unhappiness) from an existing gain (loss) of time. A criticism of this method is that the thought of increasing the amount of a resource might create utility independent of the resource itself. Thus in study 2, we tried to directly measure the utility of different time periods. Study 2a asked people to imagine that they could extend the length of a day, or prevent the shortening of a day, by 15 to 240 minutes. Participants reported the amount they would pay per minute to gain time or prevent the loss of time. Study 2b asked people to imagine that they could extend their life, or prevent the shortening of their life, by 7 to 180 days. Participants reported the amount they would pay per day to gain time or prevent the loss of time. We anticipated that participants would indicate increasing marginal utility (disutility) for time gains (losses).

Method

Participants. Study 2a participants were 205 MTurk workers (40% female, median age = 30, median education = "some college") who were paid $.50 for their participation. Study 2b participants were 145 MTurk workers (36.6% female, median age = 28, median education = "some college") who were paid $.50 for their participation.

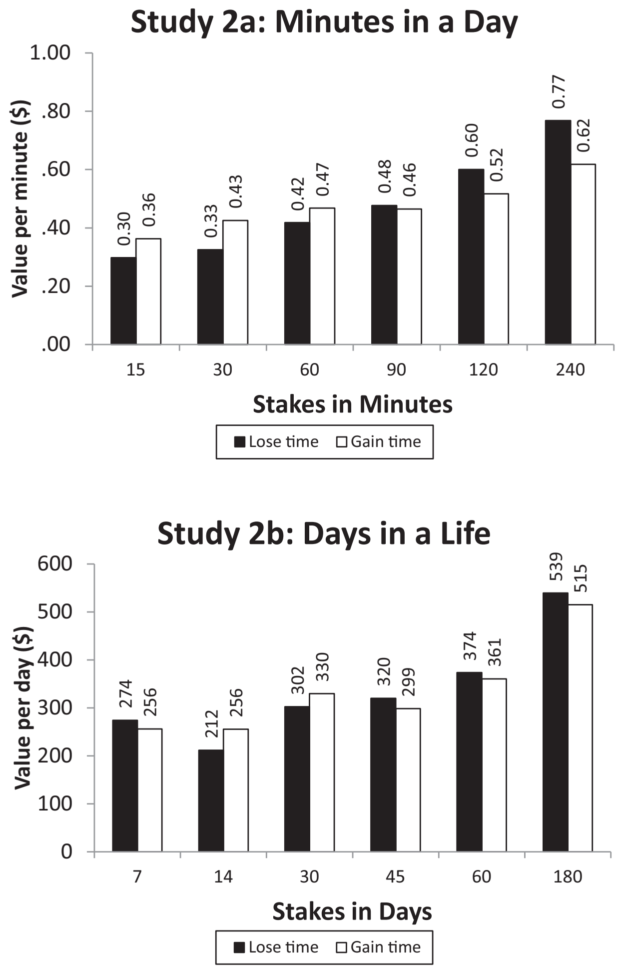
Design. Study 2a used a 2 (Domain: gain vs. loss) × 6 (Stakes in minutes: 15, 30, 60, 90, 120, 240) by 2 (Counterbalance order of stakes: 15, 30, 60, 90, 120, 240 vs. 240, 120, 90, 60, 30, 15) design. The domain and counterbalance factor were between-subject variables; stakes was a within-subject variable. Study 2b used a 2 (Domain: gain vs. loss) × 6 (Stakes in days: 7, 14, 30, 60, 90, 180) design. The reason for not counterbalancing the stake order is discussed later.

Study 2a Procedure. Participants were told the study investigated how they valued time (see appendix B). Participants in the gain scenario were asked to imagine a world where they could buy extra time. That is, they could extend their day to more than 24 hours long. Participants in the loss scenario were asked to imagine a world where they lost time. That is, a day could be less than 24 hours. The instructions illustrated how the price paid per minute could fluctuate around $1 but did not indicate that the prices should vary for the different stakes. Gain participants were then asked how much they would pay per minute to gain time (e.g., "How much per minute would you pay for [x] minutes of extra time in a day?"), whereas loss participants were asked to estimate how much they would pay to prevent the loss of time (e.g., "How much per minute would you pay to prevent the loss of [x] minutes in a day?"). After responding to the question, participants were told "You indicated you would pay [$answer] per minute or [$y * [x]] for the entire 15 minutes. Is this correct?" If the participant answered no, the answer could be changed. This allowed participants that mistakenly provided an amount for the entire time period to adjust their answer accordingly. The time stakes were 15, 30, 60, 90, 120, and 240 minutes, presented in a counterbalanced order.

