Investigations of Pennies, Percent, and Temporal Reframing to Improve Savings

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Table of Contents

List of Tables

List of Figures

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Declaration

This is thesis is being submitted by Stephen Shu for the Doctor of Philosophy (PhD) degree qualification at City, University of London, The Business School (formerly Cass), and the Department of Finance. Consistent with the degree process and upon finalization, Stephen Shu hereby grants rights to the City, University of London for its Librarian to copy this thesis at its discretion as single copies for study purposes, in whole or part, subject to customary terms of acknowledgement.

Thesis Abstract

It is not clear that people save enough, whether preparing decades in advance for retirement or preparing for nearer-term goals and needs such as rainy day accounts that can help with emergencies that come up. While there are multiple explanations for undersaving, people are not always adequately served by the financial and savings systems in place. Systems can make savings seem harder or more complex than it need be, and user interface designs may inadvertently discriminate against some people (or at least fail to help some people as much as they could). Through modest system modifications to current, incumbent savings processes, there may be opportunities to help certain subpopulations, such as those with lower income (e.g., demographic characteristics) or lower numeracy and lower financial literacy (e.g., individual behavioral differences). Note that a libertarian paternalistic perspective is one that seeks to do the most good for the most number of people while preserving freedom of choice. This thesis takes a libertarian paternalistic perspective in its investigation of methods that can potentially nudge better outcomes through changes to the behavioral architecture of savings. Chapters 1 and 2 represent a research stream that challenges the traditional notion of making retirement savings decisions in terms of percent of salary, which may discriminate against those who are less numerate, and instead investigates the notion of people making decisions using pennies for every dollar of salary they earn. Chapters 3 and 4 investigate temporally reframing savings decisions using per day, per week, or per month framing and elicitations. Insights from temporal reframing may be an important tool and approach for non-retirement savings contexts. The collection of investigations in this thesis comprises a holistic research approach by directly addressing both psychological judgments (through lab studies) and decisions and outcomes (through field studies).

Introduction and Summary to the Investigations of Pennies, Percent, and Temporal Reframing to Improve Savings

People need to make choices about saving money for the future, whether that means preparing decades in advance for retirement or preparing for nearer-term goals, but it is not clear that people save enough. On the retirement side, people who have access to a retirement plan through their employer increasingly need to make choices about savings due to the general shift by employers from defined benefit to defined contribution plans, such as in the United States (Munnell, 2006). Some simulation evidence suggests that many people fail to save enough for retirement, especially if the assessment of retirement readiness takes into account people's longevity and irregular healthcare risks during retirement (VanDerhei, 2014; 2019). And in terms of empirical data, a large fraction of people die with virtually no financial assets. In the United States 46.1 percent of people die with less than $10,000 (Poterba et al., 2011), which arguably seems to be a case more reflective of risky circumstances versus perfect planning where wealth is exhausted just before end of life. Short-term financial reserves are also constrained for a significant proportion of the population. For example, prior to the global COVID-19 pandemic and looking at the short-term financial capacity of adults in the United States, 17 percent reported that they could not pay their currently monthly bills in full, and an additional 12 percent said they would be unable to pay if they also faced a $400 emergency that had to be paid (Federal Reserve, 2019).

Furthermore, people may not always be adequately served by the financial and savings systems in place, and there may be opportunities to help certain subpopulations (both demographic and behavioral). For example, Brigitte Madrian and Dennis Shea researched auto-enrolling employees into retirement plans (versus having employees opt-in) and found that using such a choice architecture could especially help females and minorities to participate at rates more comparable to males and whites (Madrian and Shea, 2001). On the behavioral side, Sinayev and Peters found that less numerate people were more likely to self-report not having any wealth accumulated for retirement, even after controlling for demographics and intelligence separate from numeracy (Sinayev and Peters, 2015). Innumeracy is widespread with nearly a third of US adults not having the ability to do math that includes more than one step, percentages, fractions, and using simple tables and graphs (Peters, 2020). And this innumeracy has been shown to not only involve whether people can do math but also involve whether people can discriminate between numbers of different magnitudes, emotionally react to numerical tasks, and feel confident about making financial decisions (Peters, 2020). These aspects raise questions as to whether there are opportunities to improve financial savings systems that are designed for the many, but which are largely designed by the numerate few, such as people in the financial services industry who are comfortable with percentages, numbers, interest rates, compounding, investments, and complex concepts such risk.

This thesis takes a libertarian paternalism perspective in its search for improved financial systems that nudge savings outcomes. The libertarian paternalism perspective is essentially about doing the most good for the most number people (or the least amount of harm) while allowing for freedom of choice (Thaler and Sunstein, 2009). A corollary to the libertarian paternalism perspective is that there is no neutral choice architecture, and as such, the design of systems should deliberately take into consideration the psychology of how we think. From an ethical viewpoint, this thesis additionally takes the perspective that the design of systems should factor in goal alignment with the nudgee, and the degree of controllability of any nudge (e.g., nudges should avoid strong forms of control and be resistable to the extent appropriate and practical), which is influenced by the nudge controllability framework put forth by Yashar Saghai (Saghai, 2013). More specifically for this thesis, I adopt a goals perspective that it is generally preferable for people to err on the side of participating in savings programs and saving more. Such a perspective is not unlike many others in the behavioral economics discipline (Thaler and Sunstein, 2009; Thaler and Benartzi, 2004). Situations such as preparing for retirement are more analogous to one-shot games where sufficient wealth needs to be accumulated by the time of retirement as compared to repeated games where one can dramatically readjust savings and income in case of financial shortfalls mid-retirement.[1] In addition, from nudge controllability perspectives, I implement nudges which utilize information framing techniques (which are substantially non-controlling using Saghai's framework and spectrum of nudge influence types). Finally, for field studies where people make real savings and retirement savings decisions, savers may change or reverse their saving elections at any time (in addition to following other process precautions).

Chapters 1 and 2 represent a research stream that challenges the traditional notion of making retirement savings decisions in terms of percent of salary, which may discriminate against those who are less numerate, and instead investigates the notion of having people make decisions using pennies for every dollar of salary they earn. The research began in 2017 with a series of lab-based studies to understand the psychology involved and develop evidence surrounding the approach. Once the approach was better understood through lab-based research, a yearlong search for trialing the approach with actual people making retirement decisions was pursued. Given the newness of the approach and requirements to execute the study, the search involved many proposals and failed attempts. In 2019, a qualified anchor field research partner was secured and eighty-six employers were persuaded to opt-in to participating in a field study which ran from October 2019 to May 2020.

In contrast to the method of pennies reframing which arguably may be better suited for retirement savings decisions which typically involve larger sums of money to be accumulated, Chapters 3 and 4 investigate temporally reframing non-retirement savings decisions using either dollars per day, per week, or per month elicitations. Non-retirement savings decisions are increasingly being made in new contexts, such as by workers outside of traditional employer contexts and in the new, Gig Economy. Such people may have more uncertainty in their work environment (e.g., in terms of income stability) and turn to either do-it-yourself savings environments or newer solutions (e.g., FinTech apps). Chapter 3 involves a large-scale field study of saving outcomes based on temporal reframing, and

[1] Assertions aside, it is acknowledged that in some cases increasing savings could result in reduced consumption or increased borrowing behavior that lead to disutility. However, broadly addressing this debate is beyond the scope of this thesis and where there are narrower considerations, these are addressed in the relevant chapters of the thesis.

Chapter 4 investigates the psychology of such judgments in the context of uncertainty and key individual behavioral differences.

Brief summaries of the chapters are outlined below.

Chapter 1 Summary: Pennies Versus Percent Framing and Savings Judgments

One of the most pervasive ways of choosing a savings rate is to identify a percent of salary that one wants to contribute to their retirement account. However, the broader literature indicates that how numerical and financial information is presented affects people's judgments and decisions. One example is the miles per gallon illusion versus gallons per mile (Larrick and Soll, 2008) where people underestimate the financial benefits of replacing certain cars. Furthermore, highly numerate people have lower susceptibility to framing effects and have more precise affective understanding of numbers and numerical comparisons versus those less numerate (Peters et al., 2006).

In this stream of research on pennies reframing of savings rates, I hypothesize that eliciting savings rates using percentages may lead to less desirable outcomes for some subpopulations. In lab-based settings, I explore a novel, savings choice architecture that is essentially not available in the market today by framing savings decisions using pennies per dollar of salary, which avoids uses of percentages. This research stream currently includes three lab-based, experimental studies which focus on savings decisions which include the joint choice of an *initial savings rate* and an *escalator rate*. For example, if a person elects an initial, economically equivalent savings rate of 3% and an escalator rate of 2%, then they will save 3% of their salary this year, 5% of their salary next year, 7% of their salary two years from now, and so forth.

The studies above offer evidence that a small change of eliciting savings choices using pennies versus percent framing can impact people's perceptions of affordability and thus lead people to select higher savings and savings escalator rates. Treatment effects seem to improve the outcomes for those with the lowest numeracy and financial literacy the most. In the third study within this chapter, those with the lowest financial literacy selected initial rates that were more than 2 percentage points higher in the pennies frame (relative to a sample mean of 2.9%), and they also selected escalator rates that were more than 64 basis points higher (relative to a sample mean of 0.82%).

Chapter 2 Summary: Pennies Versus Percent Framing and Savings Decisions

Whereas Chapter 1 involved hypothetical choices of participants making joint choices of savings and savings escalators (and thereby also allowed for greater research and examination into the psychological processes involved), this chapter focuses on extending the work to a large-scale field study where people make actual retirement decisions regarding savings. When looking at retirement savings in the real-world, it may be instructive to consider that savings used to be framed as dollars per paycheck, and then the industry switched to percent of pay (a more psychologically abstract concept). This was a sensible shift, as percent framing results in people saving more over time as their income increases. But especially for lower income, less numerate, or lower financial literacy individuals, the framing could make a big difference. Hence the hypothesis is that eliciting savings rates using percentages may lead to less desirable outcomes for some subpopulations, and pennies reframing of savings rates, can potentially help certain subpopulations.

This chapter involves both a lab study (with a new, more diverse population compared to Chapter 1) and a field study. The field study includes eighty-six retirement plan sponsors (e.g., tax-exempt organizations in healthcare, education, government, and excluding auto-enrollment plans) with a randomized controlled trial being implemented on the retirement plan enrollment systems from October 2019 to May 2020. In the study, 2,255 participants were randomized into either a pennies or percent treatment in a between subject research design. Participants selected an initial savings rate on one screen and then on a subsequent screen were able to adjust up or down their savings rate while seeing monthly retirement income projections.

The key findings for the field study include that for those who submit a savings rate (i.e., treatment on the treated) pennies framing has positive results on increasing savings rate (64 basis points with 8.09% for pennies versus 7.45% for percent).

When looking at subpopulations, the effects are largest for those with the lower salaries (a proxy for numeracy) with those in the lowest two salary quintiles elevating their savings rates by approximately 143 and 100 basis points, respectively. Heterogeneity analysis suggests that those with less than $50,000 in annual salary may be helped by pennies reframing but that this may reverse for higher earners (i.e., those with incomes greater than $100,000), although the reversal is not statistically significant. The implications of this research seem to suggest that personalized or targeted interventions would be most suitable for pennies reframing approaches.

Chapter 3 Summary: Temporal Reframing and Savings Decisions

A growing percentage of American workers are now freelancers and thus responsible for their own retirement savings, yet they face psychological hurdles that hamper them from saving enough money for the long-term. Although prior theory-derived interventions have been successful in addressing some of these obstacles, encouraging participation in saving programs is a challenging endeavor for policymakers and consumers alike. In a field setting, we test whether framing savings in more or less granular formats (e.g., saving daily versus monthly) can encourage continued saving behavior through increasing the take-up of a recurring deposit program.

The host for this large-scale, field study is Acorns, a FinTech company with a historical motto of “Automatically Invest Life’s Spare Change”. Participants in the field study were new users to the Acorns app, and we concluded with 8,931 total participants across five between-subject treatment conditions. After signing up for an account with Acorns, users were asked if they wanted to make an initial one-time deposit to their accounts. If a given user decided to make an initial deposit, they were then randomly assigned to receive one of five different treatments, which asked whether they would like to set up a recurring deposit that varied the dollar amount and temporal frame. In three of the conditions, users would deposit a total of 1) $5 a day (1,772 users), 2) $35 a week (1,826 users), or 3) $150 a month (1,744 users), and in two additional conditions, users would deposit a total of approximately $30 a month, framed in weekly or monthly amounts: 4) $7 a week (1,817 users) and 5) $30 a month (1,772 users).

We find that framing deposits in daily amounts as opposed to monthly amounts quadruples the number of consumers who enroll. Further, framing deposits in more granular terms reduced the participation gap between lower and higher income consumers: three times as many consumers in the highest rather than lowest income bracket participated in the program when it was framed as a $150 monthly deposit, but this difference in participation was eliminated when deposits were framed as $5 per day. Due to the longitudinal nature of this study, we were also able to investigate the extent to which the initial framing of recurring deposits prompted continued enrollment in the program. Results indicated that after one month, there was a higher drop-out rate in the daily framing condition compared to the weekly or monthly conditions. Whereas approximately a quarter of the consumers who enrolled in the daily condition ended up dropping out after one month, only approximately 15% dropped out in the weekly and monthly conditions. But even with this higher drop-out rate in the daily amount condition, there were still more consumers from the daily conditions enrolled in the recurring deposits program after one month (and also for the rest of the program) than for the weekly and monthly conditions. At subsequent periods of 2 and 3 months, retention remained the same across conditions. The results of this work, within the limitations of the study design and population under study (which included people motivated enough to have downloaded an FinTech app), suggest that one way to reduce the income gap in saving behavior is by framing recurring savings programs in a granular, daily format. Not only did this framing encourage more people to save but also it may have encouraged those who tend to struggle the most to start saving.

Chapter 4 Summary: Savings Judgments and Temporal Reframing Decisions

While assessments of the Gig Economy vary in terms of size, growth, and heterogeneity, most studies suggest that this segment of the economy is sizeable, growing, and diverse in terms of types of work. Some concerns in the literature include both the present and future welfare of workers in the Gig Economy, and an increasing segment often face do-it-yourself financial savings and proportionally greater financial uncertainty whether real or psychologically perceived. It should be noted that much of the empirical economics literature finds a positive relationship between uncertainty and precautionary savings, but the findings are mixed for riskier occupations (Skinner, 1988; Jappelli and Pagano, 1994). This paper extends the work of Chapter 3 to examine the psychology of temporal reframing and non-retirement savings decisions of workers, including under income uncertainty.

The first study examines in a lab context the effects and psychological mechanisms of temporal reframing under income certainty (e.g., using Query Theory since the psychology could not be directly observed in the field context of Chapter 3) and given specified savings offerings (e.g., save $5 a day versus $150 a month). Key findings include a replication of main effects relative to daily framing increasing savings intentions. Additionally, evidence of reduced psychological pain as evidenced by both subjective feelings and objective thoughts (e.g., through a memory recall task) about affordability is demonstrated.

The second study examines in a lab context extending the finding of specific savings amounts (e.g., $5 a day) as compared to simply eliciting savings decisions using different temporal frames (e.g., how much would you save per day versus how much would you save in an open-ended question). Additionally, the study is conducted using varying levels of income uncertainty to explore to what extent precautionary savings are observed in the context of individual behavioral differences (e.g., risk and loss aversion). Key findings include that the main effect of eliciting savings decisions in a daily frame outperforms monthly or free response framing in terms of increasing intended, annualized savings. Microeconomic evidence of medium levels of income variance increasing precautionary savings is also provided with a reversal of increased savings as income variances increases to high levels (e.g., an inverted U-shaped response of precautionary savings relative to degree of income variability). Psychological mechanism differences between the specified temporal framing amount in the first study (e.g., save $5 a day) versus the unspecified temporal framing elicitation in the second study (e.g., how much would you save per day) are demonstrated between studies with perceptions of affordability mediating in the former but not latter choice architecture.

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Chapter 1. Pennies Versus Percent Framing and Savings Judgments

Abstract

The savings crisis in the United States affects a broad swath of workers, and this disproportionately affects those with lower incomes, who may also have lower education levels, numeracy, and financial literacy. For example, one of the most pervasive ways of choosing a savings rate for retirement is to identify a percent of salary that one wants to contribute to their retirement account. However, the broader literature indicates that how numerical and financial information is presented affects people's judgments and decisions. Eliciting savings rates using percentages may lead to less desirable outcomes for some subpopulations. In a laboratory setting, we explore a novel, savings choice architecture that is essentially not available in the market by framing savings decisions using pennies per dollar of salary, which avoids uses of percentages. This small change of reframing savings choices impacts people perceptions of affordability and thus leads people to select higher savings and savings escalator rates. Treatment effects seem to help those with the lowest numeracy and financial literacy the most. In the final lab study covered in this paper, those with the lowest financial literacy selected initial rates that were more than 2 percentage points higher in the pennies frame (relative to a sample mean of 2.9%), and they also selected escalator rates that were more than 64 basis points higher (relative to a sample mean of 0.82%).

1.1 Introduction

Retirement savings is an important societal problem. For one thing, many people lack easy access to a retirement savings plan. Within the United States, only about half of private-sector workers have access to an employer-sponsored defined contribution plan (The Pew Charitable Trusts, 2017). And even when workers do have access, eligible employee behavior is concerning. For example, employees may not participate in retirement plans available to them. Of those workers who are at least 22 years old with access to a defined contribution plan, the take-up rate is 72%. And when looking specifically at Millennials (those born between 1981 and

1997), the take-up falls to 52% (The Pew Charitable Trusts, 2017). Furthermore, when workers do participate, they likely do not save enough money relative to recommended rates, which are higher except for the people with the lowest of income levels (less than $15,000 per year) who may essentially rely on Social Security for the majority of their income in retirement (Bernheim et al., 2000). When one shifts the focus to examine heterogeneity of take-up rates associated with defined contribution plans by educational level, the take-up rate for Millennials with a high school diploma or less is 58%, whereas the take-up rates for Millennials with a college degree or higher is much higher at 81% (The Pew Charitable Trusts, 2017).

The big picture is that more people need to save, they need to save more money than they currently do, and there may be opportunities to help segments of the population (such as those with lower incomes or financial literacy) that may be inadvertently discriminated against due to systemic characteristics of savings system designs, such as the pervasive use of percentages and other concepts where some people likely have difficulty relating to the concepts and performing numerical and financial calculations (Lusardi, 2012). While this author is not aware of a study that both directly and comprehensively analyzes the discrimination of groups of people by savings systems designs, there is some evidence of disproportionate impacts related to use of percentages, framing, and other elements of the choice architecture. For example, as covered in Chapter 3 of this thesis in the setting of a robosaving application, nudges based on temporal reframing were used to dramatically increase participation rates of people in a recurring savings program. Participation rates increased by 4x for daily versus monthly framing of savings, and discrimination gaps in participation among those people with the lower incomes (relative to those with the highest incomes) were eliminated. Another example includes Thaler and Benartzi’s Save More Tomorrow program, which is in part based on framing percentage-based savings increases over time to get people to save more money. In one of their studies, their program got those in the less than $25,000 income range and age 25 subgroup to increase their future savings, and thus, have their median, projected income replacement ratios (a measure of projected retirement income relative to current income) rise to

108% from 57% (Thaler and Benartzi, 2004). In their study, the outcome for that group was the most dramatic for all income and age subgroups.

To improve retirement outcomes, it is instructive to look at behavioral obstacles that people face and try to create solutions to address them. Returning to Thaler and Benartzi's Save More Tomorrow program, they discovered that some key behavioral obstacles that people face relative to saving for retirement include myopia (e.g., a bias of overly seeing the present more intensely than the future), inertia (e.g., sticking with the status quo), and loss aversion (e.g., where on average people experience losses more intensely than gains). To address these behavioral obstacles, their program gets people to commit today to future savings increases that are aligned with pay increases (Thaler and Benartzi, 2004). Their program is one of the most widely known innovations in behavioral economics and has helped millions of people to save more money toward retirement (Benartzi and Thaler, 2013). As to the larger lesson from programs such as Save More Tomorrow, choice architecture and framing are key behavioral economics tools for addressing savings.

Yet there are other behavioral obstacles beyond myopia, inertia, and loss aversion, such as those related to information architecture, which refers to the way details, facts, data, figures, and the related content are presented to people. Presenting different information architectures, even when holding the total information constant, may discriminate against some segments of people to save. This may include those with lower income, educational levels, or mathematical ability. As an example, it is very widespread to present savings options as a percentage of salary (e.g., you have an option to save 3% of your salary), a method that will be referred to as "percent-based" framing. Yet research indicates that there are broad swathes of people who have difficulty with not only financial literacy (Lusardi and Mitchell, 2007) but also numeracy (Paulos, 1988), the latter of which includes working with fractions, percentages, numbers, etc. There is some evidence that objective measures of numeracy moderate certain choices, such as for problems based on risky-choice, loss-gain framing (Peters and Levin, 2008), and risk perceptions in risky-choice scenarios (Peters et al., 2011). However, as some other researchers have observed (Gamliel et al., 2016), research is somewhat scarce on the effects of numeracy as it relates to framing. So to help drive the point home relative to percent-based framing and the context for the proposed research, we neither know to what extent percent-based framing could be improved in the context of savings decisions nor know to what extent numeracy plays a role.

The genesis for the proposed research idea in this paper comes from field interactions with a financial advisor[1] who has a track record of getting companies, often with large subpopulations of lower income employees, from extremely low participation rates (e.g., less than 50%) in retirement savings programs to very high rates of participation (e.g., greater than 90%). A key concept that he uses is what is referred to in this paper as "pennies-based" framing. The idea behind pennies-based framing is to characterize savings in terms of small, concrete amounts of money as a portion of salary as opposed to percentages of salary. To motivate the concept further by way of anecdotes from the financial advisor, many people do not have an intuitive understanding of what it means to save 1% of their salary. But they find saving one penny per dollar of salary as appealing, even though the financial consequences are equivalent. Furthermore, they may also find saving one penny per dollar and escalating at one penny per dollar more in subsequent years as attractive. Yet key questions remain unanswered as the pennies-based framing intervention has never been scientifically tested (e.g., with a control and treatment group). For example, the financial advisor only implements pennies-based framing in new companies that he works with, and percent-based framing is not used. Furthermore, the financial advisor uses a portfolio of techniques (i.e., not just pennies-based framing) to increase participation and savings rates with his client companies. As such, it is not known to what extent pennies-based framing has any effect at all versus being attributable to the idiosyncratic practices of one advisor (which may not be scalable elsewhere) or specific characteristics of each company he works with. Additionally, to the extent that pennies-based framing works to improve outcomes, how does it work? Answering this latter question may provide insights as to the limits of the approach and how it may be further improved. In this research, key hypotheses are that pennies-based framing will be more effective in

[11] George Fraser is a financial advisor and Managing Director with Retirement Benefits Group and credited with the high-level idea of "pennies on the dollar" framing.

improving savings rate outcomes compared to percent-based framing and that both attitudes toward affordability and understandability will play key roles. It is also hypothesized that lower numeracy or financial literacy will play a role in affecting people's choices between pennies-based versus percent-based framing.

So, in this paper the following questions are addressed. First, to what extent can we use pennies-based framing to get more people to save more, such as those with lower incomes and lower numeracy? Given the state of the world where percentage of salary framing is so widespread, if we find out that a different framing works better, this research can have wide implications. Second, can we better understand the roles of perceptions of affordability, understandability, numeracy, and financial literacy in the choice process? Note that in the studies associated with this paper, a mixture of financial literacy and subjective numeracy measures are used to explore their role in choice. Subjective numeracy measures, which while less researched in the domain of framing and showing mixed results in terms of differential moderation relative to objective numeracy (Gamliel et al., 2016), may be a more friendly way of assessing the psychology of lower income and less numerate people as compared to objective numeracy approaches which may be viewed as less friendly and "testing" subjects under study. In this paper, methodologies associated with Query Theory (Johnson et al., 2007) are also used to objectively measure the thoughts and mental associations people make when they make pennies-based versus percent-based decisions. Query Theory has been used to account for phenomena such as the endowment effect (Johnson et al., 2007), labeling of environmental costs and preferences by political party (Hardisty et al., 2010), and discount rates for intertemporal choice (Weber et al., 2007). This research should help to expand knowledge about mental queries as they specifically relate to savings decisions.

This paper involves three lab studies which are limited to savings decisions which include the joint choice of an *initial savings rate* and an *escalator rate* without an *escalator cap*. For example, if a person elects an initial savings rate of 3% and an escalator rate of 2%, then they will save 3% of their salary this year, 5% of their salary next year, 7% of their salary two years from now, and so forth. The lab studies in this paper have excluded explicit use of an escalator cap to avoid anchoring effects.[2] The studies in this paper are also based on a forced choice architecture, where people must make an election (e.g., to save a specific percent or not save). From a current industry and policy perspective as reported by Vanguard, savings escalators are in use within a minority of plans with percentages growing. The most common initial savings rate in retirement plans which use automatic enrollment is 3%. And by far, the most common escalator rate is 1% (Vanguard, 2019), which may be viewed as too low whether in isolation or jointly with the initial rate based on target savings rates of 10% to 15%. Many escalator programs are currently implemented as opt-in choices, which can significantly contribute to underadoption. In an anecdotal conversation with the plan sponsor of health provider system, it was noted that the percent of participants opting into their escalator program was less than 2%.[3]

The studies use samples from the Amazon Mechanical Turk registered user base with participants ranging between 18 and 50 years of age. The main benefits of lab study-based approaches for this paper include being able to both test savings processes not available in the current market and investigate the psychological mechanisms at play, such as the role of subjective numeracy and objective perceptions of affordability. The limitations of lab study-based approaches include both less ecological validity and a lack of incentive compatibility (e.g., does not involve real savings decisions where money changes hands).

The first study is a Pennies 1% and 1% Lab Study (N=200), and it covers a low, introductory savings choice and may effectively be viewed as a practical boundary case where companies would likely not implement initial savings rates and escalator rates any lower than 1% and 1%. We assess the difference in participants' selections in a between-subject design when faced with 1) an opportunity to either save 1% of salary increasing by 1% every year thereafter or not save versus 2) an

[2] Escalator caps are usually set at the employer-level and automatically limit savings escalators from automatically increasing a person's savings rate beyond a certain level set by the employer (say 15%).
[3] Note that forced-choice, active-choice, or opt-out choice architectures would likely lead to higher participation rates in escalator programs, although relatively little research has comparatively tested these choice architectures in this context.

opportunity to either save 1 penny per dollar of salary increasing by 1 penny per dollar of salary every year thereafter or not save. We find evidence that setting rates this low, even for those among the lowest salaries, may be too low as evidenced by ceiling effects in participation rates ($\beta=0.0161939$, $p=0.709$) and insignificant main effects in perceived affordability ($\beta=0.1490145$, $p=0.427$).

The second study is a Pennies X% and Y% Lab Study (N=200) and broadens the scope of inquiry by allowing participants to select higher savings rates within a range that effectively spans the range of default rates of a large majority of defined contribution plans. Participants first make a choice to save at an initial savings rate (limited to between 0% to 6% of salary) followed by an escalator rate (limited to between 0% to 3%) in a between-subject design with some seeing pennies versus percent framing. In this study, no differences were detected in the initial savings rate selected ($\beta=0.108307$, $p=0.648$), although participants selected significantly higher escalator rates in the pennies condition ($\beta=0.554363$, $p=0.000$). Note that a 55-basis point increase, if it were to be realized in the field, would be quite substantial given the benefits of money compounding and that the most common escalator rate in plans with auto-escalation is 1%. Spotlight analysis indicates that subjective numeracy directionally moderates both choice and perceptions of affordability. Additionally, both structural equation modeling and Preacher-Hayes mediation analyses indicate perceptions of affordability partially mediating initial savings rates and escalator rate choices.

The third study is a Pennies X%, Y%, and Projections Lab Study (N=401) and broadens the scope of inquiry to include both self-reported and objective psychological measures, the latter using methodologies from Query Theory (Johnson et al., 2007). The study also attempts to manipulate the participant's level of understanding by providing them with a primitive, interactive tool that provides personalized "projections" as to what their savings elections would mean in terms of contributions in subsequent years (e.g., since people may not understand what rate escalators do). Furthermore, a limitation of the previous Pennies X% and Y% Lab Study was also relaxed in that instead of requiring people to choose an initial savings rate and then an escalator rate (i.e., restricted process flow), participants could freely choose to select and change either rate in any order. We find that people both save at both higher initial savings rates (β=0.5013545, p=0.004) and escalator rates (β=0.3742012, p=0.000) in the pennies framing. We also find that people subjectively report higher affordability (β=0.4111335, p=0.000) and understandability (β=0.2125477, p=0.043) with pennies framing. Spotlight analyses indicate that financial literacy moderates savings choices (e.g., initial savings rate), especially for those with lower financial literacy. Financial literacy did not moderate self-reported affordability yet directionally moderated understandability. Structural equation modeling also shows evidence for people choosing higher initial savings rates and higher escalators with objective thoughts about affordability mediating choice.

1.2 Current Literature Review

This section addresses four areas of the literature to provide context for the pennies on the dollar research. These areas are outlined in the next sections as follows: 1) financial savings judgments and decisions, 2) numeracy and financial literacy, 3) framing, and 4) Query Theory.

1.2.1 Financial Savings Judgments and Decisions

The pennies-based reframing interventions in this paper are novel within the behavioral finance and savings area. As backdrop, there are substantial benefits to interventions such as auto-enrollment (Madrian and Shea, 2001) and Save More Tomorrow (Thaler and Benartzi, 2004) which address, a term coined by Richard Thaler and Cass Sunstein (Thaler and Sunstein, 2008), choice architecture approaches (e.g., transformations of decision options and the type of influence). There are also information architecture approaches where data that is presented may be transformed. For example, Dan Goldstein and colleagues demonstrated how perceptions of adequacy differed for people when they were presented lump sums (of wealth) versus economically equivalent amounts of monthly income (Goldstein et al., 2016). John Gourville provided evidence that temporally reframing the costs of products and donations in more granular formats (e.g., such as donations framed as 85 cents per day versus 300 dollars per year) could make those transactions seem more affordable through psychological comparisons to other smaller expenses (Gourville, 1998). Additionally, in Chapter 3 of this thesis, it is demonstrated how temporal reframing of dollars per day (another information architecture approach) could be used to increase participation rates in a savings program versus other frames, such as dollars per month frames. The pennies-based framing proposed in this paper could be viewed as using information architecture approaches, where the amount of information in savings options presented to individuals is kept constant, but the communication of the information is manipulated in terms of using pennies or percent framing.

1.2.2 Numeracy and Financial Literacy

Numeracy and financial literacy are hypothesized to play key moderating roles in the psychology of pennies-based versus percent-based savings decisions. Low numeracy is widespread (Paulos, 1988), and even highly educated people can encounter difficulties when tested with standard, objective numeracy scales (Likpus et al., 2001). Pennies-based framing may reduce behavioral obstacles that some people may face regarding common savings decisions, which are often framed in terms of percent of salary, even though percentages seem to be less understood by some people. For example, when exploring numeracy and people's mental representations and ratings of risk, Peters et al. found that when people were asked to rate the risk of a mental patient committing violence, after being given numerically equivalent statistics of similar mental patients committing violence using either a percentage format (i.e., 10% of patients) or a frequency format (i.e., 10 of 100 patients), gaps in the ratings of risk between percentage and frequency formats were significant for low numerate people but not for the high numerate. High numerate people more easily transform information between the different framings whereas low numerate people may process information as seen (Peters et al., 2006). There is also evidence that affective feelings and attitudes may also play a role in explaining choices, perhaps dominating rational thinking. For example, Denes-Raj and Epstein conducted a study where participants were offered the opportunity to win prizes by drawing jellybeans from a bowl. Participants would win money (e.g., $1) when they successfully drew a red jellybean from one of two bowls. One larger bowl contained a greater number of red jellybeans although in a smaller proportion (e.g., 7 red jellybeans out of 100 jellybeans). The other smaller bowl contained fewer red jellybeans but in a larger proportion (e.g., 1 red jellybean out of 10 jellybeans). Participants could elect which bowl to draw from. However, many people elected to draw from the bowl with the larger number of beans (even though they knew that the probabilities were less favorable) because they felt they had better opportunities to win with more available red jellybeans (Denes-Raj and Epstein, 1994).

Broadly speaking there are two high-level approaches for measuring numeracy: using either objective or subjective measures, where the first approach addresses competency whereas the latter addresses confidence. Objective measurement approaches generally involve asking people math and logic questions. Some of the approaches include that by Schwartz et al. to assess basic probability and numerical ideas and the context of medical risks and benefits (Schwartz et al., 1997); Lipkus et al. to expand numeracy measures by Schwartz et al. to include assessment of a person's ability to understand percentages, understand proportions, and perform some conversions (Lipkus et al., 2001); and Peters et al. to expand the Lipkus et al. measures to include comparative frequencies, simple growth rates in probabilities, and medical-specific risk scenarios (Peters et al., 2007). As another way of thinking about numeracy, particularly in the context of short math-logic questions and in terms of measuring a person's ability to resist intuitive responses and think in a more reflective, cognitive way, Frederick has developed a widely used, three-item measure known as the Cognitive Reflection Test (Frederick, 2005). Weller et al. explored the previously mentioned numeracy measures with goals of developing a new, shorter scale (8 items) that could be used across a broad range of ages and demographics. Their analysis highlighted some considerations of the previously mentioned scales, such as that the Cognitive Reflection Test is comparatively more difficult for people relative to the other assessments and that it can also yield highly-skewed score distributions (Weller et al., 2013). As a final note on the objective numeracy literature, only a modest subset of items seems pertinent to the intervention planned (which consists mostly of understanding numbers, percentages, and proportions) and target population of people with lower numeracy and financial literacy.

Financial literacy encompasses different constructs and measures of how well an individual understands economics concepts (Lusardi, 2008; Lusardi, 2012; Lusardi and Mitchell, 2014), and as such, financial literacy might be expected to play a role in savings decisions. Different studies have provided evidence that higher financial literacy likely indicates that individuals have higher wealth accumulations (Behrman et al., 2012; Hastings and Mitchell, 2020). However, evidence is somewhat scarce relative to its effect on increased, voluntary savings. In a study based on individuals in Chile, an environment which includes a degree of mandatory pension contributions, Hastings and Mitchell did not find that higher financial literacy increased the likelihood of people voluntarily paying more into pensions (Hastings and Mitchell, 2020). Furthermore, in an experimental context relative to having participants make judgments based on how investment fees were framed, they did not find financial literacy to be a strong predictor of sensitivity to loss versus gain framing. In contrast, the behavioral interventions for pennies-based reframing are direct manipulations of how numerical information is presented in a savings choice (they are not valence-based framing situations such as that used by Hastings and Mitchell which address the loss versus gain framing around a reference point).

1.2.3 Framing

To shed additional light on where pennies-based savings interventions as addressed in this paper fit into the framing literature, it is useful to point out a typology of framing as put forth by Irwin Levin and colleagues, which covers three areas: 1) risky choice framing, 2) attribute framing, and 3) goal framing (Levin et al., 1998). Their paper includes a survey of twenty-nine papers on risky choice framing effects, thirty-six papers on attribute framing effects, and twenty-eight papers on goal framing effects. In Levin et al.'s topology, the general findings in the risky choice framing literature are exemplified by some of Tversky and Kahneman's experiments, such as the Asian Disease Problem[4], where on average people exhibit

[4] The Asian Disease Problem (Tversky and Kahneman, 1981) was implemented as a between-subject design where participants were presented with the equivalent choice problems in either a Gain

risk seeking behavior when risky choice options are framed negatively in terms of losses, whereas they exhibit risk averse behavior when risky choice options are framed positively in terms of gains (Tversky and Kahneman, 1981). In terms of the attribute framing segment of the literature, general findings include a tendency of negative frames to stimulate negative, mental associations and positive frames to stimulate positive, positive mental associations. As a classic example, Levin and Gaeth demonstrated how consumers, pre-consumption rated the quality of ground beef more favorably when the product was listed at "75% lean" versus "25% fat" (Levin and Gaeth, 1988). Finally, in terms of the goal framing area of the literature, Levin et al.'s topology refers to persuasive aspect of framing, specifically where positive framing invokes a goal of obtaining gain(s), which in turn leads to increased likelihood of some desired behavior and an end result, whereas negative framing invokes a goal of avoiding loss(es), which in turn tends to lead to a comparatively higher likelihood (relative to gain framing) of the same desired behavior and end result. A vivid anecdote by Richard Thaler helps to drive the point home where he accounts that people are more likely to find cash discounts (viewed as forgone gains relative to people using credit cards) more agreeable than credit surcharges (vivid, out-of-pocket losses), which is likely why credit card issuers prohibited merchants from charging higher prices to credit card users (Thaler, 1980). It is a nice anecdote of how loss aversion, where "losses loom larger than gains", can drive behavior even in the absence of risky outcomes.

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frame or a Loss frame. Whereas participants in the Gain frame tended to select risk adverse choices (i.e., seeking certain gains), participants in the Loss frame tended to be risk seeking (i.e., seeking uncertain losses). Both the setup, Problem 1 versus Problem 2, and percent of people selecting the choices [in brackets] are presented below:
Setup: Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimate of the consequences of the programs are as follows:

(For Gain frame participants)
If Program A is adopted, 200 people will be saved. [72 percent of participants selected]
If Program B is adopted, there is a 1/3 probability that 600 people will be saved, and 2/3 probability that no one will be saved. [28 percent of participants selected]
Which of the two programs would you favor?

(For Loss frame participants)
If Program C is adopted, 400 people will die. [22 percent of participants selected]
If Program D is adopted there is a 1/3 probability that nobody will die, and 2/3 probability that 600 people will die. [78 percent of participants selected]
Which of the two programs would you favor?

While the topology put forth by Levin et al. tends to be more focused on framing that includes the notion of valence (e.g., gains or losses, which may in turn trigger immediate negative or positive affective feelings in a person as part of intuitive thinking as opposed to reflective thinking, such as triggered and required by numerical calculations), their framework is useful for the purposes of characterizing the behavioral processes, decisions, and outcomes addressed in this paper. Namely, we address goal framing, which is focused on the persuasive aspects of framing, encouraging a particular behavior, and from a technical perspective, neither a risky choice nor attribute framing problem. We rely on a manipulation that is geared toward making savings options more appealing by making them more relatable, especially for those who self-report as either less numerate or financially literate. For some of these studies, we use subjective numeracy measures, which are friendlier to administer, but are less researched in the domain of framing and have shown mixed results in terms of differential moderation relative to objective numeracy (Gamliel et al., 2016). However, in spite of limitations that subjective numeracy measures may have, we speculate that for some savings decisions, it is more important how people feel about their numeracy versus how people test relative to numeracy, in terms of getting people to make positive steps toward saving and saving enough. In summary, we expect that some people will find savings options characterized in the pennies-based framing to be more affordable as compared to economically equivalent options in a percent-based framing condition.

1.2.4 Query Theory

To shed additional light on the psychological processes that may be involved in decisions based on pennies on the dollar versus percent-based framing, in one of the studies we elicit the thoughts of participants (i.e., associations that they make) in a way that is aligned with Query Theory (Johnson et al., 2007). Query Theory is motivated by beliefs that an individual's preferences and evaluation of decisions are based on thought processes tied to memory retrieval (Weber et al., 2006). Stemming from those beliefs are four theoretical concepts. First is the premise that an individual's evaluation process is based on queries, such as decomposition of larger questions (such as “How much should I save?”) into other questions (e.g., “Why should I save?” or “What will I forgo?” or “Is what I will forgo small?”). The second premise is that queries are executed sequentially, and the order of the queries varies based on response mode (where such queries may happen autonomously and not necessarily deliberately). A third premise is that due to output interference associated with memory recall, the order of queries matter (e.g., and may result in earlier queries being richer in terms of composition, weighing comparatively more, and suppressing or modifying subsequent thoughts). A fourth and final premise is that response modes (as triggered by different stimuli) may produce different query ordering. In a foundational paper by Johnson et al., the authors demonstrated in an endowment-related study involving a commodity good, buyers versus sellers produced different good values and queries (recorded as recalled “aspects”) as consistent with predictions of Query Theory (Johnson et al., 2007). Furthermore, the authors demonstrated that by manipulating query order, they could eliminate the endowment effect (thus, demonstrating scenarios of both evaluation values driving queries and manipulated query orders driving evaluation values). In the lab studies used in this chapter, we restrict testing of pennies framing to three of the theoretical premises of Query Theory (i.e., we do not address the fourth theoretical area of manipulating query ordering).

1.3 Pennies on the Dollar Savings Evaluations

This chapter explores the main question as to how pennies-based framing affects how people think about decisions to regularly save money and have their savings rates increase over time. This chapter explores these decisions within the limits of savings decisions which include the joint choice of an *initial savings rate* and an *escalator rate* without an *escalator cap*.

Informed by the existing body of knowledge previously described, we hypothesize the following regarding retirement savings choices:

> **H1:** Pennies-based framing will increase retirement savings choices relative to percent-based framing.
>
> **H2a:** Subjective affordability will be higher in pennies-based framing.

H2b: Objective affordability will be higher in pennies-based framing.

H3a: Subjective understandability will be higher in pennies-based framing.

H3b: Objective understandability will be higher in pennies-based framing.

H4: Affordability will explain retirement savings choices.

H5: Understandability will explain retirement savings choices.

H6: Affordability will partially mediate the relationship between pennies-based framing and retirement savings choices.

H7: Understandability will partially mediate the relationship between pennies-based framing and retirement savings choices.

H8: Providing participants with an opportunity to adjust their choices after presenting them with escalator projections will increase understandability of retirement savings choices.

H9: Numeracy and financial literacy will moderate choice in pennies-based framing.

The hypothesized relationships between these constructs are summarized in Figure 1-1.

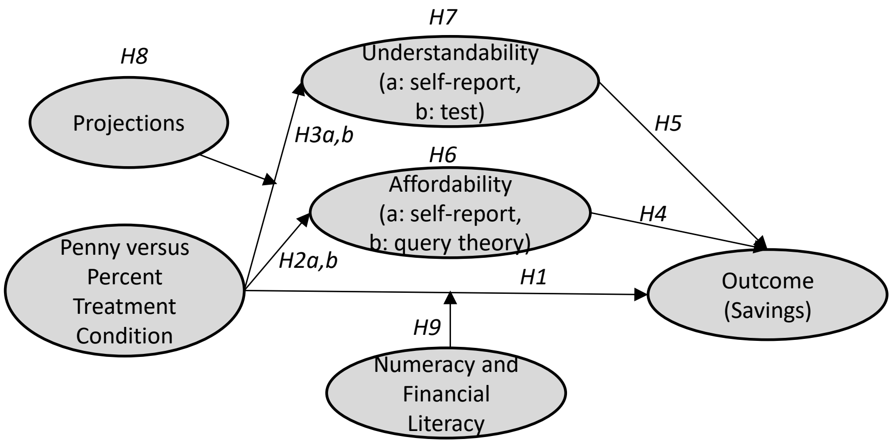


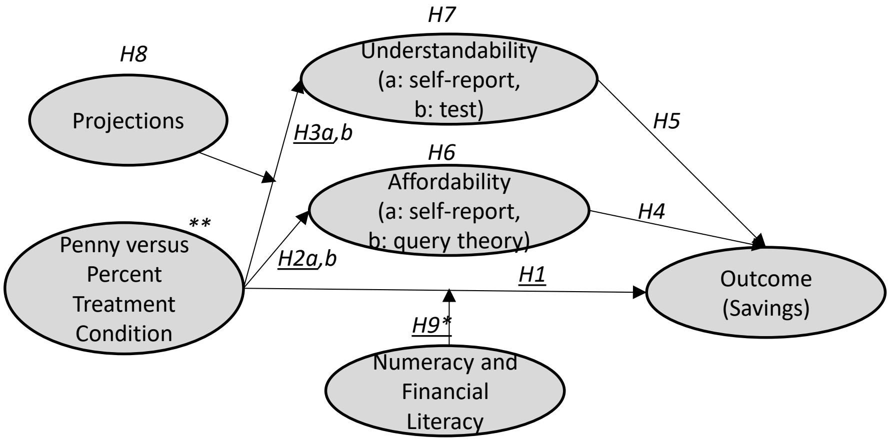
Figure 1-1. Hypothesized relationships between constructs for pennies-based framing

1.4 Pennies 1% and 1% Lab Study

The financial advisor mentioned in the introduction who originally came up with the pennies-based framing concept indicated that he generally took the approach of offering people the opportunity to save 1 penny per dollar of their salary increasing by 1 penny every year thereafter. Anecdotally, he indicated that he found this to be a very effective approach in persuading plan sponsors to adopt a new design for plan enrollment. Indirectly through adoption by the plan sponsor, he also found that he could get a large percentage of employees to save, even in employee populations with a significant segment of people with lower incomes (say earning less than $40,000 per year). He indicated that these types of people often have difficult times figuring out what 1% of salary is.

