Title

Consumer Misunderstanding of Credit Card Use, Payments, and Debt: Causes and Solutions

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CONSUMER MISUNDERSTANDING OF CREDIT CARD USE, PAYMENTS, AND DEBT: CAUSES AND SOLUTIONS

Abstract

This paper examines people's misunderstanding of debt caused by the non-linear relationships among interest rates, monthly payments, and time to pay off a debt. The paper also tests whether misunderstanding is less for people with stronger numerical skills or who are using the new statement format required by the CARD Act of 2009. A first study showed that people underestimate the amount of time it takes to eliminate a debt when payments barely cover interest owed, and this effect was worse for those low in numerical skill. A second study showed that less numerate individuals tend to underestimate the monthly payment required to pay off a debt in three years, whereas those more numerate tend to overestimate. These biases are dramatically reduced with the revised statement required by the CARD Act, although much less so when cardholders continue to use the card. A third study identified new misunderstandings caused by the revised statement. The paper considers additional techniques to help credit card holders understand the relationship between payments and eliminating debt.

Keywords

credit card debt, compound interest, loan payment biases, personal credit, payoff time

Consumers are attracted to credit cards because of the many benefits they offer when used and managed well. Credit cards are widely accepted for purchases, alleviate a need to carry much cash, provide an accurate record of purchases, facilitate reimbursement for returned merchandise, build a history of creditworthiness, and offer desirable rewards through affinity programs. Partly for these reasons, the use of credit cards is ubiquitous in the United States. In 2008, there were 177 million credit cardholders, representing about 80% of the adult population (ages 18 and up). The average consumer has 3.5 credit cards (Foster, Meijer, Schuh, & Zabek, 2010). In 2009, there were 20.2 billion transactions on credit cards with a total purchase volume of $1.76 trillion (Nilson Report, 2010).

The downside of credit cards is that many consumers misuse and mismanage their cards. These consumers engage in impulsive buying, end up with items that they do not need or perhaps even want, and spend more than they can afford. This can lead to serious debt problems, which are exacerbated by the high interest rates and late fees associated with carrying a balance on the card. In the worst cases, credit card debt can instigate years or even decades of financial hardship for individuals and families. According to the Federal Reserve Board's *2007 Survey of Consumer Finances*, 46.1% of families carry credit debt, with an average debt of $7,300. There is evidence that people under-report their credit card debt in such surveys, so the figure could be substantially higher (Zinman, 2009). One consequence of debt is bankruptcy; personal bankruptcy filings numbered over 1.4 million in 2009 (American Bankruptcy Institute, 2010).

The academic literature has highlighted several ways in which many cardholders misuse and mismanage their credit cards. Compared to using cash, credit cards cause people to spend more money in identical purchase situations (Feinberg, 1986; Hirschman, 1979; Prelec & Simester, 2001). People also have a poorer recollection of their spending and a reduced level of psychic pain associated with spending when using a credit card (Soman, 2001), making it easier to spend in the future. Moreover, people spend more when they have higher credit limits, because the increased limit makes them feel wealthier independent of their actual income and savings (Soman & Cheema, 2002), and they anchor on the minimum amount due when making payment decisions (Stewart, 2009).

The difficulties of managing credit card debt have been partially attributed to the lack of fundamental financial knowledge. A survey by Lusardi and Tufano (2009) indicated that a majority of consumers have poor debt literacy. Recently, the US government passed the Credit Card Accountability Responsibility and Disclosure (CARD) Act of 2009. Title II of this law required a redesign of the monthly statement sent to every cardholder. The purpose of the redesign was to improve consumers' understanding about the financial arrangements associated with credit cards. For example, the new statement features a table that informs consumers about how long it will take to pay off their debt if they pay only the minimum amount due each month, and how much they need to pay per month in order to eliminate their debt in three years.

In this article we investigate the reasons why many consumers do not understand the financial consequences of credit card debt and the degree to which the recent changes to the monthly credit card statement may help. There is already some evidence, for example, that the new statement reduces the extent to which people anchor on the amount due by disclosing the temporal and financial consequences of paying only this amount (Salisbury & Lemon, 2009). In the next section we discuss some of the difficulties that consumers may have in reasoning about credit card debt. We provide an overview of the inherent complexities that credit card finance poses to intuition. We then propose that people approach such problems by applying heuristics that may appear intuitively compelling but fail to fully match the complex math required when interest rates are involved. The intuitive math that people apply can lead them to severely underestimate how quickly they will pay off their debt.

Difficulties in Understanding Credit Card Debt

Managing credit card debt is an inherently complex decision problem. Inputs to the problem include the balance due and the annual interest rate on the card. The cardholder decides which new purchases to make during the month and what payment to make on the card, which determines the dollar balance for the beginning of the next month. The problem is a multi-period one, in which “flows” of charges and payments over time change the level of the “stock” of debt, or principal. Reasoning about the relationship between stocks and flows is challenging even in simple problems, such as the accumulation of water in a bathtub as a function of the inflow and outflow (Cronin, Gonzalez, & Sterman, 2009). The debt problem is significantly more complicated than simple stock-flow problems because of the effects of interest. In terms of the bathtub example, it would be as if the water in the tub were continuously expanding even as one bails it out with buckets, and as new water intermittently flows from the faucet.

A robust finding in the judgment and decision making literature is that people have more difficulty learning and estimating nonlinear relationships as opposed to linear ones (Slovic, Fischhoff, & Lichtenstein, 1977). In some cases people treat nonlinear relationships as if they were linear. One example of this is the MPG illusion (Larrick & Soll, 2008). Many people believe that increasing mileage from 34 to 50 MPG would save more gas on a car driven 10,000 miles annually than increasing mileage from 16 to 20 MPG, yet the latter change saves 29 additional gallons (see Svenson, 2008, for related examples with driving speed). Recent research has also examined how people reason about nonlinear financial relationships. People treat savings growth as linear rather than exponential, and thus severely underestimate the benefits of saving now as opposed to later (Eisenstein & Hoch, 2007; McKenzie & Liersch, 2010). For debt, people underestimate the implied annual interest rate for a given payment stream, a phenomenon known as the payment/interest bias (Stango & Zinman, 2009). As an example of this bias, suppose that a consumer purchases $1,000 of furniture on credit and repays the store $100 per month for one year. What is the annual interest rate on the loan? Although it is tempting to say 20%, this answer ignores the fact that the principal declines over the course of the year. The correct answer is 35%. For problems similar to this one, over 98% of respondents in Stango and Zinman's (2009) database (which was drawn from surveys by the Federal Reserve in 1977 and 1983) showed a payment/interest bias. Stango and Zinman (2009) further showed that, mathematically, the underestimation of exponential growth implies a payment/interest bias.

As an example of another nonlinearity introduced by interest, Figure 1 shows the time needed to pay off a loan of $4,000 as a function of the interest rate when constant monthly payments are $100 and $300. Over the range of interest rates from 0% to 30%, the relationship is well-approximated by a linear function for payments of $300 per month but is highly nonlinear for payments of $100 per month. Specifically, there is a vertical asymptote where monthly payments equal the monthly interest charges (e.g., in Figure 1, the months needed to pay off a $4,000 debt with payments of $100 a month goes to infinity at an interest rate of 30%). In a pilot study with a national panel of adults, we found that people misunderstand the relationship between interest rate and total payments. In a between-subjects design, we asked participants to rank the savings from an interest rate change assuming a regular monthly payment of either $300 or $100. For both payment levels, participants believed that they would save more money if the interest rate were reduced from 18% to 6% compared to 28% to 24%. Participants relied heavily on linear difference as their cue to savings, which is accurate for $300 but not $100 monthly payments. At a monthly payment of $100, the improvement from 18% to 6% reduces the time to pay by 17 months (saving $1,700), whereas the improvement from 28% to 24% reduces the time by 36 months (saving $3,600 dollars). [Insert Figure 1 about here.]

What accounts for these misperceptions? One possibility is that people lack basic arithmetic skills—they are innumerate. Research has found that some individuals cannot operate with percentages and fractions in a consistent manner (Lipkus, Samsa, & Rimer, 2001) and fail to apply the most basic financial principles in reasoning about savings and debt (Lusardi & Tufano, 2009). However, innumeracy alone seems an implausible explanation in this particular case. Solving the interest rate problem above involves more than simple multiplication. Although there is a formula to solve this problem that some numerate people would know how to use if presented to them, the formula would likely be challenging for even the most numerate to derive on their own. Instead, we suggest that people rely on simple mathematical operations to solve such problems, which are abstracted from experience in which the rules do yield correct solutions (Fischbein, 1989). For example, a "bigger is better" heuristic would lead people to correctly infer that cars with greater miles per gallon use less gas and that credit cards with lower interest rates have smaller interest charges. What holds for absolute quantities, however, does not necessarily hold for changes in those quantities if the underlying monotonic relationship is non-linear. It is not the case that the large change from 20 to 50 MPG saves more gas than the small change from 10 to 15, nor that the large reduction in interest rate from 18% to 6% necessarily saves more money than the small reduction from 28% to 24%. Research in mathematical education (Fischbein, 1989) has found that even highly numerate individuals will answer certain mathematical questions incorrectly if they do not realize that a mathematical rule that holds in many everyday experiences does not apply in a given instance. In addition to having learned the correct math, one needs also to recognize situations in which often valid rules do not hold true. Although more numerate individuals are more likely to possess the correct mathematical principles, they will still commit errors if they do not realize that the rule that automatically comes to mind does not apply in a given situation (Kahneman & Frederick, 2004).

The task of ranking savings that come from interest rate changes is revealing, in that it shows how an intuitive "larger is better" heuristic can lead a consumer astray in a problem involving interest rates. However, this specific task is not one that consumers are likely to frequently encounter. Therefore, we focus instead in this paper on three classes of problems that are mathematically related to problem of ranking rate changes, but which consumers are more likely to face when they think about their debt. As examples of these three classes of problems, consider a consumer with $10,000 worth of credit card debt and an APR (annual percentage interest rate) equal to 12%. In each case, assume that the consumer is no longer using the card.