Study 2b Procedure. Participants were told the study investigated how they valued time (see appendix B). Participants were asked to imagine that they had one more year to live. During this year, they would be happy and have perfect health. After one year, they would get a fatal disease, causing an immediate painless death. In the gain scenario, participants indicated how much they would pay to extend their life. In the loss scenario, participants indicate how much they would pay for keep from shortening their life. The instructions illustrated how the price paid per day could fluctuate but did not indicate that the prices should vary for the different stakes. The time stakes were six intervals ranging from 7 to 180 days. Stake order was

FIGURE 4

RESULTS OF STUDY 2A AND 2B



NOTE.—Study 2a measured the amount a person was willing to pay per minute of time for an extended (truncated) day. Increasing (diminishing) marginal utility is represtened by an upward (downward) sloping trend with increasing stakes. Study 2b measured the amount a person was willing to pay per day of time for an extended (truncated) life. Increasing (diminishing) marginal utility is represtened by an upward (downward) sloping trend with increasing stakes.

not counterbalanced because pretesting showed that declining days of life made the short time interval (i.e., 7 days) inordinately valuable (i.e., people viewed the declining stakes as a countdown to death). Unlike study 2a, participants were not asked to confirm that they were providing a value per day estimates.

Results

Data Preparation. Fifteen study 2a participants failed to respond to all six stakes and were removed from the analysis. The final sample was 190 participants. The nine study 2b participants who failed to respond to all six stakes were removed from the analysis. The final sample was 136 participants.

The data were standardized owing to the diversity of response levels (i.e., individual-level means) and ranges (i.e., individual-level variances) across individuals. To standardize the data, the mean and standard deviation was calculated for each participant using the six observations. The mean was subtracted from each response, and the difference was divided by the standard deviation. Standardized values ranged from -2.04 to 2.04. When a participant expressed no variance across the six responses ($n = 18$ in study 2a, $n = 5$ in study 2b), a value of zero was used for each response. To ease interpretation, results were transformed back into the original dollar metric for reporting purposes (see figure 4).

Study 2a Analysis. The standardized values corresponding to the six stake sizes were subjected to a repeated measure analysis of variance (ANOVA) with domain (loss vs. gain) and counterbalance order as the independent variables. This analysis revealed an interaction of domain and stakes ($F(5, 930) = 2.96$, $p < .05$) and order and stakes ($F(5, 930) = 8.49$, $p < .05$), but no domain by order ($F(1, 186 = 1.03$, $p > .05$) or three-way interaction of domain, order, and stakes ($F(5, 930) = .29$, $p > .05$). Given that the domain by stakes interaction is of more interest, and the order by stakes interaction simply reflected a stronger effect of stakes when they were ordered from high to low (e.g., 240, 120, 90, 60, 30, 15) than low to high (e.g., 15, 30, 60, 90, 120, 240), the data are graphed showing the domain by stakes interaction (see figure 4).

In the loss condition, the tests for a linear effect ($F(1, 88) = 39.81$, $p < .05$) and a quadratic effect ($F(1, 88) = 5.02$, $p < .05$) were significant. In the gain condition, the test for a linear effect ($F(1, 100) = 7.05$, $p < .05$) was significant, but the test for a quadratic effect was not significant ($F(1, 100) = .49$, $p > .05$). In each case, the positive linear trend test indicates that marginal utility (disutility) was increasing with stakes. It should be noted that a main effect test of domain was not possible because the standardization of the data meant the value of the six stakes summed to zero for each participant.

Study 2b Analysis. The standardized values corresponding to the six stake sizes were subjected to a repeated measure ANOVA with domain (loss vs. gain) as the independent variable. This analysis revealed no interaction of domain and stakes ($F(5, 670) = .45$, $p > .05$). There was a main effect of the stakes factor ($F(5, 670) = 24.03$, $p < .05$), as shown in figure 4 (values expressed in the original dollar metric). The tests for a linear effect ($F(1, 135) = 39.20$, $p < .05$) and a quadratic effect ($F(1, 135) = 15.42$, $p < .05$) were significant. The positive trend in these tests indicates that marginal utility (disutility) was increasing with stakes.

Discussion

Study 2 replicated the results of study 1 using a procedure that asked participants to value a unit of time, as opposed to estimating how much a time stake would have to increase in order to double its value (study 1). Per unit values increased as the time stake increased, indicating increasing marginal utility (disutility) with increasing amounts of time. Study 2a (the time-in-a-day scenario) showed a stronger degree of increasing marginal disutility for losses than increasing marginal utility for gains. Overall, the results are consistent with an increasing marginal utility (disutility) zone for time valuation (see figure 1).

STUDY 3

Studies 1 and 2 found that people have increasing marginal utility for increasing stakes of time. We argued that increasing marginal utility was a consequence of participants anticipating opportunities to complete increasingly valued activities. We have also argued that there is a countervailing force for time valuation. As time becomes more abundant, the next best use of a subsegment of a block of time has less value, assuming the time can be used to complete more than one activity. This is a source of diminishing marginal utility. Thus we expect that as time blocks become larger, the factor contributing to increasing marginal utility should wane and the factor contributing to diminishing marginal utility (i.e., resource abundance) should become more prominent (see figure 1). Consequently, moderate amounts of time should show increasing marginal utility, and large amounts of time should show diminishing marginal utility.