As such, the approach in the Pennies 1% and 1% Lab Study was to conduct a comparative analysis between pennies on the dollar versus percent-based framing for an introductory savings choice, one of the lowest initial savings rate and escalator rate combinations that might be offered by an employer. The study alsos explore people's subjective attitudes toward the savings opportunity (i.e., in terms of affordability and understandability) and individual differences relative to subjective numeracy.

Figure 1-2 indicates the hypotheses and boundary conditions being tested for the Pennies 1% and 1% Lab Study.



Notes: Underlining indicates the hypotheses tested in this study. (*) indicates that subjective numeracy is being measured. (**) indicates that only pennies and percent conditions covering a low, introductory savings choice of a 1% initial savings rate and 1% escalator rate are being tested.

Figure 1-2. Hypotheses being tested in the Pennies 1% and 1% Lab Study

1.4.1 Method

200 online participants in the United States were recruited between the ages of 18 and 50 years old using Amazon TurkPrime[5] with participants randomized using a between subject design (pennies versus percent conditions). Amazon TurkPrime is a platform used by a number of academics to conduct research using the Amazon Mechanical Turk participant base. To qualify for recruitment by Amazon TurkPrime

[5] An overview of the suitability of Amazon TurkPrime for data acquisition in the behavioral sciences is covered by Leib Litman et al. (Litman et al., 2016). Additional information on generalizability of Amazon MechanicalTurk studies has recently been addressed in the context of fifteen replication studies by Alexander Coppock (Coppock, 2018).

for the study, participants had to meet minimum use requirements of the platform (i.e., have completed more than 500 human intelligence tasks or HITs), have an approval rating of 95% or higher, and be between the ages of 18 and 50 years old. Duplicate IP addresses were blocked by the platform, and the country of participants was verified to be within the United States. During recruitment, prospective participants were told that they could participate in a study covering questions about hypothetical financial decisions and their attitudes. The study was expected to take between 3 to 5 minutes, and payment for participation was $0.50, which was in line with guidelines for these types of studies (Sheehan and Pittman, 2016). The actual study was implemented on Qualtrics and consisted of questions covering:

- a pennies-based savings choice (e.g., "I would choose to save 1 penny per dollar of my salary, increasing by 1 penny per dollar of my salary every year thereafter" or "I would choose not to save") or percent-based savings choice (e.g., "I would choose to save 1% of my salary, increasing by 1% of my salary every year thereafter" or "I would choose not to save"),
- attitudes toward the choice in terms affordability and understandability,
- five subjective numeracy questions,
- attitudes toward alternative (pennies or percent) savings choices, and
- demographics questions related to age, gender, income, and educational level.

The overall architecture of the study is depicted in Figure 1-3, and a detailed version of the stimulus is included in the Online Appendix, Chapter 1, Lab Study Materials, Section A.

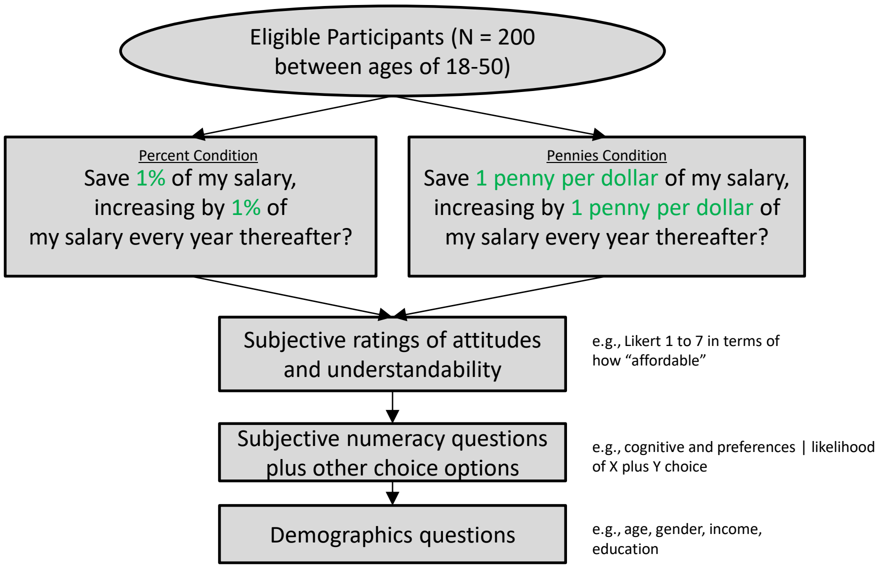


Figure 1-3. Summary of the Pennies 1% and 1% Lab Study

As a special note for the five subjective numeracy questions, we sought to minimize the number of questions to be sensitive to the target population. The first four questions are based on cognitive portion of scale outlined by Fagerlin and colleagues (Fagerlin et al., 2007), and the total, 8-item scale is known as the SNS-8. A fifth question from the same scale was added from the preferences portion of the scale. Note that this fifth question was added to make the total set strictly inclusive of the SNS-3 scale (McNaughton et al., 2015). For analysis purposes of this paper, we focus on using the SNS-3 as it concisely captures the cognitive and preference aspects of subjective numeracy.

1.4.2 Summary Statistics and Experimental Balance

Table 1-1 provides a summary of the characteristics of participants in terms of the two treatment groups (i.e., pennies versus percent frames) with statistical tests reported at a significance level of α=0.05. Based on random assignment to condition, 90 participants were put into the pennies condition and 110 participants were put into the percent condition. The mean age of participants was 32.4 years, and an F-test and Bartlett's chi-squared test do not reject the null hypothesis that either mean or standard deviations for age are the same between conditions. Slightly more than half of participants (52.8%) identify as male with the balance of males in the percent condition being somewhat higher (57.3%) versus the pennies condition (47.1%), but a chi-squared test does not reject the null hypothesis that each condition has the same proportion of males. Income bands were ordinally coded in buckets of approximately $10,000 as indicated in the notes for Table 1-1 with those having income less than $9,999 a year being coded as 1 and those earning $150,000 or more being coded as 16. On the coded scale, the mean income was 4.41 (which lies between the two buckets of "from $30,000 to $39,999 a year" and "from $40,000 to $49,999 a year). An F-test indicates that mean income in the percent condition (4.92) was significantly higher than the pennies condition (3.81), but a Bartlett's chi-squared does not reject the null hypothesis of equal variances between the conditions. In terms of reporting educational levels, a chi-squared test of proportions (% high school / % college / % advanced degree) indicates a significant difference between the proportions in pennies (50.0% / 44.4% / 5.56%) and percent (29.1% / 59.1% / 11.8%) conditions, indicative of higher educational levels to those assigned to the percent condition. Finally, in terms of two methods of measuring subjective numeracy, the mean score for the subjective numeracy cognitive subscale (i.e., subscale of SNS-8 as previously highlighted) was 17.4 (with a possible range from 4 to 24), and the short, subjective numeracy cognitive subscale (i.e., SNS-3 as previously highlighted) was 13.6 (with a possible range of 3 to 18). F-tests indicate that the means for both subjective numeracy scales were higher for the percent condition (SNS-8COG: 18.3, SNS-3: 14.0) than the pennies condition (SNS-8COG: 16.3, SNS-3: 13.0). Bartlett's chi-squared tests indicate that the variances for both subjective numeracy scales were smaller for the percent condition (SNS-8COG: 4.8, SNS-3: 3.1) than the pennies condition (SNS-8COG: 6.0, SNS-3: 3.7).

For Pennies 1% and 1% Lab Study and the SNS-3, Cronbach's α is 0.7832 across all participants. This is consistent with seven prior studies of healthcare patients using the SNS-3 in different environments where alphas ranged from 0.67 to 0.80 (McNaughton et al., 2015). Nearly 20% of the sample has a self-reported numeracy score of 10 or less (out of 18). As can be seen in Table 1-2, the distribution for subjective numeracy (SNS-3) is skewed toward the high end with more than half of participants reporting scores between 15-18 with the remainder reporting scores between 4 and 14. While McNaughton et al. do not provide distribution frequency details for the SNS-3 across their studies, it is not unusual for numeracy scales to manifest skewness when used with various populations (Weller et al., 2013).

Based on these statistical checks, randomization was imperfect with income, numeracy, and education lower in the pennies condition, which would suggest a priori that main effects may be smaller in the pennies condition than might be observed otherwise had the randomization been balanced. Based on the difference in mean coded income levels as discussed prior, mean income is estimated to be more than $10,000 lower in the pennies condition. Additionally, the variances relative to subjective numeracy were larger in the pennies condition. However, the following analyses do not adjust for chance biases (i.e., imbalance of demographic covariates and numeracy moderators that influence outcomes) beyond providing analyses with and without controls.

1.4.3 Results

To determine the comparative effect of pennies relative to percent framing, three outcome variables are examined:

- The first outcome variable is savings participation which is equal to 1 if the study participant chose to save and equal to 0 if they chose not to save.
- The second outcome variable is self-reported affordability, which is elicited through a statement about the low, introductory savings choice, “I found the option to be affordable” and collected from the person using a Likert-scale from 1 (strongly disagree) to 7 (strongly agree).
- The third outcome variable is self-reported understandability, which is elicited through a statement about the low, introductory savings choice, “I found the description of the option to be clear and understandable” and collected from the person using a Likert-scale from 1 (strongly disagree) to 7 (strongly agree).

There was no main effect of pennies framing on savings participation rates using either OLS regressions[6] or logistic regressions with or without controls (see both panels of Table 1-3). It is noteworthy to mention that the constant term in the OLS regression without controls is approximately 0.91, which is potentially indicative of a ceiling effect where a very large percent of people chose to save when offered a low, introductory savings choice regardless of whether they were offered the pennies or percent frame. The constant term is 0.82 after controlling for age, gender, income, and education.

To test the effect of framing on self-reported affordability, OLS regressions indicated a small, insignificant and directionally positive effect of pennies framing on self-reported affordability without controls ($\beta = 0.192$, $p=0.286$) and with controls ($\beta = 0.149$, $p=0.427$). See Table 1-4 for more details.

When testing the effect of framing on self-reported understandability, OLS regressions indicated a small, insignificant and directionally negative effect of pennies framing on self-reported understandability without controls ($\beta = -0.141$, $p=0.419$) and with controls ($\beta = -0.233$, $p=0.187$). See Table 1-5 for more details.

The next analyses explore the moderating role of subjective numeracy on savings based on series of spotlight analyses (i.e., collectively a floodlight). In this case, the regression coefficient on the independent, indicator variable of pennies treatment is analyzed separately across the range of the moderator (i.e., subjective numeracy) with separate focus points. For example, for any focus point at SNS-3 = *value*, then the interactions analysis is performed where the moderator' = SNS-3 minus *value*. This sets the focus point at zero. As an example, if the focus point was on the mean value of SNS-3, then the moderator' used for that spotlight analysis would be mean-centered around zero (i.e., moderator' = moderator – mean). This methodology is consistent with other approaches for simple effect testing in moderated regressions (Spiller et al., 2013) and can help to identify the continuum over which the results are significant (i.e., range based on Johnson-Neyman points, which are the points where the significance levels switch from insignificant to

[6] Ordinary least squares regressions may be used to analyze and estimate treatment effects for indicator variables (Angrist and Pischkle, 2009), although logistic regressions may also be used for robustness and to estimate the effects on likelihoods.

significant). For the Pennies 1% and 1% Lab Study, regressions were run for SNS-3 values from 4 to 18 with intervals set at 2 between focus points.

Using OLS regressions without controls indicated a significant interaction between subjective numeracy and treatment condition ($\beta = 0.027$, $p=0.025$) with significant interactions (i.e., Johnson-Neyman points) at SNS3=4 (lowest subjective numeracy) and SNS3=18 (highest subjective numeracy) but not for $4 < SNS3 < 18$. At SNS3=4, pennies framing had a negative effect on savings participation ($\beta_{SNS3 = 4} = -0.243$, $p=0.049$). At SNS3=18, pennies framing had a positive effect on savings participation ($\beta_{SNS3 = 18} = 0.139$, $p=0.039$). When running the same analyses with controls for age, gender, income, and education, there was a significant interaction between subjective numeracy and treatment condition ($\beta = 0.028$, $p=0.028$) with only one Johnson-Neyman point was observed within the range of the data at SNS3=18 (highest subjective numeracy). At SNS3=18, pennies framing had a positive effect on savings participation ($\beta_{SNS3 = 18} = 0.148$, $p=0.033$). The floodlight details are charted in the panels of Table 1-6.

A different pattern emerges when performing a series of spotlight analysis with self-reported affordability as the outcome measure. Using OLS regressions without controls indicated a directional interaction between subjective numeracy and treatment condition ($\beta = -0.065$, $p=0.223$) with marginally significant treatment differences from $6 < SNS3 < 12$. At SNS3=6, pennies framing had a positive effect on self-reported affordability ($\beta_{SNS3 = 6} = 0.756$, $p=0.104$). At SNS3=12, pennies framing had a positive effect on self-reported affordability ($\beta_{SNS3 = 12} = 0.365$, $p=0.068$). When running the same analyses with controls for age, gender, income, and education, the interaction between subjective numeracy and treatment condition was directional ($\beta = -0.065$, $p=0.235$), and all treatment differences within the range of the data were insignificant. However, in both cases of with and without controls, a pattern can be observed with evidence of higher self-reported affordability for pennies framing and those with lower subjective numeracy. Differences in self-reported affordability seem to vanish for those with higher subjective numeracy. The floodlight details are charted in the panels of Table 1-7.

Similar trend patterns emerge when performing a series of spotlight analysis with self-reported understandability as the outcome measure. Using OLS regressions without controls indicated a significant interaction between subjective numeracy and treatment condition ($\beta = -0.108$, $p=0.032$) with a significant treatment difference at SNS3=4. At SNS3=4, pennies framing had a positive effect on self-reported understandability ($\beta_{SNS3 = 4} = 1.012$, $p=0.044$). When running the same analyses with controls for age, gender, income, and education, there was a significant interaction between subjective numeracy and treatment condition ($\beta = -0.099$, $p=0.03246$), with treatment differences significant at SNS3=18. In both cases of with and without controls, a pattern can be observed with evidence of higher self-reported understandability for pennies framing and those with lower subjective numeracy. Differences in self-reported understandability seem to vanish for those with higher subjective numeracy (and trend toward marginally negative). The floodlight details are charted in the panels of Table 1-8.

Given that this study only covered a low, introductory savings choice, the stimulus (post the main intervention as listed in the online appendix) explored participants' likelihood of choosing other savings options, where the outcome variable is a self-reported 7-point, Likert assessment by the participant (definitely not choose = 1 to definitely choose = 7) in reaction to four questions, "For each option, please indicate how likely you would be to choose it:"

- Enroll at [2 pennies per dollar] (2%) of my salary, increasing by [1 penny per dollar] (1%) of my salary every year thereafter,
- Enroll at [2 pennies per dollar] (2%) of my salary, increasing by [2 pennies per dollar] (2%) of my salary every year thereafter,
- Enroll at [3 pennies per dollar] (3%) of my salary, increasing by [1 penny per dollar] (1%) of my salary every year thereafter,
- Enroll at [6 pennies per dollar] (6%) of my salary, increasing by [1 penny per dollar] (1%) of my salary every year thereafter.

Penny versus percent conditions were presented to the participant based on treatment assignment. These questions were asked after the main stimulus of the savings choice, so sequencing effects such as anchoring on the initial choice problem may be present. Although not statistically significant, OLS regressions with controls directionally indicate that people would be more likely to choose a variety of higher savings and escalator rates when presented choices in pennies versus percent framing. For initial rate = 2 and escalator rate = 1, $\beta=0.225$, $p=0.387$. For initial rate = 2 and escalator rate = 2, $\beta=0.358$, $p=0.196$. For initial rate = 3 and escalator rate = 1, $\beta=0.326$, $p=0.245$. For initial rate = 6 and escalator rate = 1, $\beta=0.391$, $p=0.193$. Detailed results are listed in Table 1-9.

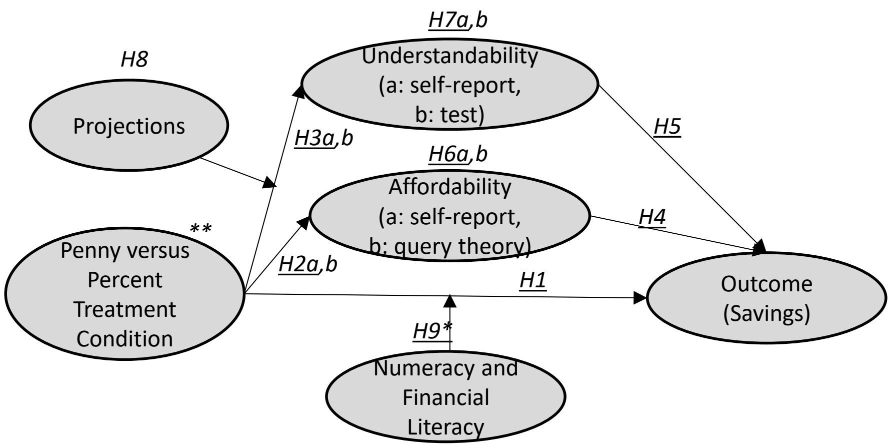
1.4.4 Pennies 1% and 1% Lab Study Discussion

It is important to note that the Pennies 1% and 1% Lab Study covers a low, introductory savings choice and may effectively be viewed as a practical boundary case where companies would likely not implement initial savings rates and escalator rates any lower than 1% and 1%. Randomization was imperfect with income, numeracy, and education lower for those in the pennies condition. A ceiling effect on savings participation was observed with more than 90% of people saving in either condition. No main effect of pennies framing was observed for self-reported affordability or understandability. Floodlight analyses indicated a potentially negative effect of pennies framing on savings participation, especially for those with lower subjective numeracy. This is admittedly somewhat difficult to reconcile with the floodlight analyses of the simple effects of subjective numeracy on self-reported affordability and understandability, where these analyses indicated positive directional support for pennies for those with lower subjective numeracy. However, to put everything into context effects in this study are not strong, likely related to the ceiling effect. Given that people directionally seem to indicate that they would be willing to choose even higher initial savings and escalator rates given penny framing, the next study relaxes some of the restrictions.

1.5 Pennies X% and Y% Lab Study

A major limitation with the Pennies 1% and 1% Lab Study surrounds the notion of an introductory savings choice which offers participants an opportunity to choose between saving at an initial saving rate of 1 percent and escalator rate of 1 percent versus opting not to save. More than 90% of participants chose to save in either pennies or percent conditions, and this ceiling effect makes it more difficult to distinguish between the effectiveness of pennies versus percent, tease apart the psychology, and understand the impact of heterogeneity. As such, in Pennies X% and Y% Lab Study the conditions of the low cap on initial savings rate and escalator rate are relaxed, and participants are allowed to choose an initial savings rate from 0 to 6 percent and an escalator rate from 0 to 3 percent. The study involves a between-subject research design that elicits choices in either pennies or percent frames. These ranges for initial savings rates and escalators rates have been selected since a large percentage of initial, default savings and escalator rates in plan designs fall within this range (Vanguard, 2019). Due to technical limitations at the time of this study, participants needed to select an initial rate first before choosing an escalator rate (implemented using a layered, pull-down menu structure).

Figure 1-4 illustrates the hypotheses and boundary conditions being tested.



Notes: Underlining indicates the hypotheses tested. (*) indicates that subjective numeracy is being measured. (**) indicates that pennies and percent conditions covering separate initial savings rate (0% to 6%) and escalator rate (0% to 3%) choices are being tested where initial rate is chosen first.

Figure 1-4. Hypotheses being tested in Pennies X% and Y% Lab Study

1.5.1 Method

200 online participants were recruited in the United States between the ages of 18 and 50 years old using Amazon TurkPrime with participants randomized using a between subject design (pennies versus percent conditions). Recruitment requirements were the same as for the Pennies 1% and 1% Lab Study, with the additional requirements that Amazon TurkPrime excluded any participants for the Pennies 1% and 1% Lab Study from participating in the new Pennies X% and Y% Lab Study. During recruitment, prospective participants were told that they could participate in a study covering questions about hypothetical financial decisions and their attitudes. The study was expected to take between 3 to 5 minutes, and payment for participation was $0.50. The actual study was implemented on Qualtrics and consisted of questions covering:

- a pennies-based savings choice (e.g., "I would choose to save __ pennies per dollar of my salary, increasing by __ pennies per dollar of my salary every year thereafter") or percent-based savings choice (e.g., "I would choose to save __% of my salary, increasing by __% of my salary every year thereafter"),
- attitudes toward the choice in terms affordability and understandability,
- five subjective numeracy questions,
- attitudes toward alternative (pennies on the dollar or percent) savings choices, and
- demographics questions related to age, gender, income, and educational level.

The overall architecture of the research design is depicted in Figure 1-5, and a detailed version of the stimulus is included in the Online Appendix, Chapter 1, Lab Study Materials, Section B.

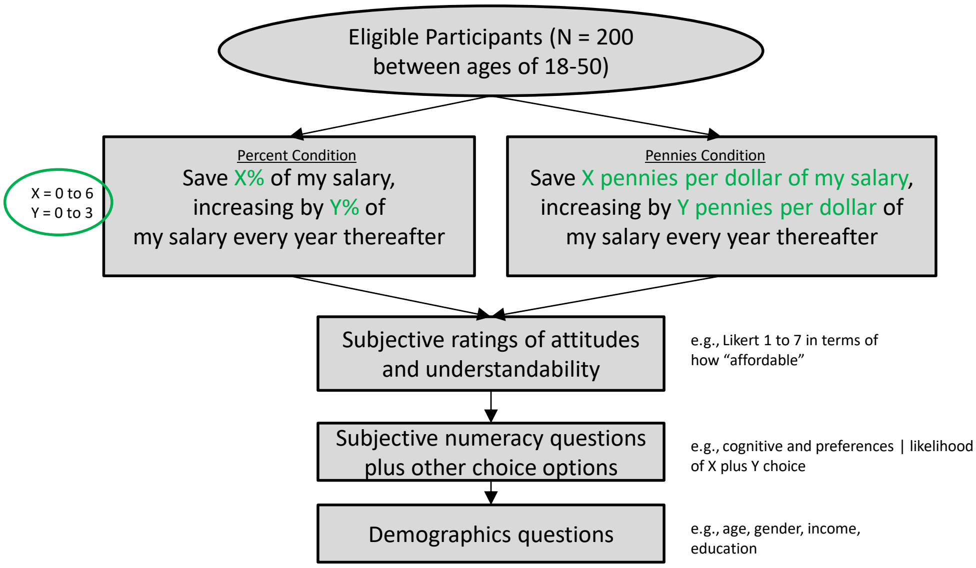


Figure 1-5. Summary of the Pennies X% and Y% Lab Study

1.5.2 Summary Statistics and Experimental Balance

Table 1-10 summarizes the characteristics of participants in the two treatment groups (i.e., pennies versus percent frames) with statistical tests as noted. Based on random assignment to condition, 99 participants were put into the pennies condition and 101 participants were put into the percent condition. The mean age of participants was 32.3 years, and an F-test and Bartlett's chi-squared test do not reject the null hypothesis that either mean or standard deviations for age are the same between conditions. More than half of participants (55.6%) identify as male with the balance of males in the percent condition being somewhat higher (57.0%) versus the pennies condition (54.1%), but a chi-squared test does not reject the null hypothesis that each condition has the same proportion of males. Income bands were ordinally coded in buckets of approximately $10,000 as done for the prior study with those having income less than $9,999 a year being coded as 1 and those earning $150,000 or more being coded as 16. On the coded scale, the mean income was 4.79 (which lies between the two buckets of "from $30,000 to $39,999 a year" and "from $40,000 to $49,999 a year). An F-test and Bartlett's chi-squared test do not reject the null hypothesis that either mean or variances for income are the same between conditions. In terms of reporting educational levels, a chi-squared test of proportions (% high school / % college / % advanced degree) did not indicate a significant difference between the proportions in pennies (29.3% / 54.6% / 16.2%) and percent (42.6% / 49.5% / 7.9%) conditions, although the significance test was just marginal with people in the percent condition skewing lower in terms of educational level. Finally, in terms of two methods of measuring subjective numeracy, the mean score for the subjective numeracy cognitive subscale (i.e., subscale of SNS-8 as previously highlighted) was 17.6 (with a possible range from 4 to 24), and the short, subjective numeracy cognitive subscale (i.e., SNS-3 as previously highlighted) was 13.8 (with a possible range of 3 to 18). F-tests and Bartlett's chi-squared tests do not reject the null hypothesis that either mean or variances for subjective numeracy are the same between conditions.

For the Pennies X% and Y% Lab Study relative to the SNS-3, Cronbach's α is 0.7738 across all participants and is consistent with both the Pennies 1% and 1% Lab Study and the seven previously mentioned studies of healthcare patients (McNaughton et al., 2015). 17% of the sample has a self-reported numeracy score of 10 or less (out of 18). As can be seen in Table 1-11, the distribution for subjective numeracy (SNS-3) is skewed toward the high end with more than half of participants reporting scores between 14-18 with the remainder reporting scores between 3 and 13.

Based on these analyses, randomization was successful for the Pennies X% and Y% Lab Study across demographic and subjective numeracy covariates.

1.5.3 Results

To determine the comparative effect of pennies relative to percent framing, four outcome variables are examined:

- The first outcome variable is the initial savings rate which can be a number between 0 and 6.
- The second outcome variable is the escalator rate which can be a number between 0 and 3.

- The third and fourth outcome variables are self-reported affordability and understandability, elicited in a similar way to that done prior (i.e., on a scale of 1 to 7 where 7 indicates the highest level of self-reported affordability or understandability).

1.5.3.1 Initial Savings Rate and Escalator Rate

There was no main effect of pennies framing on initial savings rates using OLS regression without or with controls (respectively $\beta=0.097$, $p=0.668$ and $\beta=0.108$, $p=0.648$). See Table 1-12, panel A for more details.

When testing the effect of framing on the escalator rate, there was a highly significant main effect of pennies framing on escalator rates using OLS regression without or with controls (respectively $\beta=0.562$, $p<0.001$ and $\beta=0.554$, $p<0.001$). See Table 1-12, panel B for more details.

1.5.3.2 Self-Reported Affordability and Understandability

To test the effect of framing on self-reported affordability, OLS regressions indicated a small and significant positive effect of pennies framing on self-reported affordability without controls ($\beta = 0.355$, $p=0.017$) and with controls ($\beta = 0.312$, $p=0.041$). See Table 1-13 for more details.

When testing the effect of framing on self-reported understandability, OLS regressions indicated a marginally significant and positive effect of pennies framing on self-reported understandability without controls ($\beta = 0.320$, $p=0.079$) and with controls ($\beta = 0.340$, $p=0.068$). See Table 1-14 for more details.

1.5.3.3 Moderator Analysis of Individual Behavioral Differences

Analogous to the methodology described for the prior study, the next analyses explore the moderating role of subjective numeracy on the four outcome variables for the Pennies X% and Y% Lab Study based on series of spotlight analyses, again consistent with other approaches for simple effect testing in moderated regressions (Spiller et al., 2013). Regressions are conducted for SNS-3 values at 3 and from 4 to 18 with intervals set at 2 between focus points.

Using OLS regressions without controls or with controls for age, gender, income, and education did not indicate a significant interaction between subjective numeracy and treatment condition or significant treatment differences for $3 \leq SNS3 \leq 18$ between pennies and percent conditions on initial savings rate. However, as can be seen from Table 1-15 and floodlight panels A and B, the point estimates for the treatment differences are directionally positive for those with lower subjective numeracy and decrease as subjective numeracy increases.

A similar pattern of those with the lowest subjective numeracy being helped emerges when performing a series of OLS spotlight analyses with escalator rate as the outcome measure. Interactions between subjective numeracy and treatment condition are directional (β = -0.057, p=0. 179) with treatment differences significant across the range $3 \leq SNS3 \leq 16$. For example, at SNS3=3 without controls, pennies framing had a positive treatment difference ($\beta_{SNS3=3}$ = 1.179, p=0. 014) on escalator rate. This treatment difference decreases until a Johnson-Neyman point somewhere above SNS3=16 ($\beta_{SNS3=16}$ = 0.434, p=0. 008) and below SNS3=18. When running the same analyses with controls for age, gender, income, and education, interactions between subjective numeracy and treatment condition are directional (β = -0.063, p=0. 152), and at SNS3=3 pennies framing had a positive treatment difference ($\beta_{SNS3=3}$ = 1.240, p=0. 013). Treatment difference significance persisted up to SNS3=16 ($\beta_{SNS3=16}$ = 0.415, p=0. 015). Again, the treatment differences between pennies and percent framing appear to be strongest for those with the lower subjective numeracy and vanish at the highest subjective numeracy levels. See Table 1-15 and floodlight panels C and D for more details on the floodlight analyses for escalator rate.

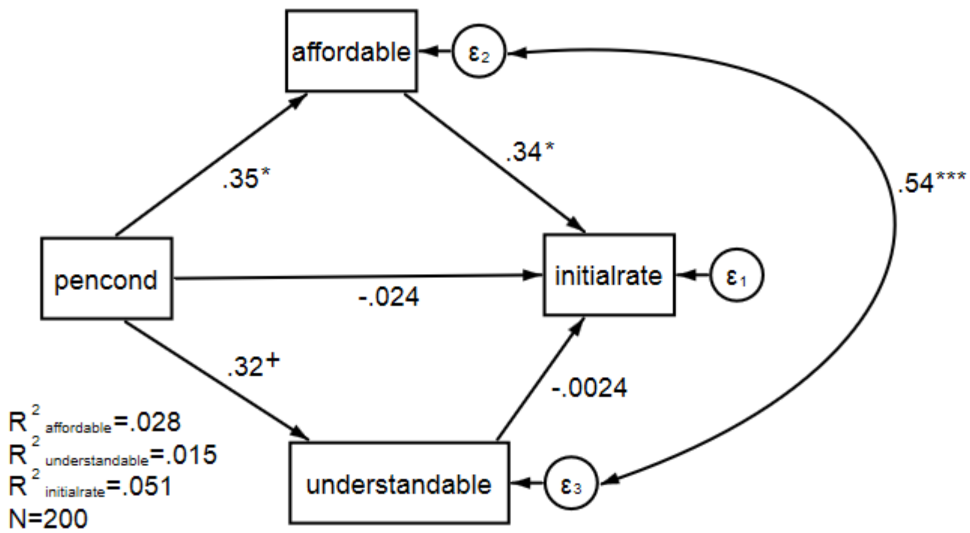
A similar pattern also emerges when performing a series of spotlight analysis with self-reported affordability as the outcome measure. Using OLS regressions without controls indicated interactions between subjective numeracy and treatment condition are directional (β = -0.062, p=0. 191) with treatment differences and Johnson-Neyman points at approximately SNS3=4 and above SNS3=14. At SNS3=4, pennies framing had a positive effect on self-reported affordability ($\beta_{SNS3 = 4}$ = 0.967, p=0.049). At SNS3=14, pennies framing had a positive effect on self-reported affordability ($\beta_{SNS3 = 14}$ = 0.343, p=0.021). When running the same analyses with controls for age, gender, income, and education, interactions between subjective numeracy and treatment condition are directional (β = -0.063, p=0. 192) with treatment differences and Johnson-Neyman points estimated at approximately SNS3=6 ($\beta_{SNS3 = 6}$ = 0.807, p=0.048) and above SNS3=14 ($\beta_{SNS3 = 14}$ = 0.301, p=0.049). The floodlight details are charted in the panels of Table 1-16.

Similar trend patterns emerge when performing a series of spotlight analysis with self-reported understandability as the outcome measure, although the range of significance appears to be narrower. Using OLS regressions without controls indicates interactions between subjective numeracy and treatment condition are directional (β = -0.065, p=0. 253) with treatment differences and Johnson-Neyman points below SNS3=10 ($\beta_{SNS3 = 10}$ = 0.575, p=0.039) and above SNS3=12 ($\beta_{SNS3 = 12}$ = 0.445, p=0.029). When running the same analyses with controls for age, gender, income, and education, interactions between subjective numeracy and treatment condition are directional (β = -0.070, p=0. 219) with treatment differences and Johnson-Neyman points at approximately SNS3=8 ($\beta_{SNS3 = 8}$ = 0.749, p=0.047) and above SNS3=12 ($\beta_{SNS3 = 12}$ = 0.469, p=0.023). In both cases of with and without controls, a pattern can be observed with evidence of higher self-reported understandability for pennies framing and those with lower subjective numeracy. Differences in self-reported understandability seem to vanish for those with higher subjective numeracy. The floodlight details are charted in the panels of Table 1-17.

1.5.3.4 Mediation Analysis of Psychological Measures

To analyze to what extent self-reported affordability and understandability may mediate effects between pennies framing and savings outcomes, two structural equation model (SEM) analyses were performed with initial savings rate and escalator rate as outcomes. These mediation analyses were performed using Stata 15 and 1,000 bootstrap replications. The model incorporated correlated residuals for affordability and understandability given that factors other than framing are likely to be influencing people’s savings decisions and resulting in correlated errors (Acock, 2013).

In terms of initial savings rate as the outcome variable, self-reported affordability significantly (and fully) mediates the effect between pennies condition framing and initial savings rate. The indirect effect using unstandardized coefficients is 0.12 (i.e., 0.35 times 0.34). Error terms for affordability and understandability are correlated ($r=0.54$, $p<0.001$). It is noteworthy to point out a marginally significant, positive direct effect of pennies framing on self-reported understandability ($b=0.3198$, $z=1.75$, $p<0.081$) but the absence of a direct effect of understandability on the outcome ($b=-0.0024$, $z=-0.02$, $p=0.984$), although the point estimate is negative. Direct effects are provided in Table 1-18 panel A, and path diagram is provided in Figure 1-6.

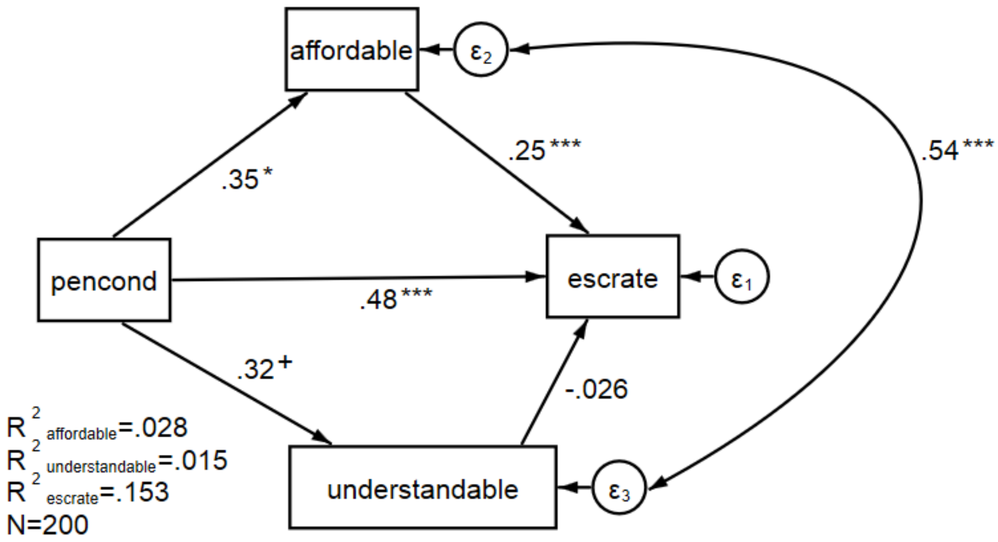


+, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001

Figure 1-6. Pennies X% and Y% Lab Study Mediation Analysis and Path Diagram for Initial Rate

In terms of escalator rate as the outcome variable, self-reported affordability significantly (and partially) mediates the effect between pennies condition framing and escalator rate. The mediation is complementary, and the indirect effect is 0.09 using unstandardized coefficients (i.e., 0.35 times 0.25). The direct effect of the pennies condition on escalator rate is highly significant ($b=0.4793$, $z=3.71$, $p<0.001$).

Error terms for affordability and understandability are correlated (r=0.54, p<0.001). It is noteworthy to point out a marginally significant, positive direct effect of pennies framing on self-reported understandability (b=0.3198, z=1.75, p<0.081) but the absence of a direct effect of understandability on the outcome (b=-0.0256, z=-0.39, p<0.698), although the point estimate is negative. Direct effects are provided in Table 1-18 panel B, and a path diagram is provided in Figure 1-7.



+, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001

Figure 1-7. Pennies X% and Y% Lab Study Mediation Analysis and Path Diagram for Escalator Rate

Given that understandability was not significant as a mediator, for robustness checks separate Preacher-Hayes mediation analyses were run with self-reported affordability mediating pennies framing on outcomes of initial savings rate and escalator rate. These mediation analyses were run using 5,000 bootstrap replications as outlined by Zhao et al. (Zhao et al, 2010). For the Preacher-Hayes bootstrap analysis for initial savings rate, the indirect effect was positive and marginally significant (a x b = 0.1211, p=0.095) with a 95% confidence interval that includes zero (i.e., -0.0211 to 0.2633). Although the significance levels differ from the SEM analysis, the magnitude of this effect (i.e., 0.1211) is comparable to the effect estimated via SEM (i.e., 0.12). The direct path from the independent variable to the outcome variable (i.e., path c) was not significant (c=0.091, p=0.668) although the positive sign indicates that self-reported affordability is a marginally significant, complementary mediator.

For the Preacher-Hayes bootstrap analysis for escalator rate, the indirect effect is positive and significant (a x b = 0.0859, p=0.026) with a 95% confidence interval that does not include zero (i.e., 0.0102 to 0.1615). Although the significance levels differ from the SEM analysis, the magnitude of this effect (i.e., 0.0859) is comparable to the effect estimated via SEM (i.e., 0.09). Prior to the analysis of the mediator, the direct path from the independent variable to the outcome variable (i.e., path c) was significant (c=0.562, p=0.668) and the positive sign indicates that self-reported affordability is a significant complementary and partial mediator.

1.5.4 Pennies X% and Y% Lab Study Discussion

The purpose of Pennies X% and Y% was to try to explore the effect of eliciting people's initial savings rate and escalator rate elections using pennies- versus percent-based framing. People selected an initial savings rate from 0 to 6 and an escalator rate from 0 to 3. The hopes were to eliminate the ceiling effect encountered in the Pennies 1% and 1% Lab Study. In contrast with the Pennies 1% and 1% Lab Study, the randomization for the Pennies X% and Y% Lab Study was successful across demographic and numeracy covariates. No main effect of pennies on initial savings rate was observed, yet a significant main effect on escalator rate was observed. A significant effect of pennies framing on self-reported affordability was observed, and there was a marginally significant effect of pennies framing on self-reported understandability. A floodlight analysis of the interaction between pennies framing and subjective numeracy on initial savings rate indicates directional support for pennies for those with lower subjective numeracy. A floodlight analysis of the interaction between pennies framing and subjective numeracy on escalator rate indicates directional support for pennies for those with lower subjective numeracy. Similar floodlight patterns were observed for self-reported affordability and understandability (varying ranges of significance). There was also evidence of self-reported affordability mediating treatment and outcomes.

There are several additional observations worth noting. The first observation is that there is some evidence for pennies framing affecting the initial savings rate (e.g., in the floodlight analyses and mediation), but that the simple main effect on initial rate does not seem to be observed. It is possible that technical limitations of the user interface and the resulting choice architecture, influenced people in an unintended way. Namely the user interface had a constraint that people pick an initial savings rate and then an escalator rate (through a nested menu choice where escalator rate is nested off the initial rate in a layered, dropdown menu). It is possible that people pick an initial rate without sufficiently considering the escalator rate. This constraint is relaxed in the next study by allowing users to pick initial rate and escalator rate in parallel. A parallel structure allows users to select either parameter first.

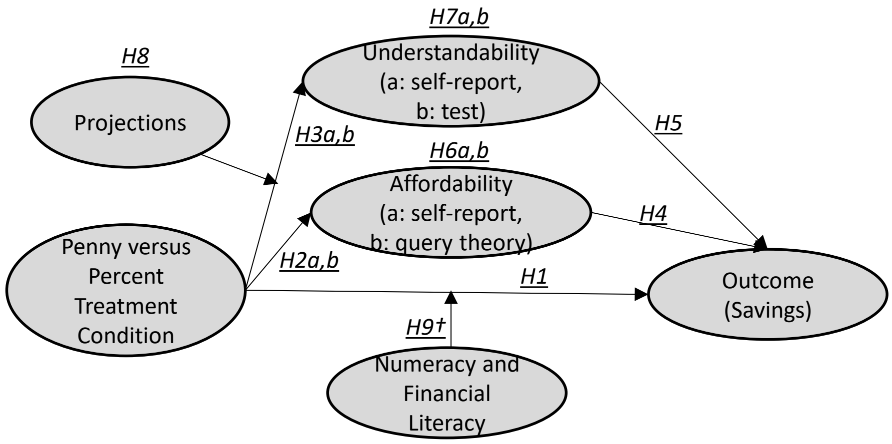
The second observation is that understandability appears to be marginally affected, and there may be something odd happening with what role understandability plays, particularly given the non-significant but negative factor loading from self-reported understandability to the outcome variable.

The third observation is that the studies so far have focused on self-reported subjective measurements due to both their more friendly nature and the scarcity of prior research on subjective numeracy as a moderator of judgments and choices. This evidence raises the question as to what extent objective measurements would play in terms of their impact on judgments and choices.

1.6 Pennies X%, Y%, and Projections Lab Study

Expanding on the boundaries and limitations of prior studies, three things are addressed as part of the research design for the next study, the Pennies X%, Y%, and Projections Lab Study. First is to relax the constraint of sequential choice of initial rate and escalator rate to include parallel choice of initial rate and escalator rate. The second thing is to manipulate understanding more strongly by implementing various forms of education and feedback (e.g., in the form of projections feedback on the implications of a participant’s elections). The third item is to include both subjective and new, objective measurements related to the mediators identified prior. Additionally, an objective measure of financial literacy is used in lieu of using a subjective numeracy measure.

Figure 1-8 indicates the hypotheses and boundary conditions being tested.



Notes: Underlining indicates the hypotheses tested. (†) indicates that financial literacy is being measured.