Problem 1 (Payoff Time): How long would it take to pay off the card with a constant monthly payment of $110?

Problem 2 (Remaining Balance): Assuming a constant monthly payment of $50, what would the balance be on the card after one year?

Problem 3 (Payment Amount): What must the constant monthly payment be in order to pay off the card in three years?

These problems are of course mathematically related. Problem 1 can be solved with the formula

(1)
$$N = \frac{-\log\left(1-\frac{iA}{P}\right)}{\log(1+i)},$$

where N is the payoff time in months given the starting debt A, a constant monthly payment P, and a monthly interest rate i (if APR = 12%, then $i = 0.01$). The formula for Problem 2 is

$$B = A(1+i)^N - \frac{P}{i}[(1+i)^N - 1] , \tag{2}$$

where B is the remaining balance owed after N months. Note that Equation 1 can be derived from Equation 2 by setting $B = 0$ and solving for N. Finally, to solve Problem 3 set $B = 0$ in Equation 1, solve for P, and then let $N = 36$.

Clearly, the math required to solve these problems is complex. Very few people have these formulas memorized, and even fewer can derive these formulas on the spot. We conjecture that people approach such problems intuitively by first answering a simpler, solvable problem—which is the equivalent problem with an interest rate equal to zero—and then adjust to account for interest. For example, in Problem 1 the zero-rate solution is that it would take 91 months to pay off the debt. We propose that people then adjust from this solution as a function of the amount of debt, the interest rate, and their personal level of numerical sophistication. If one uses Equation 1 to solve for payoff time, then all the factors that affect the path of the principal over time are implicit in the math.

With a multi-step process, however, all the factors that cause the payoff time to exceed 91 months must be adjusted for in subsequent steps. For example, a consumer might compute that the first year's interest would be 12% x $10,000 = $1,200, which would take an additional 12 months to pay off. A more numerically sophisticated consumer might try to account for the fact that interest will accrue each year. For example, this person might reason that 91 months is about 7.5 years, which can be multiplied by the $1,200 in interest charges to get $9,000 of interest payments. It would then take an additional 82 months to pay off the added charges at the $110 per month, giving an answer of 91 + 82 = 173 months. The correct answer to Problem 1 is

241 months. Even the hypothetical sophisticated individual fell short, because it is difficult to mentally keep up with the interest that accumulates over the added months, the interest that would accumulate on the months added to that, and so on.

What happens when the monthly payment in Problem 1 is increased substantially to a larger amount, such as $410? The zero-interest answer is 24 months. A consumer might add 3 months to account for $1,200 in interest charges (12% of the $10,000 loan) and come up with an answer of 27 months. Alternatively, the consumer might figure on two years of interest and get 30 months in total. Both of these approaches are very close to the correct answer of 29 months.

[Insert Figure 2 about here.]

The complete relationship between monthly payment and payoff time is shown in Figure 2. If the consumer pays $100 per month the debt will never be paid off, because there would be no contribution to principal. If the consumer pays just a penny more per month, $100.01, it would take 77 years to eliminate the debt. At $101 per month the payoff time is 39 years, and at $110 per month it will take about 20 years. Note how the curve is very steep at lower amounts when the earlier payments mostly go toward interest, and much flatter at higher amounts when most goes toward principal. A critical difference, therefore, between lower and higher payments is how the initial payments are apportioned between interest charges and reducing principal. In Problem 1, $100 out of the $110 goes toward interest on the first payment, so the interest-to-principal is 100:10, or 10:1. With monthly payments of $410 the ratio is much lower (approximately 1:4). This distinction leads to our first hypothesis.

H1. When the ratio of interest charges to principal is high for a given constant monthly payment, people will underestimate the payoff time of credit card debt. When the ratio is lower the underestimation will be reduced or eliminated.

There are two ways in which more numerate individuals are likely to differ from those less numerate in Problem 1. First, they are more likely to recognize that the zero-interest solution is insufficient, and that additional months must be added to account for interest. Second, they are more likely to understand the principle of compound interest. Therefore, when the interest-to-principal ratio is high they will account for the fact that the principal initially declines very slowly, and this will lead them to add many more months than less numerate individuals. In contrast, when the ratio of interest charges to principal is low (as with the $410 payments above), the initial intuitive answer is much closer to the correct answer, and the difference in bias will be much smaller.

H2. Individuals with greater numeracy skills will be less biased in estimating the payoff time for credit card debt, especially when the initial interest-to-principal ratio is high.

We next turn to Problem 2, which asks for the balance on the card after one year assuming a $10,000 debt, an APR of 12%, and $50 monthly payments. The correct answer is $10,634. The principal will have *increased* because the $50 payments fall short of covering the interest charges. We conjecture, however, that many people have a "borrowing" script. A *script* is a cognitive representation of a stereotypic sequence of actions, abstracted from experience, which encompasses expectations of how actors will behave and how events will unfold (Schank & Abelson, 1977). In marketing, scripts have been applied to understanding customer satisfaction with service encounters (Bitner, Booms, & Mohr, 1994), determinants of salesperson effectiveness (Leong, Busch, & John, 1989), and the acquisition of consumer knowledge by children (Peracchio, 1992). One component of a borrowing script is paying back the money that was borrowed. When payback is piecemeal, the typical outcome is that the debt is reduced.

Numerate individuals are more likely to recognize that this stereotypical feature of the script does not apply when interest charges must be covered and are not.

H3. When constant monthly payments on a credit card do not exceed the interest charges, individuals higher in numeracy are more likely to recognize that the balance will increase.

Finally, Problem 3, which assumes the same APR and debt, asks for the constant monthly payment required to pay off the card in three years. We expect that people will begin by solving the easy problem and assume a zero interest rate. This gives an initial answer of $10,000/36 = $278. A less numerate individual may stop there, or may add a small amount for interest. One possible mistake, for instance, would be to add 1% of $278, and give an answer near $300. A more numerate individual might add 1% of $10,000 to the initial answer, and thus say $378. The correct answer to Problem 3 is $332. In this case, less numerate people are likely to underestimate the impact of interest, but more numerate individuals may actually overestimate. In order for a multistep approach to succeed in this problem, one must take into account not only the added interest, but the fact that interest charges decline with the principal. Although one might expect that exceptionally numerate people would answer this question correctly, past research has shown that for related problems people rarely fully take into account the effects of a declining principal (Stango & Zinman, 2009). Therefore, we expect the more numerate individuals in our sample to overestimate the answer to this problem (presumably, a highly sensitive numeracy test could identify the exceptional individuals who would likely answer the problem correctly). Incidentally, a reasonable approach to Problem 3 would be to approximate the average monthly balance to be $5,000, and then add 1% of that to the monthly payment to get

$328 (this underestimates slightly because the average monthly balance is actually $5,437 when the loan is fully paid off with constant payments over 36 months).

H4. When estimating the constant monthly payment required to pay off a credit card debt within a fixed period of time, less numerate individuals will tend to underestimate whereas those higher in numeracy will tend to overestimate.

In sum, we expect more numerate individuals to account more for interest charges. In some cases this will lead to a reduced bias, such as in estimating the payoff time or balance when the interest-to-principal ratio is high. In other situations increased numeracy can lead to overestimation, such as in predicting the monthly payments needed to pay off a loan in three years. It is important to note that the costs of over- and underestimating are most likely not symmetric. Underestimating payoff times and required payments can lead to financial ruin, whereas overestimating merely leads, at worst, to a suboptimal transfer of consumption from the present to the future. Moreover, recent field work has shown that after controlling for other demographic variables such as age, education, and gender, there is a positive relationship between numeracy and financial outcomes (Banks & Oldfied, 2007; Smith, McArdle, & Willis, 2010). Thus, if our hypotheses are supported, it would be the less numerate, less educated, less financially secure individuals who would be most likely to underestimate payoff times, balances, and required payments. Those individuals least able to cope with debt would be the ones most likely to make financial judgments that lead them into it. An implication is that changes in how information is presented to consumers can potentially have a large impact on consumer welfare (e.g., Cox, Cox, & Zimet, 2006; Wansink & Chandon, 2006).

The remainder of the paper is organized as follows. In Study 1a we test investigate the conditions under which people underestimate the payoff time for credit card debt (Problem 1), providing tests of H1 and H2. Study 1b uses the same set of participants to test H3, which predicts a specific pattern of under- and overestimation as a function of numeracy in predicting the required monthly payment (Problem 2). In Study 2, mock credit card statements are used to test H4. The mock statements are presented in either the pre-2010 format or the new format mandated by the CARD act. This allows us to examine how well the new credit card statement helps people in deciding what their monthly payments need to be. Finally, Study 3 considers whether there is any residual misunderstanding with the new statement. Overall, we identify shortcomings in consumer understanding, consider the role of numeracy as a moderator of these shortcomings, and examine the degree to which the recent credit card reform leads to improved judgment. We conclude with suggestions for further potential improvements to credit card statements and for improving financial decision making more generally.

Study 1a: Intuitions about Monthly Payments and Payoff Time

This study examines variations of Problem 1 from the introduction, which asks how long it would take to pay off a credit card debt with a given monthly payment. We expected that participants would tackle the problem by first dividing the total debt by the monthly payment to obtain a zero-interest payment, and then add to this another amount to account for interest. Such a strategy would lead people to dramatically underestimate the time required when the monthly payment predominantly goes toward covering interest charges. We also predicted that more numerate individuals would show the same general pattern, but with an attenuated bias.

Method

Participants. Five hundred eighty two adult participants (66% female) were recruited through a national panel to participate in an online research study. Their ages ranged from 18 to 88, with a median age of 48.

Procedure. After providing basic demographic data, participants indicated how often they used credit cards (on a scale of 1 = never to 5 = nearly all the time), how many credit cards they owned, and whether they carried a balance on the single card they used the most. They were then told to "…imagine that you have decided to pay off your debt on a credit card and then close the account. You have cut the card into pieces and plan to use only cash and a debit card from here on out to pay for future purchases." They were further instructed to read a series of four questions carefully and to use their best judgment. After this introduction, participants saw four scenarios that varied only in the amount of the monthly payment, which took on values of $110, $210, $310, and $410. They responded to the scenarios sequentially in a random order. For example, the $110 scenario appeared as follows (emphasis was included in the stimuli).