The goal of study 3 was to show that large amounts of time are valued in accordance with diminishing marginal utility, but only when resource abundance was the prominent driver of value. To achieve this goal, we developed a procedure to influence the relative importance anticipating increasingly valued uses, a source of increasing marginal utility, and resource abundance, a source of diminishing marginal utility. In the base condition, we modified the study 2a and 2b stimuli so that the resources were clearly abundant. For example, the extra-time-in-a- day stimuli (study 2a) were changed from 15, 30, 60, 90, 120, and 240 minutes to 6, 12, 24, 48, 72, and 96 hours. Clearly, each additional increment of time is abundant when considered in the context of one day. To vary the importance of abundance relative to anticipated uses, these times were assessed in ascending or descending order. When the times were valued in ascending order, it was expected that the 6 hour block would be perceived as abundant and that the larger blocks of time would be perceived as even more abundant. Hence the prominence of resource abundance should create diminishing marginal utility. When the times were valued in descending order, it was expected that the 96 hour block of time would be perceived as abundant. Reductions in time should reduce the perceived opportunity to engage in valued uses. Hence value should drop as time drops, so that time stakes should result in increasing marginal utility. It should be noted that the ascending/descending order manipulation should only be effective when resources are abundant. When resources are not abundant, as in studies 1b and 2a, the opportunities-for-use factor is prominent regardless of the order of stimulus presentation (i.e., an ascending/descending stimulus order should not influence responses).

Method

Participants. Study 3a participants were 118 MTurk workers (36% female, median age = 29) who were paid $.50 for their participation. Study 3b participants were 142 MTurk workers (37% female, median age = 30, median education = "some college") who were paid $.50 for their participation.

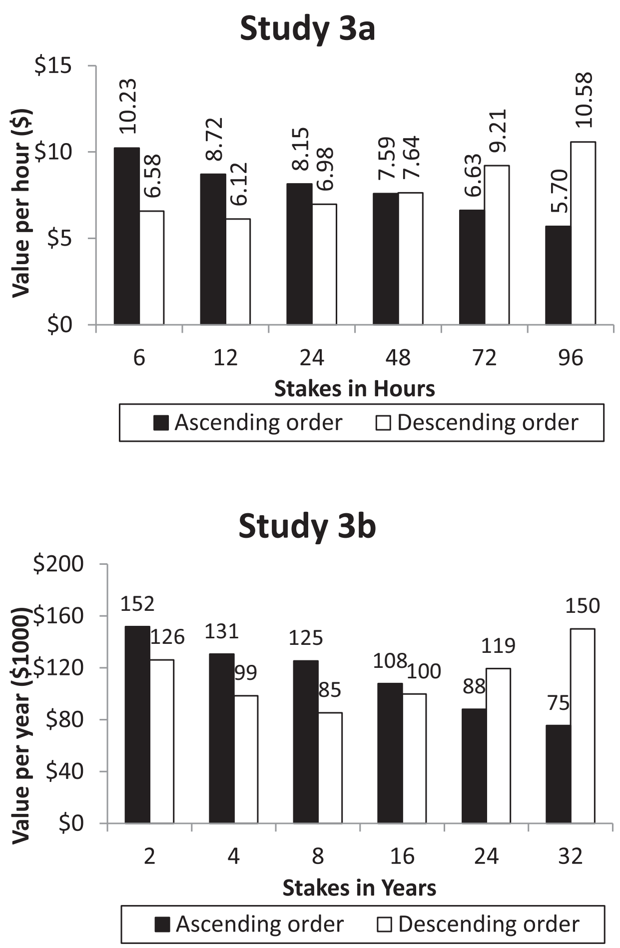
Design and Procedure. Study 3a used a 6 cell (Stakes in hours: 6, 12, 24, 48, 72, 96) within-subject design with order of stakes (ascending, descending) as a between-subject factor. The procedure for study 3a was the same as for the gain condition of study 2a (see appendix B), except that participants judged significantly longer time periods. To adjust for the longer time periods, the reference-exchange value listed in the instructions was changed to $20 per hour (recall in study 2a that the base estimate was $1 per minute). In addition, the initial instructions were modified so that the meaning of the shortest (e.g., 6 more hours in a day means "a day becomes 30 hours long") and longest (e.g., 96 more hours in a day means "a day becomes five days long") periods were explained.

Study 3b used a 6 cell (Stakes in years: 2, 4, 8, 16, 24, 32) within-subject design with order of stakes (ascending, descending) as a between-subject factor. The procedure for study 3b was the same as for the gain condition of study 2b (see appendix B), except that participants judged longer time periods. To adjust for the longer time periods, the reference-exchange value listed in the instructions was changed to $200,000 per year (recall that in study 2b the base estimate was $250 per day).

Both studies asked participants to review each answer in order confirm it was a per unit answer (e.g., willingness to pay per hour), not an entire stakes answer (e.g., amount for 6 hours). When participants indicated they had provided an amount for the entire stake, they were allowed to revise their answer.

FIGURE 5

RESULTS OF STUDY 3A AND 3B



NOTE.—Study 3a measured the amount a person was willing to pay per hour of time for an extended day. Stakes were ordered from low to high (ascending) or high to low (descending). Increasing (diminishing) marginal utility is represented by an upward (downward) sloping trend with increasing stakes. Study 3b measured the amount a person was willing to pay per year of time for an extended life. Increasing (diminishing) marginal utility is represented by an upward (downward) sloping trend with increasing stakes.

Results

Data Preparation. In study 3a, eight participants failed to respond to all six stakes. The final sample was 110 participants. In study 3b, four participants failed to respond to all six stakes. The final sample was 138 participants.