Figure 1-8. Hypotheses being tested in Pennies X%, Y%, and Projections Lab Study

1.6.1 Method

401 online participants were recruited in the United States between the ages of 18 and 50 years old using Amazon TurkPrime with participants randomized using four treatment conditions and a 2x2 factorial, between subject design (pennies versus percent) x (without projections versus with projections feedback). Recruitment requirements were the same as for the other two studies in this chapter, with the additional requirements that Amazon TurkPrime excluded any participants in prior two studies. During recruitment, prospective participants were told that they could participate in a study covering questions about hypothetical financial decisions and their attitudes. Given that this study elicited both subjective and objective measurements, the stimulus was expected to take somewhat longer than the other studies and range between 6 to 10 minutes. Payment for participation was $1.00.

The stimulus was implemented on Qualtrics and consisted of questions covering: 1) a pennies-based savings choice (e.g., “I would choose to save __ pennies per dollar of my salary, increasing by __ pennies per dollar of my salary every year thereafter”) or percent-based savings choice (e.g., “I would choose to save __% of my salary, increasing by __% of my salary every year thereafter”), 2) optional information and choices if the participant was randomly selected to receive “with projections” treatment stimulus (to be described below), 3) subjective attitudes toward the choice in terms affordability and understandability (as done with the prior two studies), 4) questions motivated by Query Theory (Johnson et al., 2007) as a way to objectively measure thoughts surrounding affordability (to be described below), 5) three questions to objectively measure certain aspects of a participant’s understanding of the pennies or percent stimulus and the initial savings and escalator rates (to be described below), 6) three financial literacy questions (Lusardi, 2008; Lusardi, 2012; Lusardi and Mitchell, 2014), and 7) demographics questions related to age, gender, income, and educational level. The overall architecture for the research design is depicted in Figure 1-9, and a detailed version of the stimulus is included in the Online Appendix, Chapter 1, Lab Study Materials, Section C.

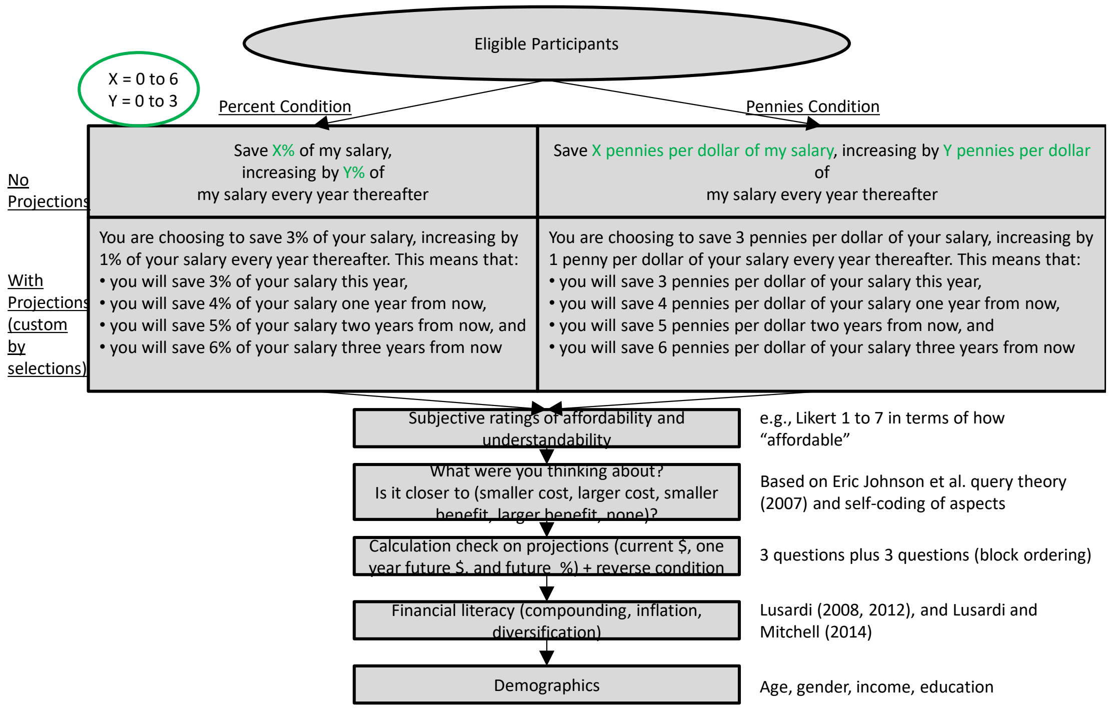


Figure 1-9. Summary of the Pennies X%, Y%, and Projections Lab Study

As outlined above for the research design, participants are placed into a treatment condition either with or without projections. The purpose of this intervention is to externally manipulate the participant's understanding by showing them the implications of their initial savings and escalator rate selections for the current year and the next three years. Participants who see projections are then able to adjust their selections (up to three times) or proceed with their choices. This stimulus occurs after a participant has made their first selections for an initial savings rate and escalator rate. The projections intervention is as follows and depends on whether the participant has been randomized into the pennies or percent branch:

> *You are choosing to save [X pennies per dollar] (X%) of your salary, increasing by [Y pennies per dollar] (Y%) of your salary every year thereafter. This means that*
>
> - *you will save [X pennies per dollar] (X%) of your salary this year,*

- *you will save [X+Y pennies per dollar] (X+Y%) of your salary one year from now,*
- *you will save [X+2Y pennies per dollar] (X+2Y%) of your salary two years from now, and*
- *you will save [X+3Y pennies per dollar] (X+3Y%) of your salary three years from now.*

For the questions motivated by Query Theory to measure objective affordability, the strategy is to first ask participants to list three items (i.e., in the literature referred to as "aspects") that they were thinking about when they made the savings selections. Then participants are asked to self-code each of the three aspects stratified along two dimensions (i.e., [smaller or larger] x [cost or benefit]). As such, coding of thoughts are based on both size and valence of the aspect. Participants could self-code aspects as "a smaller cost", "a larger cost", "a smaller benefit", "a larger benefit", or "none of the above". Note that self-coding of aspects has been used in a variety of studies (Johnson et al., 2007; Payne et al., 2013) and has produced similar results to aspects coded by independent, naive raters (Johnson et al., 2007).

Objective understanding is measured by asking participants to answer three questions related to the savings task. Namely, participants are asked to consider the situation that "a person makes $40,000 per year. This year, the person chooses to save [1 penny per dollar] (1%) of their salary, increasing by [1 penny per dollar] (1%) of their salary every year thereafter." They are then asked three, multiple choice questions about how much the person is saving this year, how much the person will be saving next year (in dollars per year), and at what rate the person will be saving two years from now (in pennies per dollar or percent of salary).

As a closing note, on August 10, 2018 Amazon TurkPrime summarized some concerns about "bots" completing studies during the period when the Pennies X%, Y%, and Projections Lab Study data was collected with the bots potentially being identifiable through duplicate GPS data.[7] Five participants had duplicate GPS locations (both same latitude and longitude), and all five of these participants identified themselves as 30-year old males, including having bot-like responses to the Query Theory questions. However, IP addresses were unique, worker IDs met criteria where HITs approved were 500+, approval rates were 95+, workers were within the United States, and workers provided correct, unique study completion codes. All five participants were excluded from the analysis due to both suspicious circumstances and responses. This corresponds to 1.2% of the sample, which based on a sample of 100,000 studies conducted on Amazon TurkPrime (detailed in the prior footnote) is below the 2.5% peak rate of submissions with duplicate GPS locations.

1.6.2 Summary Statistics and Experimental Balance

Table 1-19 summarizes the characteristics of participants for the Pennies X%, Y%, and Projections Lab Study in terms of the four treatment groups. Based on random assignment to condition, 103 participants were assigned to pennies without projections, 98 participants to pennies with projections, 102 participants to percent without projections, and 93 participants to percent with projections. The mean age of participants was 33.2 years with a standard deviation of 6.9, and an F-test does not reject the null hypothesis that the means for age are the same between conditions, but a Bartlett's chi-squared test rejects the null hypothesis that the variances are the same. More than half of the participants (55.0%) identify as male, and a chi-squared test does not reject the null hypothesis that each condition has the same proportion of males. Income bands were ordinally coded in buckets of approximately $10,000 as done for the previous two studies. On the coded scale the mean income was 5.3 (which lies between the two buckets "from $40,000 to $49,999 a year" and "from $50,000 to $59,999 a year"). An F-test and Bartlett's chi-squared test do not reject the null hypothesis that either mean or variances for income differ between conditions. In terms of reporting educational levels, a chi-squared test of proportions (% high school / % college / % advanced degree)

[7] More detail can be found on the Amazon TurkPrime blog at http://blog.turkprime.com/2018/08/concerns-about-bots-on-mechanical-turk.html (retrieved on August 11, 2018).

indicated a significant difference between proportions in pennies without projections (36.89% / 51.46% / 11.65%), pennies with projections (26.53% / 53.06% / 20.41%), percent without projections (34.31% / 58.82% / 6.86%), and percent with projections (39.78% / 52.69% / 7.53%) conditions. Most notably it can be seen that the pennies conditions (i.e., both with and without projections) included a higher proportion of those with advanced degrees as compared to percent conditions. Finally, in terms of financial literacy the mean was successfully answering 2.34 questions out of 3 with a standard deviation of 0.92, which is a distribution skewed toward the high end. Notably, the percentage of people getting all three questions correct was 59.1% which is substantially higher than has been observed broadly in the United States population. For example, one study in the US indicated a percentage of 30.2% getting all three answers correct (Mitchell et al., 2011). An F-test does not reject the null hypothesis that the means for financial literacy are the same between conditions, but a Barlett's chi-squared test rejects the null hypothesis that the variances are the same.

For the Pennies X%, Y%, and Projections Lab Study, randomization was somewhat imperfect with significant differences relative to the distribution of education and variance for both age and financial literacy. Differences in income variance were marginally significant. The high scores for financial literacy are noteworthy and may be highly related to the overall characteristics of the TurkPrime population who may, on average, be much more familiar with the financial literacy scale developed by Lusardi and Mitchell. The imperfections in randomization appear to be much narrower compared to the Pennies 1% and 1% Lab Study, as in the Pennies X%, Y%, and Projections Lab Study the population distribution only differs in significance for one covariate (i.e., education), and the means do not differ for other covariates. For the analyses that follow, no adjustments are made for potential chance biases (i.e., imbalance of demographic or behavioral covariates) beyond providing analyses with and without controls.

1.6.3 Results

To determine both the effect of pennies versus percent framing and the effect of with and without projections, four outcome variables are examined, namely initial savings rate, escalator rate, self-reported affordability, and self-reported understandability. Similar to the other studies, for pennies framing the Pennies Condition Indicator is coded as a 1, and for percent framing the Pennies Condition Indicator is coded as 0. For the treatment condition with projections, the Projections Indicator is coded as 1, and for the treatment condition without projections, the Projections Indicator is coded as 0.

1.6.3.1 Initial Savings Rate and Escalator Rate

With initial savings rate as the outcome, OLS regressions indicated a highly significant main effect of pennies framing but no main effect of providing projections ($\beta_{pennies}$=0.477, p=0.005; $\beta_{projections}$=0.191, p=0.260). The significance of the pennies framing results held with controls ($\beta_{pennies}$=0.501, p=0.004; $\beta_{projections}$=0.164, p=0.337). See Table 1-20, panel A for more details.

When looking at escalator rate as the outcome, OLS regressions also indicated a highly significant main effect of pennies framing but no main effect of providing projections ($\beta_{pennies}$=0.360, p<0.001; $\beta_{projections}$=0.091, p=0.345). The significance of the pennies framing results held with controls ($\beta_{pennies}$=0.374, p<0.001; $\beta_{projections}$=0.067, p=0.489). See Table 1-20, panel B for more details.

1.6.3.2 Self-Reported Affordability and Understandability

To test the effect on self-reported affordability as the outcome, OLS regressions indicated a highly significant main effect of pennies framing but no main effect of providing projections ($\beta_{pennies}$=0.417, p<0.001; $\beta_{projections}$=0.028, p=0.798). The significance of the pennies framing results held with controls ($\beta_{pennies}$=0.411, p<0.001; $\beta_{projections}$=0.020, p=0.855). See Table 1-21 for more details.

When testing effects on self-reported understandability as the outcome, OLS regressions indicated a significant main of both pennies framing and providing projections ($\beta_{pennies}$=0.209, p=0.043; $\beta_{projections}$=0.234, p=0.023). The significance results held with controls ($\beta_{pennies}$=0.213, p=0.043; $\beta_{projections}$=0.209, p=0.045). The significance of projections on self-reported understandability is indicative that the intervention was successful. See Table 1-22 for more details.

1.6.3.3 Moderator Analysis of Individual Behavioral Differences

The next analysis covers the role of financial literacy to see whether a participant's familiarity with financial concepts also moderates effects similar to that seen for subjective numeracy in the prior studies. The analysis includes spotlight regressions for financial literacy scores from 0 to 3 with intervals set at 1 between focus points.

When examining simple main effects related to initial savings rate and financial literacy as a moderator, the interaction between financial literacy and treatment condition is significant (β=-0.663, p<0.001) without controls. Treatment differences for pennies are highly significant for all except those most financially literate, with the point estimate at financial literacy = 0 (i.e., for those with lowest financial literacy) indicating that pennies treatment results in more than a 2-percentage point increase in initial savings rate ($\beta_{financial\_literacy=0}$=2.050, p<0.001) without controls. The point estimate on treatment differences gradually decreases with increasing financial literacy until financial literacy = 2 ($\beta_{financial\_literacy=2}$=0.723, p<0.001). At financial literacy = 3 (i.e., the highest financial literacy), the treatment benefit vanishes ($\beta_{financial\_literacy=3}$=0.060, p=0.770). When analyzing these effects with controls, the results are similar ($\beta_{interaction}$=-0.661, p<0.001; $\beta_{financial\_literacy=0}$=2.061, p<0.001; $\beta_{financial\_literacy=2}$=0.738, p<0.001; $\beta_{financial\_literacy=3}$=0.077, p=0.710). See Table 1-23, panels A and B for more details on the floodlight analyses.

When looking at escalator rate as the outcome, the interaction between financial literacy and treatment condition is directional (β=-0.123, p=0.229) without controls. The differences of treatment condition related to escalator rate and financial literacy as a moderator are significant at all levels of financial literacy from 0 to 3 with point estimates of the effect being most positive for the least financially literate ($\beta_{financial\_literacy=0}$=0.641, p=0.013; $\beta_{financial\_literacy=3}$=0.271, p=0.019). When using controls, the effects sizes are similar across the range ($\beta_{interaction}$=-0.114, p=0.266; $\beta_{financial\_literacy=0}$=0.643, p=0.013; $\beta_{financial\_literacy=3}$=0.302, p=0.010). See Table 1-23, panels C and D for more details on the floodlight analyses.

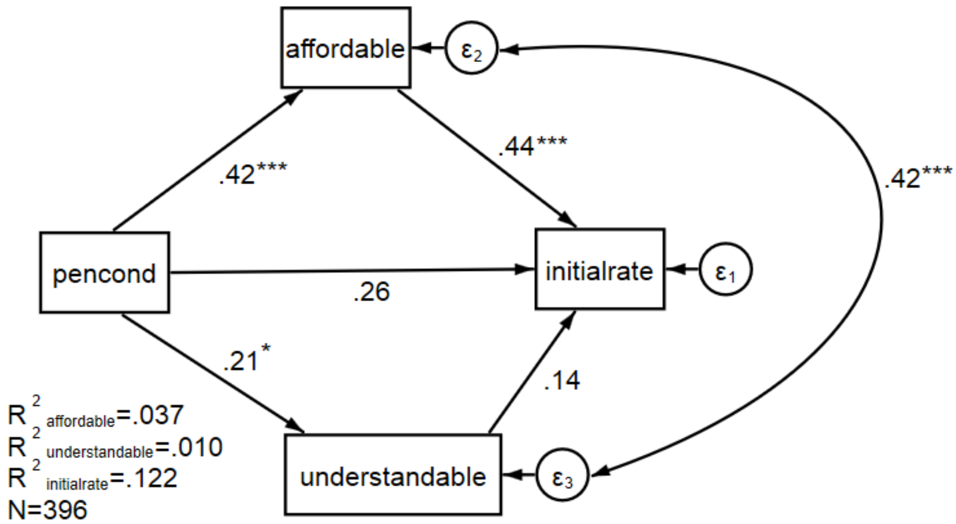
Positive results occur throughout the financial literacy range when performing a similar series of spotlight analyses on self-reported affordability as the outcome measure, although the interaction between financial literacy and treatment condition is not significant (β=0.077, p=0.514). Point estimates are that the most positive effects are on those who have the highest financial literacy ($\beta_{financial\_literacy=0}$=0.230, p=0.440; $\beta_{financial\_literacy=3}$=0.462, p=0.001). Similar results are observed when using controls ($\beta_{interaction}$=0.083, p=0.478; $\beta_{financial\_literacy=0}$=0.211, p=0.475; $\beta_{financial\_literacy=3}$=0.460, p=0.001). See Table 1-24, panels A and B for more details on the floodlight analyses.

When looking at understandability as the outcome, the interaction between financial literacy and treatment condition is directional (β=-0.120, p=0.281) without controls. The trend for self-reported understandability for pennies treatment appears to be highest for those with the lowest financial literacy and positive across the range ($\beta_{financial\_literacy=0}$=0.469, p=0.093; $\beta_{financial\_literacy=3}$=0.111, p=0.374), but the range of significance is narrow and limited to one Johnson-Neyman point observed at financial literacy = 2 ($\beta_{interaction}$=-0.111, p=0.318; $\beta_{financial\_literacy=2}$=0.230, p=0.034). Using controls yields similar trending results ($\beta_{financial\_literacy=0}$=0.453, p=0.107; $\beta_{financial\_literacy=3}$=0.119, p=0.346) with a narrow range of significance at financial literacy = 2 ($\beta_{financial\_literacy=2}$=0.231, p=0.037). See Table 1-25 for more details.

1.6.3.4 Mediation Analysis of Psychological Measures

For analyzing to what extent self-reported affordability and understandability may mediate effects between pennies framing and savings outcomes, two structural equation model (SEM) analyses were performed with initial savings rate and escalator rate as outcomes. These mediation analyses were performed using Stata 15 and 1,000 bootstrap replications. Modelling assumed correlated residuals for affordability and understandability.

With initial savings rate as the outcome variable, self-reported affordability is highly significantly and fully mediates the effect between pennies condition framing and initial savings rate. The indirect effect using unstandardized coefficients is 0.18 (i.e., 0.42 times 0.44). Error terms for affordability and understandability are correlated (r=0.42, p<0.001). It is noteworthy to point out a significant, positive direct effect of pennies framing on self-reported understandability (b=0.2060, z=2.02, p<0.043), but there is an absence of a direct effect of understandability on the outcome (b=0.1351, z=1.50, p<0.107), and the point estimate is positive. Direct effects are provided in Table 1-26 panel A, and a path diagram is provided in Figure 1-10.



+, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001

Figure 1-10. Pennies X%, Y%, and Projections Lab Study Mediation Analysis and Path Diagram for Initial Rate

With escalator rate as the outcome variable, self-reported affordability is highly significant and partially mediates the effect between pennies condition framing and escalator rate. The mediation is complementary, and the indirect effect is 0.11 using unstandardized coefficients (i.e., 0.42 times 0.27). The direct effect of the pennies condition on escalator rate is highly significant (b=0.2637, z=2.83, p=0.005). Error terms for affordability and understandability are correlated (r=0.42, p<0.001). It is noteworthy to point out a significant, positive direct effect of pennies framing on self-reported understandability (b=0.2060, z=2.02, p<0.043), but there is an absence of a direct effect of understandability on the outcome (b=-0.0861, z=-1.57, p<0.117), and the point estimate is negative. Direct effects are provided in Table 1-26 panel B, and a path diagram is provided in Figure 1-11.

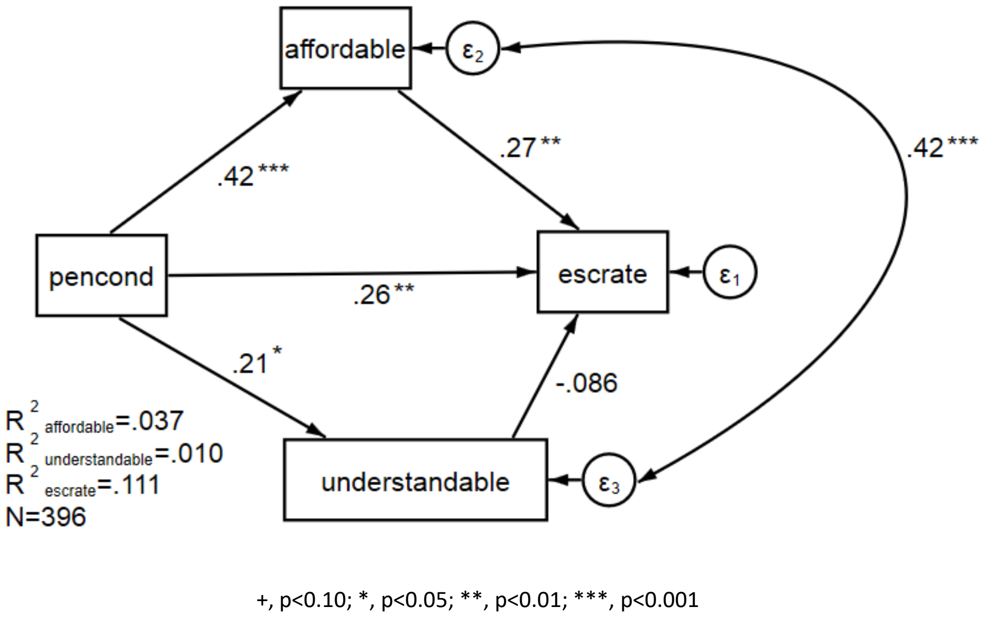


Figure 1-11. Pennies X%, Y%, and Projections Lab Study Mediation Analysis and Path Diagram for Escalator Rate

Given that understandability was not significant as a mediator, as robustness checks separate Preacher-Hayes mediation analyses were run with self-reported affordability mediating pennies framing on outcomes of initial savings rate and escalator rate. These mediation analyses were run using 5,000 bootstrap replications as outlined by Zhao et al. (Zhao et al, 2010).

For the Preacher-Hayes bootstrap analysis for initial savings rate, the indirect effect is positive and significant (a x b = 0.2054, p=0.001) with a 95% confidence interval that does not include zero (i.e., 0.0850 to 0.3258). The magnitude of this effect (i.e., 0.2054) is comparable to the effect estimated via SEM (i.e., 0.18). Prior to analysis of the mediator, the direct path from the independent variable to the outcome variable (i.e., path c) was significant (c=0.477, p=0.005), and the positive sign indicates that self-reported affordability is a significant complementary mediator.

For the Preacher-Hayes bootstrap analysis for escalator rate, the indirect effect is positive and significant (a x b = 0.0999, p=0.002) with a 95% confidence interval that does not include zero (i.e., 0.0351 to 0.1646). The magnitude of this effect (i.e., 0.0999) is comparable to the effect estimated via SEM (i.e., 0.11). Prior to the analysis of the mediator, the direct path from the independent variable to the outcome variable (i.e., path c) was significant (c=0.360, p<0.001), and the positive sign indicates that self-reported affordability is a significant complementary and partial mediator.

1.6.3.5 Analysis of Objective Understandability Based on Presentation of Projections

A measure of objective understandability is constructed by adding up total number of questions out of three that a participant gets correct related to the specific savings task described in the Method section. Objective understandability is then used as an outcome variable and regressed against pennies condition indicator, projections indicator, and with and without an integer from 0 to 3 which represents the number of times a participant loops back to change their savings elections after seeing the projected savings. The purpose of these regressions is to better understand the role of pennies framing, the presentation of projections information, and the effect of interactive education information that permits people to loopback and change elections. OLS regressions with controls indicate that there is a small and significant main effect of pennies condition treatment framing reducing objective understandability ($\beta_{pennies}$=-0.277, p=0.009), no significant effect of presenting projections information ($\beta_{projections}$=-0.0957554, p=0.377), and a significant effect of interactive loopbacks increasing understanding per loopback ($\beta_{loopbacks}$=0.6486245, p=0.023), which suggests that a single loopback may completely offset the negative effect of pennies framing on objective understandability and increase objective understandability. See Table 1-27 for more details.

Turning from the psychology to outcomes, when participants optionally choose to loop back the net effect appears to be that they lower their savings rates. When OLS regressions are run with initial savings rate against pennies condition, projections indicator, number of loopbacks, and controls, the coefficient on the number of loopbacks is marginally significant and negative ($\beta_{loopbacks}$=-0.761, p=0.099). When the same OLS regressions are run with escalator rate as the outcome variable, the coefficient on the number of loopbacks is highly significant and negative ($\beta_{loopbacks}$=-0.796, p=0.002). See Table 1-28 for more information.

1.6.3.6 Analysis of Psychological Judgments Using Query Theory

On the topic of objective affordability, participants are first asked to list three things (called “aspects” using Query Theory terminology) that they were thinking about when making the savings decision and then asked them to self-code the aspects that they were thinking about. Because the hypothesis is that aspects associated as either smaller costs or larger benefits would increase savings and perceptions of affordability, a coding scheme was selected that aligns at a high-level with the value function in the evaluation of risky prospects (Kahneman and Tversky, 1979). Namely, the following scheme was used to code participant responses for each of the 3 aspects:

- a smaller cost (cost = +1, benefit = 0),
- a larger cost (cost = -1, benefit = 0),
- a smaller benefit (cost = 0, benefit = -1),
- a larger benefit, (cost = 0, benefit = 1), and
- none of the above (cost = 0, benefit = 0).

In other words, each of the 3 aspects were coded with two variables, namely a cost variable and a benefit variable. This results in six independent variables as measures of objective affordability, and these were used within regression analyses.

When looking at initial savings rate as the outcome variable with the treatment condition, projections indicator, number of loopbacks, Query Theory variables, and controls, OLS results generally indicate that mental associations of smaller costs and larger benefits matter. All significant coefficients for the aspects have positive valence ($\beta_{aspect1\_cost}$=0.296, p=0.035; $\beta_{aspect2\_benefit}$=0.362, p=0.005; $\beta_{aspect3\_benefit}$=0.360, p=0.003). See Table 1-29, column 1 for more details.

When looking at escalator rate as the outcome variable with the treatment condition, projections indicator, number of loopbacks, Query Theory variables, and controls, OLS results generally indicate that the extent to which mental associations of smaller costs and larger benefits matter is insignificant with exception to one independent variable ($\beta_{aspect2\_benefit}$=0.151, p=0.042). Conceptually it makes sense that the relationship between affordability and the escalator rate should be weaker than between affordability and the initial savings rate (because escalators are conceptually more abstract), so the reduced number of significant coefficients is directionally logical. Note that there is no good theoretical account relative to the pennies intervention as to why the second recalled aspect (but not the first aspect) should be significant, especially relative to benefits, so statistical significance on $\beta_{aspect2\_benefit}$ may be spurious or an artifact of participants providing cost explanations for their first responses and contrasting subsequent responses with a benefit explanation. See Table 1-29, column 2 for more details on OLS results.

To provide some sense of the relationship between subjective and objective affordability, a similar OLS regression was run with subjective affordability as the outcome variable with Query Theory variables as independent variables. All significant coefficients for the aspects are positive signed ($\beta_{aspect2\_benefit}$=0.206, p=0.028; $\beta_{aspect3\_cost}$=0.296, p=0.006; $\beta_{aspect3\_benefit}$=0.250, p=0.002). This suggests that subjective and objective affordability are complementary to one another. See Table 1-30 for more details which also includes a separate regression with other covariates included.

To analyze to what extent subjective affordability, objective affordability (via the Query Theory aspects as separate measures), subjective understandability, and objective understandability may mediate effects between pennies framing and savings outcomes, two structural equation model (SEM) analyses were run with initial savings rate and escalator rate as outcomes. These mediation analyses were performed using Stata 15 and maximum likelihood estimations. Because a number of these measures are likely to measuring similar underlying constructs, pairwise, correlated residuals were assumed between:

- subjective affordability and subjective understandability,

- subjective understandability and objective understandability,
- aspect 1 cost and aspect 2 cost,
- aspect 2 cost and aspect 3 cost,
- aspect 1 benefit and aspect 2 benefit, and
- aspect 2 benefit and aspect 3 benefit.

While other correlations are possible from a technical perspective related to the Query Theory aspects, from a theoretical perspective it seems more holistic to only assume correlations between thoughts that both occur closer together in time and are of the same valence.

With initial savings rate as the outcome variable, both self-reported affordability and aspect 1 cost (i.e., the first thought around smaller costs) serve as complementary mediators between the pennies condition framing and initial savings rate. Note that the direct effect of pennies condition on initial savings rate is marginally significant ($b=0.3056$, $z=1.89$, $p=0.059$). For the mediation path for subjective affordability, the factor from pennies condition to subjective affordability is significant ($b=0.4170$, $z=3.88$, $p<0.001$), and the factor from subjective affordability to initial rate is significant ($b=0.3944$, $z=4.89$, $p<0.001$). For the mediation path for aspect 1 cost, the factor from pennies condition to aspect 1 cost is significant ($b=0.1382$, $z=2.28$, $p=0.022$) and the factor from aspect 1 cost to initial savings rate is significant ($b=0.2724$, $z=2.09$, $p=0.036$). Objective understandability is a competitive mediator with the factor from pennies condition to objective understandability being negative and significant ($b=-0.2573$, $z=-2.49$, $p=0.013$), and the factor from objective understandability being positive and significant ($b=0.1757$, $z=2.31$, $p=0.021$). All other mediation paths are insignificant. See Table 1-31 for more details, and a path diagram is depicted in Figure 1-12.

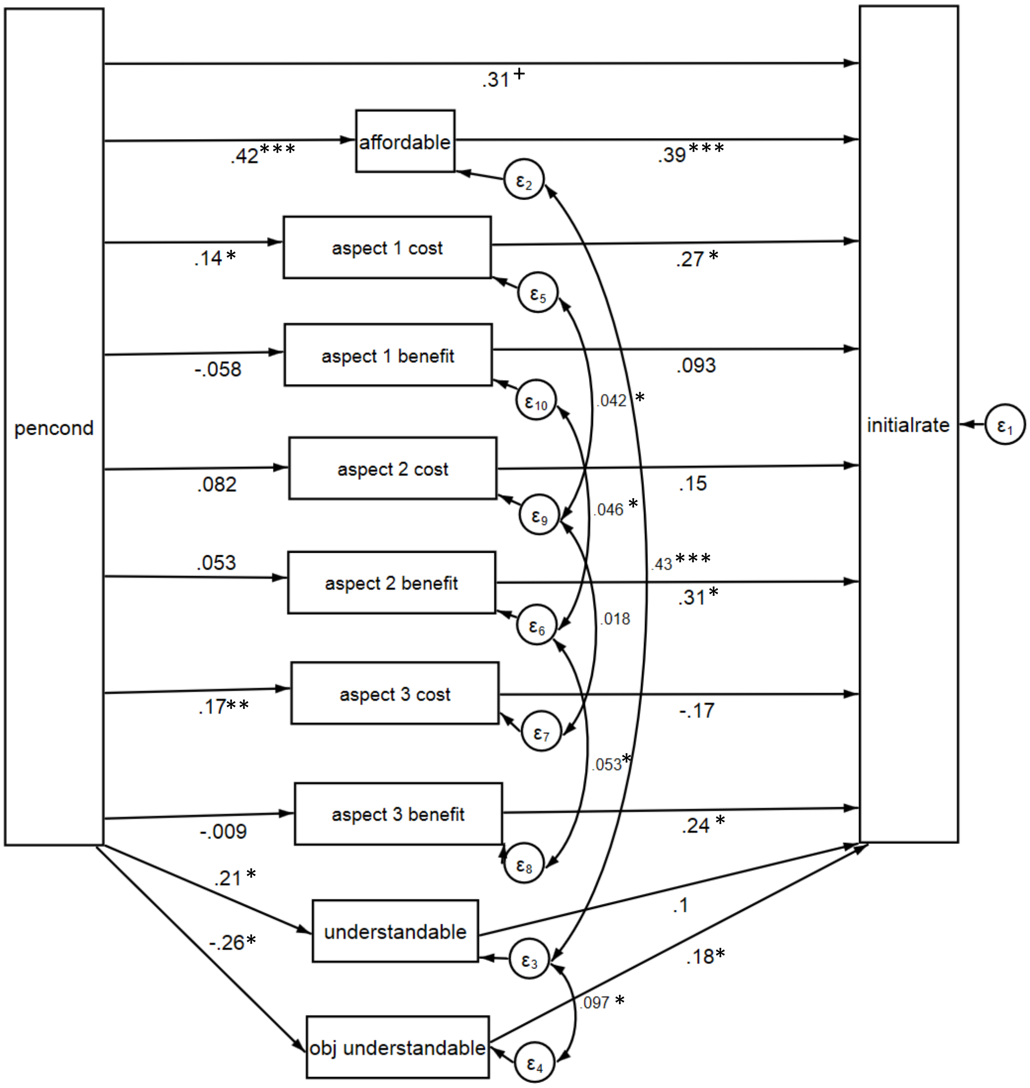


Figure 1-12. Pennies X%, Y%, and Projections Lab Study Mediation Analysis and Path Diagram for Initial Rate and Using Query Theory

When performing a similar analysis on escalator rate as the outcome variable, only self-reported affordability serves as complementary mediators between the pennies condition framing and initial savings rate. Note that the direct effect of pennies condition on escalator savings rate is significant (b=0.2483, z=2.62, p=0.009). For the mediation path for subjective affordability, the factor from pennies condition to subjective affordability is significant (b=0.4170, z=3.88, p<0.001), and the factor from subjective affordability to escalator rate is significant (b=0.2600, z=5.52, p<0.001). Objective understandability is a complementary mediator with the factor from pennies condition to objective understandability being negative and significant (b=-0.2573, z=-2.49, p=0.013), and the factor from objective understandability also being negative and significant (b=-0.1253, z=-2.82, p=0.005). All other mediation paths are insignificant. See Table 1-32 for more details, and a path diagram is depicted in Figure 1-13.

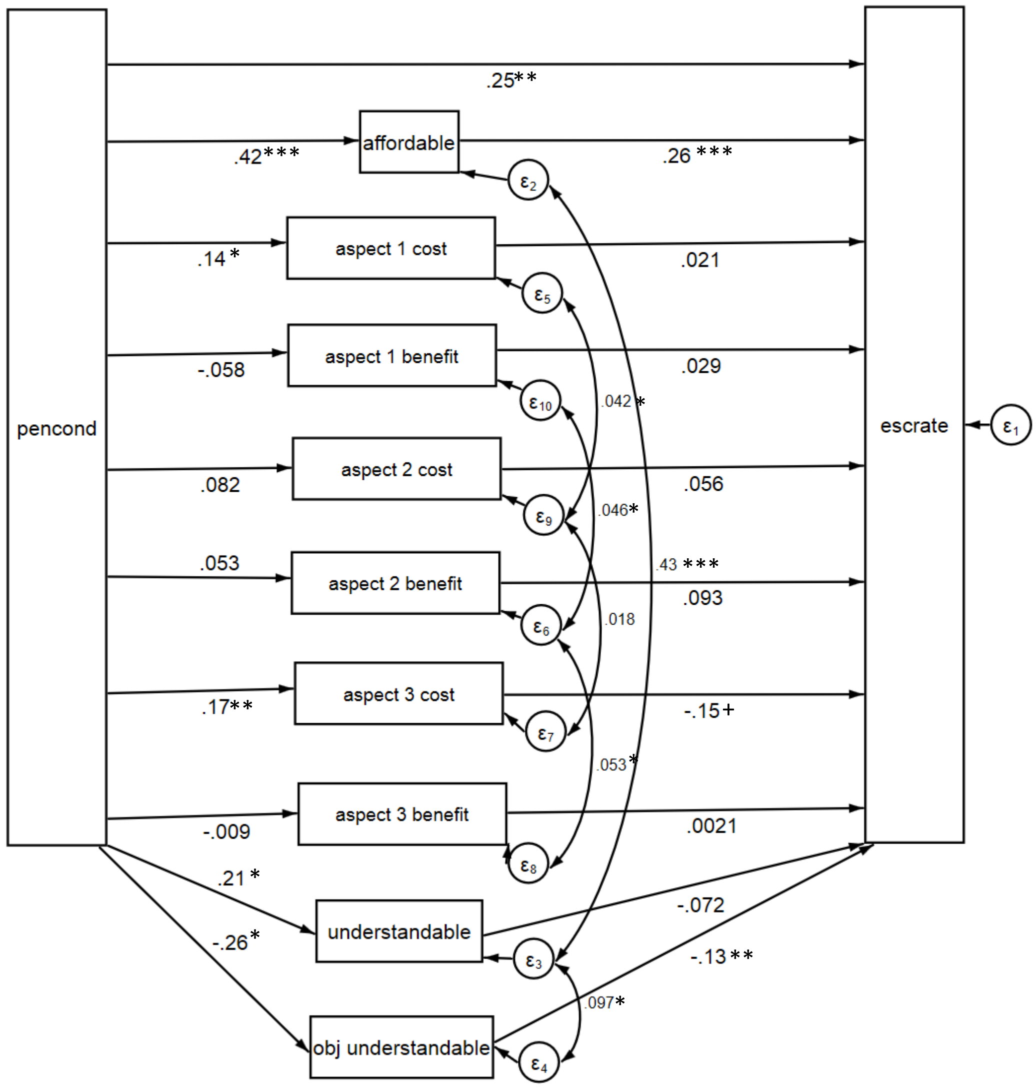


Figure 1-13. Pennies X%, Y%, and Projections Lab Study Mediation Analysis and Path Diagram for Escalator Rate and Using Query Theory

1.6.4 Pennies X%, Y%, and Projections Lab Study Discussion

The purpose of the X%, Y%, and Projections Lab Study was to try to explore the effect of eliciting people's initial savings rate and escalator rate elections using a pennies- versus percent-based frame using a between subject design with several design enhancements. Since escalators can be confusing, one design enhancement was to try to manipulate understandability through an exogenous intervention of providing some participants with projections information relative to their elections for initial savings and escalator rates. A second design enhancement was to enable participants to select either initial rate or escalator rate first and manipulate their choices in parallel until they were satisfied to continue. A third design enhancement included using objective measurements of affordability (through a stimulus based on Query Theory) and objective measurements of understandability (through a proxy-like, custom test that asks the participant to consider initial savings rate and escalator elections for a hypothetical person).

In the X%, Y%, and Projections Lab Study, evidence supports significant main effects of pennies framing on both initial savings rate (nearly 0.5% increase) and escalator rates (more than 0.3% increase) as compared to percent framing when setting mediation and moderation analyses aside. Participants also reported both higher subjective affordability and higher subjective understandability using pennies framing. Objective understandability (as specifically measured) does seem to be decreased somewhat by using pennies framing, and the use of projections information did not seem to improve objective understandability unless a person chose to loopback and take actions based on the projections to change their elections. When people looped back, they did appear to lower their initial savings rate and escalator rates. This behavior may be a result of people seeing savings figures that seemed too high for them.

In terms of other psychological aspects involved, financial literacy moderated both choices and subjective attitudes to varying degrees. This seems to provide additional evidence that pennies framing makes savings concepts more relatable to those with lower financial literacy. Evidence also showed both subjective affordability and objective affordability (particularly relative to initial thoughts and recalled aspects about smaller costs) mediating initial savings rate choices. In the case of escalator rate choices, subjective affordability seems to play a role whereas objective affordability effects were not significant as a mediator. The mediating role of objective understandability is a bit of a mixed story. Relative to initial rates, objective understandability seems to competitively mediate pennies framing to initial rates. That is, lowered objective understandability seems to have an effect of lowering the initial savings that might otherwise be selected. On the other hand, objective understandability mediates in a complementary but unusual way for escalator rate. Namely, lowered objective understandability leads to higher selected escalator rates (due to double negative signs on the factors leading to and away from the mediator). If one takes the perspective that people should err on the side selecting higher escalators, then this works favorably from an outcome perspective. But the observation of a negative factor from objective understandability to the outcome variable of escalator rate does raise questions about escalators in general, such as whether educating people about escalators can create negative demand for escalators under certain conditions.

1.7 General Discussion

The next subsections recap the original hypotheses posed at the beginning of the paper (depicted in Figure 1-1) and discuss commonalities and differences observed across the studies. A summary of hypotheses and key findings for each of the studies in captured in Table 1-33. The paper then outlines contributions, limitations, and areas for future research.

1.7.1 Psychological Mechanisms

1.7.1.1 Pennies-Based Framing and Savings Choices

Hypothesis H1 is that "Pennies-based framing will increase retirement savings choices relative to percent-based choices," and the studies generally show support for this hypothesis. That is pennies-based framing has a positive effect on main outcomes related to initial savings rates and especially the escalator rate. This is particularly true for the Pennies X%, Y%, and Projections Lab Study where ceiling effects and choice constraints (e.g., requiring initial rate to be selected first) were removed as compared to the other studies. The evidence for pennies-based framing having a positive effect on outcomes is also supported by the psychological mechanisms and individual behavioral differences discussed in the following subsections.

1.7.1.2. Pennies-Based Framing and Subjective Affordability

Hypothesis H2a is that “Subjective affordability will be higher in pennies-based framing,” and the studies generally show support for this hypothesis. Both the Pennies X% and Y% Lab Study, and the Pennies X%, Y%, and Projections Lab Study show significant main effects, and the Pennies 1% and 1% Lab Study shows directionally positive support. It seems highly plausible that support was only directionally positive for the Pennies 1% and 1% Lab Study due to ceiling effects, and that if a plan sponsor were to implement such low suggested savings rates (i.e., starting at 1% of salary) that there would be little to no difference between pennies- and percent-based framing.

1.7.1.3 Pennies-Based Framing and Objective Affordability

Hypothesis H2b is that “Objective affordability will be higher in pennies-based framing,” and the Pennies X%, Y%, and Projections Lab Study (the only study testing objective thoughts) shows support for this hypothesis. When participants were asked to recall things they were thinking about when making their savings choices and then coded their choices, the first aspect (i.e., first recalled thought) showed significance as being associated with a smaller cost (in contrast to being a larger cost, benefit, or neither). In other words, the Pennies X%, Y%, and Projections Lab Study shows direct, objectively measured psychological evidence that pennies-based framing makes savings seem less painful (or in the terminology of prospect theory, resemble a smaller loss). What is a bit counterintuitive is observing a main effect on the third aspect. However, it seems possible that this is an artifact of using a Query Theory model where there was a forced elicitation of three thoughts (i.e., aspects). In the original Query Theory, participants offer as many thoughts as they choose. They can stop after providing one aspect. Here, by forcing three aspects, it seems plausible that participants may offer their best reason first, but then offer subsequent thoughts that may be more driven by the demand process than the decision process. In any case, as will be discussed later, this third aspect does not seem to matter much as it does not mediate between pennies framing and outcomes.

1.7.1.4 Pennies-Based Framing and Subjective Understandability

Hypothesis H3a is that "Subjective understandability will be higher in pennies-based framing," and the studies show support for this hypothesis, although the effect sizes are comparatively weaker relative to that observed for subjective affordability. The Pennies X%, Y%, and Projections Lab Study shows significant main effects on subjective understandability including in the context of the higher constraints imposed by structural equation modeling. The Pennies X% and Y% Lab Study shows directionally positive support. It seems highly plausible that support was insignificant and directionally negative for Pennies 1% and 1% Lab Study due to ceiling effects. In a nutshell, people seem to subjectively view pennies framing as both more affordable and understandable as compared to percent framing.