> *You owe $10,000 on the card and the interest rate is 12% annually. You have destroyed the card and will not use it any more. Suppose that you plan to pay a fixed amount of* ***$110 per month*** *until the card is completely paid off. What is your best estimate of how many months it will take to totally pay off the card?*

Following this task, participants responded to several additional questions, including those in Study 1b below, a numeracy quiz, and a frugality scale. The numeracy quiz included the 11 items from a numeracy scale developed by Lipkus, Samsa, and Rimer, (2001). We modified the questions for online use by making them multiple choice. For example, one question read, "Suppose that the chance of having a credit card number stolen in the month of January is .0005. Out of 10,000 people, about how many of them are expected to have their credit card number stolen in January?" The multiple choice answers were 0, 2, 5, 10, and 50 (67% of participants answered this question correctly). Scores on our version of the numeracy scale were similar to those reported in the literature. We used the 8-item frugality scale developed by Lastovicka et al. (1999). Frugality measures the extent to which one gains pleasure from saving (Rick, Cryder, & Loewenstein, 2008), which we conjectured might be associated with a better appreciation of compound interest. At the conclusion of the study participants were asked for additional demographic data, including highest level of education completed and annual household income.

Results

We excluded 15 participants who gave nonsensical answers (e.g., zero months to pay off the loan), and an additional 24 who mistakenly estimated that $410 payments would lead to a longer payoff time than $110 payments (they may have misunderstood the questions or committed a typing error). This left 543 participants in the analysis. In general, inclusion of the omitted participants would have led to a slightly more pessimistic view of consumer judgment than the one we portray. A correlation matrix of all variables is shown in Table 1. Numeracy scores were higher for men, as well as for the younger, more educated, and wealthier individuals in our sample. These demographic patterns replicate past research (Banks & Oldfield, 2007). Another interesting pattern that emerges is that wealthier, more educated people possess more credit cards and use them more frequently, but at the same time are less likely to carry a balance over to the following month. This makes sense, because although credit is more accessible to the wealthy, they also have greater means to pay their debts. [Insert Table 1 about here.]

We conducted both between-participants and within-participants analyses of responses to the $110-$410 conditions. As the two approaches yielded similar results, we present only the between-participants analysis here. This analysis considered only the first question of the four encountered (*N* = 131, 136, 142, and 134 for the \$110-\$410 conditions, respectively). These answers are untainted by a desire to be consistent across the four questions, and best represent participants' initial impressions.

The correct answers are shown in Figure 2, along with the median and interquartile range of estimates for each condition. The median responses are consistent with the two-step rule that we proposed—underestimation at \$110 payments and unbiased estimates at higher payments. Of those who saw \$110 first, 115 out of 131 (88%) underestimated how long it would take to pay off the card. This is significantly more than half the participants (binomial test, $p < .001$). In contrast, the percentage of participants underestimating at monthly payments of \$210, \$310, and \$410 was 56%, 34%, and 37%, respectively. These results support H1—participants underestimated at \$110 where the interest charges to principal ratio was very high, but not at the other payment levels where the ratio was much lower. It is interesting to note that the majority actually overestimated the required payment by a small amount at payments of \$310 and \$410 (both *p*s < .01). This can happen if calculations neglect to take into account the effect of a declining principal. However, as shown in Figure 2, the impact on estimation is small for the payoff time problem. We return to overestimation in Study 2, as the bias is likely to be more pronounced in the payoff amount problem.

To test the numeracy hypothesis, we regressed the logged estimates of required months against dummy variables for whether the participant was in the \$210, \$310, or \$410 condition (e.g., the variable D210 is coded as 1 if the participant is in the \$210 condition and 0 otherwise), the participant's score on the numeracy quiz (mean-centered), and the interaction between each dummy and numeracy. The resulting equation is shown in the first column of Table 2. Note that the omitted category is the \$110 condition and that the other categories are all interacted with numeracy. This implies that the coefficient on numeracy reflects the simple effect in the $110 condition only. Within the $110 condition, more numerate participants gave higher estimates of the payoff time. The significant interaction terms for the $210-$410 conditions are negative and appear to offset the simple effect of numeracy, suggesting that numeracy does not account for differences in payoff time estimates at payments of $210 and above. We followed this up by running the model separately for each payment-level condition (columns 2-5), including also covariates from Table 1 to examine the effects of demographic factors. Consistent with the pattern of interactions in the initial model, the effect of numeracy disappeared at payments of $210 and above. Moreover, the overall model was significant only in the $110 condition (note the low R^2 in columns 3-5); this should temper any conclusion that might be drawn from the few significant effects in the models for the $210-$410 conditions (numeracy was also insignificant in the $210-$410 models when the covariates were excluded).

Of the covariates, only income was significant in the $110 condition. Overall the patterns for income and numeracy are similar. High numeracy and high income both predict higher estimates in the $110 condition, but do not predict variation in responses in the other conditions. The effect of income was not predicted, and we defer a discussion of it until after Study 1B. To better appreciate the implications of numeracy, consider three individuals who answered 6, 9, and 11 questions correctly on the quiz, which correspond to the 10^{th}, 50^{th}, and 90^{th} percentiles in our sample. Based on the “all conditions” model in Table 2, these individuals are predicted to respond to the $110 question with answers of 78, 124, and 169 months, respectively. The most numerate individuals underestimate by less than others, but they still underestimate.

The results of Study 1A support Hypotheses 1 and 2. The interest-to-principal ratio is much higher in the $110 condition than in the other conditions, and the $110 condition is the only one in which the vast majority of participants underestimate the payoff time (supporting H1). Also, more numerate participants were less biased in their estimates of payoff time in the $110 condition but not in the $210-$410 conditions (supporting H2). These results are consistent with a multistep process in which people first estimate the payoff time assuming no interest, and then add additional months to account for interest.

Study 1b: Intuitions about Failing to Cover Interest Charges

In this study we examined whether people understand that the balance increases if monthly payments do not cover interest charges. We had hypothesized that more numerate individuals would be more likely to identify situations in which the balance increases, as they would recognize that a borrowing script does not apply when interest charges must be covered. Participants were the same as those in Study 1a (*N* = 543).

Procedure

Immediately after answering the four payoff time questions in Study 1a, participants were presented with the following additional scenario (emphasis appeared in the stimuli).

> *Imagine that **<u>you owe $10,000</u>** on a credit card with **<u>an interest rate of 24%</u>** annually. Since the interest rate is so high, you plan to cut up this card and not use this card. You plan to pay a fixed amount of **<u>[$X] per month</u>** until the card is completely paid off. Assuming that you follow through with this plan, what is your best estimate of how much money you will still owe on this card after **<u>one year</u>** of making payments?*

We varied *X* between participants to be $100 (*N* = 181), $250 (*N* = 188), or $500 (*N* = 174). The median answers for the $250 and $500 conditions were $9,000 and $6,000, respectively, which closely approximate the correct answers of $9,329 and $5,976. Few participants estimated that the balance would increase above $10,000 in these two conditions (5.9% for the $250 problem and 2.3% for the $500 problem). The median estimate in the $100 condition was $10,000, compared to the correct answer of $11,341. Although the median is roughly correct, only 43% of participants in the $100 condition correctly estimated that the balance would in fact grow to more than $10,000.

We used binary logit analysis to predict the chances that a participant would estimate a balance over $10,000. We first ran a model that interacted numeracy (mean-centered) with a dummy variable for condition (D = 0 for participants in the $100 condition, 1 otherwise). The significant effect of numeracy in this model, shown in Table 3, reflects the simple effect in the $100 condition only. In support of H3, numerate individuals were more likely to correctly predict that the principal would increase in a condition where the interest charges exceed the monthly payment. Based on this model, individuals who answered 6 questions correctly on the numeracy quiz (the 10^{th} percentile) had a 29% chance of providing an estimate above $10,000, those who answered 9 correctly (50^{th} percentile) had a 46% chance, and those who got them all right (90^{th} percentile) had a 59% chance.

Note that in the first model the interaction between numeracy and D is significant and negative, showing that the tendency to provide an estimate above $10,000 is greatly reduced in the $250 and $500 conditions. The last three columns of Table 3 provide a model for each condition separately. These models show two things. First, numeracy only has a significant effect in the $100 condition. Numeracy does have a directionally *negative* effect in the $250 and $500 conditions, although this result is not significant. Second, none of the covariates predict estimates above $10,000, even in the $100 condition (the pattern for numeracy holds when the covariates are excluded). Notably, income predicted higher (more accurate) estimates in the $110 condition of Study 1a, but did not predict estimates above $10,000 in Study 1b.

Discussion

Studies 1a and 1b confirm that more numerate individuals are better at financial reasoning. The results go beyond this basic finding, however, to show that numerate people are especially better at predicting what happens when payments barely cover or fail to cover interest charges. In Study 1a, the interest-to-principal ratio was substantially higher in the $110 condition than in the $210-$410 conditions. Participants were biased only in the $110 condition, profoundly underestimating the payoff time. The bias was reduced among more numerate participants, although they too underestimated. In Study 1b the $100 condition was the only one in which the payment was smaller than the interest charges. Once again, this was the only condition in which numeracy made a difference—more numerate individuals were more likely to correctly predict that the principal would increase in this condition. The results for income were equivocal, as income behaved much like numeracy in Study 1a but was not predictive in Study 1b. One explanation for this pattern is that higher-income individuals, by virtue of their experience, have more accurate intuitions about the effects of compound interest. Alternatively, it may be that having accurate intuitions about financial matters helped them achieve higher incomes. Either way, high income individuals who are otherwise average in numeracy may still trust their intuitions over mathematical calculations, and therefore fail to recognize situations that are contrary to typical experience, such as when a debt increases in the absence of additional borrowing. Moving forward, we leave the effects of income for future research and focus mainly on numeracy, a factor for which we have concrete predictions based on the results of Studies 1a and 1b and on the results of past research.