As in the study 2 analysis, the data were standardized owing to the diversity of response levels (i.e., individual-level means) and ranges (i.e., individual-level variances) across individuals. When a participant expressed no variance across the six responses ($n = 24$ in study 3a, $n = 22$ in study 3b), a value of zero was used for each response. In order to ease interpretation, results were transformed back into the original dollar metric for reporting purposes (see figure 5).

Study 3a Analysis. The standardized values corresponding to the six stake sizes were analyzed using a repeated measures ANOVA with stimulus order as the independent variable. This analysis revealed an interaction of stimulus order and stakes ($F(5, 540) = 8.45$, $p < .05$) (see figure 5). Within the ascending stakes condition, there was diminishing marginal utility. The test for a linear effect was significant ($F(1, 56) = 6.46$, $p < .05$). The test for a quadratic effect was not significant ($F(1, 56) = .05$, $p > .05$). Within the descending stakes condition, there was increasing marginal utility. The test for a linear effect was significant ($F(1, 52) = 5.39$, $p < .05$) as was the test for a quadratic effect ($F(1, 52) = 5.14$, $p < .05$).

Study 3b Analysis. The standardized values corresponding to the six stake sizes were analyzed using a repeated measures ANOVA with stimulus order as the independent variable. This analysis revealed an interaction of stimulus order and stakes ($F(5, 680) = 7.15$, $p < .05$) (see figure 5). Within the ascending stakes condition, there was diminishing marginal utility. The test for a linear effect was significant ($F(1, 70) = 8.90$, $p < .05$). The test for a quadratic effect was not significant ($F(1, 70) = .02$, $p > .05$). Within the descending stakes condition, there was increasing marginal utility after stakes reached a critical level (8 years). The test for a linear effect was not significant ($F(1, 66) = .97$, $p > .05$). The test for a quadratic effect was significant ($F(1, 66) = 36.04$, $p < .05$).

Discussion

The results of study 3 showed two critical effects. First, when time became abundant, people showed diminishing marginal utility to increasing stakes. These results are consistent with the diminishing marginal utility zone of the value function (see figure 1). Second, when time stakes were presented in a way that made the potential uses of time more salient (i.e., descending stakes), people showed increasing marginal utility to increasing stakes. These results are important because they suggest that the value of time is not a function of the simple magnitude of time. Instead, time gains marginal value because of the expansion of its potential uses (a source of increasing marginal utility) and loses marginal value because of its overabundance (a source of diminishing marginal utility). It is the relative importance of these factors that influence the value function.

There was an anomaly in the study 3 results. Short time periods in the descending stakes condition of study 3b (i.e., 2, 4 years) showed an increase in value relative to the more moderate time periods. It could be argued that these time periods were part of an indifference zone, but we do not believe this was the case. These conditions may have shown increasing marginal utility because the descending time stakes encouraged people to consider activities they would do in the last years of their life (i.e., bucket-list activities became more salient). That is, rather than a general focus on the valued activities they could not do, with each reduction in time, participants focused on activities that would have special significance and value in the final years of life.

CONTEXTUALIZED STUDIES OF TIME

We have argued that an increased amount of time allows a person to consider a larger set of activities. For example, two nonadjacent 10 minute blocks of time allow a person to perform two 10 minute activities or a 20 minute activity that can be interrupted. In contrast, two adjacent 10 minute blocks of time provide the same usage opportunities (i.e., two 10 minute activities, a 20 minute activity that can be interrupted) or an opportunity to do a 20 minute activity that cannot be interrupted. Thus larger blocks of time have the potential to show increasing marginal utility because they afford an opportunity to engage in activities that could not otherwise be attempted. Of course, increasing marginal utility will only occur when the benefits of co-joining time exceed any decrease in utility from having excess time (i.e., resource abundance).

In study 4, we tested our ideas about co-joining time by integrating/segregating moderate or large time gains or losses. If the value function for time is double kinked, people should prefer to integrate (segregate) moderate (large) time gains and segregate (integrate) moderate (large) time losses. Thus we will show that people prefer to integrate (segregate) moderate time gains (losses) (studies 4a, 4b, and 4c), that the preference for time gain integration reverses when gains become larger (i.e., there is a preference for segregating large time gains) (study 4b), and that the preference for time loss segregation reverses when losses become larger (i.e., there is a preference for integrating large time losses) (study 4c).

Study 4a

The double-kinked value function predicts that people will prefer to integrate moderate time gains and segregate moderate time losses. Study 4a investigated these predictions using the time gains/losses that accrue from completing separate tasks.

Design and Participants. The study used a two cell between-subject design (time gain vs. time loss). The dependent measure was whether participants preferred to experience gains or losses as integrated or segregated. Participants were 210 adults (64% female, median age = 32, median education = "some college") that were recruited through MTurk and paid a nominal fee for their participation.

Procedure. Participants were told we were interested in their opinion about gaining (losing) time (see appendix C). Participants were asked to assume that they could save (lose) 30 minutes of time by completing tasks more quickly (slowly) during the day. Then they were asked if they preferred to save (lose) 30 minutes on a single task or save (lose) 10 minutes on each of three separate tasks.