1.7.1.5 Pennies-Based Framing and Objective Understandability

Hypothesis H3b is that "Objective understandability will be higher in pennies-based framing," and the results of the Pennies X%, Y%, and Projections Lab Study seem to reject this hypothesis with the main effect being that objective understandability is negatively impacted. As will be discussed later this leads to a competitive mediation process which somewhat (not fully) counteracts the benefit of savings being raised due to higher subjective affordability, and people lower their savings rates. At this point, it is important to mention that objective understandability was measured (as listed in the Online Appendix, Chapter 1, Lab Study Materials, Section C) using a pennies or percent specific stimulus with a hypothetical third-party saving and then asking the participant questions about the other person in terms of total dollars saving this year, total dollars saving next year, and savings rates in two years. In other words, the measurement of objective understandability is a proxy for one's own understanding using someone else's situation. To the extent that self-other gaps exist relative to cognitive calculations of savings, the measure of objective understandability may be limited.

1.7.1.6 Subjective Affordability and Savings Choices

Hypothesis H4 is that “Affordability will explain retirement savings choices,” and the Pennies X% and Y% Lab Study, and the Pennies X%, Y%, and Projections Lab Study show support for this hypothesis with significant, positive effects of subjective affordability explaining both higher initial savings rates and higher escalator rates. Due to ceiling effects in the Pennies 1% and 1% Lab Study, this analysis did not apply. In other words, of the psychological mechanisms explored in this paper, raising people’s perceptions of subjective affordability result in higher rates of savings.

1.7.1.7 Subjective Understandability and Savings Choices

Hypothesis H5 is that “Understandability will explain retirement savings choices,” and neither the Pennies X% and Y% Lab Study nor the Pennies X%, Y%, and Projections Lab Study support this hypothesis. Surprisingly, higher levels of subjective understandability neither seem to explain higher initial savings rate nor escalator rate choices.

1.7.1.8 Pennies-Based Framing and Psychological Processes of Affordability on Outcomes

Hypothesis H6 is that “Affordability will partially mediate the relationship between pennies-based framing and retirement savings choices,” and generally the studies support this hypothesis from multiple angles. Namely, both psychological processes of subjective and objective affordability work in concert (i.e., complementary mediation) with pennies-based framing to raise both initial savings rates and escalators rates. More specifically in the Pennies X% and Y% Lab Study, subjective affordability fully mediates initial rate choices and partially mediates escalator rate choices. In the Pennies X%, Y%, and Projections Lab Study which adds Query Theory approaches to objectively measuring psychological processes, similar mechanisms and effect patterns are observed for subjective affordability on outcomes. Additionally, in the Pennies X%, Y%, and Projections Lab Study we see a significant complementary mediating effect of objective affordability (i.e., in terms of the first recalled thoughts of participants) on initial savings rate. However, we do not observe any mediating effect of objective affordability on escalator rate. This latter observation seems to make intuitive sense as saving escalators are conceptually more abstract and probably further removed objective psychological thoughts as compared to the initial savings rate.

1.7.1.9 Pennies-Based Framing and Psychological Processes of Understandability on Outcomes

Hypothesis H7 is that "Understandability will partially mediate the relationship between pennies-based framing and retirement savings choices," and this hypothesis is only partially supported for objective understandability (in mixed ways) and not supported for subjective understandability. While it is true that pennies based framing leads to higher subjective understandability, objective understandability is somewhat lowered. From there, higher levels of subjective understandability do not translate to higher savings rates (i.e., no mediation observed). On the other hand, the lowered objective understandability seems to lower people's choices of initial savings rates (i.e., competitive mediation) and yet raise their choices of escalator rate (i.e., complementary mediation). In other words, subjective and objective thoughts diverge when it comes to understandability, and the net result is that the objective thoughts somewhat counteract the benefits of pennies-based framing in terms of initial savings rates. An additional interpretation (from an understandability perspective) is that pennies-based framing seems to influence people to defer benefits from the present (i.e., through the initial savings rate) into the future (i.e., through the rate escalator).

1.7.1.10 Impact of Interactive Education on Understandability

Hypothesis H8 is that "Providing participants with an opportunity to adjust their choices after presenting them with escalator projections will increase understandability of retirement savings choices," and this hypothesis is partially supported. Namely in the Pennies X%, Y%, and Projections Lab Study, objective understandability is positively impacted, but only in cases where participants interact with the projection information (i.e., by looping back to make their savings selections again). That is, the presence of projections information appears to affect objective understandability only if the participant interacts with it in some way. The mere presence of projections information does not seem to have any impact. But the result of interacting with the projections information is that people do better on the objective understandability test. This raises an interesting point that if people have concerns about lower objective understandability through pennies framing that this potentially can be reversed through using interactive tools.

1.7.1.11 Impact of Numeracy and Financial Literacy on Savings Choices

Hypothesis H9 is that "Numeracy and financial literacy will moderate choice in pennies-based framing," and the studies generally support this hypothesis. When looking at the studies in total, it appears as though those with the lowest numeracy and financial literacy will be helped the most to save at higher rates. In the Pennies 1% and 1% Lab Study where a ceiling effect was encountered, it was observed that those with the highest numeracy were impacted most, but for the Pennies X% and Y% Lab Study and the Pennies X%, Y%, and Projections Lab Study, the data reveals patterns of savings rates that are differentially impacted more positively for those with lower numeracy or financial literacy.

1.7.2 Conclusion

This research serves to explore a novel, savings choice architecture that is essentially not available in the market save for a handful of plans but if made more widely available could help those who are less numerate or financially literate. The studies demonstrate that pennies-based framing could encourage those types of people to save more money by making the savings choice seem less intimidating and more affordable. Seemingly small changes to initial savings rates and escalator rates can have a dramatic impact on increasing retirement savings. While effect sizes in lab studies may differ from those experienced in the field, using an illustrative example of an average person starting to save at age 30 with an annual salary of $40,000, no salary increases, real returns on savings of 4% (compounded monthly), an escalator cap of 10% of salary, a job tenure of five years, then the average person will have saved approximately 20% more under pennies based framing by age 32, and by age 65 they will have a total of $209,106 versus $170,103 saved (which is $39,003 more or nearly one year more of salary).[8]

This paper also explored in detailed the psychological mechanisms in play during savings choices that included an initial savings rate and escalator rate. The author is not aware of other studies that look at the psychology of these types of decisions, especially relative to the escalator rate, which is a complicated concept but one that has a big impact on outcomes. Revisiting the prior example, if an escalator is not implemented, then by age 65 the average person would have a total of $122,848 versus $106,698 saved in the pennies versus percent conditions, respectively. When contrasted against the totals of $209,106 versus $170,103 with the escalator, then the impacts of the escalator could account for approximately 40% of total savings at retirement.

Finally, this paper also explores the moderating role of individual differences, particularly subjective numeracy and financial literacy. Research that includes subjective numeracy and savings is scarce. The SNS-3 can be an important concept in administering numeracy assessments in a friendly way to those populations of people who may be more sensitive to being tested (e.g., those with the lowest income, least education, lowest numeracy). This paper provides some evidence that supports the use of SNS-3 as a subjective numeracy scale for choice problems in the financial services space.

The importance of individual differences is underscored by the following illustrative example, which demonstrates how pennies reframing could have an even more dramatic impact on increasing retirement savings for those with lower income who are the least financially literate. Using an illustrative example of an average person starting to save at age 30 with an annual salary of $25,000, no salary increases, real returns on savings of 4% (compounded monthly), an escalator cap of 10% of salary,

[8] This illustration further assumes the baseline initial savings rates, escalator rates, and income adjustments for a $40,000 annual salary per the Pennies X%, Y%, and Projections Lab Study and outlined in Table 1-20. Namely, under percent based framing the initial savings rate is 3.31% and escalator rate is 1.04%. Furthermore, under pennies based framing the initial savings rate is boosted 0.50 percentage points to 3.81%, and the escalator rate is boosted 0.37 percentage points to 1.41%.

a job tenure of five years, then this person will have saved on the order of 60% more by age 65 in pennies versus percent framing. That is such a person would have a total of $165,845 versus $99,808 saved (which is $66,037 more or more than two years of salary).[9]

Additional areas for further research include implementing the pennies framing concept within a field context and seeing to what extent results seen in lab may translate to actual savings rate choices in the real world. Ideally one would identify a sample population with a large percentage of people on the lower end of the income spectrum, say between $25,000 and $50,000 and diverse levels of numeracy. Potential approaches could include implementing the savings choice environment directly within one or more companies. Other possibilities might include implementing the choice environment through a technology provider, such as a recordkeeper in the retirement space that provides services to other companies. This is the approach that is explored in Chapter 2 of this thesis.

In terms of the choice problem itself, there are other variations of potential interest. For example, only a minority of companies implement a rate escalator. It would be useful to conduct additional research that focuses on the initial rate only, perhaps the escalator only, or a mix. Additionally, the research here limited a person's choice for initial savings rates to be between 0% and 6%. The research also limited a person's choices for rate escalators to be between 0% and 3%. The purpose of this limitation was largely driven by a desire to keep the numbers within ranges set by current social norms within the retirement industry. However, these constraints were stylized for the purposes of conducting lab studies. Another key choice item to address might be the mechanics of the escalator, specifically the escalator rate cap (where the SECURE Act of 2019 recently extended safe harbor provisions for escalator caps from 10% to 15%). The lab studies conducted here did not specify a cap at which the escalations would stop (which was intended to avoid

[9] This illustration further assumes the baseline initial savings rates, escalator rates, and income adjustments for a $25,000 annual salary per the Pennies X%, Y%, and Projections Lab Study and outlined in Table 1-20. Namely, under percent based framing the initial savings rate is 3.15% and escalator rate is 0.94%. Furthermore, under pennies based framing the initial savings rate is boosted 2.06 percentage points to 5.21%, and the escalator rate is boosted 0.64 percentage points to 1.60%. Note that the differential boost rates are based on the point estimates for the least financially literate as estimated through spotlight analysis and outlined in Table 1-23.

psychological anchoring effects). However, it is plausible that the lack of an escalator cap creates anxiety and depresses the percentage of people that would select an escalator.

In terms of further research regarding psychological processes, the role of interactive tools and education should be further explored. For example, people may not reflect enough about savings choices (both in the lab and the real world). Perhaps they should be required to go through certain just-in-time education, such as education about savings rate escalators. In the Pennies X%, Y%, and Projections Lab Study, interaction with educational information was optional, but this could have been required. Finally, as can be seen for the analyses regarding the savings escalator, the main effect of pennies framing on escalator rates were only partially mediated. This suggests that there are still hidden complementary mediators that have not been explained relative to pennies framing and the effects on escalator choices. It may be hard to get at these psychological mechanisms without 1) separating the initial rate from the escalator rate choice and 2) doing separate Query Theory or other psychological explorations to tease out potential confounds with the joint choice problem and limitation of the experimental design.

1.8 References

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1.9 Appendix

Table 1-1. Demographic and Subjective Numeracy Balance Across Randomly Assigned Conditions for Pennies 1% and 1% Lab Study

This table summarizes the characteristics of participants in terms of the two treatment groups (i.e., pennies versus percent frames). Note that the second to last row reports chi-squared statistics for education and the percentage of male. The last row reports for all other covariates both statistical tests for means and variances. For the means, a one-way ANOVA is reported with an F-statistic and p-value. For variances, a Bartlett's test for equal variances is reported with a $\chi^2(1)$ for gender or $\chi^2(2)$ for education, and p-value. For statistical tests, the null hypothesis is that the groups are equal, and underline formatting in the table indicates cases where the null hypothesis is rejected at α=0.05 (i.e., treatment groups are not equal).

At a high-level, this table reflects that randomized assignment was imperfect with both mean annual income and mean subjective numeracy being lower for those assigned to the pennies condition, along with the distribution of education also being skewed lower for those in the pennies condition. Variances for subjective numeracy (both the SNS-8 cognitive subscale and SNS-3) were higher for the pennies condition.

	Mean Age (standard deviation)	Percentage Male * (standard deviation)	Mean Annual Income ** (standard deviation)	Percent Education (% high school / % college / % advanced degree)	Subjective Numeracy Cognitive Subscale (SNS-8COG) (standard deviation)	Subjective Numeracy (SNS-3) (standard deviation)	Observations
Pennies	32.13 (6.86)	47.1	3.81 (2.71)	50.00% / 44.44% / 5.56%	16.3 (6.0)	13.0 (3.7)	90
Percent	32.67 (6.55)	57.3	4.92 (3.28)	29.09% / 59.09% / 11.82%	18.3 (4.8)	14.0 (3.1)	110
Overall	32.43 (6.68)	52.8	4.41 (3.08)	38.50% / 52.50% / 9.00%	17.4 (5.4)	13.6 (3.4)	200
Chi-squared for percentage male and education [p-value]	N/A	2.01 [0.16]	N/A	9.80 [<u>0.01</u>]	N/A	N/A	
(F-statistic	(0.32,	N/A	(6.45,	N/A	(7.34,	(5.02,	

	Mean Age (standard deviation)	Percentage Male * (standard deviation)	Mean Annual Income ** (standard deviation)	Percent Education (% high school / % college / % advanced degree)	Subjective Numeracy Cognitive Subscale (SNS-8COG) (standard deviation)	Subjective Numeracy (SNS-3) (standard deviation)	Observations
for means, Bartlett's χ^2 for variance) [p-value mean, p-value variance]	0.20) [0.57, 0.66]		3.41) [0.01, 0.07]		5.53) [0.01, 0.02]	4.28) [0.03, 0.04]	

* Note that this only includes participants reporting male or female for gender and excludes those reporting "other" or "prefer not to say." However, note that of 200 participants that 5 participants reported a gender of either "other" or "prefer not to say" and that all of these observations were in the pennies condition. So in the gender column, there are a total of 195 observations with 85 in the pennies condition and 110 in the percent condition.

****** Income is coded as follows:

1: $9,999 a year or less
2: From $10,000 to $19,999 a year
3: From $20,000 to $29,999 a year
4: From $30,000 to $39,999 a year
5: From $40,000 to $49,999 a year
6: From $50,000 to $59,999 a year
7: From $60,000 to $69,999 a year
8: From $70,000 to $79,999 a year
9: From $80,000 to $89,999 a year
10: From $90,000 to $99,999 a year
11: From $100,000 to $109,999 a year
12: From $110,000 to $119,999 a year
13: From $120,000 to $129,999 a year
14: From $130,000 to $139,999 a year
15: From $140,000 to $149,999 a year
16: $150,000 a year or more
-1: Prefer not to say

Those who preferred not to report their income (4 total observations) have been excluded from these statistics (# observations excluded from pennies = 1, # observations excluded from percent = 3)

Table 1-2. Subjective Numeracy Distribution for Pennies 1% and 1% Lab Study

This table summarizes the distribution of participants by reported subjective numeracy. Specifically, a short, 3-question subjective numeracy scale (SNS-3) was used (McNaughton et al., 2015). The subjective numeracy score was calculated for each participant was constructed by adding up the answers to questions 3a, 3d, and 4 in Online Appendix: Chapter 1 Lab Studies Materials, Section A. Respectively, these three questions are rated on a 6-point Likert-type scale, "How good are you at working with fractions?" (Not at all good = 1 to Extremely good = 6), "How good are you at figuring out how much a shirt will cost if it is 25% off?" (Not at all good = 1 to Extremely good = 6), and "How often do you find numerical information to be useful?" (Never = 1 to Very often = 6).

For the study sample, SNS-3 had mean = 13.6, SD = 3.4, and Cronbach's $\alpha = 0.7832$.

Subjective Numeracy (SNS-3)	Number of Participants	Percent of Participants	Cumulative
3	0	0.00	0.00
4	3	1.50	1.50
5	3	1.50	3.00
6	2	1.00	4.00
7	3	1.50	5.50
8	7	3.50	9.00
9	11	5.50	14.50
10	12	6.00	20.50
11	10	5.00	25.50
12	11	5.50	31.00
13	12	6.00	37.00
14	24	12.00	49.00
15	36	18.00	67.00
16	31	15.50	82.50
17	16	8.00	90.50
18	19	9.50	100.00
TOTAL	200	100.00	

Table 1-3. Main Effect on Savings (Participation Rates) for Pennies 1% and 1% Lab Study

Panel A reports the results of ordinary least squares regressions† where the outcome variable is an indicator variable whether the participant has chosen to save. In the special case of this study, since the initial savings rate and escalator rate can only be the economic equivalent of 1% and 1% respectively versus 0% and 0%, only participation rates are analyzed as opposed to separate savings and escalator rates. Panel A Column 1 reports OLS without controls, and Column 2 reports OLS results with controls††. Panel B Column 1 reports logistic regressions without controls, and Column 2 reports logistic regressions with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001. e^B = exponentiated *B*.

PANEL A (OLS Regressions)

	(1)			(2)		
	Indicator for participation in savings	St. Err.	p-value	Indicator for participation in savings	St. Err.	p-value
Pennies Condition Indicator	0.0020202	0.0408808	0.961	0.0161939	0.0433323	0.709
Age				0.0004235	0.003214	0.895
Gender‡				0.0061712	0.021999	0.779
Income				0.0023675	0.0077127	0.759
Education				0.0324714	0.0374689	0.387
Constant	0.9090909***	0.0274237	0.000	0.8209045***	0.1251082	0.000
R^2	0.0000			0.0073		
Adj R^2	-0.0050			-0.0188		
N	200			196		

PANEL B (Logistic Regressions)

	(1)			(2)		
Predictor	*B*	*SE B*	e^B	*B*	*SE B*	e^B
Pennies Condition Indicator	0.0246926	0.4971872	1.02	0.207647	0.5186499	1.23
Age				0.0041213	0.0376044	1.00
Gender‡				0.0766007	.2600477	1.08
Income				0.0376336	0.0999988	1.04
Education				0.4107909	0.458749	1.51
Constant	2.302585***			1.234041		
χ^2		0.00			1.53	
df		1			5	

† Ordinary least squares regressions may be used to analyze and estimate treatment effects for indicator variables (Angrist and Pischkle, 2009), although logistic regressions may also be used for robustness and to estimate the effects on likelihoods.

†† Note that when running regressions with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-4. Main Effect on Self-Reported Affordability for Pennies 1% and 1% Lab Study

This table reports the results of ordinary least squares regressions where the outcome variable is a self-reported 7-point, Likert assessment by the participant (strongly disagree = 1 to strongly agree = 7) in reaction to the question, “I found the option to be affordable” performed after the main stimulus of the savings choice. Column 1 reports OLS without controls, and Column 2 reports OLS results with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	(1)			(2)		
	Self-Reported Affordability	St. Err.	p-value	Self-Reported Affordability	St. Err.	p-value
Pennies Condition Indicator	0.1919192	0.1794676	0.286	0.1490145	0.1873179	0.427
Age				0.0046202	0.0138937	0.740
Gender‡				-0.1307353	0.0950979	0.171
Income				0.0360272	0.0333406	0.281
Education				-0.2566721	0.1619714	0.115
Constant	5.763636***	0.1203905	0.000	5.936134***	0.5408206	0.000
R^2	0.0057			0.0298		
Adj R^2	0.0007			0.0043		
N	200			196		

†† Note that when running OLS with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients for the OLS, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-5. Main Effect on Self-Reported Understandability for Pennies 1% and 1% Lab Study

This table reports the results of ordinary least squares regressions where the outcome variable is a self-reported 7-point, Likert assessment by the participant (strongly disagree = 1 to strongly agree = 7) in reaction to the question, "I found the description of the option to be clear and understandable" performed after the main stimulus of the savings choice. Column 1 reports OLS without controls, and Column 2 reports OLS results with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	(1)			(2)		
	Self-Reported Understandability	St. Err.	p-value	Self-Reported Understandability	St. Err.	p-value
Pennies Condition Indicator	-0.1414141	0.1746657	0.419	-0.2333588	0.1761001	0.187
Age				0.0021544	0.0130616	0.869
Gender‡				-0.1036868	0.0894029	0.248
Income				0.0607194+	0.031344	0.054
Education				-0.4259778	0.1522715	0.006
Constant	6.063636***	0.1171693	0.000	6.536036***	0.5084327	0.000
R^2	0.0033			0.0522		
Adj R^2	-0.0017			0.0272		
N	200			196		

†† Note that when running OLS with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients for the OLS, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

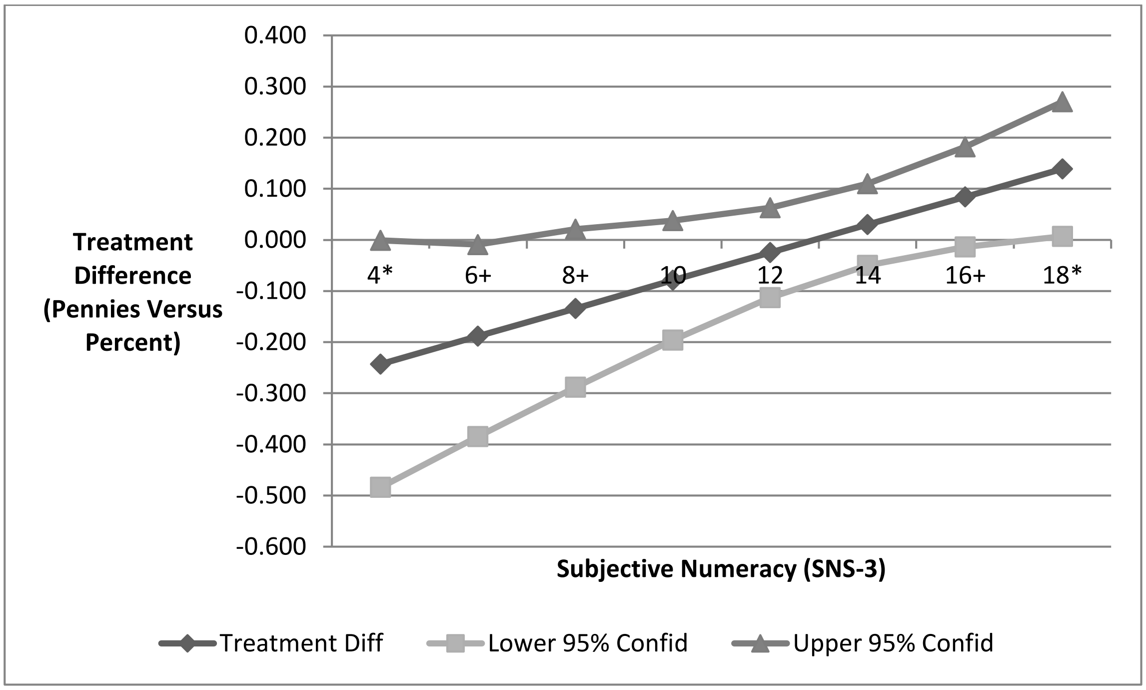
Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-6. Floodlight Analysis of the Difference Between Pennies and Percent on Savings (Participation Rates) for Pennies 1% and 1% Lab Study Across the Range of Subjective Numeracy Values

These tables explore the moderating role of subjective numeracy on savings (i.e., Study 1 is a special case of participation) for a low, introductory savings choice based on series of spotlight analyses (i.e., collectively a floodlight). In this case, the regression coefficient on the independent, indicator variable of pennies treatment is analyzed separately across the range of the moderator (i.e., subjective numeracy) with separate focus points. For example, for any focus point on SNS-3 = *value*, then the interactions analysis is performed where the moderator' = SNS-3 minus *value.* This sets the focus point at zero. As an example, if the focus point was on the mean value of SNS-3, then the moderator' used for that spotlight analysis would be mean-centered around zero (i.e., moderator' = moderator – mean). This methodology is consistent with other approaches for simple effect testing in moderated regressions (Spiller et al., 2013) and can help to identify the continuum over which the results are significant (i.e., range based on Johnson-Neyman points). Panel A includes the analysis without controls and Panel B includes controls for age, gender, income, and education for participants choosing to report. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

PANEL A (without controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Savings (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(196)	p-value
4	-0.243*	-0.484	-0.001	-1.98	0.049
6	-0.188+	-0.385	-0.009	-1.88	0.061
8	-0.134+	-0.288	0.021	-1.70	0.090
10	-0.079	-0.196	0.038	-1.34	0.183
12	-0.025	-0.113	0.063	-0.55	0.581
14	0.030	-0.050	0.110	0.73	0.466
16	0.084+	-0.014	0.182	1.70	0.092
18	0.139*	0.007	0.270	2.08	0.039



PANEL B (with controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Savings (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(188)	p-value
4	-0.241+	-0.494	0.013	-1.87	0.062
6	-0.185+	-0.392	0.022	-1.76	0.080
8	-0.130	-0.293	0.033	-1.57	0.119
10	-0.074	-0.198	0.049	-1.18	0.238
12	-0.019	-0.112	0.075	-0.39	0.694
14	0.037	-0.047	0.121	0.86	0.390
16	0.092+	-0.009	0.194	1.79	0.075
18	0.148*	0.012	0.284	2.14	0.033

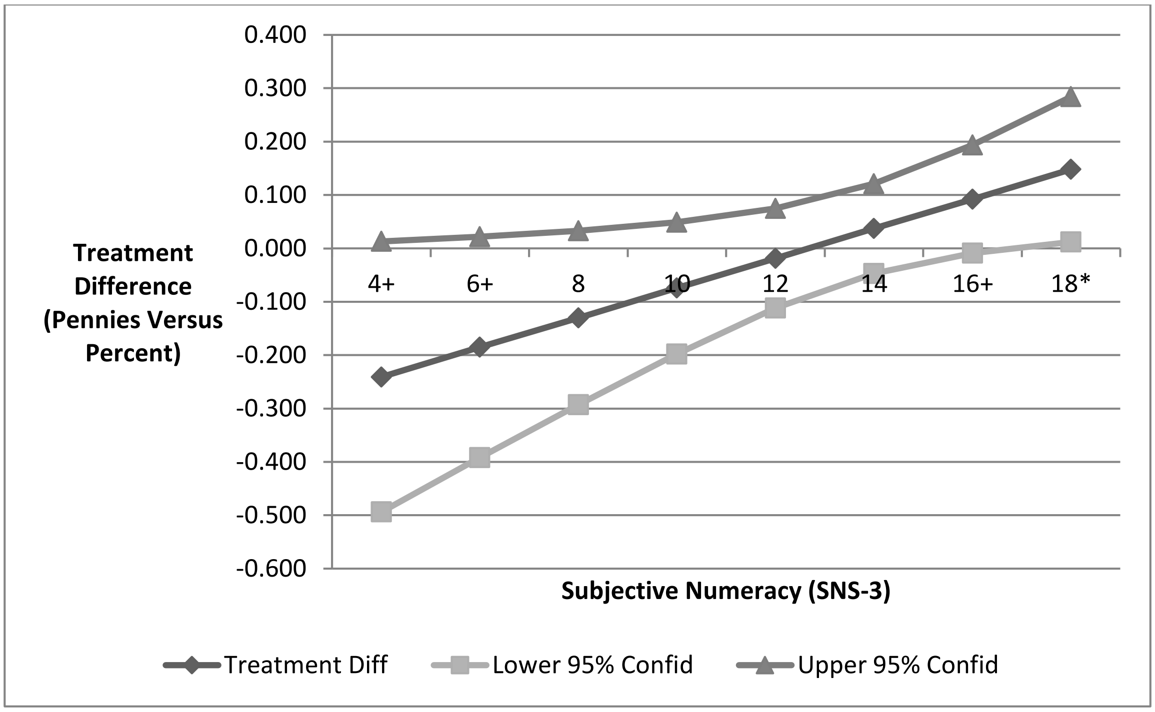
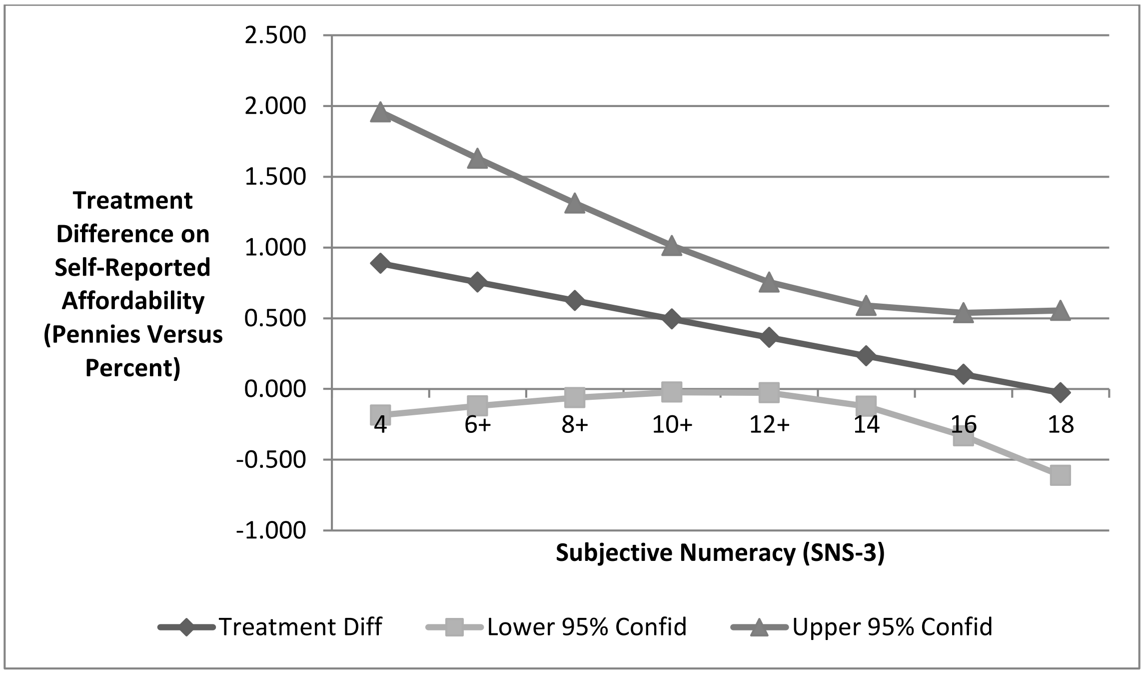


Table 1-7. Floodlight Analysis of the Difference Between Pennies and Percent on Self-Reported Affordability for Pennies 1% and 1% Lab Study Across the Range of Subjective Numeracy Values

These tables explore the moderating role of subjective numeracy on self-reported affordability for a low, introductory savings choice based on series of spotlight analyses (i.e., collectively a floodlight). In this case, the regression coefficient on the independent, indicator variable of pennies treatment is analyzed separately across the range of the moderator (i.e., subjective numeracy) with separate focus points. For example, for any focus point on SNS-3 = *value*, then the interactions analysis is performed where the moderator' = SNS-3 minus *value.* This sets the focus point at zero. As an example, if the focus point was on the mean value of SNS-3, then the moderator' used for that spotlight analysis would be mean-centered around zero (i.e., moderator' = moderator – mean). This methodology is consistent with other approaches for simple effect testing in moderated regressions (Spiller et al., 2013) and can help to identify the continuum over which the results are significant (i.e., range based on Johnson-Neyman points). Panel A includes the analysis without controls and Panel B includes controls for age, gender, income, and education for participants choosing to report. +, $p<0.10$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$.

PANEL A (without controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Self-Reported Affordability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(196)	p-value
4	0.887	-0.184	1.958	1.63	0.104
6	0.756+	-0.119	1.631	1.70	0.090
8	0.625+	-0.062	1.313	1.79	0.074
10	0.495+	-0.023	1.013	1.88	0.061
12	0.365+	-0.027	0.756	1.84	0.068
14	0.234	-0.122	0.590	1.30	0.196
16	0.104	-0.331	0.538	0.47	0.639
18	-0.027	-0.610	0.556	-0.09	0.928



PANEL B (with controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Self-Reported Affordability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(188)	p-value
4	0.826	-0.278	1.931	1.48	0.141
6	0.696	-0.207	1.600	1.52	0.130
8	0.566	-0.146	1.278	1.57	0.118
10	0.436	-0.102	0.974	1.60	0.112
12	0.305	-0.101	0.713	1.48	0.140
14	0.176	-0.192	0.544	0.94	0.347
16	0.046	-0.399	0.490	0.20	0.839
18	0.004	-0.597	0.606	0.01	0.989

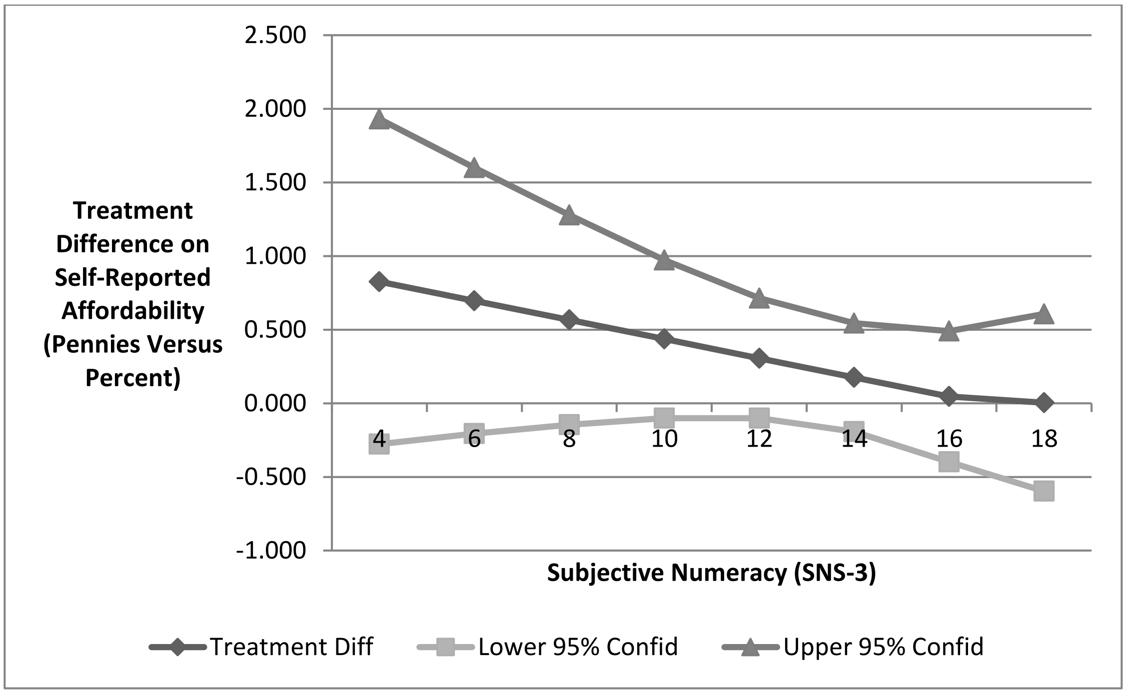
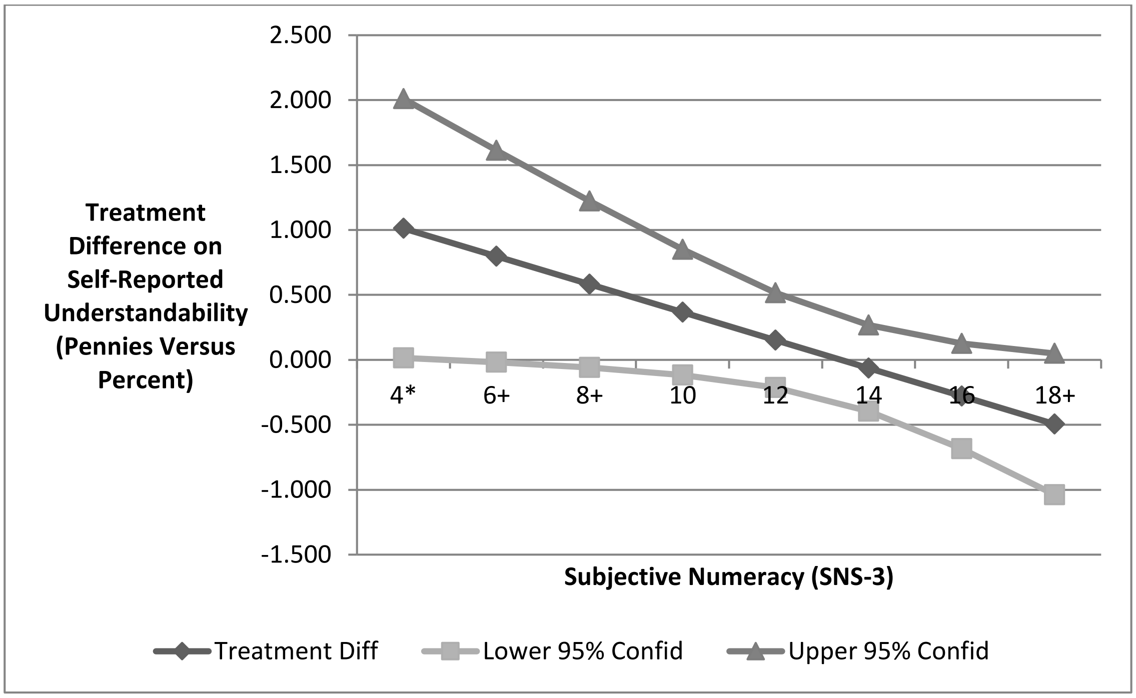


Table 1-8. Floodlight Analysis of the Difference Between Pennies and Percent on Self-Reported Understandability for Pennies 1% and 1% Lab Study Across the Range of Subjective Numeracy Values

These tables explore the moderating role of subjective numeracy on self-reported understandability for a low, introductory savings choice based on series of spotlight analyses (i.e., collectively a floodlight). In this case, the regression coefficient on the independent, indicator variable of pennies treatment is analyzed separately across the range of the moderator (i.e., subjective numeracy) with separate focus points. For example, for any focus point on SNS-3 = *value*, then the interactions analysis is performed where the moderator' = SNS-3 minus *value.* This sets the focus point at zero. As an example, if the focus point was on the mean value of SNS-3, then the moderator' used for that spotlight analysis would be mean-centered around zero (i.e., moderator' = moderator – mean). This methodology is consistent with other approaches for simple effect testing in moderated regressions (Spiller et al., 2013) and can help to identify the continuum over which the results are significant (i.e., range based on Johnson-Neyman points). Panel A includes the analysis without controls and Panel B includes controls for age, gender, income, and education for participants choosing to report. +, $p<0.10$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$.

PANEL A (without controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Self-Reported Understandability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(196)	p-value
4	1.012*	0.015	2.011	2.00	0.047
6	0.798+	-0.018	1.613	1.93	0.055
8	0.582+	-0.059	1.223	1.79	0.075
10	0.367	-0.116	0.850	1.50	0.136
12	0.151	-0.213	0.516	0.82	0.414
14	-0.064	-0.396	0.268	-0.38	0.705
16	-0.279	-0.684	0.126	-1.36	0.176
18	-0.495+	-1.038	0.049	-1.80	0.074



PANEL B (with controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Self-Reported Understandability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(188)	p-value
4	0.803	-0.187	1.793	1.60	0.111
6	0.606	-0.205	1.416	1.47	0.142
8	0.408	-0.230	1.047	1.26	0.209
10	0.211	-0.272	0.694	0.86	0.390
12	0.014	-0.352	0.379	0.07	0.942
14	-0.184	-0.514	0.146	-1.10	0.273
16	-0.381+	-0.779	0.017	-1.89	0.061
18	-0.578*	-1.111	-0.046	-2.14	0.033

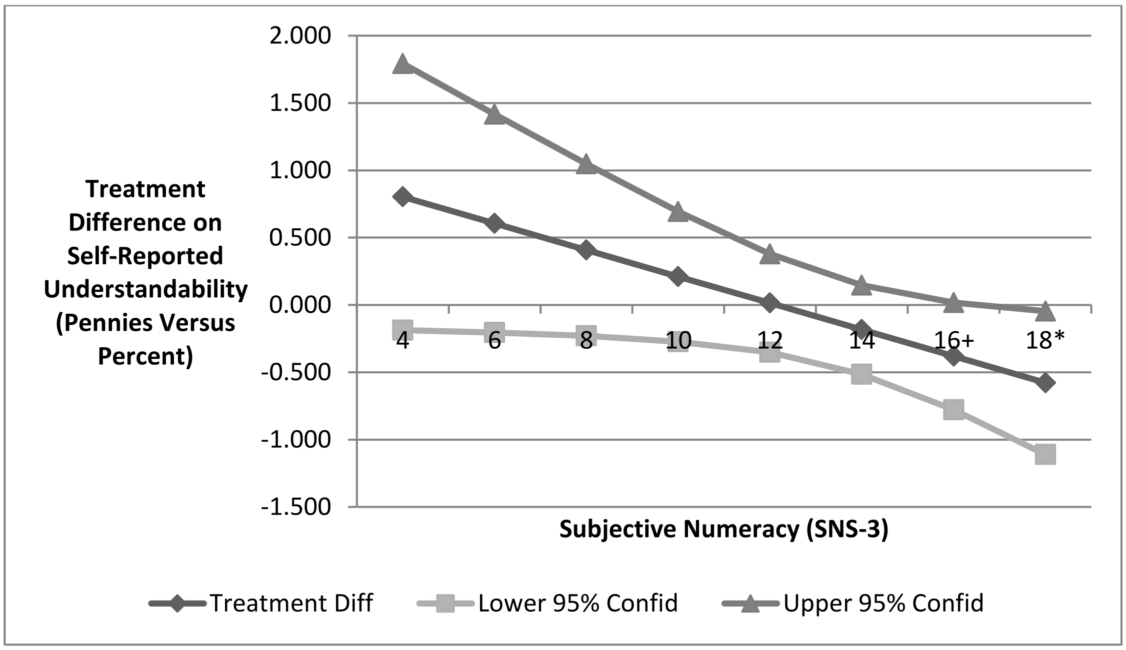


Table 1-9. Main Effect of Pennies Framing on Self-Reported Likelihood of Choosing Other Savings Rates

This table reports the results of ordinary least squares regressions where the outcome variable is a self-reported 7-point, Likert assessment by the participant (definitely not choose = 1 to definitely choose = 7) in reaction to four questions, "For each option, please indicate how likely you would be to choose it: "a) Enroll at [2 pennies per dollar] (2%) of my salary, increasing by [1 penny per dollar] (1%) of my salary every year thereafter", "b) Enroll at [2 pennies per dollar] (2%) of my salary, increasing by [2 pennies per dollar] (2%) of my salary every year thereafter", "c) Enroll at [3 pennies per dollar] (3%) of my salary, increasing by [1 penny per dollar] (1%) of my salary every year thereafter", "d) Enroll at [6 pennies per dollar] (6%) of my salary, increasing by [1 penny per dollar] (1%) of my salary every year thereafter." Penny versus percent conditions were presented to the participant based on treatment assignment. These questions were asked after the main stimulus of the savings choice, so sequencing effects such as anchoring on the initial choice problem may be present. Columns a through d report OLS with controls††, and levels of significance are unchanged with or without controls. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

Question	(a)		(b)		(c)		(d)	
	Initial rate = 2 and escalator rate = 1		Initial rate = 2 and escalator rate = 2		Initial rate = 3 and escalator rate = 1		Initial rate = 6 and escalator rate = 1	
	Self-Reported Likelihood (St. Err)	p-value	Self-Reported Likelihood (St. Err)	p-value	Self-Reported Likelihood (St. Err)	p-value	Self-Reported Likelihood (St. Err)	p-value
Pennies Condition Indicator	0.2247649 (0.2594743)	0.387	0.3577832 (0.2755943)	0.196	0.3263908 (0.279927)	0.245	0.3911623 (.2996814)	0.193
Age	-0.0006798 (0.0192456)	0.972	-0.0132857 (0.0204413)	0.517	-0.0072889 (0.0207626)	0.726	-0.010151 (0.0222279)	0.648
Gender‡	0.0689744 (0.1317304)	0.601	-0.0290546 (0.1399143)	0.836	-0.0386736 (0.1421139)	0.786	0.0958369 (0.1521429)	0.530
Income	0.0682344 (0.0461837)	0.141	0.0755219 (0.0490529)	0.125	0.0777964 (.0498241)	0.120	0.0612971 (.0533402)	0.252

Question	(a)		(b)		(c)		(d)	
	Initial rate = 2 and escalator rate = 1		Initial rate = 2 and escalator rate = 2		Initial rate = 3 and escalator rate = 1		Initial rate = 6 and escalator rate = 1	
Education	0.0580867 (0.2243641)	0.796	-0.0365955 (0.2383028)	0.878	0.0021147 (0.2420492)	0.993	0.1112829 (0.2591306)	0.668
Constant	4.439128*** (0.7491491)	0.000	4.545474*** (0.7956904)	0.000	4.269285*** (0.8081997)	0.000	3.690902*** (0.8652343)	0.000
R^2	0.0202		0.0212		0.0198		0.0213	
Adj R^2	-0.0055		-0.0046		-0.0060		-0.0045	
N	196		196		196		196	

†† Note that when running OLS with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients for the OLS, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-10. Demographic and Subjective Numeracy Balance Across Randomly Assigned Conditions for Pennies X% and Y% Lab Study

This table summarizes the characteristics of participants in terms of the two treatment groups (i.e., pennies versus percent frames). Note that the second to last row reports chi-squared statistics for education and the percentage of male. The last row reports for all other covariates both statistical tests for means and variances. For the means, a one-way ANOVA is reported with an F-statistic and p-value. For variances, a Bartlett's test for equal variances is reported with a $\chi^2(1)$ for gender or $\chi^2(2)$ for education, and p-value. For statistical tests, the null hypothesis is that the groups are equal, and underline formatting in the table indicates cases where the null hypothesis is rejected at α=0.05 (i.e., treatment groups are not equal).