Study 2: Testing the Benefits of Credit Card Reform

The first study dealt with Problem 1 (payoff time) and Problem 2 (remaining balance) from the introduction. In the second study we turn to Problem 3 (payment amount). This problem requests an estimate of the constant monthly payment needed to pay off a credit card debt in 36 months. We predicted in H4 that the bias in prediction would be moderated by numeracy. Specifically, we predicted that less numerate individuals would tend to underestimate the required payment and that more numerate individuals would tend to overestimate.

Problem 3 also presents a unique opportunity to examine the efficacy of the CARD Act of 2010. The purview of the act is sweeping; we focus here on the new rules for the monthly credit card statement. The act mandates that statements report in a clear and concise table with several facts about monthly payments, under the assumption that no further expenses are charged to the credit card (see Figure 3). These include the length of time that it would take to pay the balance if only the minimum amount due is paid each month, the amount the borrower must pay each month to erase the balance in three years, and the total expenses (including principal and interest charges) under each of the preceding scenarios. In addition, the CARD Act requires a warning that making only minimum payments will increase the total interest charges and the amount of time needed to pay the balance. [Insert Figure 3 about here.]

The task in Study 2 was to estimate the constant monthly payment needed in order to eliminate the balance in three years. At first glance this appears trivial if the new statement is provided, as this amount is apparently given in the table. Indeed we expected that people would be very good at reading tables, and that they would estimate the payment amount correctly *provided that* the main assumption of the table holds—“no additional charges” on the card. In practice, however, the assumption of "no additional charges" is not realistic, as many people with credit card debt continue to use their cards. We wanted to test whether the new statement is helpful when the credit card is still being used. For some participants, therefore, we changed the scenario such that the cardholder expects to continue spending $500 on the card each month. In this case the required monthly payment is approximately $850, which represents the sum of the amount in box J and the new expenses (the actual amount is slightly less, because the $352.16 already includes the repayment of a small fraction of the $500 in new activity). Although all of these numbers are on the statement and no complex calculations are required, we suspected that the math would still be confusing to some people, especially the less numerate. Just as many participants neglected the need to cover interest in Study 1a, we expected that less numerate participants would neglect to cover both interest and new charges in Study 2.

To test the efficacy of the new statement under different conditions, we varied whether participants saw a scenario with a new or old statement, and whether or not they were still using the card. In addition, the CARD Act does not completely constrain the format in which banks present information. One area in which banks differ is that some banks separate new activity and finance charges into separate boxes (as in Figure 3), whereas others combine them into a single box. To examine this, we included format as an exploratory variable.

Method

Participants. Five hundred two adult participants (67% female) were recruited through a national panel to participate in an online research study. The age range was 19 to 87, with a median age of 52.

Procedure. Participants were randomly assigned to one of eight conditions comprising a 2 (*Statement*: new vs. old) x 2 (*Use*: card is used vs. not used) x 2 (*Format*: new expenses and interest are aggregated vs. segregated) design. After answering several demographic questions, participants were shown a credit card statement designed for their respective condition analogous to the one in Figure 3. The new balance, minimum amount due, and APR were the same in all conditions, as shown in the figure. For the old statement, the minimum payment warning and table were omitted, as these did not typically exist prior to the CARD Act. For the aggregated format, boxes C and D were combined into a single box labeled "New activity $ including fees and finance charges if any." In all cases the new balance was $10,602.58 and the minimum amount due was $212.00 (2% of the balance). When the card was not being used, there was no new activity and the previous balance was $10,794.63 instead of $10,300.00.

In order to familiarize participants with the statement and confirm a basic level of understanding, we asked them to identify which box contained each of the following pieces of information: interest rate, new purchases, total debt, minimum amount due, and new interest charges. Solution rates on these questions ranged between 89% and 97%. Most participants did well on the statement quiz: 82% answered all five questions correctly, and an additional 11% missed only one question. We decided to focus only on people who could read and understand the numbers in the statement. Therefore, we dropped the 33 participants who scored less than 4 on the statement quiz from the analysis. These individuals most likely either lacked basic comprehension skills beyond the present focus, or they were simply not paying attention, in which case their responses are not meaningful. Six participants gave absurd answers to the estimation question (e.g., answer of zero, or answers above the balance on the card). We omitted these participants as well, leaving 463 participants included in the analysis.

In the final part of the survey participants completed an 8-item numeracy quiz, based on a scale recently developed by Weller et al. (2010). The new scale is psychometrically improved relative to the original numeracy scale, and includes items with a wider range of solution rates. The scale includes five items from the original Lipkus, Samsa, and Rimer (2001) scale, two from Frederick's (2005) 3-item cognitive reflection task (CRT), and one from the expanded numeracy scale of Peters et al. (2007). We modified the new 8-item scale in two ways. First, we replaced the Peters et al. (2007) question (which is lengthier than the others) with the third item from the CRT (which has a similar solution rate in published data). Second, we made all the questions multiple choice. Even with these changes, the distribution of numeracy on our quiz (M = 3.71, SD = 1.87) is similar to the distribution reported by Weller et al. (2010).

Results

As the distribution of participants' estimates was skewed, we focused on whether participants underestimated, overestimated, or correctly estimated the required monthly payment. We counted an answer as correct if it was between $325 and $375 when the card was not being used, and between $825 and $875 when it was being used (the correct answers are roughly $350 and $850, respectively). We subjected the data to a multinomial logit analysis. Given three possible outcomes (underestimate, overestimate, and correct), multinomial logit estimates two equations, each of which estimates the odds of a base outcome (being correct) against one of the other two outcomes (underestimating or overestimating). Multinomial logit tests the null hypothesis that a given coefficient is zero in both equations (i.e., it only needs to differ from zero in one of the equations to be significant). We first estimated a fully crossed effects model (factors coded +1 and -1) and found that none of the interactions involving the factors were significant. This led us to fit a simpler model with dummy coding (use card: 1 = yes, 0 = no; statement: 1 = new, 0 = old; format: 1 = aggregated, 0 = segregated). We also included gender (1 = female, 0 = male), as well as age and numeracy quiz score (as a continuous variable), both mean-centered. The individual equations are shown in Table 4. We first estimated a model comprising the first two equations, which compares the odds of being correct against both under- and overestimation. The coefficients for the third equation, which compares underestimation and overestimation, are simply the difference between the first two equations (we recoded the categories and reran the model to obtain significance levels for this third equation).

The simultaneous test of both equations (i.e., first two columns of Table 3) indicated that there were main effects of continued card use (Wald $\chi^2(2) = 60.77$, $p < .001$), statement ($\chi^2(2) = 104.75$, $p < .001$), and numeracy ($\chi^2(2)$ 20.75, $p < .001$), as well as a numeracy x statement interaction, $\chi^2(2) = 6.23$, $p = .044$. There was no effect of format ($\chi^2(2) = 2.93$, $p = .231$), although the numeracy x format interaction approached significance $\chi^2(2) = 4.65$, $p = .098$. There were no effects for gender and age. We next turn to the equations in Table 4. The coefficients in this table can be thought of as investigating further the nature of the results that were significant in the simultaneous tests. With one exception (the numeracy x format interaction), all of the significant results in the table follow a simultaneous test that was significant at $\alpha = 0.05$. [Insert Table 4 and Figure 4 about here.]

We highlight three prominent results, which are apparent both in the equations of Table 3 and in Figure 4 (a graphical display using a median split on the numeracy quiz; scores of 4 and above are high). First, changing from the old to the new statement greatly increased the odds of being right compared to both under- and overestimation, as can be seen by comparing the left and right columns of Figure 4. Collapsing across use and numeracy, overestimation with the new statement is reduced from 44% to 10%, and underestimation is reduced from 41% to 23%. Statistically, the reduction in both overestimation and underestimation is captured by the significant statement effects in the first two columns of Table 3. The statement effect is also significant in the third column, which corresponds to an increase in the odds of underestimating versus overestimating (i.e., using the percentages above, the ratio of underestimation to overestimation increases from 41:44 to 23:10).

Second, comparing the top and bottom panels in Figure 4, using the card reduces the chances of being correct. Collapsing across numeracy, the reduction is from 26% to 3% with the old statement, and from 87% to 47% with the new statement. In the logit analysis, this is reflected in the significant effects of use in the first two columns. Use is also significant in the third column, indicating that the ratio of underestimation to overestimation increases when consumers use the card.

Finally, as predicted by H4, people commit different errors depending on their level of numeracy. Less numerate participants often underestimated the amount they would need to pay each month, whereas those higher in numeracy tended to overestimate. This is reflected in the significant negative effect of numeracy in the third column. Note that this is a simple effect that applies to the old statement when the card is no longer being used (upper left panel of Figure 3). However, the absence of a numeracy x use interaction suggests that the differential bias holds when the card is being used as well. Overall, with the old statement less numerate individuals underestimated 54% of the time and those more numerate overestimated 58% of the time. The numeracy x statement interactions in the second and third columns indicate that the new statement is more effective at reducing overestimation (in favor of either being correct or underestimation) for more numerate individuals. Finally, the numeracy x format interaction in the first column suggests that the aggregated format may help reduce underestimation for more numerate individuals. A possible reason for this is that more numerate people may be more cognizant of the need to include new activity in their payment, and might therefore be anchored by a higher number when boxes C and D in Figure 3 are combined into a single box. However, we would also note that the interaction in question is not significant at $\alpha = 0.05$ in the simultaneous test of both equations and should therefore be interpreted cautiously.