Results. The manipulation of the moderate time gains versus losses was significant ($\chi^2 = 15.49$). In the time gain scenario, participants preferred to have their gains integrated (61%, $n = 64$) instead of segregated (39%, $n = 41$), a choice share that is significantly different from chance ($z = 2.24$, $p < .05$). In the time loss scenario, participants preferred to have their losses segregated (66.7%, $n = 70$) instead of integrated (33.3%, $n = 35$), a choice share that is significantly different from chance ($z = 3.42$, $p < .05$).

Study 4b

Study 4b investigated moderate versus large time gains using a holiday meal preparation scenario. We predicted that people would prefer to integrate moderate time gains but segregate large time gains.

Design and Participants. The study used a two cell between-subject design (moderate time gain vs. large time gain). The dependent measure was whether participants preferred to experience the time gains as integrated or segregated. Participants were 176 adults (45% female, median age = 28, median education = "some college") that were recruited through MTurk and paid a nominal fee for their participation.

Procedure. Participants were told that a typical consumer spends a considerable amount of time preparing a holiday meal (see appendix D). Further, celebrity chefs provide consumers with time-saving recipes. These recipes allowed consumers to save time preparing the ingredients or cooking the food. In the moderate time gain scenario, participants were asked if they wanted to save 10 minutes on preparing the ingredients and 10 minutes on cooking the food, save 20 minutes on preparing the ingredients, or save 20 minutes on cooking the food. In the large time gain scenario, these times were increased to 60 minutes of time savings for preparing and cooking and 120 minutes of savings when cooking or preparing.

Results. The manipulation of the moderate versus large time gains was significant ($\chi^2 = 12.01$). Participants preferred to have their moderate time gains integrated (66.3%, $n = 59$) instead of segregated (33.7%, $n = 30$), a choice share that is significantly different from chance ($z = 3.07$, $p < .05$). Participants preferred to have their large time gains segregated (59.8%, $n = 52$) instead of integrated (40.2%, $n = 35$), a choice share that is significantly different from chance ($z = 1.82$, $p < .10$).

Study 4c

Study 4c investigated moderate versus large time losses using a public transportation scenario. We predicted that people would prefer to segregate moderate time losses but integrate large time losses.

Design and Participants. The study used a two cell between-subject design (moderate time gain vs. large time loss). The dependent measure was whether participants preferred to experience the time losses as integrated or segregated. Participants were 237 adults (47% female, median age = 28, median education = "some college") who were recruited through MTurk and paid a nominal fee for their participation. Participants were not daily commuters.

Procedure. Participants were told that 35 million people regularly use public transportation in the United States and that the number one source of dissatisfaction is delays in service (see appendix E). Participants were asked to assume that their normal commute time was 60 minutes, consisting of two 20 minute bus rides and two 10 minute wait times. Participants were then asked to indicate which of two delays they would prefer. The moderate time delay, integrated loss option increased the travel time of one bus ride from 20 to 30 minutes. The moderate time delay, segregated loss option increased the travel time of each bus ride from 20 to 25 minutes. It was clear that the total travel time was increased from 60 to 70 minutes in each condition. The long time delay, integrated loss option increased the travel time of one bus ride from 20 to 60 minutes. The long time delay, segregated loss option increased the travel time of each bus ride from 20 to 40 minutes. It was clear that the total travel time was increased from 60 to 100 minutes in each condition.

Results. The manipulation of the moderate versus large time loss was significant ($\chi^2 = 7.06$). Participants preferred to have their moderate time delays segregated (58.9%, $n = 73$) instead of integrated (41.1%, $n = 51$), a choice share that is significantly different from chance ($z = 1.98$, $p < .05$). They also preferred to have their long time delays integrated (58.4%, $n = 66$) instead of segregated (41.6%, $n = 47$), a choice share that is significantly different from chance ($z = 1.75$, $p < .10$).

GENERAL DISCUSSION

The current studies show that the valuation of time is consistent with a double-kinked value function: small time gains and losses are valued in line with diminishing marginal utility (disutility) (owing to an indifference zone), moderate time gains and losses are valued in line with increasing marginal utility (disutility), and large time gains and losses are valued in line with diminishing marginal utility (disutility). This conclusion is based on a variety of approaches to assessing the value of time. First, we studied time in a decontextualized setting and showed that many people need less than twice the time to double the utility (disutility) experienced from gaining (losing) a smaller amount of time (study 1). This response implies increasing marginal utility (disutility) for moderate amounts of time. We also looked at time in contextualized but unfamiliar settings. In these settings, people also provided increasing per unit values for increasing amounts of time, as implied by increasing marginal utility (disutility) (study 2). When time became abundant, however, people provided decreasing per unit values for increasing time stakes (study 3). Finally, we studied time in more naturalistic settings and observed that the preference to aggregate moderate time gains reverses as time gains become larger, and the preference to segregate moderate time losses reverses as time losses become larger (study 4). Collectively, the results of the studies reflect a double-kinked value function.