At a high-level, this table reflects that randomized assignment worked, although differences in education were marginally significant with education skewing a bit higher for those in the pennies condition.

	Mean Age (standard deviation)	Percentage Male * (standard deviation)	Mean Annual Income ** (standard deviation)	Percent Education (% high school / % college / % advanced degree)	Subjective Numeracy Cognitive Subscale (SNS-8COG) (standard deviation)	Subjective Numeracy (SNS-3) (standard deviation)	Observations
Pennies	32.02 (7.16)	54.1	4.97 (2.68)	29.29% / 54.55% / 16.16%	17.7 (4.8)	13.7 (3.2)	99
Percent	32.47 (7.87)	57.0	4.61 (2.80)	42.57% / 49.50% / 7.92%	17.5 (4.7)	13.8 (3.0)	101
Overall	32.25 (7.51)	55.6	4.79 (2.74)	36.00% / 52.00% / 12.00%	17.6 (4.7)	13.8 (3.1)	200
Chi-squared for percentage male and education [p-value]	N/A	0.17 [0.68]	N/A	5.52 [0.06]	N/A	N/A	
(F-statistic for means, Bartlett's χ^2	(0.18, 0.88) [0.67,	N/A	(0.83, 0.21) [0.36,	N/A	(0.07, 0.03) [0.79,	(0.05, 0.62) [0.83,	

	Mean Age (standard deviation)	Percentage Male * (standard deviation)	Mean Annual Income ** (standard deviation)	Percent Education (% high school / % college / % advanced degree)	Subjective Numeracy Cognitive Subscale (SNS-8COG) (standard deviation)	Subjective Numeracy (SNS-3) (standard deviation)	Observations
for variance) [p-value mean, p-value variance]	0.34]		0.65]		0.87]	0.43]	

* Note that this only includes participants reporting male or female for gender and excludes those reporting "other" or "prefer not to say." However, note that of 200 participants that 2 participants reported a gender of either "other" of "prefer not to say" and that these observations were split between conditions. In the gender column, there are a total of 198 observations with 98 in the pennies condition and 100 in the percent condition.

****** Income is coded as done as outlined in Table 1-1. Those who preferred not to report their income (7 total observations) have been excluded from these statistics (# observations excluded from pennies = 3, # observations excluded from percent = 4)

Table 1-11. Subjective Numeracy Distribution for Pennies X% and Y% Lab Study

This table summarizes the distribution of participants by reported subjective numeracy. Specifically, a short, 3-question subjective numeracy scale (SNS-3) was used (McNaughton et al., 2015).

For this sample, SNS-3 had mean = 13.8, SD = 3.1, and Cronbach's α = 0.7738.

Subjective Numeracy (SNS-3)	Number of Participants	Percent of Participants	Cumulative
3	2	1.00	1.00
4	0	0.00	1.00
5	0	0.00	1.00
6	2	1.00	2.00
7	4	2.00	4.00
8	5	2.50	6.50
9	11	5.50	12.00
10	10	5.00	17.00
11	7	3.50	20.50
12	14	7.00	27.50
13	25	12.50	40.00
14	22	11.00	51.00
15	31	15.50	66.50
16	29	14.50	81.00
17	21	10.50	91.50
18	17	8.50	100.00
TOTAL	200	100.00	

Table 1-12. Main Effect of Pennies Framing on Savings for Pennies X% and Y% Lab Study

Panel A reports the results of ordinary least squares regressions where the outcome variable is the initial savings rate chosen by the participant. Panel A Column 1 reports OLS without controls, and Column 2 reports OLS results with controls††. Panel B reports the results of ordinary least squares regressions where the outcome variable is the escalator rate chosen by the participant. Panel B Column 1 reports OLS without controls, and Column 2 reports OLS with controls††. +, $p<0.10$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$.

PANEL A (Initial Savings Rate)

	(1)			(2)		
	Initial savings rate	St. Err.	p-value	Initial savings rate	St. Err.	p-value
Pennies Condition Indicator	0.0971097	0.2259378	0.668	0.108307	0.236795	0.648
Age				0.016995	0.0159439	0.288
Gender‡				0.0713738	0.1181177	0.546
Income				0.0521055	0.0469844	0.269
Education				-0.1719282	0.1957887	0.381
Constant	4.306931***	0.1589613	0.000	3.778424***	0.5765487	0.000
R^2	0.0009			0.0176		
Adj R^2	-0.0041			-0.0087		
N	200			193		

PANEL B (Escalator Rate)

	(1)			(2)		
	Escalator rate	St. Err.	p-value	Escalator rate	St. Err.	p-value
Pennies Condition Indicator	0.5615562***	0.1314743	0.000	0.554363***	0.1380866	0.000
Age				-0.0105482	0.0092977	0.258
Gender‡				-0.0470901	0.0688801	0.495
Income				0.0003683	0.0273989	0.989
Education				0.0144739	0.1141739	0.899
Constant	1.29703***	0.0925004	0.000	1.623927***	0.3362134	0.000
R^2	0.0844			0.0925		
Adj R^2	0.0797			0.0682		
N	200			193		

†† Note that when running regressions with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-13. Main Effect of Pennies Framing on Self-Reported Affordability for Pennies X% and Y% Lab Study

This table reports the results of ordinary least squares regressions where the outcome variable is a self-reported 7-point, Likert assessment by the participant (strongly disagree = 1 to strongly agree = 7) in reaction to the question, "I found the option to be affordable" performed after the main stimulus of the savings choice. Column 1 reports OLS without controls, and Column 2 reports OLS results with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	(1)			(2)		
	Self-Reported Affordability	St. Err.	p-value	Self-Reported Affordability	St. Err.	p-value
Pennies Condition Indicator	0.3546355*	.1474202	0.017	0.3120085*	0.1518584	0.041
Age				-0.0023667	0.0102249	0.817
Gender‡				0.0229998	0.0757497	0.762
Income				0.0117109	0.0301315	0.698
Education				-0.1226843	0.1255607	0.330
Constant	5.554455***	0.1037193	0.000	5.829758***	0.3697449	0.000
R^2	0.0284			0.0253		
Adj R^2	0.0235			-0.0008		
N	200			193		

†† Note that when running OLS with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients for the OLS, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-14. Main Effect of Pennies Framing on Self-Reported Understandability for Pennies X% and Y% Lab Study

This table reports the results of ordinary least squares regressions where the outcome variable is a self-reported 7-point, Likert assessment by the participant (strongly disagree = 1 to strongly agree = 7) in reaction to the question, “I found the description of the option to be clear and understandable” performed after the main stimulus of the savings choice. Column 1 reports OLS without controls, and Column 2 reports OLS results with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	(1)			(2)		
	Self-Reported Understandability	St. Err.	p-value	Self-Reported Understandability	St. Err.	p-value
Pennies Condition Indicator	0.319832+	0.1811574	0.079	0.3404232+	0.1853879	0.068
Age				0.0159595	0.0124826	0.203
Gender‡				0.0903249	0.0924749	0.330
Income				0.0311125	0.0367843	0.399
Education				-0.3963361***	0.1532839	0.010
Constant	5.831683***	.1274556	0.000	5.863474***	0.4513827	0.000
R^2	0.0155			0.0526		
Adj R^2	0.0105			0.0273		
N	200			193		

†† Note that when running OLS with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients for the OLS, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

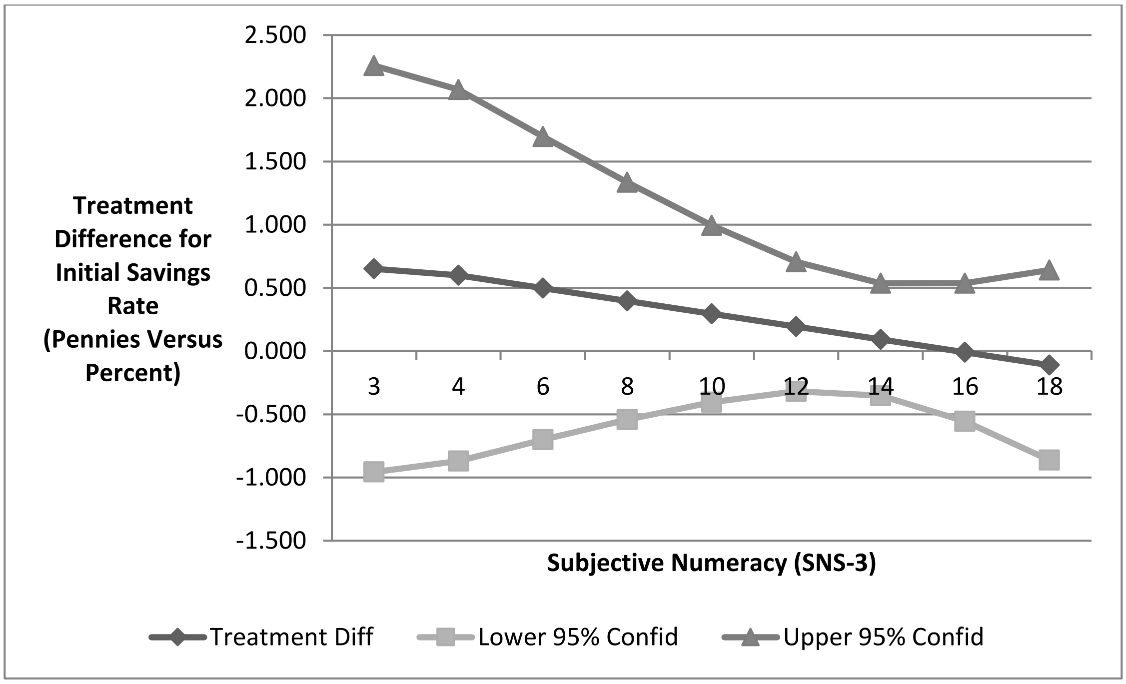
Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-15. Floodlight Analysis of the Difference Between Pennies and Percent on Savings for Pennies X% and Y% Lab Study Across the Range of Subjective Numeracy

These tables explore the moderating role of subjective numeracy on savings (i.e., in terms of initial savings rate and escalator rate) for a savings choice based on series of spotlight analyses (i.e., collectively a floodlight). In this case, the regression coefficient on the independent, indicator variable of pennies treatment is analyzed separately across the range of the moderator (i.e., subjective numeracy) with separate focus points. For example, for any focus point on SNS-3 = *value*, then the interactions analysis is performed where the moderator' = SNS-3 minus *value.* This sets the focus point at zero. As an example, if the focus point was on the mean value of SNS-3, then the moderator' used for that spotlight analysis would be mean-centered around zero (i.e., moderator' = moderator – mean). This methodology is consistent with other approaches for simple effect testing in moderated regressions (Spiller et al., 2013) and can help to identify the continuum over which the results are significant (i.e., range based on Johnson-Neyman points). Panel A covers the initial savings rate and includes the analysis without controls and Panel B includes controls for age, gender, income, and education for participants choosing to report. Panels C and D cover the same analyses for escalator rate for the cases of both with and without controls. +, $p<0.10$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$.

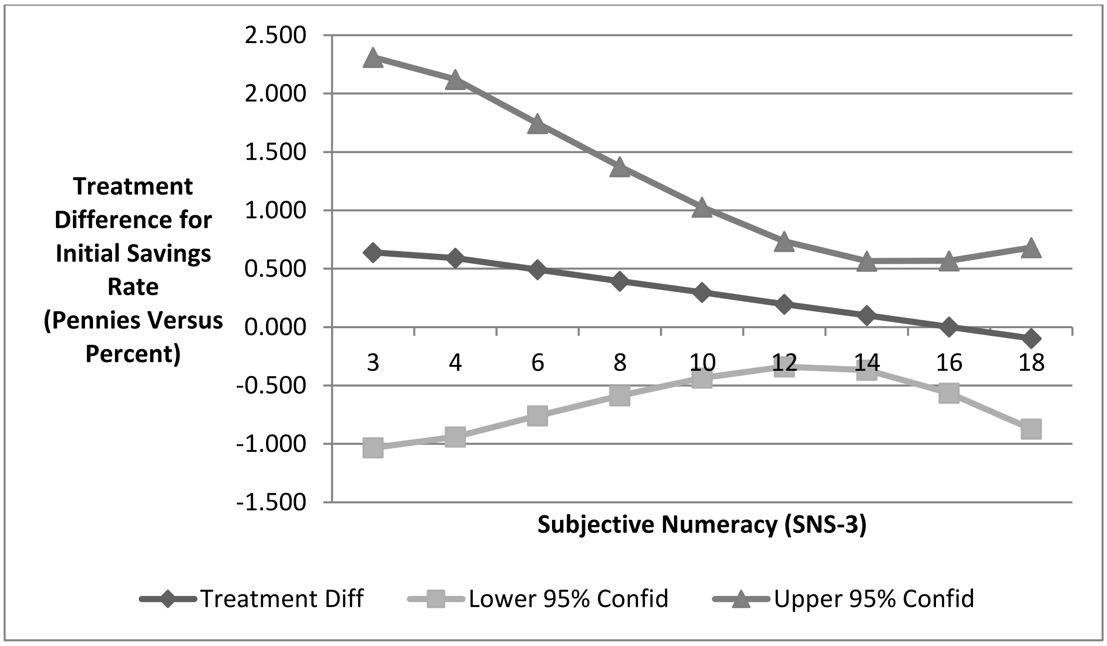
PANEL A (initial savings rate as outcome without controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Initial Savings Rate (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(196)	p-value
3	0.651	-0.957	2.258	0.80	0.426
4	0.600	-0.870	2.070	0.80	0.422
6	0.498	-0.702	1.698	0.82	0.414
8	0.397	-0.543	1.336	0.83	0.406
10	0.295	-0.405	0.995	0.83	0.407
12	0.193	-0.318	0.705	0.75	0.456
14	0.092	-0.352	0.536	0.41	0.683
16	-0.009	-0.555	0.537	-0.03	0.973
18	-0.111	-0.861	0.640	-0.29	0.771



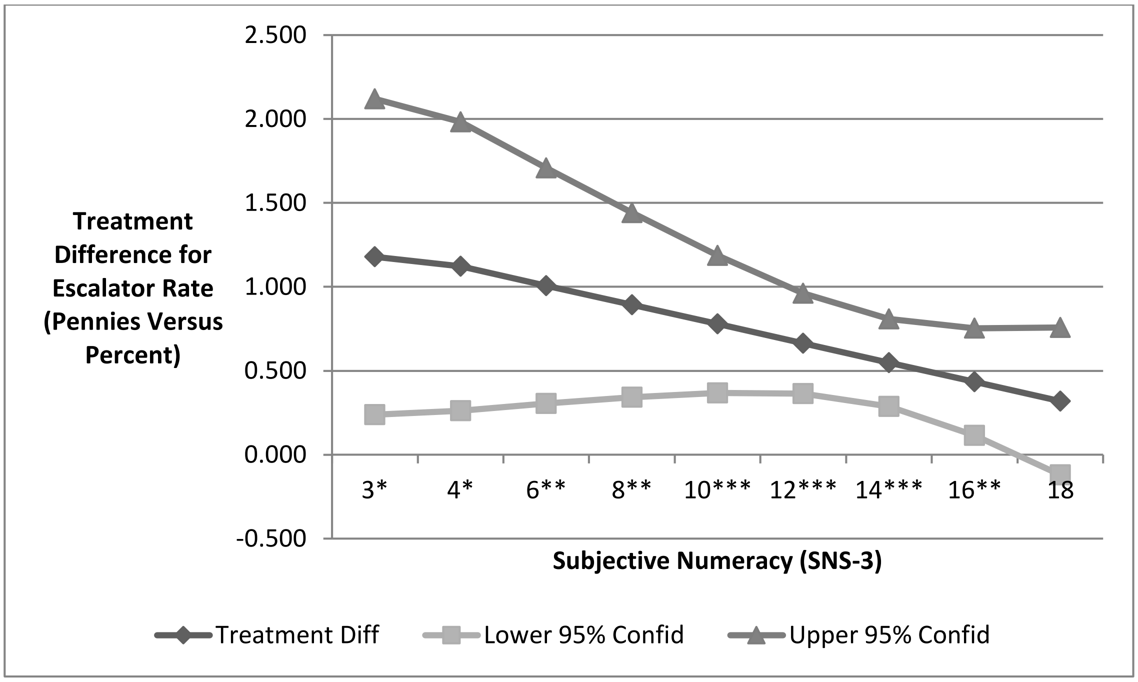
PANEL B (initial savings rate as outcome with controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Initial Savings Rate (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(185)	p-value
3	0.640	-1.033	2.311	0.75	0.451
4	0.591	-0.939	2.121	0.76	0.447
6	0.493	-0.758	1.743	0.78	0.438
8	0.395	-0.586	1.375	0.79	0.428
10	0.297	-0.436	1.029	0.80	0.426
12	0.198	-0.339	0.736	0.73	0.467
14	0.100	-0.366	0.566	0.43	0.671
16	0.002	-0.565	0.570	0.01	0.993
18	-0.096	-0.873	0.682	-0.24	0.809



PANEL C (escalator rate as outcome without controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Escalator Rate (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(196)	p-value
3	1.179*	0.239	2.120	2.47	0.014
4	1.122*	0.262	1.982	2.57	0.011
6	1.007**	0.305	1.709	2.83	0.005
8	0.893**	0.343	1.442	3.20	0.002
10	0.780***	0.368	1.187	3.75	0.000
12	0.663***	0.364	0.962	4.37	0.000
14	0.549***	0.288	0.809	4.16	0.000
16	0.434**	0.114	0.753	2.68	0.008
18	0.319	-0.120	0.758	1.43	0.153



PANEL D (escalator rate as outcome with controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Escalator Rate (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(185)	p-value
3	1.240*	0.261	2.219	2.50	0.013
4	1.177**	0.281	2.072	2.59	0.010
6	1.050**	0.318	1.782	2.83	0.005
8	0.922**	0.349	1.497	3.17	0.002
10	0.796***	0.367	1.225	3.66	0.000
12	0.669***	0.354	0.984	4.20	0.000
14	0.542***	0.269	0.815	3.92	0.000
16	0.415*	0.083	0.748	2.46	0.015
18	0.288	-0.167	0.744	1.25	0.213

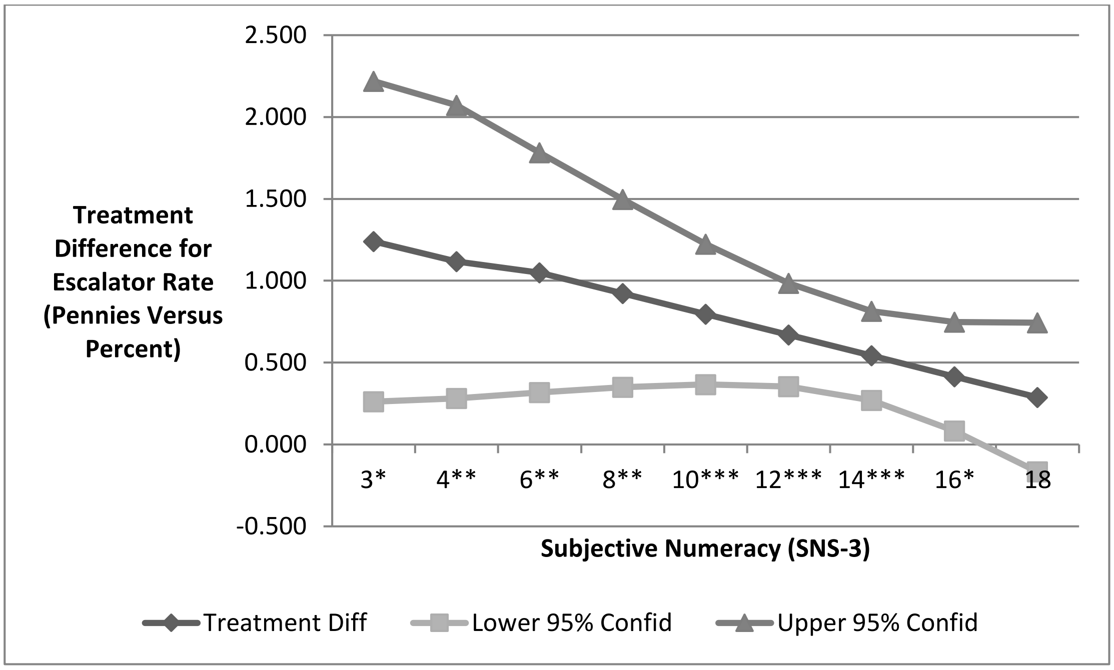
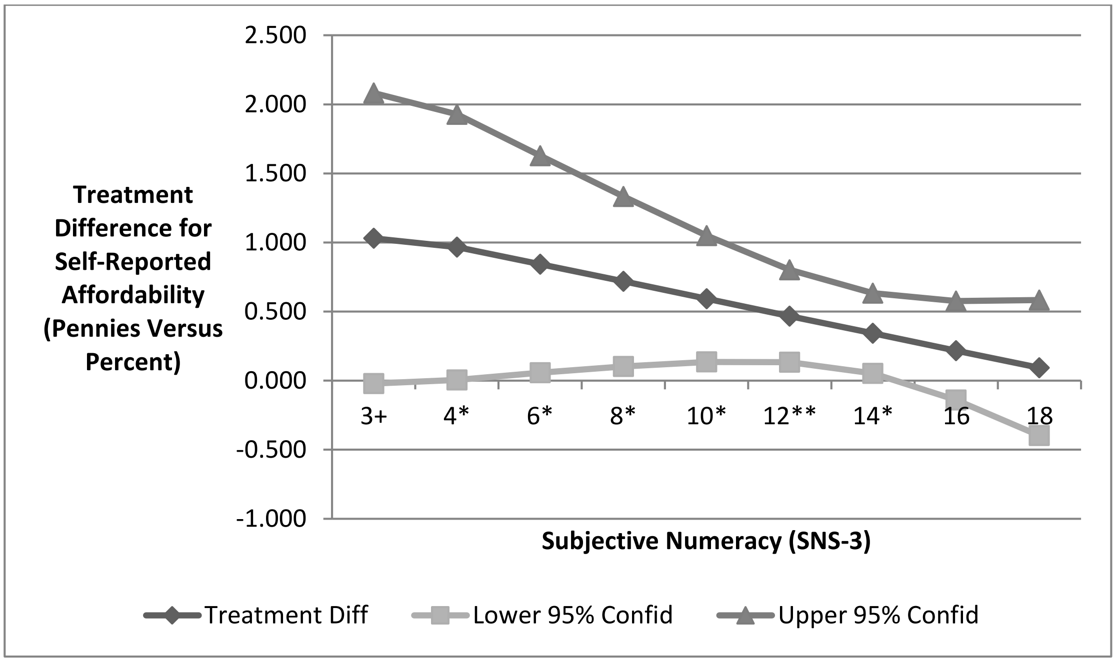


Table 1-16. Floodlight Analysis of the Difference Between Pennies and Percent on Self-Reported Affordability for Pennies X% and Y% Lab Study Across the Range of Subjective Numeracy

These tables explore the moderating role of subjective numeracy on self-reported affordability for a savings choice based on series of spotlight analyses (i.e., collectively a floodlight). In this case, the regression coefficient on the independent, indicator variable of pennies treatment is analyzed separately across the range of the moderator (i.e., subjective numeracy) with separate focus points. For example, for any focus point on SNS-3 = *value*, then the interactions analysis is performed where the moderator' = SNS-3 minus *value.* This sets the focus point at zero. As an example, if the focus point was on the mean value of SNS-3, then the moderator' used for that spotlight analysis would be mean-centered around zero (i.e., moderator' = moderator – mean). This methodology is consistent with other approaches for simple effect testing in moderated regressions (Spiller et al., 2013) and can help to identify the continuum over which the results are significant (i.e., range based on Johnson-Neyman points). Panel A includes the analysis without controls and Panel B includes controls for age, gender, income, and education for participants choosing to report. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

PANEL A (without controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Self-Reported Affordability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(196)	p-value
3	1.030+	-0.022	2.082	1.93	0.055
4	0.967*	0.005	1.929	1.98	0.049
6	0.843*	0.057	1.628	2.12	0.036
8	0.718*	0.103	1.332	2.30	0.022
10	0.593*	0.135	1.050	2.55	0.011
12	0.468**	0.133	0.803	2.76	0.006
14	0.343*	0.052	0.634	2.33	0.021
16	0.218	-0.139	0.576	1.20	0.230
18	0.093	-0.398	0.584	0.38	0.708



PANEL B (with controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Self-Reported Affordability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(185)	p-value
3	0.997+	-0.075	2.069	1.83	0.068
4	0.934+	-0.047	1.914	1.88	0.062
6	0.807*	0.005	1.608	1.99	0.048
8	0.680*	0.052	1.309	2.14	0.034
10	0.554*	0.084	1.023	2.33	0.021
12	0.427*	0.083	0.772	2.45	0.015
14	0.301*	0.002	0.599	1.99	0.049
16	0.174	-0.190	0.538	0.94	0.347
18	0.047	-0.451	0.545	0.19	0.851

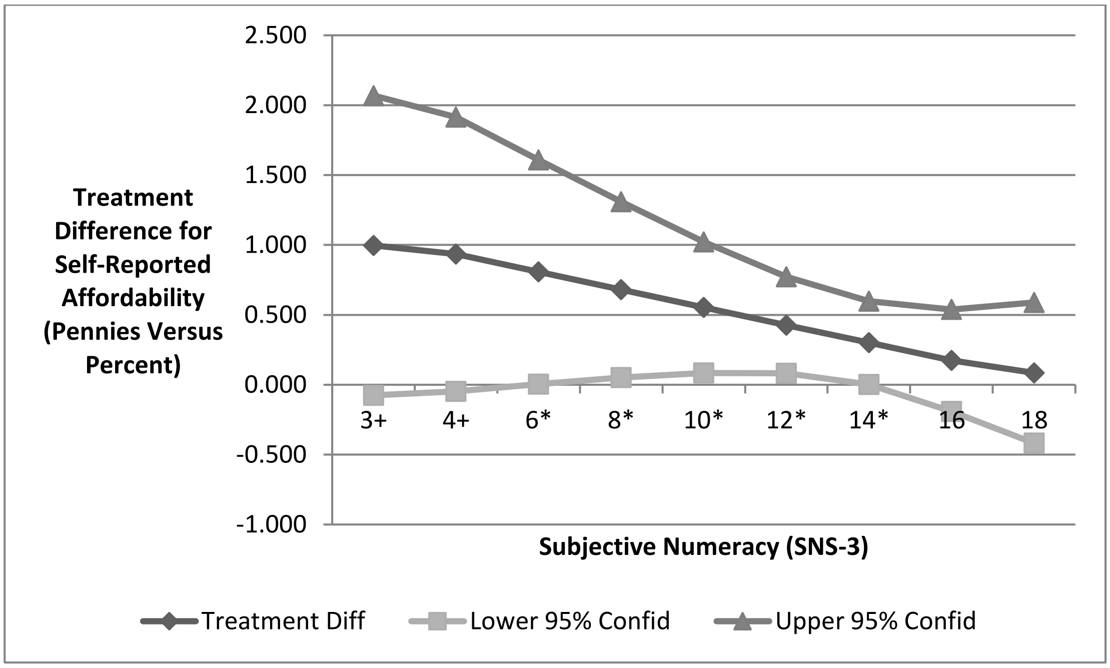
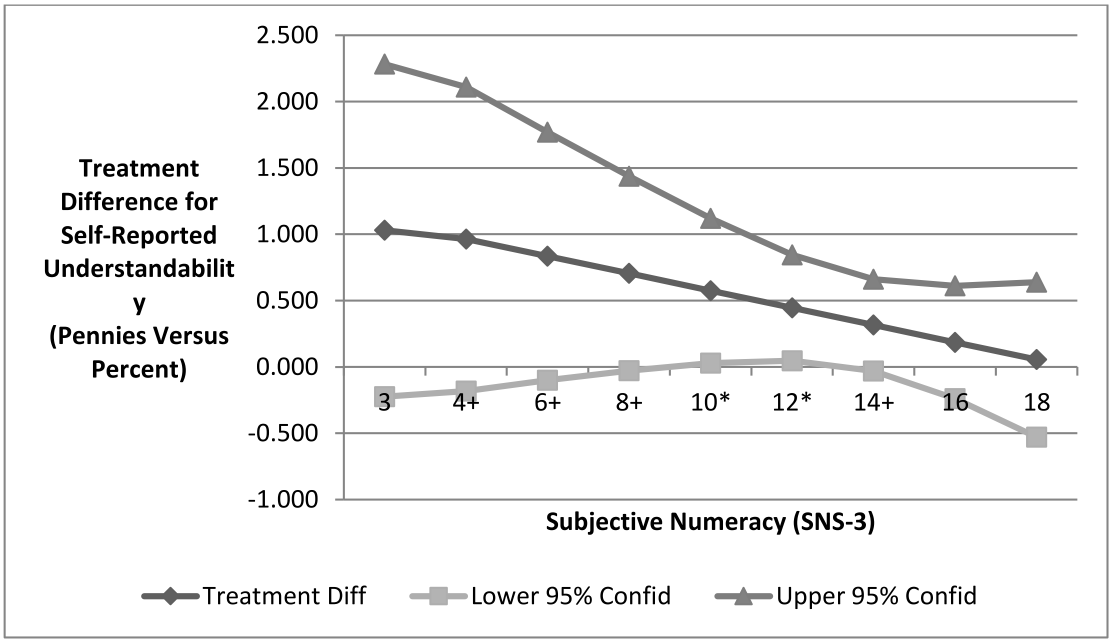


Table 1-17. Floodlight Analysis of the Difference Between Pennies and Percent on Self-Reported Understandability for Pennies X% and Y% Lab Study Across the Range of Subjective Numeracy

These tables explore the moderating role of subjective numeracy on self-reported understandability for a savings choice based on series of spotlight analyses (i.e., collectively a floodlight). In this case, the regression coefficient on the independent, indicator variable of pennies treatment is analyzed separately across the range of the moderator (i.e., subjective numeracy) with separate focus points. For example, for any focus point on SNS-3 = *value*, then the interactions analysis is performed where the moderator' = SNS-3 minus *value.* This sets the focus point at zero. As an example, if the focus point was on the mean value of SNS-3, then the moderator' used for that spotlight analysis would be mean-centered around zero (i.e., moderator' = moderator – mean). This methodology is consistent with other approaches for simple effect testing in moderated regressions (Spiller et al., 2013) and can help to identify the continuum over which the results are significant (i.e., range based on Johnson-Neyman points). Panel A includes the analysis without controls and Panel B includes controls for age, gender, income, and education for participants choosing to report. +, $p<0.10$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$.

PANEL A (without controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Self-Reported Understandability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(196)	p-value
3	1.030	-0.223	2.282	1.62	0.107
4	0.965+	-0.181	2.110	1.66	0.098
6	0.835+	-0.100	1.770	1.76	0.080
8	0.705+	-0.027	1.437	1.90	0.059
10	0.575*	0.030	1.121	2.08	0.039
12	0.445*	0.047	0.844	2.20	0.029
14	0.316+	-0.031	0.662	1.80	0.074
16	0.186	-0.240	0.611	0.86	0.391
18	0.056	-0.529	0.640	0.19	0.851



PANEL B (with controls)

Subjective Numeracy (SNS-3)	Treatment Difference on Self-Reported Understandability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(185)	p-value
3	1.099+	-0.159	2.357	1.72	0.087
4	1.029+	-0.123	2.180	1.76	0.080
6	0.889+	-0.052	1.830	1.86	0.064
8	0.749*	0.011	1.487	2.00	0.047
10	0.609*	0.058	1.161	2.18	0.030
12	0.469*	0.065	0.874	2.29	0.023
14	0.329+	-.021	0.680	1.85	0.065
16	0.190	-0.237	0.617	0.88	0.382
18	0.050	-0.535	0.635	0.17	0.866

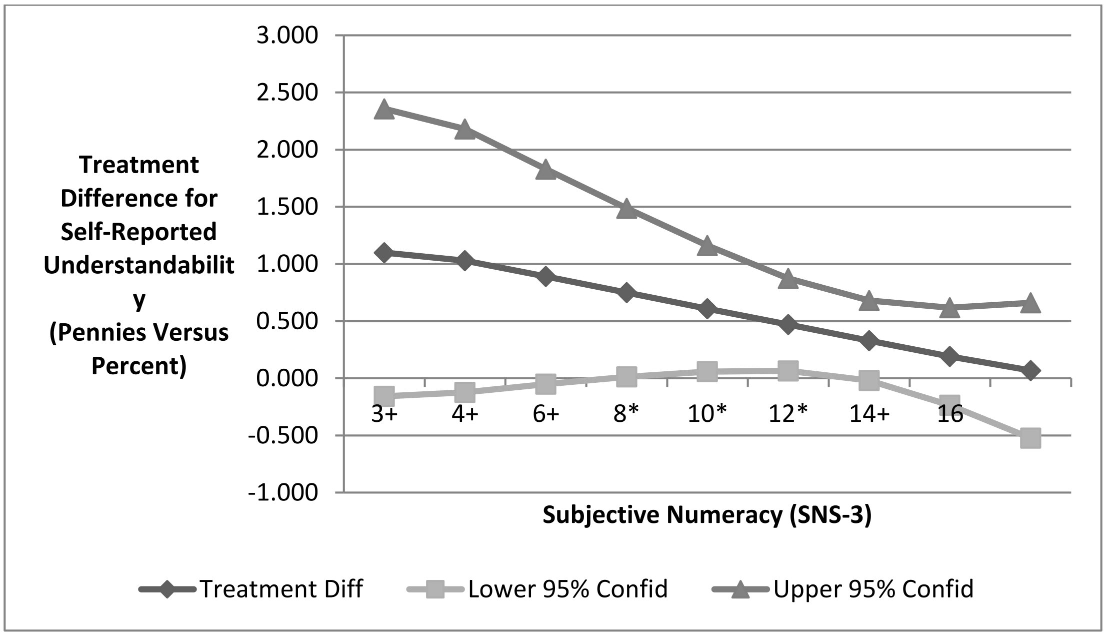


Table 1-18. Analyses for Pennies X% and Y% Lab Study with Affordability and Understandability Mediating Outcomes of Initial Savings Rate and Escalator Rate

These tables explore the mediating roles of affordability and understandability on initial savings rate and escalator rate using structural equation modeling using Stata 15 and 1,000 bootstrap replications. The model uses correlated residuals for affordability and understandability. Panel A includes the analysis for initial savings rate as the outcome variable and Panel B includes the analysis for escalator rate as the outcome variable. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

PANEL A (initial savings rate)

Direct Effects (unstandardized)	b	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Initial Rate <-					
- Affordable	0.3426*	0.0491	0.6361	2.29	0.022
- Understandable	-0.0024	-0.2290	0.2242	-0.02	0.984
- Pennies Condition Indicator	-0.0236	-0.4492	0.4020	-0.11	0.913
Affordable <-					
- Pennies Condition Indicator	0.3546*	0.0713	0.6380	2.45	0.014
Understandable <-					
- Pennies Condition Indicator	0.3198+	-0.0393	0.6790	1.75	0.081

PANEL B (escalator rate)

Direct Effects (unstandardized)	b	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Escalator Rate <-					
- Affordable	0.2550***	0.1241	0.3858	3.82	0.000
- Understandable	-0.0256	-0.1547	0.1035	-0.39	0.698
- Pennies Condition Indicator	0.4793***	0.2264	0.7322	3.71	0.000
Affordable <-					
- Pennies Condition Indicator	0.3546*	0.0713	0.6380	2.45	0.014
Understandable <-					
- Pennies Condition Indicator	0.3198+	-0.0393	0.6790	1.75	0.081

Table 1-19. Demographic and Financial Literacy Balance for Pennies X%, Y%, and Projections Lab Study

This table summarizes the characteristics of participants in terms of the four treatment groups (i.e., [pennies versus percent frames] x [with versus with projections]). Note that the second to last row reports chi-squared statistics for education and the percentage of male. The last row reports for all other covariates both statistical tests for means and variances. For the means, a one-way ANOVA is reported with an F-statistic and p-value. For variances, a Bartlett's test for equal variances is reported with a $\chi^2(3)$ for gender and financial literacy or $\chi^2(6)$ for education, and p-value. For statistical tests, the null hypothesis is that the groups are equal, and underline formatting in the table indicates cases where the null hypothesis is rejected at α=0.05 (i.e., treatment groups are not equal).

At a high-level, this table reflects that randomized assignment was imperfect with significant differences relative to education and variance for both age and financial literacy. Differences in income were marginally significant.

	Mean Age (standard deviation)	Percentage Male * (standard deviation)	Mean Annual Income ** (standard deviation)	Percent Education (% high school / % college / % advanced degree)	Financial Literacy (standard deviation)†	Observations
Pennies without projections	33.22 (6.55)	56.9	5.30 (3.47)	36.89% / 51.46% / 11.65%	2.33 (0.97)	103
Pennies with projections	32.65 (5.70)	61.2	5.78 (3.28)	26.53% / 53.06% / 20.41%	2.46 (0.78)	98
Percent without projections	34.03 (8.11)	52.5	5.03 (2.70)	34.31% / 58.82% / 6.86%	2.34 (0.87)	102
Percent with projections	32.75 (6.98)	48.9	5.05 (3.25)	39.78% / 52.69% / 7.53%	2.23 (1.04)	93
Overall	33.18 (6.90)	55.0	5.29 (3.19)	34.34% / 54.04% / 11.62%	2.34 (0.92)	396
Chi-squared for percentage male and education [p-	N/A	3.31 [0.35]	N/A	13.19 [0.04]	N/A	

	Mean Age (standard deviation)	Percentage Male * (standard deviation)	Mean Annual Income ** (standard deviation)	Percent Education (% high school / % college / % advanced degree)	Financial Literacy (standard deviation)†	Observations
value]						
(F-statistic for means, Bartlett's χ^2 for variance) [p-value mean, p-value variance]	(0.83, 12.70) [0.48, 0.01]	N/A	(1.11, 6.78) [0.34, 0.08]	N/A	(1.13, 9.33) [0.34, 0.03]	

* Note that this only includes participants reporting male or female for gender and excludes those reporting "other" or "prefer not to say." However, note that of 396 participants that 3 participants reported a gender of either "other" of "prefer not to say" and that these observations were split between the pennies without projections, percent without projection, and percent with projections conditions. So in the gender column, there are a total of 393 observations.

****** Income is coded as done as outlined in Table 1-1. Those who preferred not to report their income (7 total observations) have been excluded from these statistics (# observations excluded from pennies without projections = 2, pennies with projections = 4, percent without projections = 0, percent with projections = 1).
† If a participant answered "refuse to answer" for any of the financial literacy questions, these have been excluded from these statistics. A total of 2 participants refused to answer at least one of the financial literacy questions, and all of these participants were part of the pennies without projections condition.