Discussion

An intriguing finding in Study 2 is that with the old statement numeracy was unrelated to getting the right answer. Instead, as predicted in H4, individuals low in numeracy tended to underestimate the amount they needed to pay (especially when they were still using the card) and those higher in numeracy tended to overestimate. The pattern is consistent with less numerate individuals adding insufficient interest. In the scenario of not using the card, ignoring interest completely would suggest monthly payments of $10,602.58 ÷ 36 = $294.52. With the old statement, 37% of less numerate individuals reported estimates of $300 or less in this condition, compared to 12% of those more numerate. Those higher in numeracy, on the other hand, appear to have often added too much interest. We believe this happened because they failed to take into account the effects of declining principal. Monthly interest on the above balance is $106.03. For the amount needed to pay the card off in three years, one might be tempted to compute $294.52 + $106.03 = $400.55 (26% of the more numerate answers were within $15 of this amount). However, this neglects the fact that finance charges decline as one pays down the debt.

Although being above average in numeracy does not necessarily ensure getting the right answer, the more numerate appear to be more cognizant of interest. These results suggest that less numerate individuals are more likely to underpay their credit card bill, which of course has more severe consequences compared to overpaying. It is the less numerate, less educated, lower income individuals who are probably hurt the most by their mistake.

A striking result in Study 2 is that the new statement facilitates a much better appreciation for what monthly payments must be to pay off a loan in three years. The new statement reduces both underestimation and overestimation, regardless of whether the card is still being used and of the numeracy level of the consumer (see Figure 4). In this sense we would regard the new statement as a major improvement. In addition to helping consumers plan their payments, the new statement also protects against certain scams. For example, one known scam is to offer a service in which debt would be reprocessed by an intermediary such that the consumer would pay off the loan faster by paying slightly more per month. To illustrate how such a deal might appear attractive, we asked 74 undergraduate students to imagine that they put $300 per month on a card for which they already owed $10,000 (with 17.9% APR). We told them that they paid $450 per month and that "At that rate it will take you 29 years to pay off the $10,000." The majority of participants (72%) said that they would be more likely than not to pay a service $700 per month so that they would be debt-free in three years. However, in this situation the three-year payoff amount is $661, which nets the intermediary a profit of $1,404 for doing very little except for working out the math. The new statement protects against this scam by showing consumers more clearly what they can accomplish on their own.

However, as we have shown, the new statement is not perfect. Many individuals are still prone to error when they are still using the card. In particular, the less numerate are more prone to underestimation. Because numeracy is correlated with income and education, individuals who have difficulty with the new statement are likely to be the same ones who will suffer the most from mounting credit card debt.

Study 3: Testing Confusion Caused by Credit Card Reform

In addition to testing H4, Study 2 afforded an opportunity to also examine a major policy initiative designed to improve credit card payment decisions. The new statement in our view represents a major improvement. However, even with the new statement many people still underestimated the size of the payments needed when they are still using the card. In working with the new statement we discovered two additional potential sources of confusion, which we test in Study 3. The first issue has to do with the disclosures for the minimum amount due (boxes G, H, and I in Figure 3). It would be easy to conclude that it would take 22 years to eliminate the debt (assuming no further charges) by paying $212 each month. That is not correct—it would actually take slightly less than 6 years. The 22 years refers to how long it would take if one always paid the amount in box F, which changes from statement to statement by systematically declining as the balance goes down. It would take only 6 years if one pays $212 each month going forward. The second source of confusion relates to the monthly payment required to eliminate the balance in three years (box J in Figure 3). In the example, one must pay $352.16 each month in order to successfully get out of debt in three years. However, the amount in box J will also change from statement to statement by systematically declining as the balance goes down. By always paying exactly the amount that appears in Box J each month, it would take much longer than three years to eliminate the balance. These distinctions are likely to be missed by many consumers.

We examine these two issues with the new statement in Problems 1' and 2' below, which complement Problems 1 and 2 from the introduction by examining inferences about aspects of payoff time and remaining balance with the new statement. Problem 1' (Payoff Time) uses the same 463 participants as Study 2 (they answered this question after completing the Study 2 questions), and problem 2' (Remaining Balance) uses a new set of 107 participants recruited in the same manner as those in Study 2. For this group, the overall survey was identical, except that the Study 2 questions were replaced with problem 1'. Six participants did not achieve a score of at least 4 on the statement quiz, leaving 101 participants remaining for problem 2'.

Problem 1' (Payoff Time)

Participants saw the same statement that they saw in Study 2, except that all participants were told to "imagine that you cut up your credit card and plan to no longer use it." This yields a 2 (statement) x 2 (format) design. Participants were asked "If you pay exactly $212 each month (see box F), how long will it take you to pay off the entire balance on the card?" The multiple choice answers were "Less than 22 years", "22 years", and "More than 22 years". A multinomial logit model revealed only an effect of statement, $\chi^2(2) = 168.00$, $p < .001$. Notably, there was no individual or interactive effect of numeracy. With the old statement, 49% of participants said it would take less than 22 years (the correct answer), 18% said it would take 22 years, and 33% said more than 22 years. In contrast, with the new statement 87% said that it would take exactly 22 years, and only 7% of participants correctly answered that it would take less than 22 years.

Problem 2' (Remaining Balance)

Participants saw the statement from the Study 2 condition in which the card is not used further, the new statement design is used, and all costs are aggregated. One group received the instructions (emphases were included in the stimuli):

Imagine that you would like to pay off the entire balance on the card in three years. You have cut the card up into pieces and will no longer be using this card. Suppose that each

> *month you always pay exactly the amount indicated in Box J for that month. This will be a lower amount each month. What is your best estimate of the total balance on this credit card at each time indicated below, given that you will not be using the card?*

Participants responded on four sliders that ranged from $0 to $10,000 for 12, 24, 36, and 48 months from now. For the second group, the third and fourth sentences were replaced with

> *Suppose that each month you always pay exactly $352.16, the amount indicated in Box J for this month. You will pay this same amount each month.*

Thus the difference between the two conditions is that one group always pays $352.16, whereas the other always pays the amount that appears in box J each month which is systematically declining. Of the 101 participants who scored at least 4 out of 5 on the statement quiz, 15 did not report a lower balance after 48 months compared to 12 months. These participants evidently misunderstood the question, so we conducted our analysis on the remaining 86 participants (N = 39 in the Pay box J condition and N = 47 in the Pay $352.16 condition). The correct answers and interquartile ranges of responses are shown in Figure 5. The distributions were very similar for the two conditions, despite the difference in the instructions. Median estimates (the middle, larger dot in each range) closely approximated the correct values when paying a constant amount of $352.16 (the solid curve). However, medians in the Pay box J condition fell far short of the correct answers for 24, 36, and 48 months, as shown by the dashed curve. The percentage of participants in the Pay box J condition who underestimated was 56% (22 participants out of 39) at 12 months, 85% (33) at 24 months, 87% at 36 months (34) and 90% (35) at 48 months. With a null hypothesis of 50% underestimating (which is roughly equivalent to testing the population median) the proportions are significantly below 50% at 24, 36, and 48 months (binomial tests, $p < .001$, two-tailed). [Insert Figure 5 about here.]

Discussion

The information in the new statement is a vast improvement over the old statement, which gave little guidance on how much to pay beyond the minimum amount due. However, most people do not have a clear understanding of what some of the numbers in the new statement actually mean. In the case of Problem 1', believing that paying $212 each month would lead to 22 years of payments might nudge people to make larger payments, which arguably would make them better off in the long run. However, paying box J each month and expecting to eliminate debt within 3 years is clearly incorrect and not in the consumer's best interest. Moreover, it may take a long time to discover that the box J strategy is ineffective, as the balance curves for paying box J versus paying a constant amount do not show large separation until after about 18 months. Especially confusing is that different rules apply to each box—the payoff time for the minimum amount due assumes that the cardholder pays the amount that appears in the box each month, whereas the three-year payoff amount assumes that the cardholder repeatedly pays the amount that appears on the first statement. In sum, the revised credit card statement solves many problems, but introduces two new sources of confusion when card owners misinterpret the minimum payment amount and the 3-year payment amount.

General Discussion

The misuse and mismanagement of credit cards are a source of serious personal debt problems to many individuals and families. This paper investigated one source of difficulty that may lead to mismanagement of personal finances—a misunderstanding of the relationship between monthly payments and debt. The specific relationship between monthly payment and time to pay off a debt is steeply non-linear. There is an asymptote where payments just cover interest. When a constant monthly payment is just to the right of the asymptote most of the payment goes toward paying interest charges and only a small portion is applied to the principal. In these cases the interest-to-principal ratio is high, the loan will take a very long time to pay off, and small increments in the monthly payment will dramatically reduce the payoff time (if monthly payments are to the left of the asymptote the loan will never be paid off).

Given the complexity of the math involved to compute payoff time, we conjectured that people break the problem into pieces—they first compute the payoff time assuming an interest rate of zero, and then add an additional amount of time to account for the interest charges. This process predicts a specific pattern of bias (see H1), wherein people are likely to underestimate the payoff time when the interest-to-principal ratio is high (we tested a 10:1 ratio) but not when it is lower (we tested ratios of approximately 1:1, 1:2, and 1:3). We also predicted that more numerate people would better appreciate the iterative nature of compound interest and would therefore underestimate by less (H2). Both hypotheses were supported in Study 1a. We next tested, in Study 1b, people's intuitions about what happens to the balance when the monthly payment does not cover the interest charges. As we had predicted in H3, this effect was also moderated by numeracy, such that more numerate individuals were more likely to estimate an increasing balance on the card. These results are consistent with people having a borrowing script in which payments toward a debt are expected to reduce the debt. More numerate individuals are more likely to favor math over their initial intuition, and therefore recognize situations in which the script does not apply.

In contrast to estimating payoff time, in Study 2 we observed substantial underestimation and overestimation for the task of estimating the constant monthly payment needed to pay off a loan in three years. However, as we had predicted in H4, the direction of the bias is moderated by numeracy. Less numerate individuals tend to underestimate the required payment and more numerate individuals tend to overestimate. This appears to happen because less numerate individuals anchor on the zero-interest payment, whereas those higher in numeracy neglect to modify their interest calculations to account for the declining balance.