We contend that time is ideally studied as a noncontextualized resource. Yet given that time is inherently coupled with events, it could be argued that attempts to value noncontextualized time are artificial. This would imply, for instance, that we were not measuring participants' responses to genuine time outcomes in study 1 but instead were measuring responses to mere numbers. To rule out this alternative explanation, we replicated the results of study 1 in more contextualized experimental settings (studies 2 and 3). Moreover, our results are in opposition to the robust finding that people are less sensitive to an increasing magnitude as the base increases (e.g., the distance between 5 and 7 seems larger than the distance between 105 and 107; Dehaene 2011) that would imply diminishing, not increasing, marginal utility. Thus the fact that moderate amounts of time show increasing marginal utility is inconsistent with research on pure number valuation.

Valuing Resources

This research focuses on the value an individual assigns to a resource (e.g., time), not a good. There is no doubt that the accumulation and consumption of uniform goods results in diminishing marginal utility (e.g., Galak, Kruger, and Loewenstein 2013; Horowitz et al. 2007). Yet a resource is not like a good because larger aggregations of a resource alter the opportunities for its use. The enhanced usage opportunities associated with larger amounts of time (e.g., 1.5 hours allows one to complete three 30 minute activities *or* one 1.5 hour activity, whereas three 30 minute blocks allows one to complete three 30 minute activities) were critical to observing increasing marginal utility for time, as more time was associated with more and better uses. This may be true of other resources as well, given the right conditions. For example, consider money. Money is not like time (Leclerc et al. 1995; Okada and Hoch 2004; Saini and Monga 2008; Soman 2001; Zauberman and Lynch 2005). It can be saved and aggregated in order to purchase goods and services with a higher per-dollar utility (i.e., enhanced usage opportunities are apparent even when money is insufficient). Yet some people do not have the opportunity to save and aggregate money. For the poor, money is hard to accumulate. Thus the poor might experience money in the same way the general population experiences time. This may be why the poor spend a much higher proportion of their disposable income on lotteries (Ariyabuddhiphongs 2011). Winning a lottery would create opportunities to consume higher utility-per-dollar goods and services (Kwang 1965). Of course, inferring an increasing marginal utility function from the outcome of a gamble should be done with caution (Rabin 2000; Wakker 1994).

There are other resources that could exhibit increasing marginal utility. Natural resources (e.g., wildlife, recreation areas, habitat, biodiversity), social capital (social network, interpersonal ties, family support), cultural capital (education, art, taste), psychological resources (e.g., patience, resilience, willpower), and physiological resources (e.g., metabolic energy, mental energy, pain tolerance) all have to-be-determined uses. These resources have the potential to show increasing marginal utility when more of the resource affords better opportunities for use. For example, consider the accumulation of cultural capital. An accumulation of cultural capital can increase the appreciation of future cultural consumption; hence it can have a convex value function during its initial accumulation (e.g., Alderighi and Lorenzini 2012). Similarly, an initial accumulation of wildlife could enhance the value of wildlife at an increasing rate (e.g., opportunities for wildlife observation, hunting). The initial growth in a social or business network could have increasing marginal benefits. A growth in willpower allows one to attempt more difficult and fulfilling tasks. Strength and endurance can afford greater participation in self-actualizing life's experiences. Thus resources can exhibit increasing marginal utility as the supply of the resource transitions from small to moderate amounts.

Understanding the Resource Value Function

Figure 1 presents a value function that has three zones: indifference, increasing marginal utility, and diminishing marginal utility. The width of these zones depends on the relative importance of the anticipated opportunities for the use of a resource and the perceptions of resource abundance. We expect that the relative importance of these factors depends, in part, on context. To illustrate, consider the time blocks that were used across the studies in this article. In study 1a and 1b, the 5 to 10 minute stake showed diminishing marginal utility and the 15 to 30 minute stake showed constant marginal utility (on average). In study 4b, the 10 to 20 minute stake showed increasing marginal utility. The implication is that there is not an exact mapping of specific unit times to the value function. The mapping varies by contexts (i.e., what is small, moderate, and large in the given situation) and individuals (e.g., study 1 documents that individuals differ in their response to gaining or losing specific amounts of time).

Perhaps the more interesting issue is an understanding of the factors that will moderate the relative influence of the opportunities for use and abundance on value. We anticipate that the more ambiguous a resource (i.e., there is uncertainty about its allocation to uses), the wider the indifference zone, the narrower the increasing marginal utility zone, and the wider the diminishing marginal utility zone. For example, people have a difficult time understanding natural resource usage. When this is the case, they exhibit insensitivity to changes in the amount of the resource (Carson 1997). In contrast, when the resource-to-usage mapping is clear, people are sensitive to the increased availability of the resource (Carson 1997). Thus when the resource-to-usage relationship is well established, there is an opportunity to observe increasing marginal utility.