Table 1-20. Main Effect of Pennies Framing and Projections on Savings for Pennies X%, Y%, and Projections Lab Study

Panel A reports the results of ordinary least squares regressions where the outcome variable is the initial savings rate chosen by the participant. Panel A Column 1 reports OLS without controls, and Column 2 reports OLS results with controls††. Panel B reports the results of ordinary least squares regressions where the outcome variable is the escalator rate chosen by the participant. Panel B Column 1 reports OLS without controls, and Column 2 reports OLS with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

PANEL A (Initial Savings Rate)

	(1)			(2)		
	Initial savings rate	St. Err.	p-value	Initial savings rate	St. Err.	p-value
Pennies Condition Indicator	0.477197**	0.1693411	0.005	0.5013545**	0.1718697	0.004
Projections Indicator	0.1912142	0.1694276	0.260	0.1642963	0.1709940	0.337
Age				0.0191547	0.0125174	0.127
Gender‡				-0.0216984	0.0864310	0.802
Income				0.0799942**	0.0294150	0.007
Education				0.030171	0.1457570	0.836
Constant	4.016224***	0.1447177	0.000	2.901223***	0.4886119	0.000
R^2	0.0227			0.0541		
Adj R^2	0.0178			0.0392		
N	396			388		

PANEL B (Escalator Rate)

	(1)			(2)		
	Escalator rate	St. Err.	p-value	Escalator rate	St. Err.	p-value
Pennies Condition Indicator	0.3600943***	0.0961182	0.000	0.3742012***	0.0977335	0.000
Projections Indicator	0.0908737	0.0961673	0.345	0.0672885	0.0972355	0.489
Age				0.0047139	0.007118	0.508
Gender‡				-0.0706886	0.0491489	0.151
Income				0.0430386**	0.0167268	0.010
Education				0.0571613	0.0828845	0.491
Constant	1.294002***	0.0821419	0.000	0.8230338***	0.2778485	0.000
R^2	0.0364			0.0654		
Adj R^2	0.0315			0.0506		
N	396			388		

†† Note that when running regressions with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-21. Main Effect of Pennies Framing and Projections on Self-Reported Affordability for Pennies X%, Y%, and Projections Lab Study

This table reports the results of ordinary least squares regressions where the outcome variable is a self-reported 7-point, Likert assessment by the participant (strongly disagree = 1 to strongly agree = 7) in reaction to the question, "I found the option to be affordable" performed after the main stimulus of the savings choice and projections (if applicable). Column 1 reports OLS without controls, and Column 2 reports OLS results with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	(1)			(2)		
	Self-Reported Affordability	St. Err.	p-value	Self-Reported Affordability	St. Err.	p-value
Pennies Condition Indicator	0.4172871***	0.1079744	0.000	0.4111335***	0.1079878	0.000
Projections Indicator	0.0277361	0.1080296	0.798	0.0196013	0.1074376	0.855
Age				0.0136022+	0.0078648	0.085
Gender‡				-0.0892858	0.0543057	0.101
Income				0.0668992***	0.0184818	0.000
Education				-0.0805516	0.0915809	0.380
Constant	5.538716***	0.0922741	0.000	4.889531***	0.3070007	0.000
R^2	0.0367			0.0835		
Adj R^2	0.0318			0.0691		
N	396			388		

†† Note that when running OLS with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients for the OLS, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-22. Main Effect of Pennies Framing and Projections on Self-Reported Understandability for Pennies X%, Y%, and Projections Lab Study

This table reports the results of ordinary least squares regressions where the outcome variable is a self-reported 7-point, Likert assessment by the participant (strongly disagree = 1 to strongly agree = 7) in reaction to the question, "I found the description of the option to be clear and understandable" performed after the main stimulus of the savings choice. Column 1 reports OLS without controls, and Column 2 reports OLS results with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	(1)			(2)		
	Self-Reported Understandability	St. Err.	p-value	Self-Reported Understandability	St. Err.	p-value
Pennies Condition Indicator	0.2085364*	0.1026164	0.043	0.2125477*	0.1045452	0.043
Projections Indicator	0.2340176*	0.1026688	0.023	0.2091378*	0.1040125	0.045
Age				0.0063461	0.0076141	0.405
Gender‡				-0.0038628	0.0525744	0.941
Income				0.0129395	0.0178926	0.470
Education				-0.0284725	0.0886613	0.748
Constant	5.915753***	0.0876952	0.000	5.697201***	0.2972137	0.000
R^2	0.0229			0.0243		
Adj R^2	0.0180			0.0090		
N	396			388		

†† Note that when running OLS with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients for the OLS, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

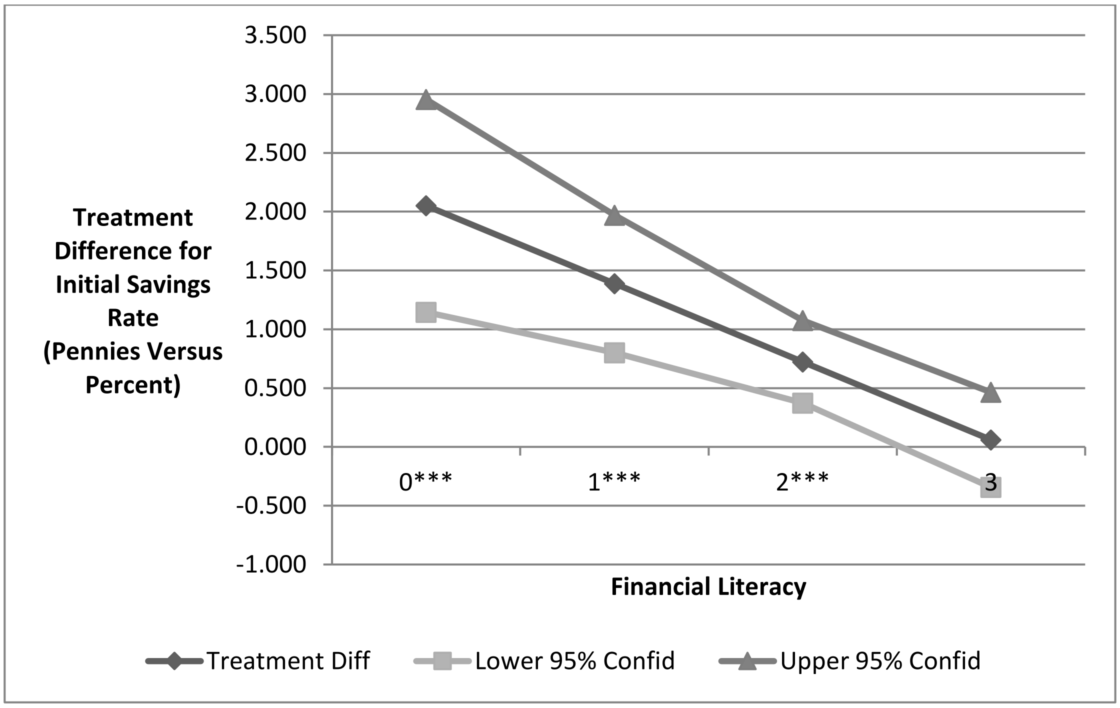
Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-23. Spotlight Analyses of the Difference Between Pennies and Percent on Savings for Pennies X%, Y%, and Projections Lab Study Across the Range of Financial Literacy Scores

These tables explore the moderating role of financial literacy on savings (i.e., in terms of initial savings rate and escalator rate) for a savings choice based on series of spotlight analyses (i.e., collectively a floodlight). In this case, the regression coefficient on the independent, indicator variable of pennies treatment is analyzed separately across the range of the moderator (i.e., financial literacy score) with separate focus points. This methodology is consistent with other approaches for simple effect testing in moderated regressions (Spiller et al., 2013) and can help to identify the continuum over which the results are significant (i.e., range based on Johnson-Neyman points). Panel A covers the initial savings rate and includes the analysis without controls and Panel B includes controls for age, gender, income, and education for participants choosing to report. Panels C and D cover the same analyses for escalator rate for the cases of both with and without controls. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

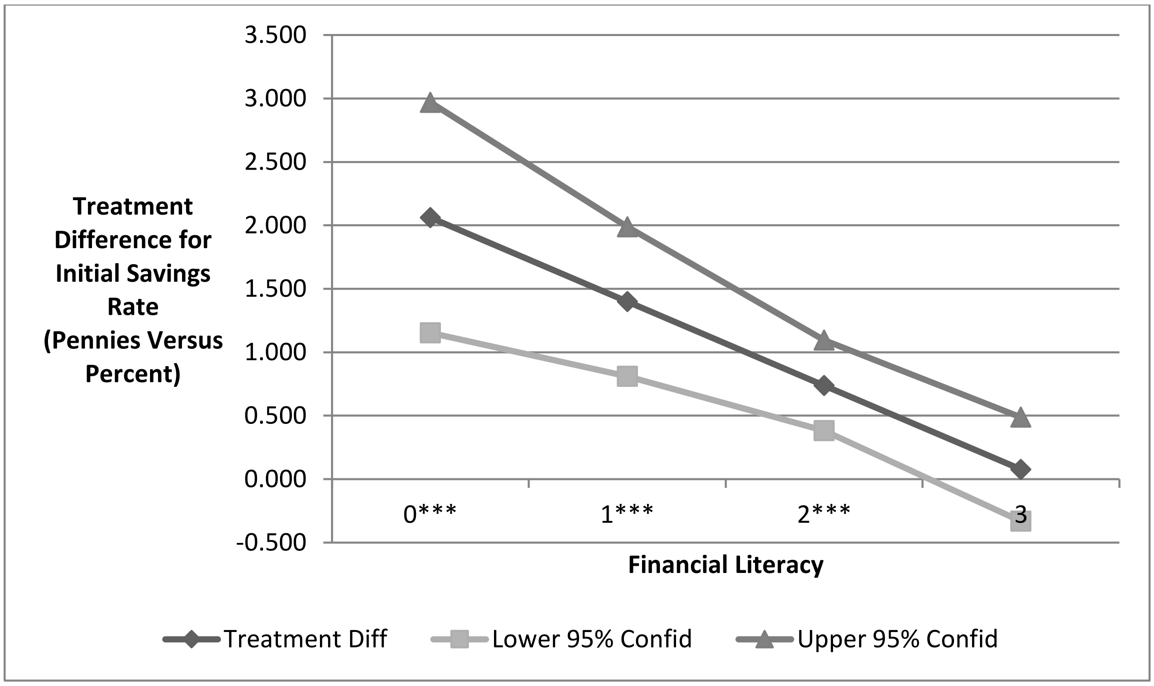
PANEL A (initial savings rate as outcome without controls)

Financial Literacy	Treatment Difference on Initial Savings Rate (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(390)	p-value
0	2.050***	1.145	2.954	4.46	0.000
1	1.387***	0.802	1.971	4.66	0.000
2	0.723***	0.372	1.075	4.04	0.000
3	0.060	-0.344	0.464	0.29	0.770



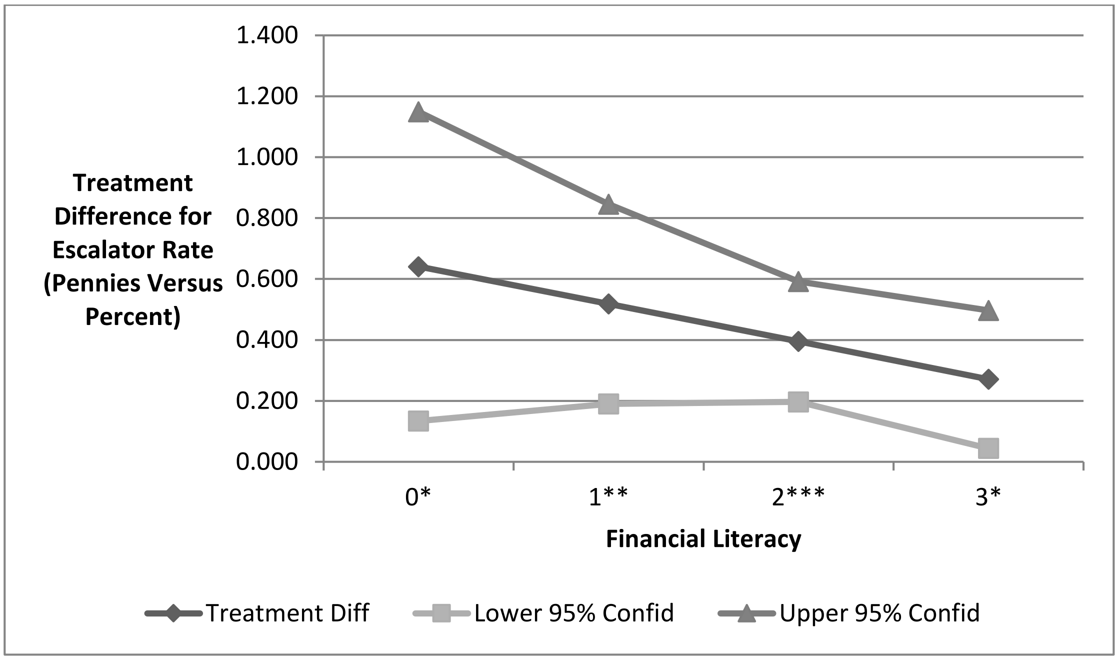
PANEL B (initial savings rate as outcome with controls)

Financial Literacy	Treatment Difference on Initial Savings Rate (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(378)	p-value
0	2.061***	1.1527	2.969	4.46	0.000
1	1.400***	0.811	1.988	4.68	0.000
2	0.738***	0.381	1.095	4.07	0.000
3	0.077	-0.332	0.487	0.37	0.710



PANEL C (escalator rate as outcome without controls)

Financial Literacy	Treatment Difference on Escalator Rate (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(390)	p-value
0	0.641*	0.134	1.149	2.49	0.013
1	0.518**	0.190	0.846	3.10	0.002
2	0.395***	0.197	0.592	3.93	0.000
3	0.271*	0.044	0.497	2.35	0.019



PANEL D (escalator rate as outcome with controls)

Financial Literacy	Treatment Difference on Escalator Rate (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(378)	p-value
0	0.643**	0.137	1.149	3.18	0.002
1	0.530**	0.202	0.857	2.59	0.010
2	0.416***	0.217	0.614	4.11	0.000
3	0.302**	0.074	0.530	2.60	0.010

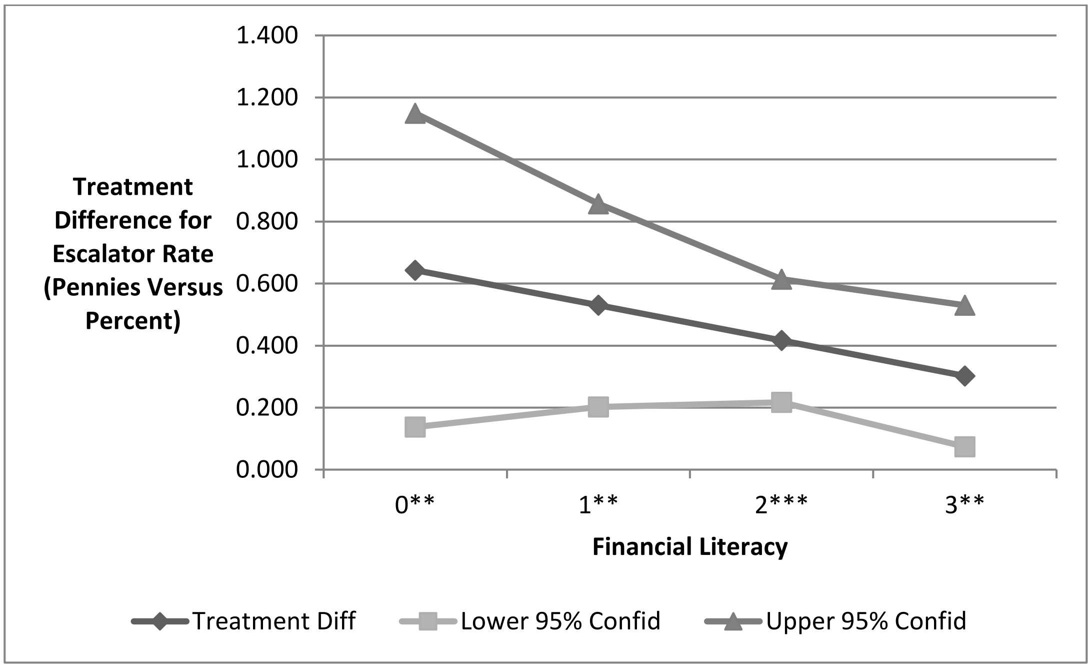
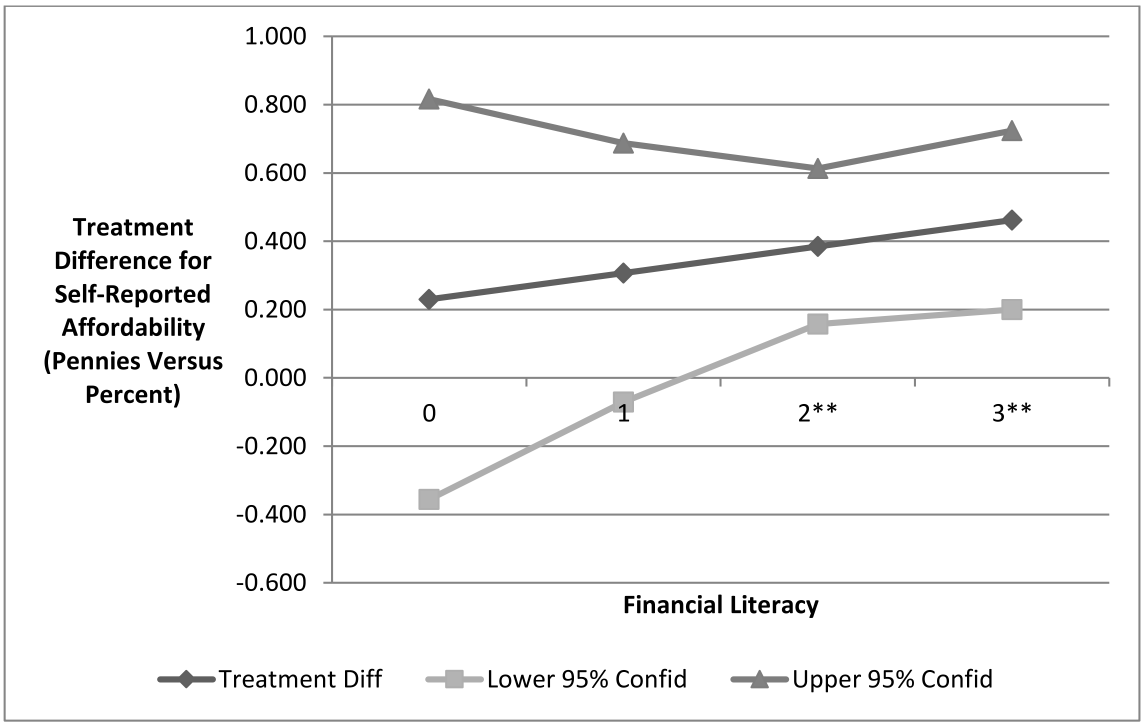


Table 1-24. Spotlight Analyses of the Difference Between Pennies and Percent on Self-Reported Affordability the Pennies X%, Y%, and Projections Lab Study Across the Range of Financial Literacy Scores

These tables explore the moderating role of financial literacy on self-reported affordability for a savings choice based on series of spotlight analyses (i.e., collectively a floodlight). In this case, the regression coefficient on the independent, indicator variable of pennies treatment is analyzed separately across the range of the moderator (i.e., financial literacy) with separate focus points. This methodology is consistent with other approaches for simple effect testing in moderated regressions (Spiller et al., 2013). Panel A includes the analysis without controls and Panel B includes controls for age, gender, income, and education for participants choosing to report. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

PANEL A (without controls)

Financial Literacy	Treatment Difference on Self-Reported Affordability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(390)	p-value
0	0.230	-0.356	0.816	0.77	0.440
1	0.307	-0.071	0.687	1.60	0.111
2	0.385**	0.157	0.613	3.32	0.001
3	0.462**	0.200	0.724	3.47	0.001



PANEL B (with controls)

Financial Literacy	Treatment Difference on Self-Reported Affordability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(378)	p-value
0	0.211	-0.369	0.790	0.71	0.475
1	0.294	-0.082	0.669	1.54	0.125
2	0.377**	0.149	0.604	3.25	0.001
3	0.460**	0.198	0.721	3.46	0.001

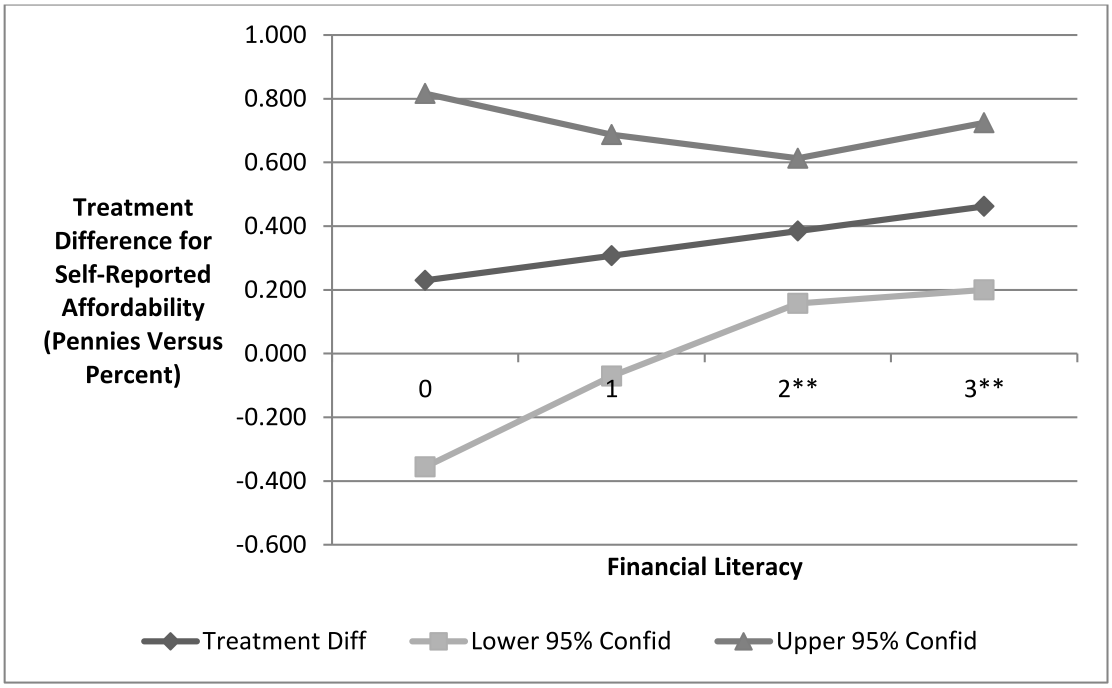
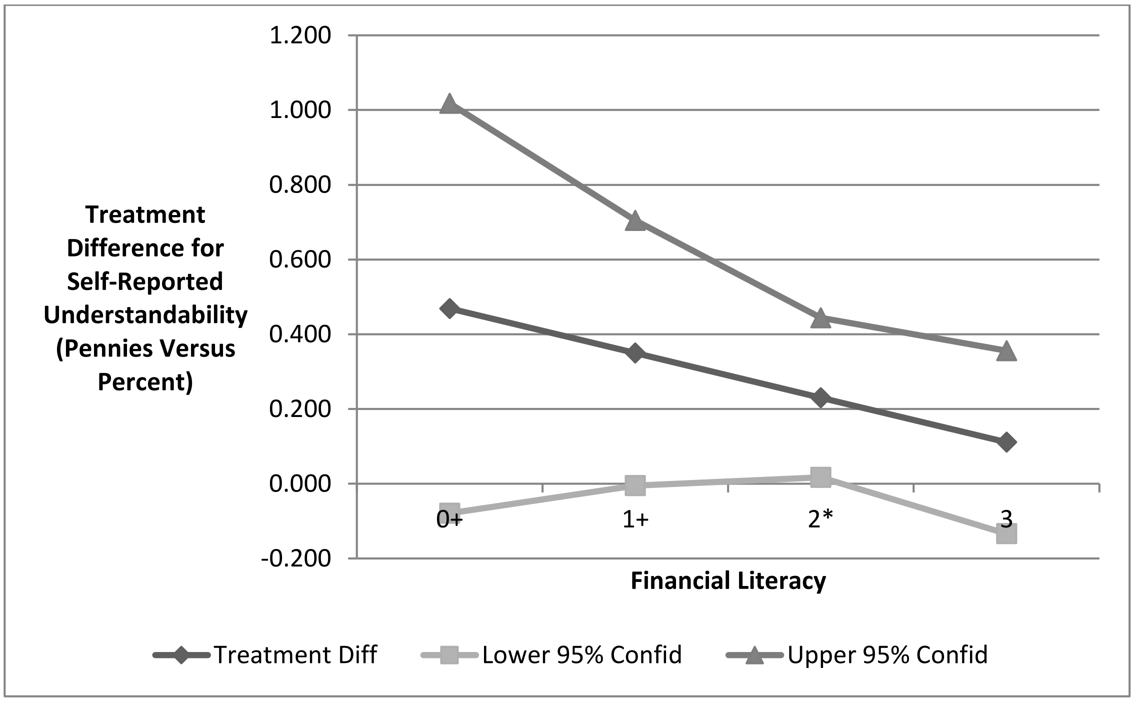


Table 1-25. Spotlight Analyses of the Difference Between Pennies and Percent on Self-Reported Understandability for the Pennies X%, Y%, and Projections Lab Study Across the Range of Financial Literacy Scores

These tables explore the moderating role of financial literacy on self-reported understandability for a savings choice based on series of spotlight analyses (i.e., collectively a floodlight). In this case, the regression coefficient on the independent, indicator variable of pennies treatment is analyzed separately across the range of the moderator (i.e., financial literacy) with separate focus points. This methodology is consistent with other approaches for simple effect testing in moderated regressions (Spiller et al., 2013). Panel A includes the analysis without controls and Panel B includes controls for age, gender, income, and education for participants choosing to report. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

PANEL A (without controls)

Financial Literacy	Treatment Difference on Self-Reported Understandability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(390)	p-value
0	0.469+	-0.079	1.018	1.68	0.093
1	0.350+	-0.005	0.705	1.94	0.053
2	0.230*	0.017	0.444	2.12	0.034
3	0.111	-0.134	0.356	0.89	0.374



PANEL B (with controls)

Financial Literacy	Treatment Difference on Self-Reported Understandability (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(378)	p-value
0	0.453	-0.098	1.004	1.62	0.107
1	0.342+	-0.015	0.699	1.88	0.061
2	0.231*	0.014	0.447	2.09	0.037
3	0.119	-0.129	0.368	0.94	0.346

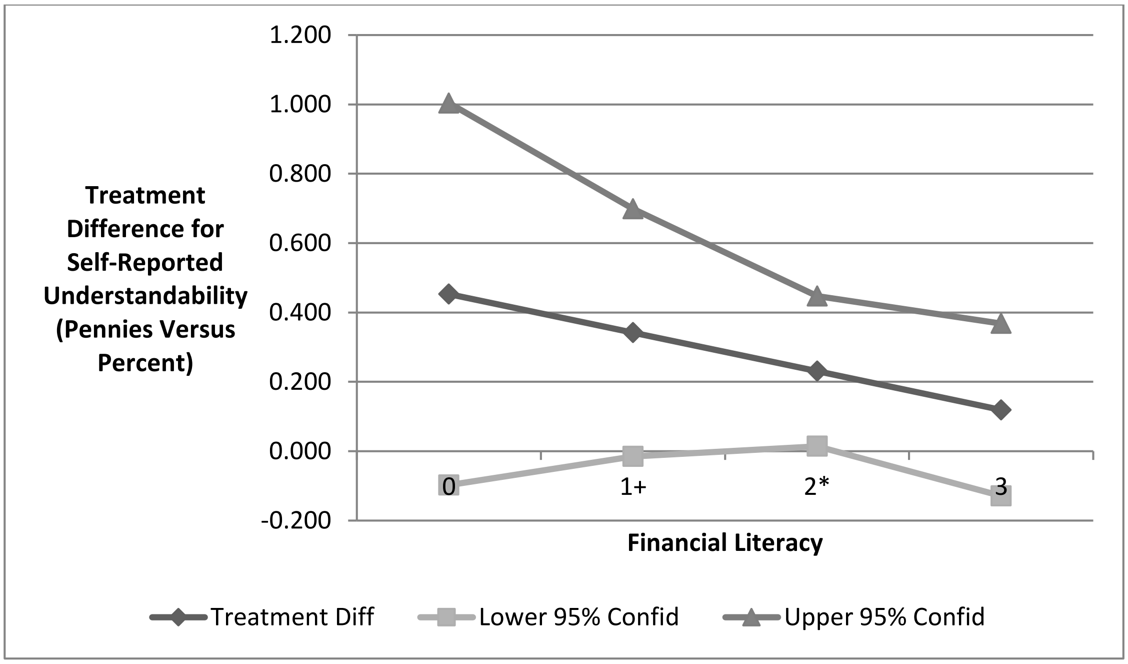


Table 1-26. Analyses for the Pennies X%, Y%, and Projections Lab Study with Affordability and Understandability Mediating Outcomes of Initial Savings Rate and Escalator Rate

These tables explore the mediating roles of affordability and understandability on initial savings rate and escalator rate using structural equation modeling using Stata 15 and 1,000 bootstrap replications. Modelling assumes correlated residuals for affordability and understandability. Panel A includes the analysis for initial savings rate as the outcome variable and Panel B includes the analysis for escalator rate as the outcome variable. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

PANEL A (initial savings rate)

Direct Effects (unstandardized)	b	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Initial Rate <-					
- Affordable	0.4424***	0.2446	0.6402	4.38	0.000
- Understandable	0.1351	-0.0417	0.3120	1.50	0.134
- Pennies Condition Indicator	0.2628	-0.0569	0.5826	1.61	0.107
Affordable <-					
- Pennies Condition Indicator	0.4170***	0.2094	0.6246	3.94	0.000
Understandable <-					
- Pennies Condition Indicator	0.2060*	0.0060	0.4061	2.02	0.043

PANEL B (escalator rate)

Direct Effects (unstandardized)	b	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Escalator Rate <-					
- Affordable	0.2715***	0.1822	0.3608	5.96	0.000
- Understandable	-0.0861	-0.1938	0.0216	-1.57	0.117
- Pennies Condition Indicator	0.2637**	0.0812	0.4462	2.83	0.005
Affordable <-					
- Pennies Condition Indicator	0.4170***	0.2094	0.6246	3.94	0.000
Understandable <-					
- Pennies Condition Indicator	0.2060*	0.0060	0.4061	2.02	0.043

Table 1-27. Main Effect of Pennies Framing, Use of Projections, and Interactive Education Via Loopbacks on Objective Understandability for the Pennies X%, Y%, and Projections Lab Study

This table reports the results of ordinary least squares regressions where the outcome variable is an objective test constructed to assess a participant's understanding of how an initial savings rate and escalator rate relate to current year savings, next year's savings, and savings rates two years from now. Column 1 reports OLS with controls but without using the number of times a person has looped back to change their savings as a regressor (a person can loopback to change their savings elections up to three times). Column 2 uses OLS with controls and with the number of loopbacks as a regressor††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	(1)			(2)		
	Objective Understandability	St. Err.	p-value	Objective Understandability	St. Err.	p-value
Pennies Condition Indicator	-0.2780339**	0.1064555	0.009	-0.2769411**	0.1058743	0.009
Projections Indicator	-0.0392883	0.1059131	0.711	-0.0957554	0.1082037	0.377
Number of Loopbacks				0.6486245*	0.2843613	0.023
Age	0.0005477	0.0077532	0.944	-0.0023549	0.0078151	0.763
Gender‡	0.0714904	0.0535351	0.183	0.0897961+	0.0538437	0.096
Income	-0.0169398	0.0182195	0.353	-0.0164104	0.0181214	0.366
Education	-0.083354	0.0902814	0.356	-0.0766762	0.0898353	0.394
Constant	2.540069***	0.3026446	0.000	2.621539***	0.3031008	0.000
R^2	0.0280			0.0411		
Adj R^2	0.0127			0.0234		
N	388			388		

†† Note that when running OLS with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients for the OLS, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-28. Main Effect of Loopbacks on Savings for the Pennies X%, Y%, and Projections Lab Study

The table reports the results of ordinary least squares regressions where the outcome variables are the initial savings rate and escalator rate chosen by the participant. Column 1 reports OLS for initial saving rate, and Column 2 reports OLS results for escalator rate with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	(1)			(2)		
	Initial savings rate	St. Err.	p-value	Escalator rate	St. Err.	p-value
Pennies Condition Indicator	0.5000723**	0.1714824	0.004	0.3728595***	0.0966736	0.000
Projections Indicator	0.2305534	0.1752553	0.189	0.1366215	0.0988005	0.168
Number of Loopbacks	-0.7610799+	0.4605744	0.099	-0.796412**	0.2596497	0.002
Age	0.0225606+	0.012658	0.075	0.0082779	0.007136	0.247
Gender‡	-0.0431778	0.0872095	0.621	-0.0931652+	0.0491646	0.059
Income	0.079373**	0.0293508	0.007	0.0423886*	0.0165466	0.011
Education	0.0223354	0.1455044	0.878	0.0489619	0.0820284	0.551
Constant	2.805629***	0.4909263	0.000	0.7230011**	0.2767607	0.009
R^2	0.0609			0.0879		
Adj R^2	0.0436			0.0711		
N	388			388		

†† Note that when running regressions with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-29. Main Effect of Objective Affordability Measures on Savings for the Pennies X%, Y%, and Projections Lab Study

The table reports the results of ordinary least squares regressions where the outcome variables are the initial savings rate and escalator rate chosen by the participant. There are three pairs of independent variables which are a measurement of objective affordability, with one pair (a cost and benefit, labeled respectively as "Aspect N Cost" and "Aspect N Benefit" where N represents the order in which the aspect was recalled by the participant) associated with each of the three aspects mentally identified by the participant. The following coding applies for each aspect: a smaller cost (cost = +1, benefit = 0), a larger cost (cost = -1, benefit = 0), a smaller benefit (cost = 0, benefit = -1), a larger benefit, (cost = 0, benefit = 1), none of the above (cost = 0, benefit = 0). Column 1 reports OLS for initial saving rate, and Column 2 reports OLS results for escalator rate with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	(1)			(2)		
	Initial savings rate	St. Err.	p-value	Escalator rate	St. Err.	p-value
Pennies Condition Indicator	0.4490583**	0.1699376	0.009	0.3792104***	0.0987388	0.000
Projections Indicator	0.2225761	0.1700441	0.191	0.129191	0.0988007	0.192
Number of Loopbacks	-0.8042146+	0.4499792	0.075	-0.8269615**	0.2614512	0.002
Aspect 1 Cost	0.2957839*	0.1396771	0.035	0.0466584	0.0811566	0.566
Aspect 1 Benefit	0.1132952	0.1295063	0.382	-0.0002712	0.075247	0.997
Aspect 2 Cost	0.2311675+	0.1363525	0.091	0.0488321	0.0792248	0.538

	(1)			(2)		
	Initial savings rate	St. Err.	p-value	Escalator rate	St. Err.	p-value
Aspect 2 Benefit	0.3619284**	0.1275209	0.005	0.1511613*	0.0740934	0.042
Aspect 3 Cost	-0.0884097	0.155493	0.570	-0.1348691	0.090346	0.136
Aspect 3 Benefit	0.3595766**	0.1220627	0.003	0.0351697	0.0709221	0.620
Age	0.0188956	0.0122914	0.125	0.0071626	0.0071417	0.317
Gender‡	-0.0047142	0.08501	0.956	-0.0902841+	0.0493934	0.068
Income	0.0689964*	0.028735	0.017	0.0409759*	0.0166959	0.015
Education	0.0610606	0.1428161	0.669	0.0646366	0.0829804	0.437
Constant	2.806169***	0.4803624	0.000	0.6975491*	0.2791048	0.013
R^2	0.1338			0.1064		
Adj R^2	0.1037			0.0753		
N	388			388		

†† Note that when running regressions with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-30. Relationship of Subjective and Objective Affordability Measures for the Pennies X%, Y%, and Projections Lab Study

The table reports the results of ordinary least squares regressions where the outcome variable is subjective affordability as indicated by the participant. There are three pairs of independent variables which are a measurement of objective affordability, with one pair (a cost and benefit, labeled respectively as "Aspect N Cost" and "Aspect N Benefit" where N represents the order in which the aspect was recalled by the participant) associated with each of the three aspects mentally identified by the participant. The following coding applies for each aspect: a smaller cost (cost = +1, benefit = 0), a larger cost (cost = -1, benefit = 0), a smaller benefit (cost = 0, benefit = -1), a larger benefit, (cost = 0, benefit = 1), none of the above (cost = 0, benefit = 0). Column 1 includes only the objective affordability measures, and Column 2 includes all covariates. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	(1)			(2)		
	Subjective Affordability	St. Err.	p-value	Subjective Affordability	St. Err.	p-value
Pennies Condition Indicator				0.3518628**	0.1077594	0.001
Projections Indicator				0.039915	0.1078269	0.711
Number of Loopbacks				-0.1859266	0.285337	0.515
Aspect 1 Cost	0.0177272	0.0886412	0.842	-0.0088131	0.0885709	0.921
Aspect 1 Benefit	0.0406762	0.08323	0.625	0.0298754	0.0821214	0.716
Aspect 2 Cost	0.1638207+	0.087573	0.062	0.1461731+	0.0864627	0.092

	(1)			(2)		
	Subjective Affordability	St. Err.	p-value	Subjective Affordability	St. Err.	p-value
Aspect 2 Benefit	0.2059566*	0.0824193	0.013	0.1784365*	0.0808625	0.028
Aspect 3 Cost	0.2692062**	0.0983786	0.006	0.2287767*	0.0985999	0.021
Aspect 3 Benefit	0.2500205**	0.0786433	0.002	0.2319978**	0.0774014	0.003
Age				0.0124823	0.0077941	0.110
Gender‡				-0.0677668	0.0539059	0.209
Income				0.061408**	0.0182212	0.001
Education				-0.1093667	0.0905614	0.228
Constant	5.688953***	0.0633062	0.000	4.969325***	0.3046033	0.000
R^2	0.0801			0.1452		
Adj R^2	0.0659			0.1154		
N	396			388		

†† Note that when running regressions with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 1-1.

Table 1-31. Mediation Analyses for Both Subjective and Objective Psychological Measures Affecting Initial Savings Rate for the Pennies X%, Y%, and Projections Lab Study

These tables explore the mediating roles of subjective affordability, objective affordability, subjective understandability, and objective understandability on initial savings rate using structural equation modeling using Stata 15 and maximum likelihood estimation. For the fitted model, N=396, $\chi^2(30)=56.31$, RMSEA=0.047, CFI=0.874, and SRMR=0.054. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

Direct Effects (unstandardized)	B	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Initial Rate <-					
- Affordable	0.3944092***	0.2363383	0.55248	4.89	0.000
- Aspect 1 Cost	0.2724373*	.0172236	.527651	2.09	0.036
- Aspect 2 Cost	0.150327	-0.1020108	0.4026648	1.17	0.243
- Aspect 3 Cost	-0.1725536	-0.4588854	0.1137782	-1.18	0.238
- Aspect 1 Benefit	.0931696	-0.1461134	0.3324525	0.76	0.445
- Aspect 2 Benefit	0.3078115*	0.0697072	0.5459158	2.53	0.011
- Aspect 3 Benefit	0.2374314*	0.0078317	0.4670311	2.03	0.043
- Understandable	0.1049438	-0.0583035	0.2681911	1.26	0.208
- Objective Understandability Score	0.1756659*	0.0268094	0.3245223	2.31	0.021
- Pennies Condition Indicator	0.3055724+	-0.0115977	0.6227424	1.89	0.059
Affordable <-					
- Pennies Condition Indicator	0.416992***	0.2061634	0.6278205	3.88	0.000
Aspect 1 Cost <-					
- Pennies Condition Indicator	0.1382319*	0.0195753	0.2568885	2.28	0.022
Aspect 2 Cost <-					
- Pennies Condition Indicator	0.082434	-0.0384607	0.2033286	1.34	0.181
Aspect 3 Cost <-					
- Pennies Condition Indicator	0.1742824**	0.0689312	0.2796337	3.24	0.001
Aspect 1 Benefit <-					
- Pennies Condition Indicator	-0.0582472	-0.1853773	0.0688829	-0.90	0.369
Aspect 2 Benefit <-					

Direct Effects (unstandardized)	B	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
- Pennies Condition Indicator	0.0528894	-0.0756976	0.1814764	0.81	0.420
Aspect 3 Benefit <-					
- Pennies Condition Indicator	-0.0089552	-0.1433992	0.1254887	-0.13	0.896
Understandable <-					
- Pennies Condition Indicator	0.2060467*	0.0042706	0.4078228	2.00	0.045
Objective Understandability Score <-					
- Pennies Condition Indicator	-0.2573287*	-0.459993	-0.0546645	-2.49	0.013
Modeled Residual Covariances					
- Affordable & Understandable	0.4259846***	0.3105827	0.5413864	7.23	0.000
- Understandable & Objective Understandability Score	0.0970711*	0.0009686	0.1931736	1.98	0.048
- Aspect 1 Cost & Aspect 2 Cost	0.0422099*	0.0055834	0.0788364	2.26	0.024
- Aspect 2 Cost & Aspect 3 Cost	0.0179708	-0.0142244	0.050166	1.09	0.274
- Aspect 1 Benefit & Aspect 2 Benefit	0.0464383*	0.0049299	0.0879468	2.19	0.028
- Aspect 2 Benefit & Aspect 3 Benefit	0.0532293*	0.0092398	0.0972189	2.37	0.018

Table 1-32. Mediation Analyses for Both Subjective and Objective Psychological Measures Affecting Escalator Rate for the Pennies X%, Y%, and Projections Lab Study

These tables explore the mediating roles of subjective affordability, objective affordability, subjective understandability, and objective understandability on escalator rate using structural equation modeling using Stata 15 and maximum likelihood estimation. For the fitted model, N=396, $\chi^2(30)=56.31$, RMSEA=0.047, CFI=0.863, and SRMR=0.052. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

Direct Effects (unstandardized)	B	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Escalator Rate <-					
- Affordable	0.2600403***	0.1676409	0.3524398	5.52	0.000
- Aspect 1 Cost	0.0214239	-0.1277599	0.1706077	0.28	0.778
- Aspect 2 Cost	0.0562891	-0.0912136	0.2037919	0.75	0.454
- Aspect 3 Cost	-0.147711+	-0.3150848	0.0196627	-1.73	0.084
- Aspect 1 Benefit	0.0290101	-0.1108615	0.1688817	0.41	0.684
- Aspect 2 Benefit	0.0931722	-0.0460104	0.2323548	1.31	0.190
- Aspect 3 Benefit	0.0021029	-0.1321084	0.1363142	0.03	0.976
- Understandable	-0.0722692	-0.1676946	0.0231561	-1.48	0.138
- Objective Understandability Score	-0.1253018**	-0.2123151	-0.0382885	-2.82	0.005
- Pennies Condition Indicator	0.2482624**	0.0628623	0.4336625	2.62	0.009
Affordable <-					
- Pennies Condition Indicator	0.416992***	0.2061634	0.6278205	3.88	0.000
Aspect 1 Cost <-					
- Pennies Condition Indicator	0.1382319*	0.0195753	0.2568885	2.28	0.022
Aspect 2 Cost <-					
- Pennies Condition Indicator	0.082434	-0.0384607	0.2033286	1.34	0.181
Aspect 3 Cost <-					
- Pennies Condition Indicator	0.1742824**	0.0689312	0.2796337	3.24	0.001
Aspect 1 Benefit <-					
- Pennies Condition Indicator	-0.0582472	-0.1853773	0.0688829	-0.90	0.369
Aspect 2 Benefit <-					

Direct Effects (unstandardized)	B	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
- Pennies Condition Indicator	0.0528894	-0.0756976	0.1814764	0.81	0.420
Aspect 3 Benefit <-					
- Pennies Condition Indicator	-0.0089552	-0.1433992	0.1254887	-0.13	0.896
Understandable <-					
- Pennies Condition Indicator	0.2060467*	0.0042706	0.4078228	2.00	0.045
Objective Understandability Score <-					
- Pennies Condition Indicator	-0.2573287*	-0.459993	-0.0546645	-2.49	0.013
Modeled Residual Covariances					
- Affordable & Understandable	0.4259846***	0.3105827	0.5413864	7.23	0.000
- Understandable & Objective Understandability Score	0.0970711*	0.0009686	0.1931736	1.98	0.048
- Aspect 1 Cost & Aspect 2 Cost	0.0422099*	0.0055834	0.0788364	2.26	0.024
- Aspect 2 Cost & Aspect 3 Cost	0.0179708	-0.0142244	0.050166	1.09	0.274
- Aspect 1 Benefit & Aspect 2 Benefit	0.0464383*	0.0049299	0.0879468	2.19	0.028
- Aspect 2 Benefit & Aspect 3 Benefit	0.0532293*	0.0092398	0.0972189	2.37	0.018

Table 1-33. Summary of Hypotheses for Chapter 1 Studies and Key Findings

	Pennies 1% and 1% Lab Study	Pennies X% and Y% Lab Study	Pennies X%, Y%, and Projections Lab Study
H1: Pennies-based framing will increase retirement savings choices relative to percent-based framing.	No main effect (ceiling effect)	No main effect on initial rate (under choice constraint of initial rate being picked first)	Main effect on initial rate (positive)
		Main effect on escalator rate (positive)	Main effect on escalator rate (positive)
H2a: Subjective affordability will be higher in pennies-based framing.	No effect (directionally positive)	Main effect (positive)	Main effect (positive)
H2b: Objective affordability will be higher in pennies-based framing.			Main effect on objective affordability (first and third aspect) (positive)
H3a: Subjective understandability will be higher in pennies-based framing.	No effect (directionally negative)	No effect (marginally positive)	Main effect (positive)
H3b: Objective understandability will be higher in pennies-based framing.			Main effect (negative)
H4: Affordability will explain retirement savings choices.		Significant, positive effect of subjective affordability on initial rate	Significant, positive effect of subjective affordability on initial rate
		Significant, positive effect of subjective affordability on escalator rate	Significant, positive effect of subjective affordability on escalator rate

	Pennies 1% and 1% Lab Study	**Pennies X% and Y% Lab Study**	**Pennies X%, Y%, and Projections Lab Study**
H5: Understandability will explain retirement savings choices.		No effect of subjective understandability on initial rate	No effect of subjective understandability on initial rate
		No effect of subjective understandability on escalator rate	No effect on of subjective understandability escalator rate
H6: Affordability will partially mediate the relationship between pennies-based framing and retirement savings choices.		Significant, positive fully mediating effect of subjective affordability on initial rate	Significant, complementary mediating effect of subjective affordability on initial rate
			Significant, complementary mediating effect of objective affordability (first aspect) on initial rate
		Significant, positive partially mediating effect of subjective affordability on escalator rate	Significant, positive partially mediating effect of subjective affordability on escalator rate
			No mediating effect of objective affordability on escalator rate
H7: Understandability will partially mediate the relationship between pennies-based framing and retirement savings choices.		No mediating effect of subjective understandability on initial rate	No mediating effect of subjective understandability on initial rate
			Competitive mediating effect of objective

	Pennies 1% and 1% Lab Study	Pennies X% and Y% Lab Study	Pennies X%, Y%, and Projections Lab Study
			understandability on initial rate
		No mediating effect of subjective understandability on escalator rate	No mediating effect of subjective understandability on escalator rate
			Complementary mediating effect of objective understandability on escalator rate
H8: Providing participants with an opportunity to adjust their choices after presenting them with escalator projections will increase understandability of retirement savings choices.			Main effect of projections on self-reported understandability in cases of user interaction (positive)
H9: Numeracy and financial literacy will moderate choice in pennies-based framing.	Counterintuitive, positive effect for highest numeracy only	Directionally positive effect on initial rate for lower numeracy	Simple main effect on initial rate moderated by financial literacy
		Directionally positive effect on escalator rate for lower numeracy	Directional, simple main effect on escalator rate moderated by financial literacy

1.10 Online Appendix: Chapter 1 Lab Studies Materials

Section A – Stimulus for Pennies 1% and 1% Lab Study

Instructions

In this survey we would like to learn about how you would make a retirement savings plan decision.