Study 2 also afforded an opportunity to test the efficacy of the new credit card statement introduced in 2010. The new statement is very effective when the credit card is no longer being used, for both numerate and innumerate alike. The new statement is also helpful when the consumer is still using the card, albeit to a lesser degree. Although the new statement is clearly superior, there is still room for improvement as many individuals, especially the less numerate, still underestimate if they continue to use the card (see bottom right panel of Figure 4). Additional misperceptions were demonstrated in Study 3, which showed that most people do not fully understand the meaning of the numbers in the legally required table in the new statement. People think that the payoff time associated with the minimum amount due refers to how long it would take to pay off the card if they always paid an amount equal to this month's minimum. In fact, it refers to the payoff time if they always pay an amount equal to the minimum reported on each new statement, which declines with the balance. Moreover, the new statement invites the interpretation that, in order to discharge the debt within three years, it is sufficient to pay whatever amount appears in the 3-year payoff box. In fact, that particular number refers to paying off the balance within three years of the statement date. Consumers must use instead the amount appearing on the *first* statement when they begin their efforts to pay off the card. We note that in practice this may be difficult to achieve: One would need to memorize or record the amount in the 3-year payoff box today and consistently refer to it when making a series of future payments. Moreover, one would need to know to do this, and either avoid using the card or know to add new expenses to the payment.

There is an on-going debate in decision making research about the most effective strategies for “debiasing” individual biases (Larrick, 2004). Nisbett (1992) and his colleagues argued for the effectiveness of training people in simple decision making rules, such as the law of large numbers and ignoring sunk costs. Others, however, have argued that it may be better to change the decision environment than to try to improve reasoning (Klayman & Brown, 1993). Recently, this focus on improving the environment has acquired the catchy label “nudge” (Thaler & Sunstein, 2008). To illustrate the approaches, consider how institutions might encourage employees to save more for retirement. One approach is to train employees in compounding; a second approach is to nudge people by making savings the default option (Benartzi & Thaler, 2004). Because the actual formula for compounding is complex, many financial advisors train people on the simpler “rule of 72” (e.g., for a given rate of return of X, an investment will double every 72/X years). The latter rule is crude but easy to implement and fully conveys the exponential effect of compounding: A rate of return of 7% will double in 10 years and quadruple in 20 years. As a tribute to nudges, we will call these simple rules “kludges” (which are quick, inelegant, but effective solutions to information technology problems, and is pronounced with a long “u”).

The new statement offers a nudge for better credit card decision making: It makes clear the dangers of paying only the minimum and the relatively small additional payment needed to get out of debt in three years. However, like the rule of 72 in compounding, there is a viable kludge for credit card debt that many consumer finance sites offer. The key feature of the kludge is to call attention to covering new charges and covering the interest owed by a comfortable margin. The rule can be summarized as roughly "pay 3 to make 3": To pay off a debt in about three years, always pay off new charges plus triple the initial interest owed. For example, with $300 in new charges and $50 in interest charges, the consumer can pay $450 each month to be on a path to paying off the debt. Covering new charges ensures that the balance does not grow and tripling the interest insures that the principal (on which future interest is charged) actually shrinks. The advantage of pay 3 to make 3 is that the consumer can apply it across a range of situations, and moreover can gain an intuition for the need to cover interest charges by a comfortable margin. The disadvantage is that, unlike the table in the new credit card statement, it is only approximate. For example, the kludge is nearly perfect when the interest rate is 14%, but it actually takes 4 years to pay off the card when the rate is 10% rate and about 2 years when the rate is 20% (the existence of these minor errors are what make it a kludge). In many cases, what is critical is that the cardholder is on a path toward paying off the debt in a reasonable amount of time, in which case pay 3 to make 3 is sufficient.

As consumers begin to use the new statement, it would be interesting and useful to examine the consequences for monthly payments in field studies. A recent memorandum of The Office of Management and Budget (Sunstein, 2010) urges U.S. government agencies to use randomized experiments to test methods to disclose information to consumers (e.g., financial statements, food labels, etc.). Our tests of the new statement provide an example of how this can be done. We would urge policy makers to experimentally test additional modifications to determine the best method for improving comprehension. For example, the statement might list a payoff date along with the three-year payoff amount and encourage cardholders to write this amount down (perhaps a big sign on the refrigerator will do). Consumers might also be explicitly warned that if they use the card, a 3-year payoff requires adding new expenses to the reported 3-year payoff amount. It might also be helpful for the statement to include more detailed definitions of the various line items and table entries. Another possibility would be to tailor the statement toward the needs of the individual consumer. There are of course web sites that purport to offer such services, although not in every case with the best of intentions. One helpful tool would be an amount printed on the statement that the cardholder must pay in order to pay off the card by a date that the cardholder has pre-specified. This amount would vary as a function of current expenses, so that no math would be required. If the consumer falls behind in payments, he or she can always change the date. However, frequently changing the date should be a cue that one is spending too much.

In the end, of course, the responsibility for managing personal finances rests with the individual consumer. It is also the case that confusing credit card statements, inherently difficult math, high credit limits, and unscrupulous lending have contributed to individual debt. Credit card reform (both past and future) is by no means a panacea for the age-old problems of impulsiveness and overspending. However, we have tried to test the extent to which improved statements can help consumers better understand the consequences of their spending and credit card payments. The information provided in the revised statements will be most useful to those consumers who seek to improve decisions that have consequences for long-term financial goals.

References

American Bankruptcy Institute (2010), (accessed July 28, 2010), [available at http://www.abiworld.org/am/template.cfm?section=bankruptcy_statistics1].

Banks, James and Zoe Oldfield (2007), "Understanding pensions: Cognitive function, numerical ability, and retirement saving," *Fiscal Studies, 28 (2)*, 143-70.

Benartzi, Shlomo and Richard H. Thaler (2004), "Save More Tomorrow™: Using behavioral economics to increase employee savings," *Journal of Political Economy, 112 (S1)*, S164-S87.

Bitner, Mary Jo, Bernard H. Booms, and Lois A. Mohr (1994), "Critical Service Encounters: The employee's viewpoint," *Journal of Marketing, 58 (4)*, 95-106.

Cox, Anthony D., Dena Cox, and Gregory Zimet (2006), "Understanding consumer responses to product risk information," *Journal of Marketing, 70 (1)*, 79-91.

Cronin, Matthew A., Cleotilde Gonzalez, and John D. Sterman (2009), "Why don't well-educated adults understand accumulation? A challenge to researchers, educators, and citizens," *Organizational Behavior and Human Decision Processes, 108 (1)*, 116-30.

Eisenstein, Eric M. and Stephen J. Hoch (2007), "Intuitive Compounding: Framing, Temporal Perspective, and Expertise," *Unpublished manuscript*.

Feinberg, Richard A. (1986), "Credit cards as spending facilitating stimuli: A conditioning interpretation," *Journal of Consumer Research, 13 (3)*, 348-56.

Fischbein, Efraim (1989), "Tacit models and mathematical reasoning," *For the learning of mathematics, 9 (2)*, 9-14.

Foster, Kevin, Erik Meijer, Scott Schuh, and Michael A. Zabek (2010), "The 2008 Survey of Consumer Payment Choice," *Federal Reserve Bank of Boston*.

Frederick, Shane (2005), "Cognitive reflection and decision making," *Journal of Economic* Perspectives, *19 (4)*, 25-42.

Hirschman, Elizabeth C. (1979), "Differences in consumer purchase behavior by card payment system," *Journal of Consumer Research, 6 (1)*, 58-66.

Kahneman, Daniel and Shane Frederick (2002), " Representativeness revisited: Attribute substitution in intuitive judgment," in *Heuristics & Biases: The Psychology of Intuitive Judgment.*, Thomas Gilovich, Dale Griffin and Daniel Kahneman, eds. New York: Cambridge University Press.

Klayman, Joshua and Kaye Brown (1993), "Debias the environment instead of the judge: An alternative approach to reducing error in diagnostic (and other) judgment," *Cognition*, *49 (1-2)*, 97-122.

Larrick, Richard P. (2004), "Debiasing," in *Blackwell Handbook of Judgment and Decision* Making, Derek J. Koehler and Nigel Harvey, eds. Malden: MA: Blackwell.

Larrick, Richard P. and Jack B. Soll (2008), "The MPG illusion," *Science, 320*, 1593-94.

Lastovicka, John L., Lance A. Bettencourt, Renee S. Hughner, and Ronald J. Kuntze (1999), "Lifestyle of the tight and frugal: Theory and measurement," *Journal of Consumer Research, 26 (1)*, 85-98.

Leong, Siew Meng, Paul S. Busch, and Deborah Roedder John (1989), "Knowledge bases and salesperson effectiveness: A script-theoretic analysis," *Journal of Marketing Research, 26 (2)*, 164-78.

Lipkus, Isaac M., Greg Samsa, and Barbara K. Rimer (2001), "General performance on a numeracy scale among highly educated samples," *Medical Decision Making, 21 (1)*, 37-44.

Lusardi, Annamaria and Peter Tufano (2009), "Teach Workers About the Perils of Debt," *Harvard Business Review, 87 (11)*, 22-+.

Manning, Robert D. (2000), *Credit Card Nation: The Consequences of America's Addiction to Credit*. New York: Basic Books.

McKenzie, Craig R. M. and Michael J. Liersch "Misunderstanding Savings Growth: Implications for Retirement Savings Behavior," *Unpublished Manuscript*.

Nilson Report, February (issue 943), 2010.

Nisbett, Richard E. (1992), *Rules for reasoning*. Hillsdale, NJ: Lawrence Erlbaum.

Peters, Ellen, Judith H. Hibbard, Paul Slovic, and Nathan F. Dieckmann (2007), "Numeracy skill and the communication, comprehension, and use of risk and benefit information," *Health Affairs, 26 (3)*, 741-48.

Peracchio, Laura A. (1992), "How do young children learn to be consumers: A script-processing approach," *Journal of Consumer Research, 18 (4)*, 425-40.

Prelec, Drazen and Duncan Simester (2001), "Always leave home without it: A further investigation of the credit-card effect on willingness to pay," *Marketing Letters, 12 (1)*, 5-12.

Rick, Scott I., Cynthia E. Cryder, and George Loewenstein (2008), "Tightwads and spendthrifts," *Journal of Consumer Research, 34 (6)*, 767-82.