Studying the Resource Value Function

Studies 1 through 3 used novel approaches to study resource valuation, whereas study 4 used a more common approach. Although the study 4 method may feel more familiar, owing to the research on mental accounting, it does have a potential problem. Study 4 used familiar scenarios. Whenever a context is familiar, time savings or losses can be associated with specific usage opportunities. That is, blocks of time are no longer valued solely for their potential uses, at an abstract level, but for specific uses. If the specific uses for a larger block of time provide more utility per minute than for multiple smaller blocks of time, then integrated (segregated) time gains (losses) will be preferred. If the specific uses for a larger block of time provide less utility per minute than for multiple smaller blocks of time, segregated (integrated) time gains (losses) will be preferred. This may not have been an issue in study 4a, but it certainly could have been an issue in study 4b and 4c. People have ideas about how to reallocate time in a kitchen or on a bus. Thus a preference for integrating/segregating gained or lost time likely depends on an implicit value for the time and an explicit plan for how the time could be used. These two sources of value need not agree. When they do not, the explicit plan for using the time may have a stronger influence on resource valuation than the underlying value function. This suggests one should be cautious about the generalizability of the integration/segregation results across domains and samples.

Time Valuation under Risk

We studied the value function for time stakes in a riskless context. Many of our time valuations and time-based decisions occur in such riskless contexts. Yet the value function for time could also be studied in a risky choice context, even under the nonexpected utility assumption that risk attitudes are not solely determined by the utility function (Abdellaoui, Bleichrodt, and L'Haridon 2008; Wakker 2010). That is to say, nonexpected utility theorists assume that the value function *can* be derived from risky choice data, but only in the case that a risk attitude is decomposed into *all* of its underlying parts (i.e., the utility function, the probability weighting function, loss aversion). Thus the influence of probability weighting and loss aversion on risk attitudes should be made explicit and controlled for.

To understand this recommendation, consider someone who is indifferent between gaining 20 minutes for sure and participating in a gamble with a 50% probability of gaining 60 minutes and a 50% probability of gaining nothing at all. As the certainty equivalent of this gamble (20 minutes) is lower than its expected value (30 minutes $= .5 \times 60$ minutes $+ .5 \times 0$ minutes), this person is risk averse. This risk aversion could, however, be driven by two factors: by a concave value function for gains (i.e., people only need to gain 20 minutes to be half as happy as gaining 60 minutes) and/or by a pessimistic weighting of probabilities (i.e., people perceive an objective 50% probability of gaining 60 minutes as a subjective 30% probability). Therefore, probability weighting should be taken into account when measuring the time value function under risk (i.e., the influence exerted by optimism or pessimism would otherwise bias the shape of the value function).

Attempts have been made to measure the value function for time outcomes under risk (i.e., taking probability weighting into account; Abdellaoui and Kemel 2014; Festjens et al. 2014). For example, Festjens et al. (2014) measured the value function for time using a method of Abdellaoui et al. (2008). This method is based on the repeated elicitation of the certainty equivalent of several two-outcome gambles (e.g., 50% chance of gaining 30 minutes and 50% chance of gaining 0 minutes; gaining time was defined as leaving an experimental session earlier than planned or as finishing a task earlier than planned). Consistent with our findings, they did not observe diminishing marginal utility for time gains or losses. They found that the value function for time gains (losses) showed constant marginal utility (increasing marginal utility). It should be noted that one major shortcoming of decision science methodologies, such as these, is that the value function and the probability weighting function are often highly correlated and not independently measured (Qiu and Steiger 2011). Again, this supports our decision to study the value function for time in a riskless choice context.

Conclusion

Ten studies were used to show that time valuation is consistent with a double-kinked value function. The results were in contrast to historical evidence of diminishing marginal utility for good and services. The implication is that the properties of a resource determine the way in which it is valued. As a consequence, there is an opportunity to further investigate the influence of resource properties on resource valuation.

DATA COLLECTION INFORMATION

The data were collected online between August 2011 and February 2015. The data were analyzed by the second author. The analyses were reviewed by the first author.

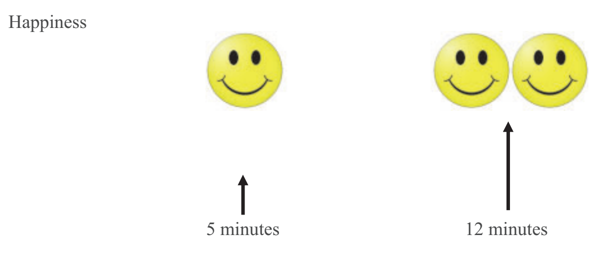
APPENDIX A
EXAMPLE OF STUDY 1A PROCEDURE

Screen 1 (first part of instructions)

We are interested in how you would respond to gaining time.

"Gaining time" is defined as **needing less time than expected to complete a pleasant task**.

We know that the objective value of unexpectedly gaining 10 minutes of time is twice that of unexpectedly gaining 5 minutes of time. Yet most people do not feel that way about the subjective value of gained time. For example, some people would feel pretty happy if they gained 5 minutes. Yet gaining 10 minutes would not make them twice as happy as gaining 5 minutes. They might need to gain 12 minutes to make them twice as happy gaining 5 minutes.



Screen 2 (second part of instructions)

Other people feel that they would need to gain LESS than 10 minutes to make them twice as happy as gaining 5 minutes. For example, some people think they would need to gain 8 minutes to make them twice as happy as gaining 5 minutes.