Suppose your employer provides you with an opportunity to participate in a retirement savings plan that enables you to automatically save a portion of your salary each pay period. The plan would enable you to save and invest your money pre-tax (within government limits) until retirement.

Researcher note: based on context, participant gets text in either [ ] or ( ) covering either "penny per dollar" or "pennies per dollar" instead of "%" framing.

Question 1

Please select one of the following:

- ❍ I would choose to save [1 penny per dollar] (1%) of my salary, increasing by [1 penny per dollar] (1%) of my salary every year thereafter.

- ❍ I would choose not to save.

Question 2

Recall the previous question, which gave you an option to save [1 penny per dollar] (1%) of your salary, increasing by [1 penny per dollar] (1%) of your salary every year thereafter.

What was your attitude toward this option?

Items	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
a) *I found the option to be affordable.*	1	2	3	4	5	6	7
b) *I found the description of the option to be clear and understandable.*	1	2	3	4	5	6	7

We would now like to ask you some questions about yourself.

Question 3

Please select an answer for each row:

Items	Not at all good	-	-	-	-	Extremely good
a) *How good are you at working with fractions?*	1	2	3	4	5	6
b) *How good are you at working with percentages?*	1	2	3	4	5	6
c) *How good are you at calculating a 15% tip?*	1	2	3	4	5	6

Items	Not at all good	-	-	-	-	Extremely good
d) *How good are you at figuring out how much a shirt will cost if it is 25% off?*	1	2	3	4	5	6

Question 4

Please answer the following question:

Items	Never	-	-	-	-	Very often
How often do you find numerical information to be	1	2	3	4	5	6

Items	Never	-	-	-	-	Very often
useful?						

Earlier, we gave you a choice between a savings option of [1 penny per dollar] (1%) of your salary, increasing by [1 penny per dollar] (1%) of your salary every year thereafter, against an option to not save at all. Next we're going to show you some additional savings options that could have been presented to you. For each option, please indicate how likely you would be to choose it.

Question 5

Please select an answer for each row:

Items	Definitely not choose	-	-	Unsure	-	-	Definitely choose
a) *Enroll at [2 pennies per dollar] (2%) of my salary,*	1	2	3	4	5	6	7

Items	Definitely not choose	-	-	Unsure	-	-	Definitely choose
increasing by [1 penny per dollar] (1%) of my salary every year thereafter							
b) *Enroll at [2 pennies per dollar] (2%) of my salary, increasing by [2 pennies per dollar] (2%) of my salary every year thereafter*	1	2	3	4	5	6	7

Items	Definitely not choose	-	-	Unsure	-	-	Definitely choose
c) *Enroll at [3 pennies per dollar] (3%) of my salary, increasing by [1 penny per dollar] (1%) of my salary every year thereafter*	1	2	3	4	5	6	7
d) *Enroll at [6 pennies per dollar] (6%) of my salary, increasing by [1 penny per dollar]*	1	2	3	4	5	6	7

Items	Definitely not choose	-	-	Unsure	-	-	Definitely choose
(1%) of my salary every year thereafter							

Question 6

What is your age (in years)? ________ **(Research coding note: 18 to 99)**

Question 7

What is your gender?

- ❍ Male
- ❍ Female
- ❍ Other
- ❍ Prefer not to say

Question 8

What is your annual income?

- ❍ $9,999 a year or less
- ❍ From $10,000 to $19,999 a year
- ❍ From $20,000 to $29,999 a year
- ❍ From $30,000 to $39,999 a year
- ❍ From $40,000 to $49,999 a year
- ❍ From $50,000 to $59,999 a year
- ❍ From $60,000 to $69,999 a year
- ❍ From $70,000 to $79,999 a year
- ❍ From $80,000 to $89,999 a year
- ❍ From $90,000 to $99,999 a year
- ❍ From $100,000 to $109,999 a year
- ❍ From $110,000 to $119,999 a year
- ❍ From $120,000 to $129,999 a year
- ❍ From $130,000 to $139,999 a year
- ❍ From $140,000 to $149,999 a year
- ❍ $150,000 a year or more
- ❍ Prefer not to say

Question 9

What is the highest degree or level of school you have completed? If currently enrolled, please indicate highest degree received.

- ❍ High school
- ❍ College degree
- ❍ Advanced degree

Thank you for your participation in this survey!

Section B – Stimulus for Pennies X% and Y% Lab Study

Instructions

In this survey we would like to learn about how you would make a retirement savings plan decision.

Suppose your employer provides you with an opportunity to participate in a retirement savings plan that enables you to automatically save a portion of your salary each pay period. The plan would enable you to save and invest your money pre-tax (within government limits) until retirement.

Researcher note: based on context, participant gets text in either [ ] or ( ) covering either "penny per dollar" or "pennies per dollar" instead of "%" framing.

Question 1

Please indicate how much you would choose to save:

I would choose to save [X pennies per dollar] (X%) of my salary, increasing by [Y pennies per dollar] (Y%) of my salary every year thereafter.

Researcher note: X is from 0 to 6, Y is from 0 to 3

Question 2

Recall the previous question, where you were given an option to save a certain [number of pennies per dollar] (percent) of your salary, increasing by a certain [number of pennies per dollar] (percent) of your salary every year thereafter.

What was your attitude toward this option?

Items	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
a) *I found the option to be affordable.*	1	2	3	4	5	6	7
b) *I found the description of the option to be clear and understandable.*	1	2	3	4	5	6	7

We would now like to ask you some questions about yourself.

Question 3

Please select an answer for each row:

Items	Not at all good	-	-	-	-	Extremely good
a) *How good are you at working with fractions?*	1	2	3	4	5	6
b) *How good are you at working with percentages?*	1	2	3	4	5	6
c) *How good are you at calculating a 15% tip?*	1	2	3	4	5	6

Items	Not at all good	-	-	-	-	Extremely good
d) *How good are you at figuring out how much a shirt will cost if it is 25% off?*	1	2	3	4	5	6

Question 4

Please answer the following question:

Items	Never	-	-	-	-	Very often
How often do you find numerical information to be	1	2	3	4	5	6

Items	Never	-	-	-	-	Very often
useful?						

Next we’re going to show you some additional savings options that could have been presented to you. For each option, please indicate how likely you would be to choose it.

Question 5

Please select an answer for each row:

Items	Definitely not choose	-	-	Unsure	-	-	Definitely choose
a) *Enroll at [2 pennies per dollar] (2%) of my salary, increasing by [1*	1	2	3	4	5	6	7

Items	Definitely not choose	-	-	Unsure	-	-	Definitely choose
penny per dollar] (1%) of my salary every year thereafter							
b) *Enroll at [2 pennies per dollar] (2%) of my salary, increasing by [2 pennies per dollar] (2%) of my salary every year thereafter*	1	2	3	4	5	6	7

Items	Definitely not choose	-	-	Unsure	-	-	Definitely choose
c) *Enroll at [3 pennies per dollar] (3%) of my salary, increasing by [1 penny per dollar] (1%) of my salary every year thereafter*	1	2	3	4	5	6	7
d) *Enroll at [6 pennies per dollar] (6%) of my salary, increasing by [1 penny per dollar]*	1	2	3	4	5	6	7

Items	Definitely not choose	-	-	Unsure	-	-	Definitely choose
(1%) of my salary every year thereafter							

Question 6

What is your age (in years)? ________ **(Research coding note: 18 to 99)**

Question 7

What is your gender?

- ❍ Male
- ❍ Female
- ❍ Other
- ❍ Prefer not to say

Question 8

What is your annual income?

- ❍ $9,999 a year or less
- ❍ From $10,000 to $19,999 a year
- ❍ From $20,000 to $29,999 a year
- ❍ From $30,000 to $39,999 a year
- ❍ From $40,000 to $49,999 a year
- ❍ From $50,000 to $59,999 a year
- ❍ From $60,000 to $69,999 a year
- ❍ From $70,000 to $79,999 a year
- ❍ From $80,000 to $89,999 a year
- ❍ From $90,000 to $99,999 a year
- ❍ From $100,000 to $109,999 a year
- ❍ From $110,000 to $119,999 a year
- ❍ From $120,000 to $129,999 a year
- ❍ From $130,000 to $139,999 a year
- ❍ From $140,000 to $149,999 a year
- ❍ $150,000 a year or more
- ❍ Prefer not to say

Question 9

What is the highest degree or level of school you have completed? If currently enrolled, please indicate highest degree received.

- ❍ High school
- ❍ College degree
- ❍ Advanced degree

Thank you for your participation in this survey!

Section C – Stimulus for Pennies X%, Y%, and Projections Lab Study

Instructions

In this survey we would like to learn about how you would make a retirement savings plan decision.

Suppose your employer provides you with an opportunity to participate in a retirement savings plan that enables you to automatically save a portion of your salary each pay period. The plan would enable you to save and invest your money pre-tax (within government limits) until retirement.

Researcher note: 2x2 design (pennies or percent) x (no projections or projections) where based on context, participant gets text a) in either [ ] or ( ) covering either "penny per dollar" or "pennies per dollar" instead of "%" framing and b) with or without projections workflow text in <>.

Question 1

Please indicate how much you would choose to save:

I would choose to save [X pennies per dollar] (X%) of my salary, increasing by [Y pennies per dollar] (Y%) of my salary every year thereafter.

Researcher note: X is from 0 to 6, Y is from 0 to 3

<#Begin projections: If user randomized into with projection text, then on next screen, provide the following text>

Question 1 continued

You are choosing to save [X pennies per dollar] (X%) of your salary, increasing by [Y pennies per dollar] (Y%) of your salary every year thereafter. This means that:

- you will save [X pennies per dollar] (X%) of your salary this year,
- you will save [X+Y pennies per dollar] (X+Y%) of your salary one year from now,
- you will save [X+2Y pennies per dollar] (X+2Y%) of your salary two years from now, and

- you will save [X+3Y pennies per dollar] (X+3Y%) of your salary three years from now

I wish to proceed with my choices <Researcher note: This path continues to Question 2>

I wish to go back and change my choices <Researcher note: This path returns to Question 1>

<# End projections>

Question 2

Recall the previous question, where you were given an option to save a certain [number of pennies per dollar] (percent) of your salary, increasing by a certain [number of pennies per dollar] (percent) of your salary every year thereafter.

What was your attitude toward this option?

Items	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
a) *I found the option to be affordable.*	1	2	3	4	5	6	7
b) *I found the description of the option to be clear and understandable.*	1	2	3	4	5	6	7

Question 3

Please list three things you were thinking about when you were given an option to save a certain [number of pennies per dollar] (percent) of your salary, increasing by a certain [number of pennies per dollar] (percent) of your salary every year thereafter.

1: {Item1}

2: {Item2}

3: {Item3}

Question 4a to 4c (4a – Item1, 4b – Item 2, 4c – Item 3):

As the {first, second, or third} item you listed, you wrote:

"{Item1, Item 2, or Item3}"

Would you characterize this item as closest to:

- a smaller cost
- a larger cost
- a smaller benefit
- a larger benefit
- none of the above

Researcher note: The next section of questions complement the subjective tests of understandability and are instead objective tests of understandability. They are executed using block ordering, where people in the pennies condition first see the Block1 questions first (i.e., questions 5-7 on pennies) and Block2 questions second (i.e., questions 8-10 on %). People in the percent condition see reverse block ordering. This ordering helps to keep the focus on understandability of the condition directly applicable to them.

<#Begin Block 1 with pennies> or <#Begin Block 2 with %>

<Researcher note on additional text before Question 8: Now consider another situation.> For the next three questions, suppose a person makes $40,000 per year. This year, the person chooses to save [1 penny per dollar] (1%) of their salary, increasing by [1 penny per dollar] (1%) of their salary every year thereafter.

Question 5 (Question 8 is the same)

This means that this year the person is saving:

- $40 per year
- $400 per year
- $4,000 per year
- More than $4,000 per year
- Do not know

Question 6 (Question 9 is the same)

Next year the person will be saving:

- $40 per year
- $80 per year
- $400 per year
- $800 per year
- $4,000 per year
- More than $4,000 per year
- Do not know

Question 7 for pennies (or Question 10 for %)

Recall that this year the person chooses to save [1 penny per dollar] (1%) of their salary, increasing by [1 penny per dollar] (1%) of their salary every year thereafter. Two years from now the person will be saving:

- [1 penny per dollar] (1%) of their salary
- [2 pennies per dollar] (2%) of their salary
- [3 pennies per dollar] (3%) of their salary
- [4 pennies per dollar] (4%) of their salary

- Do not know

<#End Block>

Now we would like to ask you a few additional financial questions.

Question 11

Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

- More than $102
- Exactly $102
- Less than $102
- Do not know
- Refuse to answer

Question 12

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy more than, exactly the same as, or less than today with the money in this account:

- More than today
- Exactly the same as today
- Less than today
- Do not know
- Refuse to answer

Question 13

Do you think that the following statement is true or false? “Buying a single company stock usually provides a safer return than a stock mutual fund.”

- True
- False
- Do not know
- Refuse to answer

Researcher Note: Based on (Lusardi, 2008; Lusardi, 2012; Lusardi and Mitchell, 2014) financial literacy questions.

Question 14

What is your age (in years)? ________ **(Research coding note: 18 to 99)**

Question 15

What is your gender?

- ❍ Male
- ❍ Female
- ❍ Other
- ❍ Prefer not to say

Question 16

What is your annual income?

- ❍ $9,999 a year or less
- ❍ From $10,000 to $19,999 a year
- ❍ From $20,000 to $29,999 a year
- ❍ From $30,000 to $39,999 a year
- ❍ From $40,000 to $49,999 a year
- ❍ From $50,000 to $59,999 a year
- ❍ From $60,000 to $69,999 a year
- ❍ From $70,000 to $79,999 a year
- ❍ From $80,000 to $89,999 a year
- ❍ From $90,000 to $99,999 a year
- ❍ From $100,000 to $109,999 a year
- ❍ From $110,000 to $119,999 a year
- ❍ From $120,000 to $129,999 a year
- ❍ From $130,000 to $139,999 a year
- ❍ From $140,000 to $149,999 a year
- ❍ $150,000 a year or more
- ❍ Prefer not to say

Question 17

What is the highest degree or level of school you have completed? If currently enrolled, please indicate highest degree received.

- ❍ High school
- ❍ College degree
- ❍ Advanced degree

Thank you for your participation in this survey!

Chapter 2. Pennies Versus Percent Framing and Savings Decisions

Abstract

At one point in time when employees made retirement savings decisions, they indicated how many dollars per paycheck they wanted to save into the retirement plans offered by their employers. Then at some point the industry switched to a percent of pay model, a more psychologically abstract concept, yet a sensible shift since percent framing results in people saving more over time as their income increases. But especially for lower income, less numerate, or lower financial literacy individuals, the framing could make a big difference. This paper provides evidence that eliciting savings rates using percentages may lead to less desirable outcomes for some subpopulations, and that pennies reframing of savings rates, can potentially help certain subpopulations. A randomized controlled trial including 2,255 participants across eighty-six retirement plan sponsors was conducted where participants were randomized into either a pennies or percent treatment for making retirement savings elections. Key findings for the field study include that for those who submit a savings rate (i.e., treatment on the treated) pennies framing had positive, directional results on increasing savings rate (50 basis points with 8.02% for pennies versus 7.52% for percent). When looking at subpopulations, the effects are largest and significant for those with the lower salaries (a proxy for numeracy) with those in the lowest two salary quintiles elevating their savings rates by approximately 156 and 99 basis points, respectively. Heterogeneity analysis suggests that those with less than $50,000 in annual salary may be helped by pennies reframing but that this may reverse for higher earners (i.e., those with incomes greater than $100,000), although the reversal is not statistically significant. The implications of this research seem to suggest that personalized or targeted interventions would be most suitable for pennies reframing approaches.

2.1 Introduction

In the United States, retirement savings is an important issue with a significant percentage of people either not participating in a saving program or failing to save enough. Part of the issue lies with access to a retirement savings program where only 51 percent of all workers have access to a defined contribution plan with another 13 percent having access to both a defined benefit and contribution plan (Bureau of Labor Statistics, 2018). However, even when participants have access to a retirement plan, they may fail to participate in the plan. Research published by Pew Charitable Trusts indicates that participation rates in defined contribution plans for eligible workers who are at least 22 years old are 72 percent. And plan participation skews downward to 52 percent when looking at younger generations such as Millennials (Pew Charitable Trusts, 2017). When going beyond participation and looking at savings rates, some simulation evidence suggests that many people fail to save enough for retirement, especially if the assessment of retirement readiness accounts for a person's longevity and irregular healthcare risks during retirement (VanDerhei, 2014; 2019). And in terms of empirical data outcomes in the United States, 46.1 percent have essentially no assets at end of life (Poterba et al., 2011). While some fraction of those people may have planned their decumulation glidepaths perfectly to have zero assets at the end of retirement, it is likely that a large fraction of people had inadequate wealth for their retirement journey. Bernheim, Forni, Gokhle, and Kotlikoff have attempted to analyze whether Americans should normatively be saving more for retirement, including under considerations regarding financial uncertainty of the Social Security system. They conclude that with exception to very low-income households (e.g., households with less than $15,000 in annual income who may have to rely nearly exclusively on social safety nets), low-, middle-, and upper-income households should be saving much more than they currently do. For additional context about their analysis, for low-income households with annual income between $15,000 and $45,000, their median recommended savings rate is 13 percent. For middle-income households with annual income between $45,000 and $100,000, their median recommended savings rate is 14 percent (Bernheim et al., 2010).

Evidence indicates that choice architecture and design can make a big difference in terms of affecting retirement savings outcomes for employees. For example, Madrian and Shea examined the effects of auto-enrolling employees into a retirement plan (versus having employees opt-in) and found that using such a choice architecture raised participation rates from approximately 37% to 86% when controlling for employee tenure (Madrian and Shea, 2001). And related to choosing retirement savings rates, Thaler and Benartzi recognized that people face certain behavioral obstacles such as myopia (e.g., a bias of overly seeing the present more intensely than the future), inertia (e.g., sticking with the status quo), and loss aversion (e.g., where on average people experience losses more intensely than gains). To address those behavioral obstacles, they created the Save More Tomorrow program, a choice architecture to get people to commit today to future savings increases that are aligned with pay increases (Thaler and Benartzi, 2004). Their program has helped millions of people to save more money toward retirement (Benartzi and Thaler, 2013).

To set the context for the choice architecture approach explored in this paper, consider that at one point in time when employees made retirement savings decisions, they indicated how many dollars per paycheck they wanted to save for retirement. Saving a fixed dollar amount per pay period is a concrete concept from a psychological perspective. However, the downside of such an approach is that when salaries go up, having a fixed dollar contribution means that savings rates will go down over time (all else equal). To resolve this, the industry shifted to a percent of pay framing, although percentages are a more abstract concept than dollars. The shift seemed sensible from the perspective that percent framing results in people saving more over time as their income increases. But especially for lower income, less numerate, or lower financial literacy individuals, the framing of information into more abstract concepts could make a big difference.

How does information framing affect judgment and decision-making? Sometimes information framing affects a broad swathe of people, such as the case of the miles per gallon (MPG) versus gallons per mile illusion (Larrick and Soll, 2008). In the case of the MPG illusion, people underestimate the financial consequences of replacing certain cars, such as whether there would be a bigger financial benefit of replacing a car that gets 10 MPG with an 11 MPG car or a 35 MPG car with a 50 MPG car. The MPG illusion poses people with judgment challenges from both an emotional perspective (e.g., switching from 35 MPG to 50 MPG feels like a bigger benefit than going from 10 MPG to 11 MPG) and cognitive, numeracy perspective (e.g., unfamiliar, multiple step analysis, problem solving, and division skills generally needed to find the right answer). In another paper on temporal reframing and savings, it was demonstrated that participation in a savings program both increased for people at all income levels and quadrupled overall when the program was framed as saving $5 per day instead of $150 per month (Hershfield et al., 2020). The math required for this temporal framing decision seems comparatively simpler from a numeracy perspective than required for the MPG illusion judgment, yet framing still had a broad effect across demographics, potentially being partially explained by affecting people's feelings and perceptions of affordability (e.g., temporal reframing and saving is explored more in Chapters 3 and 4 of this thesis).

Sometimes information framing will affect subpopulations of people, such as disproportionately affecting the less numerate. In a study that shares some common concerns with this chapter in terms of whether people broadly understand percentages, Peters, Hart, and Fraenkel ran a between-subject study which asked participants to consider a hypothetical, daily pill that reduces the frequency of headaches from every few months to once or twice a year (Peters et al., 2011). For participants randomly assigned to a percentage framing group, they were told that "10% of patients get a bad blistering rash". On the other hand, for participants randomly assigned to a frequency framing group, they were told that "10 out of every 100 patients get a bad blistering rash". Participants were then asked to rate the riskiness of the pill. The study found that the less numerate were more sensitive to the framing of the decision, with those in the percentage framing group rating the pill as less risky than those in the frequency framing group. On the other hand, the more numerate rated the riskiness of the pill similarly whether they were in the percentage or frequency framing group. Arguably the most interesting aspect of the study was that the differences between the less numerate and more numerate were eliminated by using frequency framing instead of percentage framing. That study is in some sense a case of eliminating inequities by eliminating percentages.

Before describing the studies in this paper, it is useful to consider a few additional perspectives on retirement savings and numeracy. A first perspective is that saving for retirement is a relatively infrequent and complicated decision that requires both judgments and choices to be made relative to numbers and money (such as how much to save and where to invest money). A second perspective is that the notion of numerical competency can be thought of in terms of at least three competencies[1] which relate to one another, and these competencies affect judgments and decision making (Peters, 2020). These three competencies differ between individuals and include 1) an evolutionary ability to intuitively discriminate between two numbers (e.g., an "approximate number system" which affects how precisely we perceive how far numbers are apart from one another), 2) objective numeracy (essentially how good we are at understanding and using math), and 3) subjective numeracy (essentially how confident we are about using numbers). So, people who are less numerate may have less capacity or facility on multiple dimensions. They may not have an intuitive sense about numbers. They may not be good with numbers. They may not feel confident about numbers. Any or all of these may hamper their decision making. The third and final perspective is that the numeracy problem is significant. An estimated one-third of US adults have a level of numeric competency which demonstrates at most the ability to count, sort, use simple arithmetic, and apply simple percentages such as 50% (Peters, 2020). Moreover, such people may not be able to adequately use systems which distract from the task at hand, such as systems which have a lot of text or elements.

The notion of reframing savings decisions in terms of pennies stems from discussions with a financial advisor that works in the retirement plan space with employers and has had thousands of one-on-one retirement savings discussions with front line workers in those organizations.[2] He has used the pennies concept with a number of companies, usually with populations containing a significant proportion of lower income employees, that have had extremely low participation rates (e.g., 30-40 percent) in their retirement plans. While neither a scientific study or randomized controlled trial has ever been run to date prior to the studies

[1] Financial literacy likely also plays a role in aspects of retirement savings decision (Lusardi and Mitchell, 2007; 2011), but has been excluded relative to the main body of this manuscript as some of the direct financial literacy concerns are alleviated somewhat by the retirement system user interface implemented in the field study (such as showing long-run, retirement income projections).
[2] George Fraser is a financial advisor and Managing Director with Retirement Benefits Group and credited with the "pennies on the dollar" reframing concept.

presented here and Chapter 1, he has anecdotally had success getting companies to increase participation rates to over 95 percent by getting employees to consider saving just 1 penny per dollar of their salary and increasing that by 1 penny every year (which is equivalent to saving 1% per year with a 1% rate escalator). He describes the situation that when it comes to retirement savings decisions, many people don't know what 1% is, but they know and can relate to what one penny out of a dollar means.

In this chapter and building on the studies in Chapter 1, the primary hypothesis is that users who see savings choices in a pennies-based frame will select higher savings rates than those in a percent-based frame. As a secondary hypothesis, those with lower numeracy should be helped to a greater extent through pennies reframing. In cases where it is unfeasible to directly measure numeracy, it is anticipated that income will moderate choice with pennies-based framing helping those with lower numeracy (proxied by lower income) more than those with high numeracy (proxied by higher income).

The first study in this chapter is a Pennies X% and 7% Anchor Lab Study (N=270, experienced participants in a retirement savings program) that uses hypothetical choices and investigates the primary impact of pennies versus percent framing and a secondary, factorial cross with a 7% anchor rate (versus a no anchor, free response elicitation of savings rates). The simple main effect of pennies framing approximately doubles the intended savings rates of participants relative to percent framing for the no anchor, free response.[3] An interaction effect between the framing and 7% anchor is detected, such that savings rates seem to be increased when using this anchor in the percent frame while savings rates are decreased when using this 7% anchor in the pennies frame. Although not significant but directional and consistent with the evidence in Chapter 1 is a pattern that subjective numeracy moderates framing with the savings rate of lower numeracy participants being elevated the most in terms of savings rates using the pennies

[3] Since the study involves hypothetical savings intentions, the magnitudes of the effects and effect sizes would unlikely translate to real-world choices of savings rates, although insights can be gleaned regarding the nature of the choices.

frame relative to the percent frame. Perceptions of affordability and understandability mediating choice were not detected.

The second study in this chapter is a Pennies X% Field Study (around 2,000 participants from different tax-exempt organizations) and finds that for those who submit a savings rate, pennies framing had positive, directional results on increasing submitted rates (50 basis points with 8.02% for pennies versus 7.52% for percent). The effects are largest for those with lower salaries, and those in the lowest two salary quintiles elevated their savings rates by approximately 156 and 99 basis points, respectively. A floodlight analysis that examines heterogeneity based on income suggests that those with less than $50,000 in annual salary may be helped by pennies reframing but that this may eventually reverse for higher earners (i.e., those with incomes greater than $100,000), although the difference for higher earners is not statistically significant.

2.2 Pennies X% and 7% Anchor Lab Study

2.2.1 Context and Sample Selection

This Pennies X% and 7% Anchor Lab Study was done in conjunction with a retirement services and recordkeeping provider, a company that provides business-to-business platform services to thousands of corporate customers including hosted technology infrastructure, custodial holdings, account management, and financial investments related to retirement plans. At the time the study was conducted, the provider had made available approximately 2,000 potential participants from a digital user group who had opted-in and pre-consented to optionally answer for no compensation, various surveys related to new designs of websites by the provider. Users became part of the digital user group at some point during their tenure with a company that was a customer of the provider, although an estimated one-fifth of the people in the digital user group may not have had active status with their employers. Based on the context for joining the digital user group, it is reasonable to characterize potential participants as having prior experience with retirement savings choices. Email recruitment for this study was targeted to those between the ages of 18 and 70 years old.

Given statistical powering constraints of a limited pool of potential participants and response rates, especially given the inclusion of moderator requirements, a target sample size was not specified, but recruitment was allowed for ten days, and recruitment ran from July 22 to August 1, 2019.

2.2.2 Research Design and Methods

Eligible participants in the digital user group pool were invited by email to take part in an online research study to better understand how people make financial decisions about retirement. If participants did not participate upon the first email request, they were sent a second email invitation after a week from the original request. Eligible participants were told that if they took part, they would be asked questions about hypothetical financial decisions and their attitudes.

In the primary intervention, all participants were instructed to assume that their employer provided them with an opportunity to participate in a retirement savings plan that enables them to save a portion of their salary each pay period. They were told that the plan would enable them to save and invest their money pre-tax (within government limits) until retirement. Participants were then told to consider that they had just logged into the retirement savings plan website. The research design was a between-subject, 2x2 factorial design (pennies versus percent, free response versus "7 percent anchored") with participants randomized into one of the four conditions:

- The two free response conditions were aimed at getting people's desired savings rates without psychologically anchoring them on any specific value.
- The two "7 percent anchored" conditions attempted to anchor participants on a rate economically equivalent to 7% while letting them still select whatever savings rate they wanted.[4]

In the free response conditions, depending on whether participants were assigned to the pennies or percent factorial dimension, participants were asked to consider a screen which indicated either "I would like to save ___ pennies for every dollar I

[4] This 7% value is based on the current, commercial implementation of the research host with scientific evidence that such an anchor rate maximizes savings rate elections by participants while minimizing opt outs (Beshears et al, 2017).

earn" or "I would like to save ___ % of what I earn." In the "7 percent anchored" conditions, depending on whether participants were assigned to the pennies or percent factorial dimension, participants were asked to consider a screen which indicated either "I would like to save - 7 pennies + for every dollar I earn" or "I would like to save - 7% + of what I earn." The graphics for each of the four conditions is shown in Figure 2-1. All participants were then asked to enter how much they would like to save by either filling in the blank for the statement "___ pennies for every dollar I earn" or "___ % of what I earn" depending on whether they were assigned to the pennies or percent factorial dimension.

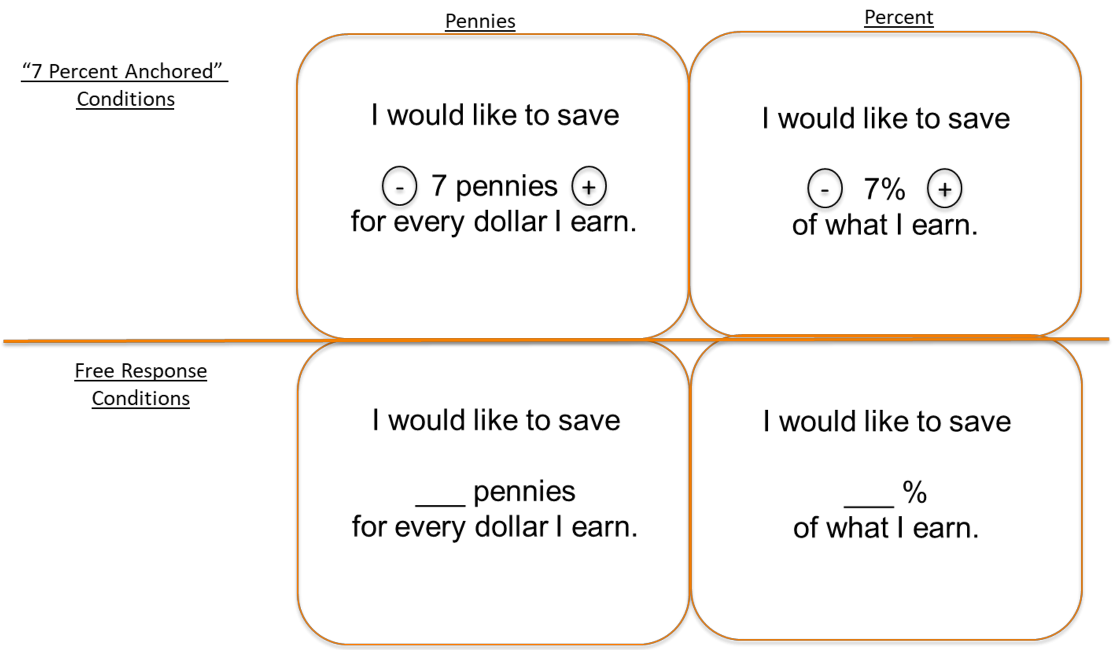


Figure 2-1. Screens for Lab Study: Hypothetical Retirement Saving Choice

As a follow-up to the primary intervention, participants were then asked questions related to psychological perceptions, individual behavioral differences, and demographics. For the psychological perceptions, participants were first asked to rate whether they found the option to be affordable and then they were asked to rate whether they found the description of the option to be clear and understandable. Responses to both questions were made on a Likert scale (1 –

strongly disagree, 6 – strongly agree).[5] To address individual behavioral differences, participants were then asked three questions based on the SNS-3 scale which essentially asks a person to subjectively rate their own numeracy (McNaughton et al., 2015).[6] Participants were then asked demographics questions about their age, gender, income, and educational level. The complete stimulus is provided in the Online Appendix, Chapter 2, Pennies X% and 7% Anchor Lab Study Materials.

2.2.3 Results

2.2.3.1 Summary Statistics and Experimental Balance

A total of 270 participants were recruited for the Pennies X% and 7% Anchor Lab Study. Table 2-1 provides a summary of the characteristics of participants in terms of the four treatment groups. Based on random assignment to condition, 70 were put into the Pennies Free condition, 57 into the Percent Free condition, 70 into the Pennies Seven Anchor condition, and 73 into the Percent Seven Anchor condition. The mean age of participants was 59.4 years old, and an F-test and Bartlett's chi-squared test do not reject the null hypothesis that either mean or standard deviations for age are the same between conditions. More than half of participants (59.4%) identify as male, and the proportion of males in the Pennies Seven Anchor condition was imbalanced with a chi-squared test rejecting the null hypothesis of an equal proportion of males. Income bands were bucketed into bins with a range of approximately $10,000 coded as indicated in the notes for Table 2-1. As a point of reference, a coded income score of 10 indicates a salary from $90,000 to $99,999 a year, and a coded income score of 11 indicates a salary from $100,000 to $109,999 a year. The mean coded income score was 10.32 and reflects that the sample of participants had very high income. An F-test and Bartlett's chi-squared test do not reject the null hypothesis that either mean or standard deviations for income are the same between conditions. Educational levels are also very high for this sample with 44.44% reporting having a college degree and 37.41% reporting having an advanced degree, and a chi-squared test does not reject the null hypothesis of an

[5] These elicitations are analogous to those used in Chapter 1 which showed evidence for pennies framing (versus percent framing) increasing users' perceptions of affordability which in turn mediated choices of savings rates.
[6] This use of subjective numeracy and SNS-3 scale is motivated by the evidence provided in Chapter 1 regarding numeracy as moderator for pennies versus percent framing.

equal balance of educational levels between conditions. A mentioned previously, the individual behavioral difference of subjective numeracy was measured using the SNS-3 scale, which can result in a minimum value of 3 and a maximum value of 18 for a participant. The mean SNS-3 score was 15.7 with an acceptable Cronbach's alpha of 0.796. A F-test and Bartlett's chi-squared test do not reject the null hypothesis that either mean or standard deviations for SNS-3 are the same between conditions. Notably, correlation between income and subjective numeracy is 0.42.[7] Also, the correlation between education and subjective numeracy is 0.29.

To summarize, randomization into the treatments was successful with exception to the chance bias of a larger proportion of males in the Pennies Seven Anchor condition. In the sections which follow, no statistical adjustments are made to account for chance bias beyond providing analyses with and without controls where noted.[8]

2.2.3.2 Main Results

The main outcome variable in this analysis is the intended savings rate chosen by participants, and the mean savings rate for each of the four conditions is depicted in Figure 2-2, which is divided into two panels. Panel A reflects the primary conditions of interest and reflects the savings rate intentions of participants in a free response scenario (i.e., where people were asked to provide a savings rate with no anchor provided for the saving rate). In Panel A, the mean savings rate was 29.53% in the pennies condition (PenniesFree condition) and 14.53% in the percent condition (PercentFree condition). Panel B reflects the savings rate intentions of participants in a seven percent anchored condition (i.e., where people were asked to provide a savings rate with a 7% anchor value provided on the screen as a soft default savings rate). In Panel B, the mean savings rate was 25.51% in the pennies

[7] The correlation between income and subjective numeracy is noted here as income is used as a moderator in the field study, where it was not feasible to measure the numeracy of participants.
[8] While the 7% anchored conditions (i.e., Pennies Seven Anchor and Percent Seven Anchor conditions) are important to provide some sense of calibration relative to the provider's commercial implementation to maximize savings rates and minimize opt outs by using 7% soft defaults, from a theoretical basis this paper and the field experiment (described in the next section) focus on pennies versus percent reframing effects as opposed to anchoring effects.

condition (PenniesFree condition) and 20.88% in the percent condition (PercentFree condition). The chart whiskers reflect +/- 1 standard error.

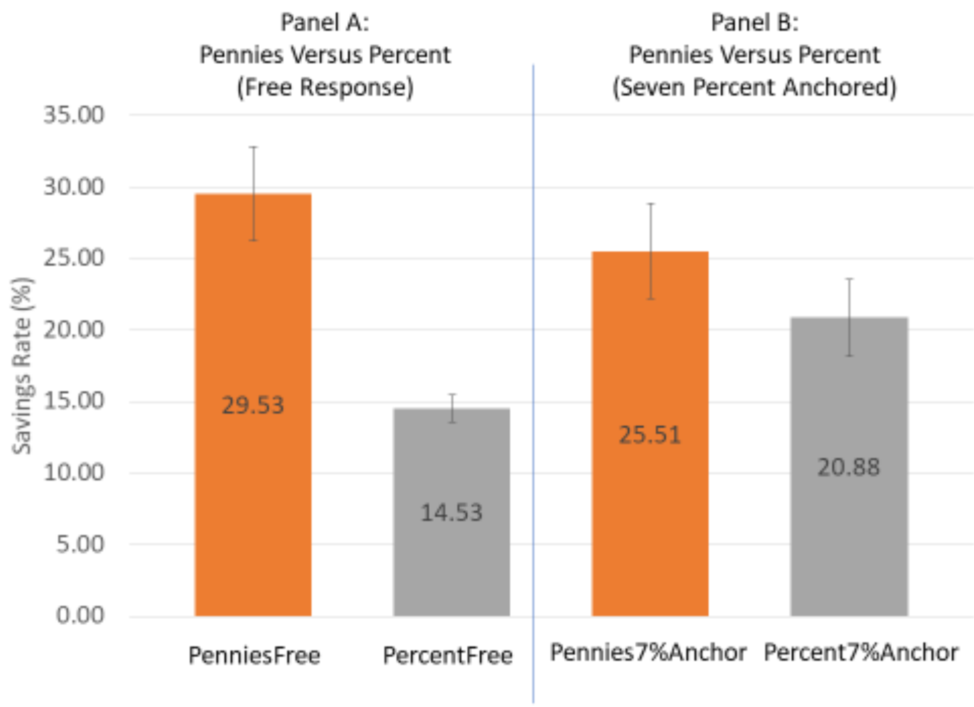


Figure 2-2. Summary of Savings Rates for Lab Study and Hypothetical Retirement Savings Choices by Condition

To better illustrate the nature of pennies framing, percent framing, and anchoring with a 7% savings rates on the screen display, four OLS regression analyses are outlined in Table 2-2 with the intended savings rate of the participant as the outcome variable. Model 1 has two independent variables with Pennies Condition Indicator (pennies treatment = 1, percent treatment = 0) and Seven Anchor Condition Indicator (7% anchored treatment = 1, free response treatment = 0). Model 2 adds demographic controls for age, gender, income, and education. Model 3 adds the individual behavioral difference of subjective numeracy as an independent variable. Finally, Model 4 adds an interaction variable between Pennies Condition Indicator and Seven Anchor Condition Indicator using percent and free response as the base reference point. The coefficient on Pennies Condition Indicator is significant in all four models ($\beta s > 9.487$, $ps<.001$). When looking at Model 4, the coefficient on Seven Anchor Condition Indicator is significant ($\beta s > 9.487$, $ps<.001$), driven by the addition of the interaction term which has a marginally significant coefficient ($\beta = -10.844$, $p<.10$), but likely explains why anchoring decreases the intended savings rate in the pennies frame (between PenniesFree and Pennies7%Anchor) but increases the intended savings rate in the percent frame (between PercentFree and Percent7%Anchor) as seen in Figure 2-2.

As a final note, the intended savings rates in this hypothetical choice seem too high relative to what people would choose to save in a real-world setting (ignoring tax strategies where people may contribute very high rates until regulatory caps on total amounts are reached). So as opposed to looking at specific savings levels and the calibration of these hypothetical choice results to real-world decisions, readers should mostly look to the Pennies X% and 7% Anchor Lab Study to gain insights about the between condition differences in intentions. These caveats also apply to interpreting the results in the following section on additional analyses. With those caveats, pennies framing looks to increase savings rate intentions. The difference between conditions is larger when looking at cases which do not include anchoring, and anchoring tends to make the between condition differences smaller.

2.2.3.3 Additional Analyses

2.2.3.3.1 Analysis of Subjective Numeracy as a Moderator

Although power is challenged to measure interactions when considering a single study, to explore how subjective numeracy may affect intended savings, OLS regressions were run with savings rate as the outcome variable and independent variables of pennies condition treatment indicator (pennies = 1, percent = 0), subjective numeracy, and the interaction between subjective numeracy and treatment condition. The coefficient on the interaction term was not significant, but directionally negative[9] without controls ($\beta = -1.449$, $p=0.298$) and with controls of age, gender, income, and education ($\beta = -1.397$, $p=0.344$), which indicates that the

[9] Note that a negatively-valenced coefficient (while not statistically significant) is consistent with the observed heterogeneity in the studies in Chapter 1 regarding subjective numeracy.

positive effects on pennies framing are largest on those with lower subjective numeracy and decrease as subjective numeracy scores increase. To better illustrate how the proposed intervention of pennies versus percent framing affects people based on their subjective numeracy a floodlight analysis was performed to understand the treatment difference between the free response frames according to subjective numeracy. The results of this analysis (without controls) are depicted in Figure 2-3 and illustrates that pennies framing has significant, non-negative effects relative to percent framing across a broad range of subjective numeracy levels (Johnson-Neyman significance region for $6 \leq SNS3 \leq 18$). This methodology is consistent with simple effect testing in moderated regressions (Spiller et al., 2013), and Figure 2-3 uses a significance convention of +, $p<0.10$; *, $p<0.05$; **, $p<0.01$; ***, $p<0.001$. For example, at SNS3=6 (a low subjective numeracy level) the treatment difference is about 29 percentage points ($\beta = 29.460$, $p=0.036$). At SNS3=18 (a high subjective numeracy level) the treatment difference is about 12 percentage points ($\beta = 12.067$, $p<0.001$). Results are largely the same with demographic controls (i.e., age, gender, income, education) and have the same Johnson-Neyman significance region of $6 \leq SNS3 \leq 18$ with the treatment difference at SNS3=6 being about 29 percentage points ($\beta = 29.704$, $p=0.047$) and the treatment difference at SNS3=18 being about 13 percentage points ($\beta = 12.942$, $p=0.018$). In a nutshell, pennies framing has the greatest positive effect relative to savings rate intentions for those at the lowest end of the subjective numeracy spectrum, although the effect is also present for those at the highest end of the subjective numeracy spectrum.