Salisbury, Linda C. and Katherine N. Lemon (2009), "The effects of information disclosure on consumer debt repayment decisions," Paper presented at the meeting of the Society for Judgment and Decision Making. Boston, MA.

Schank, Roger C. and Robert P. Abelson (1977), *Scripts, plans, goals, and understanding*. Hillsdale, NJ: Erlbaum.

Slovic, Paul, Baruch Fischhoff, and Sarah Lichtenstein (1977), "Behavioral Decision Theory," *Annual Review of Psychology, 28*, 1-39.

Smith, James P., John J. McArdle, and Robert Willis (2010), "Financial decision making and cognition in a family context," *The Economic Journal, 120*, F363-F80.

Soman, Dilip (2001), "Effects of payment mechanism on spending behavior: The role of rehearsal and immediacy of payments," *Journal of Consumer Research, 27 (4)*, 460-74.

Soman, Dilip and Amar Cheema (2002), "The effect of credit on spending decisions: The role of the credit limit and credibility," *Marketing Science, 21 (1)*, 32-53.

Stango, Victor and Jonathan Zinman (2009), "Exponential Growth Bias and Household Finance," *Journal of Finance, 64 (6)*, 2807-49.

Stewart, Neil (2009), "The cost of anchoring on credit-card minimum repayments," *Psychological Science, 20 (1)*, 39-41.

Svenson, Ola (2008), "Decisions among time saving options: When intuition is strong and wrong," *Acta Psychologica, 127 (2)*, 501-09.

Thaler, Richard H. and Cass R. Sunstein (2008), *Nudge: Improving decisions about health, wealth, and happiness*. New Haven: Yale University Press.

Wansink, Brian and Pierre Chandon (2006), "Can "Low-Fat" nutrition labels lead to obesity?," *Journal of Marketing Research, 43 (4)*, 605-17.

Weller, Joshua A., Nathan Dieckmann, Martin Tusler, C. K. Mertz, and Ellen Peters (2010), " Development and Testing of an abbreviated numeracy scale: A Rasch analysis approach" *Unpublished manuscript*.

Zinman, Jonathan (2009), "Where is the missing credit card debt," *Review of Income and Wealth, 55 (2)*, 249-65.

TABLE 1: CORRELATION MATRIX FOR VARIABLES IN STUDY 1

		Mean	Std. dev.	1	2	3	4	5	6	7	8
1	Numeracy	8.47	1.96	1.00							
2	Frugality	5.09	.65	-.01	1.00						
3	Female	.66	.48	-.24***	.06	1.00					
4	Age	46.25	14.04	-.15***	.11*	-.04	1.00				
5	Education	3.99	1.49	.24***	.01	-.08	-.10*	1.00			
6	Income	3.48	1.86	.12**	-.01	-.07	-.05	.30***	1.00		
7	Carry balance	.48	.50	-.02	-.13**	.15***	-.08	-.10*	-.12**	1.00	
8	Card frequency	3.35	1.15	.06	.02	-.07	.03	.25***	.26***	-.20***	1.00
9	Card quantity	3.56	2.73	.04	-.04	.08	.14***	.13**	.20***	.06	.35***

Notes. $^{*}p < .05$. $^{**}p < 0.01$. $^{***}p < .001$. $N = 543$. Most variables are as defined in the text. The education and income variables are category means. For education, 1 = less than high school, 2 = high school/GED, 3 = some college, 4 = 2-year college degree, 5 = 4-year college degree, 6 = masters degree, 7 = doctoral or professional degree. For income, 1 = less than $20,000, 2 = $20,000 - $40,000, 3 = $40,001 - $60,000, ..., and 9 = more than $160,000.

TABLE 2: LOGGED PAYOFF TIME ESTIMATES REGRESSED AGAINST PREDICTORS IN STUDY 1A

		Models for each condition separately			
	All conditions	\$110	\$210	\$310	\$410
Intercept	4.742***	4.670***	2.967***	3.489***	4.367***
	.064	*.773*	*.683*	.580	*.660*
Numeracy	.154***	.140**	-.006	.038	.057
	.031	*.044*	*.037*	*.030*	*.043*
D210	-.608***				
	.090				
D310	-.975***				
	.089				
D410	-1.233***				
	.090				
Numeracy x D210	-.111*				
	.046				
Numeracy x D310	-.117**				
	.043				
Numeracy x D410	-.151**				
	.046				
Female		-.029	-.014	.004	-.049
		.167	*.149*	*.135*	*.157*
Age		.007	.006	.004	.002
		.006	*.005*	*.005*	*.005*
Education		-.016	.102*	.046	.011
		.055	*.049*	*.051*	*.053*
Income		.154**	.048	-.023	-.075†
		.046	*.037*	*.036*	*.041*
Other covariates included	no	yes	yes	yes	yes
N	543	127	127	136	126
R^2	.305***	.273***	.078	.041	.053

Notes. $^{\dagger}p < .1$ $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$. Values in italics are standard errors. D210, D310, and D410 are dummy variables for the \$210, \$310, and \$410 conditions, respectively. “Other covariates” include frugality, carry balance, card frequency, and card quantity.

TABLE 3: LOGIT MODEL PREDICTING THE CHANCES OF GIVING AN ESTIMATE ABOVE $10,000 IN STUDY 1B

	All participants	$100	$250	$500
Intercept	$-.285^{***}$	-.393	-2.687^{***}	-3.420^{***}
	.155	*.297*	*.529*	.826
Numeracy	$.252^{***}$	$.305^{**}$	-.226	-.167
	.082	*.099*	*.151*	*.308*
D	2.921^{***}			
	.139			
Numeracy x D	$-.459^{***}$			
	.152			
Female		.037	-.228	-.975
		.355	*.696*	*1.092*
Age		.011	-.016	.026
		.012	*.024*	*.043*
Education		.135	-.064	-.533
		.116	*.049*	*.463*
Income		.016	-.066	.328
		.087	*.182*	*.335*
N	543	171	177	168
Generalized R^2	$.225^{***}$	$.090^{**}$	.016	.019

Notes. $^{**}p < .01$. $^{***}p < .001$. Values in italics are standard errors. The dependent variable equals 1 if the participant's estimate is over $10,000 and 0 otherwise. D = 0 if a participant is in the $100 payment condition and D = 1 otherwise. Coefficients are tested with a Wald χ^2 test. The generalized R^2 is based on the likelihood ratio test and is significant if the hypothesis that all coefficients are zero is rejected. Female = 1 if the participant is female and 0 if male. Numeracy and the other covariates are mean-centered. A small number of participants did not provide income information and are included only in the "all participants" model (10, 11, and 6 participants were omitted from the $100, $250, and $500 condition models, respectively).

TABLE 4: MULTINOMIAL LOGIT MODEL FOR STUDY 2

	Correct vs. underestimate	Correct vs. overestimate	Underestimate vs. overestimate
Intercept	.083	-.892**	- .975**
	.376	*.340*	*.335*
Use	-2.676***	-1.681*	.995***
	.343	*.334*	*.293*
Statement	2.777***	3.450***	.673*
	.341	*.353*	*.318*
Format	.445	.446	.001
	.290	*.295*	*.267*
Numeracy	.217	-.111	-.327*
	.166	*.147*	*.147*
Female	-.315	.057	.372
	.326	*.326*	*.299*
Age	.004	-.005	-.009
	.011	*.011*	*.010*
Numeracy x use	-.059	.027	.086
	.199	*.190*	*.165*
Numeracy x statement	.143	.480*	.338†
	.195	*.202*	*.183*
Numeracy x format	.337*	.074	-.262†
	.171	*.169*	*.154*

Notes. †$p < .1$. *$p < .05$. **$p < .01$. ***$p < .001$. Values in italics are standard errors.

FIGURE 1: EFFECT OF THE MONTHLY PAYMENT AMOUNT AND INTEREST RATE ON THE TIME TO PAY OFF A $4,000 LOAN.

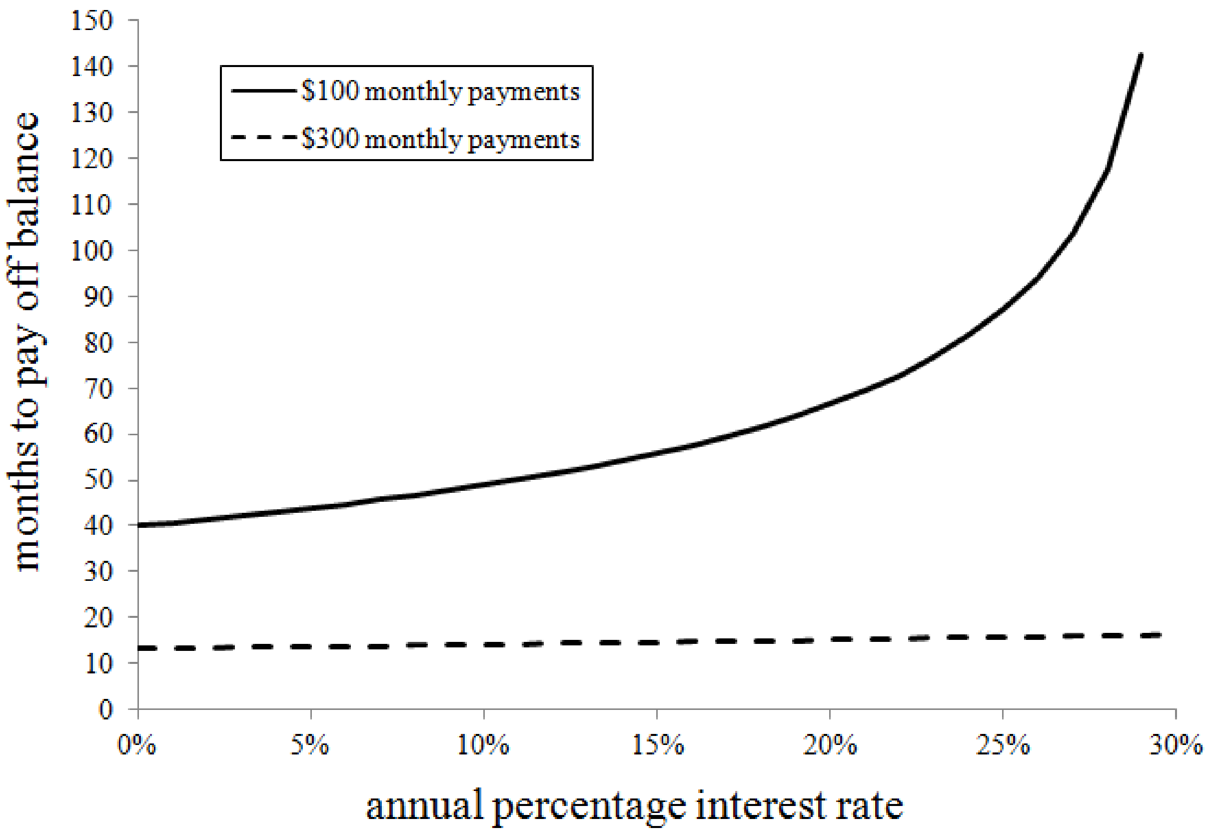

FIGURE 2: TIME TO PAY OFF A $10,000 CREDIT CARD BALANCE WITH AN APR OF 12%.