APPENDIX B

Study 2a Scenario

We are trying to understand how people value their time. This is a difficult issue to investigate because people are constrained in their time—in order to spend more time on one activity, time has to be diverted from another activity. To get around this problem, we want you to do the following:

Imagine a world where [you could buy extra time each day] [some days are shorter than others]. That is, rather than your day being 24 hours long, your day could be [more] [less] than 24 hours long. We want to know how much you would pay to [lengthen your day] [keep your day from shortening].

Other people that have given us estimates say they will pay about $1 per minute [of extra time] [to prevent the loss of time]. In addition, the amount they say they are willing to pay per minute varies by the number of minutes. Depending on the length of time, you can pay less than $1 per minute (e.g., $.80 per minute), $1 per minute, or more than $1 per minute (e.g., $1.20 per minute) to [buy time] [prevent time from being lost]. You will be asked to value time blocks ranging from 15 minutes to 240 minutes. We are interested in how the value of time varies over these time blocks.

Study 2b Scenario

We are trying to understand how people value their time.

Imagine that you have 1 more year to live. During this year you will be happy and have perfect health. After 1 year, you get a fatal disease, causing an immediate painless death.

Now imagine you [could buy extra time for yourself] [receive the news that you may not make it a year.]. That is, rather than having 1 remaining year, you could have [more] [less] than 1 year of quality life. We want to know how much you would pay to [lengthen your life beyond a year] [keep your life from ending in less than a year].

People who have taken this survey before have said they would pay about $250 for an extra day of quality life. In addition, the amount they said they were willing to pay per day varied by the number of days. Depending on the length of time, they said they would pay less than $250 per day (e.g., $200 per day), $250 per day, or more than $250 per day (e.g., $300 per day) to buy days.

APPENDIX C

Time Gain: We are interested in your general opinion about gaining time. Assume you had the chance to save 30 minutes of time by completing tasks more quickly during your day. Would you prefer to

a. Save 10 minutes on three separate tasks, with the total time savings amounting to 30 minutes. (39%, $n = 41$)
b. Save 30 minutes on a single task. (61%, $n = 64$)

Time Loss: We are interested in your general opinion about losing time. Assume you knew you were going to lose 30 minutes of time by completing tasks more slowly during your day. Would you prefer to

a. Lose 10 minutes on three separate tasks, with the total time loss amounting to 30 minutes. (67.7%, $n = 70$)
b. Lose 30 minutes on a single task. (33.3%, $n = 35$)

APPENDIX D

Moderate Time Gain: A typical consumer spends considerable time preparing a holiday meal. Celebrity chefs provide consumers with time-saving recipes. Recipes for the exact same dish can be created so that time is saved on preparing the ingredients or cooking the food (time that must be spent at the stove). Which type of time savings would be most attractive to you?

a. Save 10 minutes on preparing the ingredients and 10 minutes on cooking the food (time that must be spent at the stove). (33.7%, $n = 30$)
b. Save 20 minutes on preparing the ingredients. (50.6%, $n = 45$)
c. Save 20 minutes on cooking the food (time that must be spent at the stove). (15.7%, $n = 14$)

Big Time Gain: A typical consumer spends considerable time preparing a holiday meal. Celebrity chefs provide consumers with time-saving recipes. Recipes for the exact same dish can be created so that time is saved on preparing the ingredients or cooking the food (time that must be spent at the stove). Which type of time savings would be most attractive to you?

a. Save 60 minutes on preparing the ingredients and 60 minutes on cooking the food (time that must be spent at the stove). (59.8%, $n = 52$)
b. Save 120 minutes on preparing the ingredients. (21.8%, $n = 19$)

c. Save 120 minutes on cooking the food (time that must be spent at the stove). (18.4%, $n = 16$)

APPENDIX E

A total of 35 million people regularly use public transportation in the United States. The number one source of dissatisfaction with public transportation is delays in service. Trains, buses, and subways often do not arrive when they should. As a consequence, commute time increases and commuters are irritated.

We would like to understand what types of public transportation delays people find most irritating. Suppose your typical commute consists of two bus trips, separated by a transfer between buses. As shown below, you typically wait 10 minutes for the first bus to arrive, travel 20 minutes, wait 10 minutes for the second bus to arrive, and travel 20 more minutes. Your total commute time is 60 minutes.

	Typical Wait	Travel Time
Bus A	10 minutes	20 minutes
Bus B	10 minutes	20 minutes

Although no one likes delays, they do happen. If your commute was to experience delays, which of the following two delays would you prefer?

Moderate Time Loss

a. The travel time on the first bus is 30 minutes instead of 20. Everything else remains the same, and your commute time increases from 60 minutes to 70 minutes. (41.1%, $n = 51$)

b. The travel time on first bus is 25 minutes instead of 20, and the travel time on the second bus is 25 minutes instead of 20. Everything else remains the same, and your commute time increases from 60 minutes to 70 minutes. (58.9%, $n = 73$)

Big Time Loss

a. The travel time on the first bus is 60 minutes instead of 20. Everything else remains the same, and your commute time increases from 60 minutes to 100 minutes. (58.4%, $n = 66$)

b. The travel time on the first bus is 40 minutes instead of 20, and the travel time on the second bus is 40 minutes instead of 20. Everything else remains the same, and your commute time increases from 60 minutes to 100 minutes. (31.6%, $n = 47$)

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