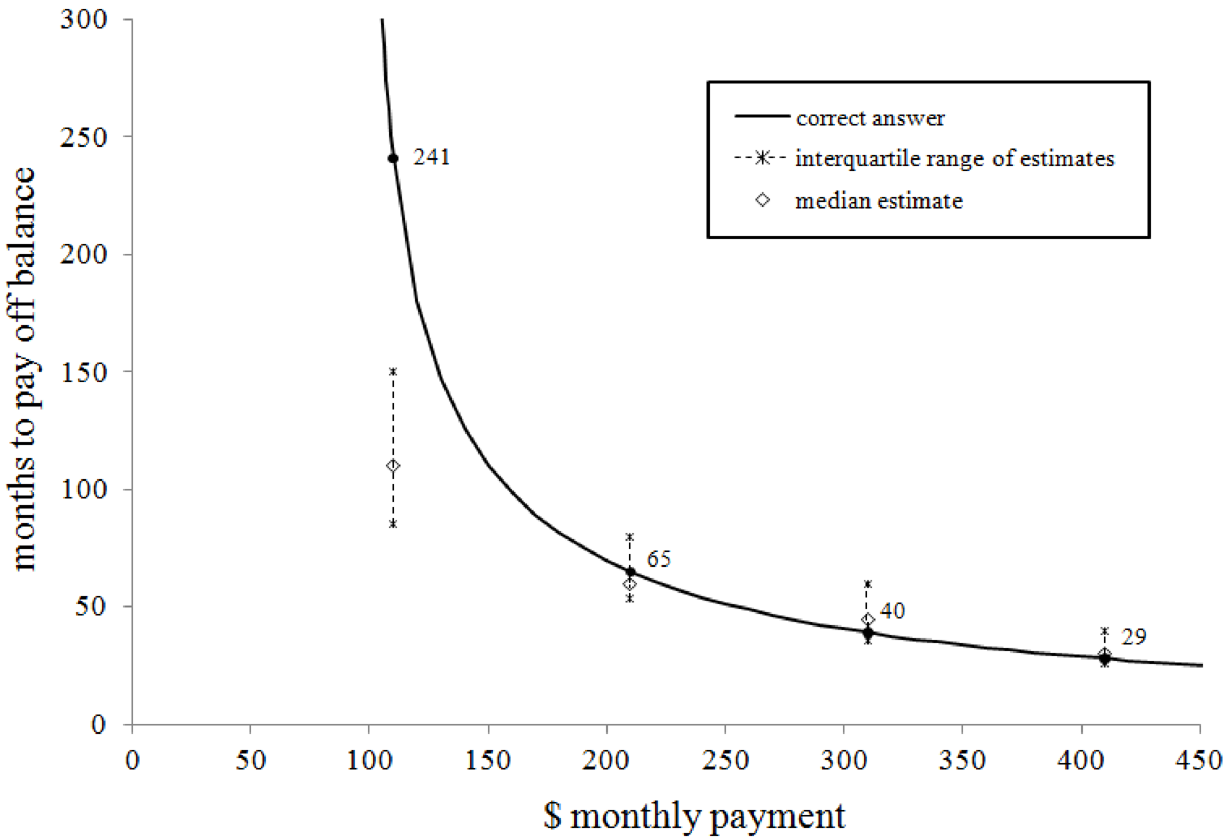

FIGURE 3: ILLUSTRATIVE MONTHLY CREDIT CARD STATEMENT INDICATING INFORMATION REQUIRED BY THE CARD ACT OF 2009.

American Consumers Bank

Payment Due Date
7/15/2010

Previous Balance $	Payment Activity $	New Activity $	Fees and Finance Charges	New Balance $	Minimum Amount Due $
(A) 10,300.00	(B) -300.00	(C) +500.00	(D) +102.58	(E) 10,602.58	(F) 212.00

Late Payment Warning: If we do not receive your Minimum Amount Due by the Payment Due Date listed above, you will have to pay a late fee of up to $39.00.

Minimum Payment Warning: If you make only the minimum payment each period, you will pay more in interest and it will take you longer to pay off your balance. For example:

If you make no additional charges and each month you pay...	You will pay off the balance shown on this statement in about...	And you will pay an estimated total of...
(G) Only the Minimum Amount Due	(H) 22 years	(I) $20,294.97
(J) $352.16	(K) 3 years	(L) $12,677.67

(M) **Annual Percentage Rate**
12.0%

FIGURE 4: SUMMARY OF INDIVIDUAL'S ESTIMATES TO PAY OFF LOAN BALANCE IN THREE YEARS UNDER DIFFERENT CIRCUMSTANCES

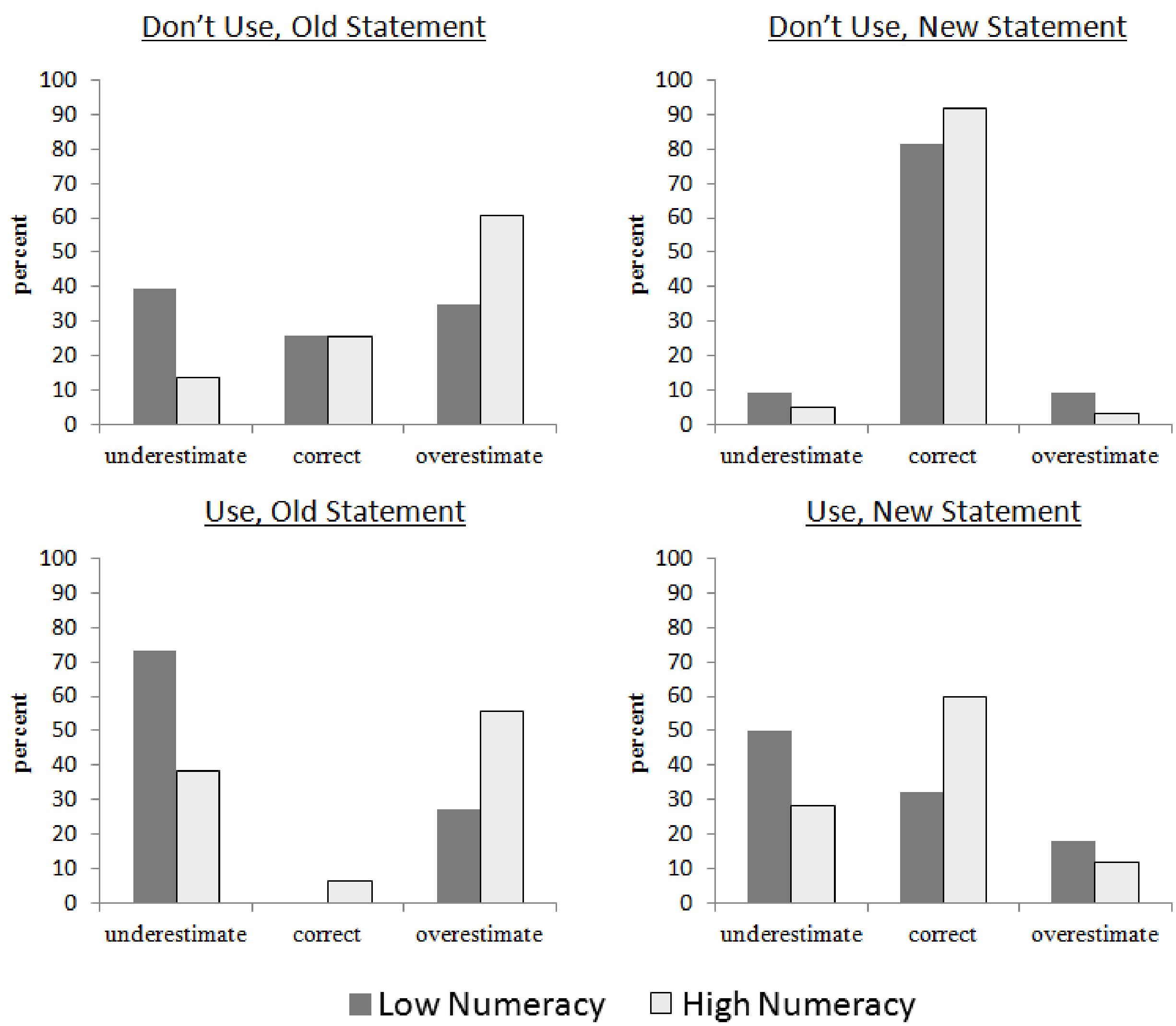

FIGURE 5: TIME TO PAY OFF A $10,000 CREDIT CARD DEBT GIVEN THAT THE CARD WILL NO LONGER BE USED. AMOUNTS SHOWN ARE FOR TWO INTERPRETATIONS OF THE TABLE IN THE NEW CREDIT CARD STATEMENT.