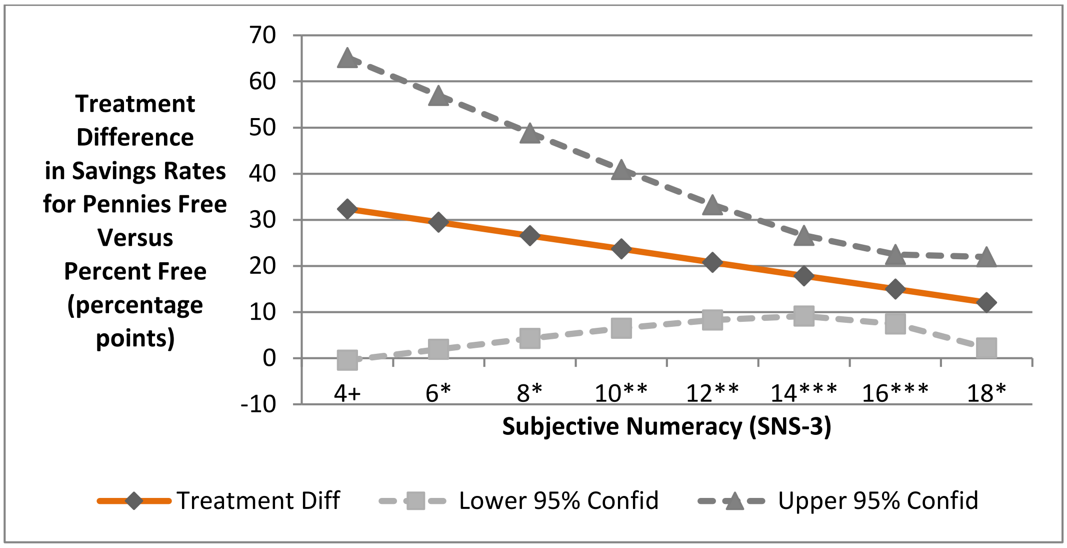


Figure 2-3. Floodlight Analysis of Treatment Differences in Savings Rates for Lab Study by Subjective Numeracy Score

2.2.3.3.2 Robustness Check of Main Results

As a robustness check of the main results, a structural equation model (SEM) analysis was performed using 1,000 bootstrap replications and savings rate as the outcome variable. Pennies Condition Indicator, the Seven Anchor Indicator, the interaction between Pennies Condition Indicator and Seven Anchor Indicator, and demographic controls were modeled, along with perceptions of affordability and understandability as hypothesized mediators between Pennies Condition Indicator and savings rate. Coefficients on the Pennies Condition Indicator (b=14.475, z=4.05, p=<.001), Seven Anchor Indicator (b=7.624, z=2.52, p=.012), and interaction between Pennies Condition Indicator and Seven Anchor Indicator (b=-12.376, z=-2.21, p=0.027) were all significant and had similar valences to those coefficients in Table 2-2, Model 4 covering the main regression analysis results. Perceptions of affordability and understandability did not mediate outcomes.[10] More details on the SEM analysis can be found in Online Appendix: Supplemental SEM Analyses as outlined in Table 2S2-1 and Figure 2S2-1.

[10] Although the statistical power for this study is generally low for a mediation analysis, the finding of no mediation is in contrast to the Chapter 1 findings of affordability perceptions of pennies framing partially mediating savings outcomes (complementary mediation).

2.3 Pennies X% Field Study

2.3.1 Context and Sample Selection

The Pennies X% Field Study was done in conjunction with the same retirement services and recordkeeping provider as described for the Pennies X% and 7% Anchor Lab Study. The study involved recruitment efforts from a potential pool of hundreds of tax-exempt organizations, such as those in the healthcare, education, government, religious, public services, and arts areas. To maximize the percentage of active decisions by individuals in the study, we specifically recruited non-auto enrollment plans and plans which had enrollment activity just prior to the launch of the field study (i.e., during the first six months of 2019). To try to recruit and obtain consent from these tax-exempt organizations, the customer relations team of the provider was provided with a standard presentation deck to be used with the recruitment of the tax-exempt organizations to consent to participate in the study. The presentation deck outlined that the research would be about testing what effect does reframing participant savings choices in pennies or percent have on savings elections and that the test would be implemented through conducting a randomized controlled trial on the organization’s website that processes retirement savings enrollment and savings elections of individual employees. To minimize potential contamination, no results from the prior lab study were shared, and the presentation deck did not include the hypotheses for the research. The customer relations team of the provider had discussions with hundreds of retirement plan administrators, and eighty-six qualified organizations opted-in to participate in the study.

Each tax-exempt organization essentially gets their own retirement plan website on the recordkeeping provider’s technology platform. This technology platform can conceptually be thought of as two systems as depicted in Figure 2-4. The first system is the enrollment system which is the first step as part of the retirement savings process for any employee that chooses to consider retirement savings choices. The enrollment system is where eligible employees can opt-in to retirement savings, choose an initial savings rate, utilize tools to view projected monthly retirement income based on savings rate, and choose their investment allocations. As will be described in the next section, the pennies reframing intervention is only implemented in the enrollment system, and the intervention is limited to only the initial portion of the enrollment process. The second system is the ongoing system, and it comprises all the user interface processes whereby participants who have previously enrolled in retirement plan savings may manage their accounts on an ongoing basis. This could include viewing their accounts or changing their savings rates and investment choices, among other activities. Since the pennies intervention was only implemented for a portion of the process in the enrollment system and was not implemented in the ongoing system (e.g., to minimize costs of changing the technology systems)[11], the primary study measurements of interest for this paper are outcomes (e.g., initial savings rates) from the enrollment system. Other study measurements are also provided 60-days after participants have made initial elections, but these measurements are not the primary focus of the paper as some participants may have revisited their accounts using the ongoing system. Any decisions made in that system would have been only in the traditional, percent framing. Participants may have also made subsequent, retirement election changes by calling into a call center or filling out a form with their employer. Such means of changing elections would also have only been in a traditional, percent framing environment.

[11] While it was theoretically desirable to implement pennies framing throughout the entire enrollment process in the first system (enrollment system) and second system (ongoing system), at the time the study was conducted the retirement system provider could not implement changes throughout, and so the focus was on changes to a small subset of user interface screens of the first system.

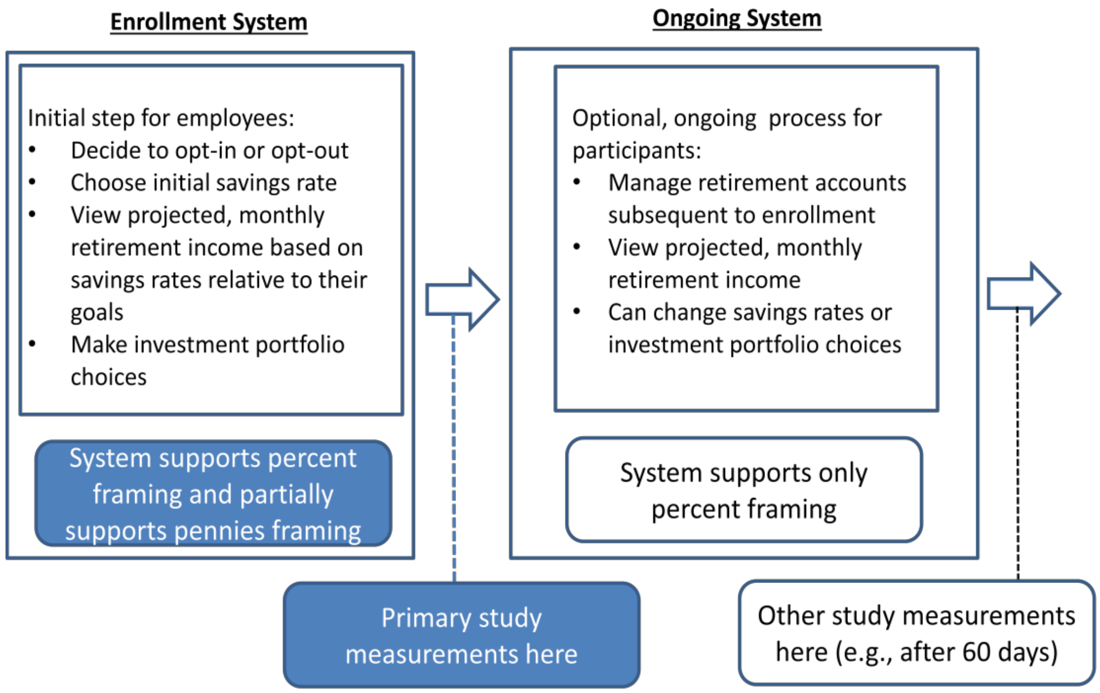


Figure 2-4. Conceptual Overview of Systems, Limitations of Pennies X% Field Study, and Measurements

It should be noted that retirement plans may differ between organizations, such as in terms of their employee eligibility rules (e.g., new employees or tenure requirements), open enrollment periods (during which all eligible employees can join the plan), employee communications, employer contribution matching contributions formulas, investment options, hiring, turnover, paper forms, financial advisor support, etc. The study did not require any of these pre-existing processes to be changed.

Participant enrollment data was collected between the dates of October 24, 2019 through May 20, 2020 during which the intervention treatments were implemented in the enrollment system, and retirement account changes were tracked for an additional 60 days. As additional environmental context, local governments in the United States started to implement lockdown policies related to the COVID-19 pandemic around March 2020 (Goolsbee et al, 2020), which happens roughly in the middle of the data collection period of the study.

2.3.2 Research Design and Methods

The study is implemented as a between-subject design with participants randomly assigned into one of two conditions (i.e., pennies versus percent treatment). The process works as follows with asterisks indicating points in the process which differ between treatment conditions. An eligible employee who opts into retirement plan savings via the online, web enrollment system will have completed the steps on eight screens[12]:

- **Screen 1 to Login**: To begin the process, users must provide login credentials to access the enrollment system (e.g., plan number and verification code).
- **Screen 2 for Personal Information**: For this step, users must enter their contact info, annual salary, and number of pay periods per year that apply for them.
- **Screen 3 for Retirement Goals**: In this step, users are told that it helps to set goals for retirement, and to facilitate that, they are asked to enter their goals for retirement age, income replacement rate (where they are informed that the average person seeks to replace 70% of their pre-retirement income in retirement), and current savings.
- **Screen 4 to Indicate Desired Savings Rate (*)**: Next users are asked to enter their desired savings rate. Depending on which treatment condition users were randomly assigned to, they are asked to complete the sentence on the screen which reads, "I would like to save [___ pennies for every dollar I earn] [____ % of what I earn]".
- **Screen 5 to Understand and Refine Selections (*)**: After indicating their goals and desired savings rate, users are then presented with a screen that allows them to reflect on their choices (e.g., savings rate, retirement age) and the implications of their choices on their projected retirement income. Relative to projected monthly retirement income, they are shown how much they would have, how much they need for their goal, and the gap

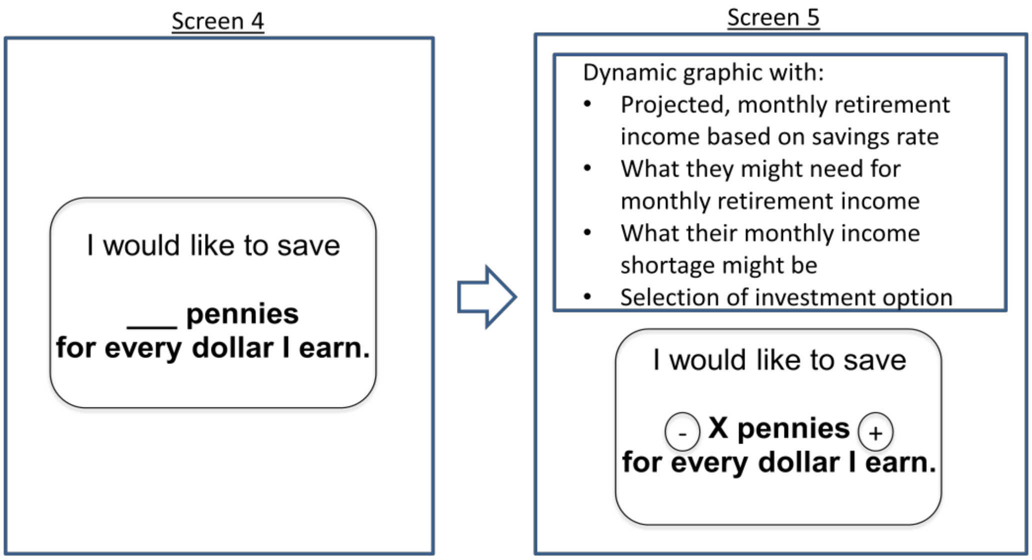
[12] Users may complete the enrollment process by logging into the website multiple times and completing the steps across multiple sessions before submitting their elections. If cookies have been allowed by the user, then users would be put into the same experimental treatment that they were originally randomized into (i.e., pennies or percent treatment condition).

(e.g., you will have $X, you may need $Y, and you might be short $Z). They are also given an opportunity to adjust the savings rate they indicated on the prior screen to both 1) see how their projected retirement income figures change and 2) see how both their contributions and take-home pay will be affected (e.g., you will contribute $A pre-tax into your account per pay period and only $B comes out of your take home pay after taxes). Notably, regardless of whether a user is adjusting their savings using either a "pennies for every dollar they earn" or "percent of what they earn" frame (based on their treatment condition), all users are shown what their choices would mean in terms of dollars per month for contributions, take home pay changes, and projected retirement income, which helps users to understand the consequences of their decisions. On this screen, users are also able to select investment options using one of three methods, such as through using a professionally managed account where they can delegate their investment management and portfolio construction, using a guided process that helps them select investment options, or directly choosing their investment options. A conceptual overview of Screens 4 and 5 is illustrated in Figure 2-5.

- **Screen 6 for Beneficiaries**: On this screen, a user has the option to specify beneficiaries to receive assets in the account in case of the death (or specification of beneficiaries can be deferred until a later date).
- **Screen 7 to Confirm Elections**: As a final screen before submitting their retirement savings elections, users are presented with a screen that acknowledges the initial savings rate to be submitted in terms of percent of salary[13], contribution amount in dollars, take home pay deduction in dollars, investment allocations, and beneficiaries. On this screen users are also offered an option to elect a rate escalator, which pre-commits to increase pre-tax contributions (e.g., by 1 percent every year up to 10 percent) starting on a date in the future (e.g., delayed one year). Such elections are also expressed in terms of percentages.

[13] Due to implementation cost considerations, the confirmation screen was left unchanged from the prior implementation such that users in both pennies and percent treatment conditions saw all confirmations using percent framing.

- **Screen 8 to Acknowledge and Follow-up**: On the final screen, users are informed that they have successfully enrolled in the retirement plan. They are also given an option to be contacted in case they would like to consolidate prior retirement accounts (e.g., roll in money from prior retirement accounts).



Participants in the percent condition instead saw "____ % of what I earn" for the bold text. All other information was the same between conditions.

Figure 2-5. Conceptual Overview of the Primary Treatment Under Study and Screens Impacted in the Enrollment System

Data from the provider consisted of the following at the individual participant-level:

1. Participant- and session-level data for the enrollment system – For participants who visit the enrollment system multiple times, information was provided regarding what treatment condition they received (which could be inconsistent between treatments if the participant disabled cookies in their Internet browser), the date of the session, and whether they submitted or did not submit contributions elections during the session.
2. Initially submitted retirement savings contribution elections – This was either the savings rate or fixed dollar amount per pay period initially submitted by a participant in the enrollment system. Note that these elections represent the main outcomes under study.
3. Savings rate elections in effect after 60 days – For participants who submitted savings contribution elections via the enrollment system, these were the savings contribution elections on record with the provider 60 days after the initial submission (i.e., the case where a study participant is consider fully treated by the intervention). For participants who did not submit savings contributions elections via the enrollment system, then these were the savings contributions elections on record with the provider 60 days after a participant's initial session and treatment encounter in the enrollment system).
4. Demographic and other data – For each participant, this data includes the plan id (to identify the employer's retirement savings plan), salary, pay frequency, gender, age, Roth contributions elected, after-tax contributions elected, rate escalation elections, and account status.

The field study was pre-registered prior to the collection of any data[14], and key elements of the pre-registration are described here relative to excluding observations. For the base analysis, participants making Roth contributions were excluded. Participants were also excluded from the analysis when the online interface failed to put the user in a treatment condition (e.g., for software infrastructure technical reasons). Participants were also excluded if they terminated

[14] The pre-registration for the study is available at https://aspredicted.org/blind.php?x=5zr3jk.

from their employer within 60 days of their initial intervention. Two other exclusion rules were also pre-registered as related to excluding individuals whose salary selections were overridden by a plan-wide intervention within 60 days of their initial intervention and excluding participants if they were part of plan sponsor who utilized advisors to interact with participants (e.g., to try to control for potential contamination by advisors who may interfere with the intended treatment). These two exclusion rules would apply if contamination happened or was possible. However, the need to apply either of these exclusion rules did not arise.

In terms of additional exclusions that were not pre-registered, for the base analysis participants making after-tax contributions were also excluded for the same two reasons as for excluding those making Roth contributions. The first reason is that the pennies intervention was targeted at pre-tax contributions and so there was no theoretical reason why such an intervention would also have direct effects on accounts with different taxable treatments (e.g., Roth and after-tax). The second reason is that including observations that enable different tax strategies (such as Roth and after-tax accounts) would likely create additional variance in the main outcome variable of interest, the pre-tax savings rate. In terms of other exclusions, the base analysis case only includes participants who saw consistent treatments within the enrollment system. Participants received consistent treatments if they saw the assigned treatment condition on Screens 4 and 5 during each visit to the enrollment system (i.e., in each web session). Although this exclusion rule decreases the number of participants in the study (because some participants are contaminated in their received treatment versus assigned condition), it eliminates the need to make theoretical assumptions (which might be tenuous) about which treatment most directly applies when the participant ultimately makes a retirement savings election decision since the treatment condition is the same for the user for all web sessions. Finally, extreme outliers were dropped, namely those with annual salaries less than $500 or greater than $1,000,000, as such extreme outliers were not anticipated a priori. Upon inspection, many of these extreme outliers were deemed to be either data entry errors with implausible values or very far from the target population being researched (e.g., salaries amounting to millions or tens of millions of dollars per year).

Since the main purpose of the study is to assess the effect of pennies reframing on savings rates, the main outcome variable for the base analysis is on those treated who complete the enrollment process relative to their pre-tax, initial submitted savings rate (referred to as the initial submitted savings rate). The savings rate in effect 60 days after initial submission is also analyzed, although as noted prior, the pennies treatment is only in effect within the enrollment system and not the ongoing system where subsequent changes to savings elections would occur. Note that participants were able to submit either a savings rate or a fixed amount to save per pay period. If a participant indicated a fixed amount to be saved per pay period, then for analysis purposes this was converted to a savings rate by annualizing the fixed savings amount, specifically by multiplying the fixed amount by the number pay periods per year on record, and then dividing the result by the participant's annual salary.

Additionally, to assess the extent of any effects of pennies reframing on opt-outs (i.e., 0% savings rates), an indicator variable is constructed for a 0% savings rate at initial submission. Furthermore, as a test of whether pennies reframing might cause significant differences in participants treated versus not treated between conditions (e.g., people hesitating to enroll online), an indicator variable for 0% savings rate at initial treatment is also constructed.

Certain outcomes were also censured and treated as null values: 1) savings rates greater than 100% were censured, 2) cases where the savings rate needed to be estimated from fixed dollar amounts and paycheck frequency but where salary had been winsorized[15], and 3) cases where enrollment elections were submitted but where the savings rate was not recorded for some technical reason.

2.3.3 Field Study Results

2.3.3.1 Summary Statistics and Experimental Balance

As employees entered the enrollment system between the dates of October 24, 2019 through May 20, 2020, they were randomly assigned to either a pennies or

[15] Winsorization details are described in more detail later in this chapter, but savings rates estimated based on a winsorized salary are deemed an unreliable measure.

percent treatment group. Table 2-3 summarizes the characteristics of participants for the field study by treatment group with statistical tests reported for checks of experimental balance. A total of 2,255 participants were recruited, and based upon random assignment, 1,104 participants were put into the pennies treatment group and 1,151 participants were put into the percent treatment group. Age was winsorized at the 1%/99% level, and the mean winsorized age of participants in the field study was 38.20. An F-test and Bartlett's chi-squared test do not reject the null hypothesis that either the mean or standard deviations for winsorized age are the same between conditions. In contrast to the lab study, the field study had a majority of female participants (64.6%), a minority of males (28.5%), and small percentage of those with unspecified gender (6.9%). A chi-squared test does not reject the null hypothesis that each condition has the same gender balance. Annual income was winsorized at the 1% and 99% levels, and mean winsorized income was $68,577 with one missing value for income in the pennies condition. An F-test and Bartlett's chi-squared test do not reject the null hypothesis that either the mean or standard deviations for winsorized income are the same between conditions. From this analysis, we conclude that randomization of participants was successful across the demographic covariates.

2.3.3.2 Main Results

In the base analysis, we first look at the submitted saving rates of those who complete Screens 1 through 8 in the enrollment system (i.e., treatment effects on the treated, N = 1884). Across all retirement plans and income levels, Figure 2-6 illustrates that participants on average submitted higher savings rates in the pennies condition (mean = 8.02, se = 0.24) versus the percent condition (mean = 7.52, se = 0.23). Note that Figure 2-6 depicts postestimation margin results generated after running OLS regression with winsorized submitted savings rate as the outcome variable with independent variable of treatment condition, winsorized age (mean centered), gender (contrast coded), income quintile (categorical), interaction between treatment condition and income quintile (categorical), and plan fixed effects. Whiskers reflect +/- 1 standard error.

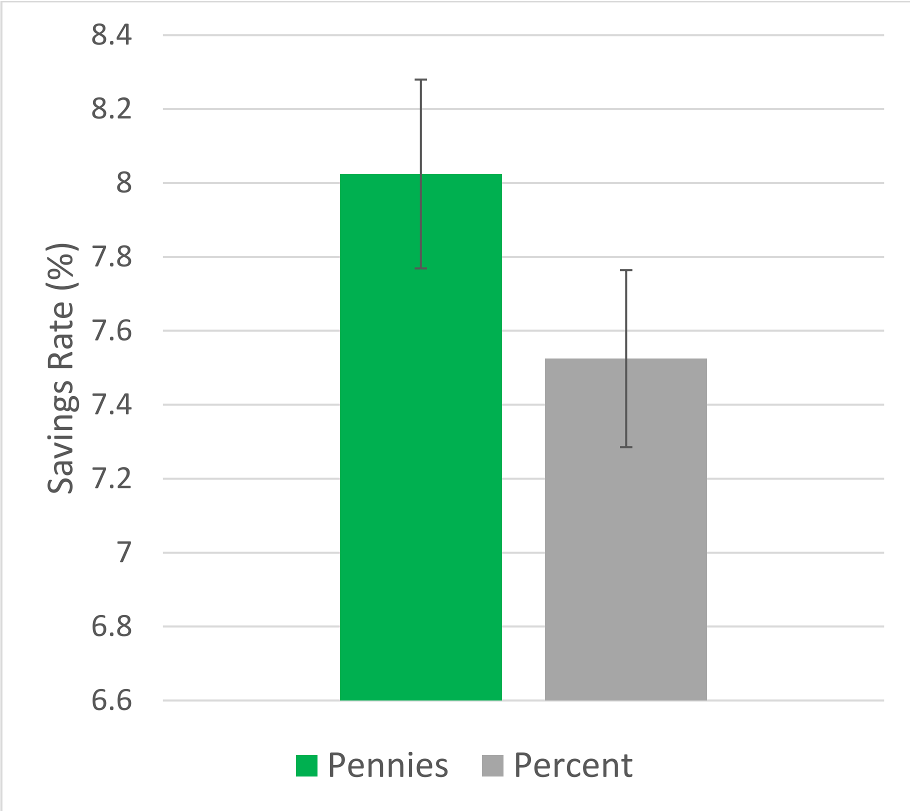


Figure 2-6. Submitted Savings Rates by Treatment Condition for Those Who Completed the Enrollment System Process

Since one of the main hypotheses is concerned with whether pennies framing would increasingly help those with lower incomes to save more, it is useful to visually compare average submitted savings rates by condition and income. Income quintiles were constructed based on the total pool of participants who started the enrollment process and received consistent treatment throughout (N = 2255 with one missing value for income in the pennies treatment group). Descriptive stats for the income quintiles are provided in Table 2-4. The average submitted savings rates of those who completed the enrollment process by treatment condition by income quintile is shown in Figure 2-7 where the whiskers reflect +/- 1 standard error. These postestimation margin results are based on running an OLS regression with winsorized submitted savings rate[16] as the outcome variable with independent variable of treatment condition, winsorized age (mean centered), gender (contrast

[16] Submitted savings rates (and other savings rates in this chapter) are winsorized at the 0%/99% levels (i.e., winsorized from the top).

coded), income quintile (categorical), interaction between treatment condition and income quintile (categorical), and plan fixed effects (using the plan with the largest number of participants as the base reference point). The general pattern is that the pennies treatment group has higher submitted savings rates as compared to the percent framing group for lower income quintiles 1 through 4 with exception to the highest income quintile 5 where percent framing has higher submitted savings rates.

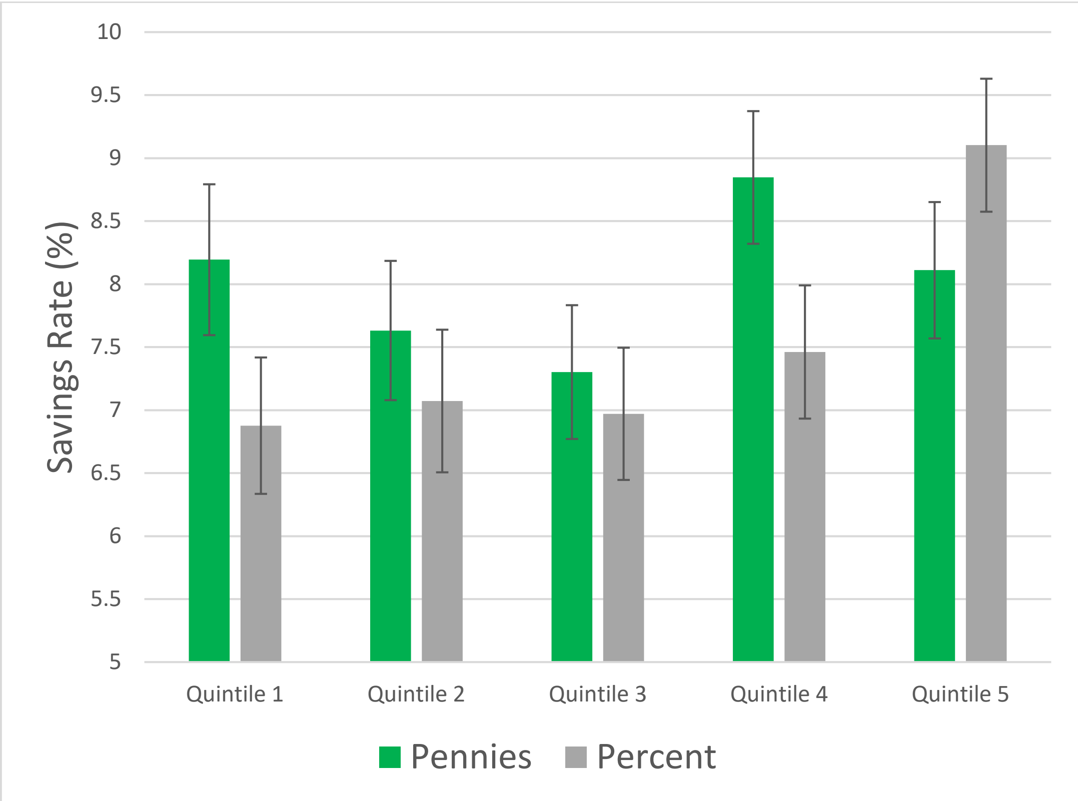
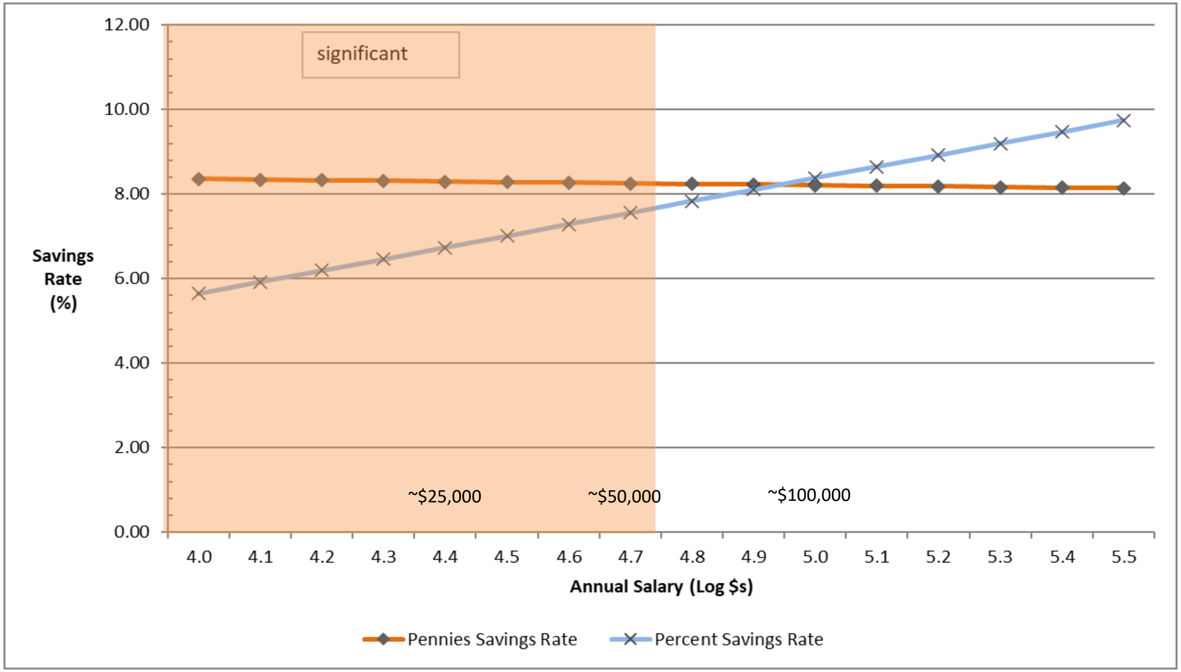


Figure 2-7. Submitted Savings Rates by Treatment Condition by Income Quintile for Those Who Completed the Enrollment System Process

To more precisely explore the simple main effect of pennies framing and interaction with income (i.e., using log income as a continuous variable in contrast to the categorical treatment prior), six OLS regression models are presented in Table 2-5. The Base Model has submitted savings rate as the outcome variable (e.g., 1 unit equates to a 1 percent submitted savings rate) with independent variables of pennies treatment condition indicator (pennies frame = 1, percent frame = 0), demographic controls for age (mean centered), gender (contrast coded male = 1, unknown = 0, and female = -1), log of winsorized income (mean centered), the interaction between treatment condition and log of winsorized income, and plan fixed effects. For the Base Model, the pennies framing treatment shows a positive but not significant, simple main effect on submitted savings rate ($\beta = 0.525$, $p = 0.121$) and a significant interaction between treatment condition and log of winsorized income ($\beta = -2.880$, $p = 0.030$). Given the significant interaction term, the next five regression models focus on better exploring what that interaction is by estimating the treatment effects at the means of each income quintile. Model 1 spotlights at the mean of quintile 1 and reveals a significant treatment effect of pennies framing (at log income = 4.4, $\beta = 1.561$, $p = 0.009$). Model 2 spotlights at the mean of quintile 2 and reveals a significant treatment effect of pennies framing (at log income 4.6, $\beta = 0.985$, $p = 0.016$). Models 3, 4, and 5 spotlight at quintiles 3, 4, and 5 but coefficients on the treatment effect are not significant (at log income 4.8, $\beta = 0.409$, $p = 0.229$; at log income 4.9, $\beta = 0.121$, $p = 0.749$; at log income 5.1, $\beta = -0.455$, $p = 0.409$). In other words, when controlling for demographics and plan fixed effects, there is an interaction effect of pennies framing increasing submitted savings rates, most dramatically for those with lower income and diminishing as income increases. To better visualize the nature of effect of pennies versus percent framing, a complete floodlight over the range of income is provided in the panels of Figure 2-8.[17] The range of significance for the interaction of treatment condition with log of winsorized income is from the lowest income level to log income of 4.7 (which is about $50,000). Above the $50,000, the interaction is not significant, although linear estimation projects a crossover point somewhere around log income of 5.0 (which is about $100,000) where pennies framing may start to have a reverse effect and start to lower the savings rates of those with higher income. Most notably in Figure 2-8, in contrast to percent framing which has a floodlight plot that slopes upward as income increases, pennies framing tends to flatten the floodlight plot with those with lower incomes saving at rates more comparable to those with higher income.

[17] This floodlight covers pennies and percent conditions with age and gender controls plus plan sponsor fixed effects. Shaded regions indicate Johnson-Neyman significance regions. Data points for the floodlight are listed below the diagram (N = 1883).

Figure 2-8. Floodlight Diagram of Submitted Savings Rates by Treatment Condition Across the Range of Income for Those Who Completed the Enrollment System Process



(Figure 2-8 continued)

Salary (log $)	Salary ($)	Treatment Difference (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(1795)	p-value	Constant (Percent Savings Rate)	Pennies Savings Rate
4.0	$ 10,000	2.713	0.601	4.825	2.52	0.012	5.645	8.357
4.1	$ 12,589	2.425	0.558	4.292	2.55	0.011	5.918	8.343
4.2	$ 15,849	2.137	0.510	3.763	2.58	0.010	6.191	8.328
4.3	$ 19,953	1.849	0.456	3.242	2.60	0.009	6.465	8.313
4.4	$ 25,119	1.561	0.390	2.732	2.61	0.009	6.738	8.299
4.5	$ 31,623	1.273	0.305	2.241	2.58	0.010	7.011	8.284
4.6	$ 39,811	0.985	0.187	1.783	2.42	0.016	7.284	8.269
4.7	$ 50,119	0.697	0.009	1.385	1.99	0.047	7.558	8.255
4.8	$ 63,096	0.409	-0.257	1.075	1.20	0.229	7.831	8.240
4.9	$ 79,433	0.121	-0.620	0.862	0.32	0.749	8.104	8.225
5.0	$ 100,000	-0.167	-1.056	0.722	-0.37	0.713	8.377	8.211
5.1	$ 125,893	-0.455	-1.535	0.625	-0.83	0.409	8.651	8.196
5.2	$ 158,489	-0.743	-2.038	0.553	-1.12	0.261	8.924	8.181
5.3	$ 199,526	-1.031	-2.555	0.494	-1.33	0.185	9.197	8.167
5.4	$ 251,189	-1.319	-3.081	0.444	-1.47	0.142	9.470	8.152
5.5	$ 316,228	-1.607	-3.612	0.399	-1.57	0.116	9.744	8.137

The focus of the analysis so far has been on those treated, specifically those that complete the enrollment process. One potential concern of focusing solely on analysis of the fully treated may be that pennies versus percent framing could potentially cause more participants to exit the online enrollment process early (e.g., due to the process feeling less natural in the pennies frame). A second concern may be that pennies framing could increase the fraction of participants who complete the enrollment process but end up submitting 0% savings rates.

To explore the first area as to what extent there should be concern that participants who see pennies framing exit the process earlier than would otherwise happen in a percent frame, an indicator variable was constructed which was set to 1 if participants on their initial treatment either did not submit a savings rate or submitted a 0% savings rate during their initial session and was set to 0 otherwise. In other words, this indicator variable can be thought of as a flag whether people had a 0% savings rate after their initial treatment. Using this indicator variable as the outcome variable, four OLS[18] regression model analyses were performed (See Table 2-6). In Model 1, the sole independent variable was an indicator variable for the pennies treatment condition, and the simple main effect of pennies framing was positive, marginally significant, and small ($\beta = 0.032$, $p = 0.082$). Model 2 added demographic controls of winsorized age (mean centered), gender (contrast coded male = 1, female = -1, other = 0), and log of winsorized income (mean centered), and the simple main effect of pennies framing continued to be marginally significant and small ($\beta = 0.033$, $p = 0.073$). Finally, given the prior evidence of potential interaction effects between treatment condition and income, an interaction variable between the two was included in Model 3. When adding the interaction term, the simple main effect was marginally significant and small ($\beta = 0.033$, $p = 0.073$) and the coefficient on the interaction was not significant ($\beta = 0.032$, $p = 0.652$). Model 4 added plan fixed effects, and the resulting simple main effect was not significant ($\beta = 0.030$, $p = 0.100$). To provide additional color, when Model 4 is instead run as a logistic regression, the simple main effect was not

[18] Ordinary least squares (OLS) regression may be used to analyze and estimate treatment effects for indicator variables (Angrist and Pischkle, 2009).

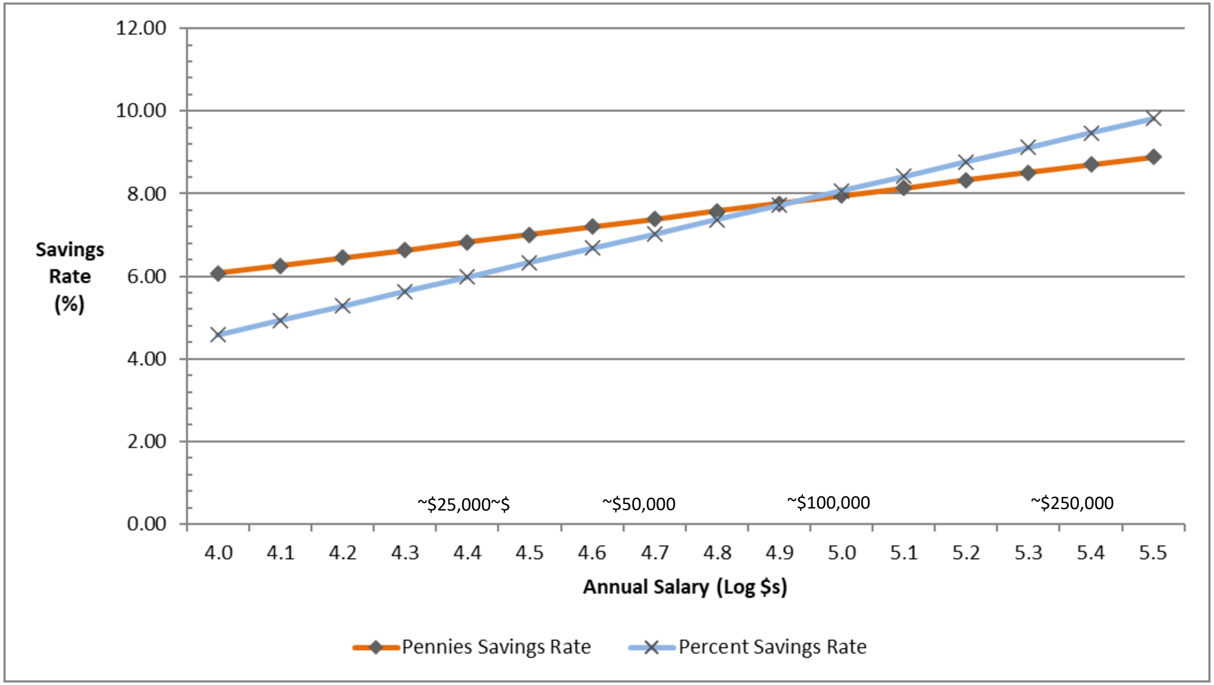
significant (B = 0.167, e^B = 1.18, p = 0.103). Altogether, this evidence suggests that pennies framing may have a marginal effect on increasing the propensity of people to hesitate to save (for example, some may be surprised to see an elicitation to save pennies and then exit the web session to attempt to enroll later).

To explore the second area of concern as to whether pennies framing could increase the fraction of participants submitting 0% savings rates (essentially opting out of savings) in the online enrollment system, an indicator variable was constructed which was set to 1 if participants submitted a 0% savings rate during enrollment and was set to 0 otherwise. Using this indicator variable as the outcome variable, four OLS regression model analyses were again performed (See Table 2-7). In Model 1, the sole independent variable was an indicator variable for the pennies treatment condition. Model 2 added demographic controls, Model 3 added an interaction term, and Model 4 added plan fixed effects. In Models 3 and 4, the interaction terms were not significant. And in all four models, coefficients on the pennies treatment condition indicators were small and not significant ($0 \leq \beta s \leq 0.00331$, $ps \geq 0.566$), thus suggesting that people who complete the online enrollment process do not submit 0% rates with increased frequency.

As mentioned previously, participants may also change their savings rates after making initial submissions in the enrollment system. If they were to do so, *all participants* (regardless of their assignment to condition) would then be making changes in a *percent frame environment* (e.g., the ongoing system). For the next OLS regressions analyses, the savings rates in effect 60 days from a participant's initial treatment is used as the outcome variable with independent variables of pennies treatment condition (pennies = 1, percent = 0), demographic controls of winsorized age (mean centered), gender (contrast coded), log of winsorized income (mean centered), an interaction term of treatment condition and log of winsorized income (mean centered), and plan fixed effects. Although the interaction between treatment condition and log of winsorized income is no longer significant after 60 days (β = -1.6109, p = 0.190), a floodlight analysis was conducted to better explore the relationships. Figure 2-9 depicts the savings rates in effect 60 days based on a participant's initial treatment group with a floodlight over the range of income.

Although the initial pennies framing helped those with lower income to initially submit higher savings rates, after 60 days some people in both initial treatment groups (i.e., pennies and percent) change their rates in the percent environment of the ongoing system. Differences in effects after 60 days now fall outside of significance, although the general pattern of pennies framing helping those with lower income is still directionally apparent.

Figure 2-9. Floodlight Diagram of Savings Rates by Treatment Condition After 60 Days Across the Range of Income for Those Who Completed the Enrollment System Process



Salary (log $)	Salary ($)	Treatment Difference (Pennies Versus Percent)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	t(1795)	p-value	Constant (Percent Savings Rate)	Pennies Savings Rate
4.0	$ 10,000	1.487	-0.470	3.445	1.49	0.136	4.585	6.072
4.1	$ 12,589	1.326	-0.404	3.057	1.50	0.133	4.934	6.260
4.2	$ 15,849	1.165	-0.342	2.673	1.52	0.130	5.282	6.448
4.3	$ 19,953	1.004	-0.287	2.295	1.52	0.127	5.631	6.635
4.4	$ 25,119	0.843	-0.243	1.928	1.52	0.128	5.980	6.823
4.5	$ 31,623	0.682	-0.215	1.579	1.49	0.136	6.328	7.010
4.6	$ 39,811	0.521	-0.219	1.261	1.38	0.168	6.677	7.198
4.7	$ 50,119	0.360	-0.278	0.997	1.11	0.269	7.026	7.385
4.8	$ 63,096	0.199	-0.418	0.816	0.63	0.528	7.375	7.573
4.9	$ 79,433	0.037	-0.649	0.724	0.11	0.915	7.723	7.761
5.0	$ 100,000	-0.124	-0.947	0.699	-0.29	0.768	8.072	7.948
5.1	$ 125,893	-0.285	-1.285	0.715	-0.56	0.577	8.421	8.136
5.2	$ 158,489	-0.446	-1.645	0.753	-0.73	0.466	8.769	8.323
5.3	$ 199,526	-0.607	-2.018	0.804	-0.84	0.399	9.118	8.511
5.4	$ 251,189	-0.768	-2.400	0.864	-0.92	0.356	9.467	8.699
5.5	$ 316,228	-0.929	-2.786	0.928	-0.98	0.327	9.815	8.886

(Figure 2-9 continued)

To better understand how people change their rates after 60 days, two threads of analyses are performed: 1) an analysis of whether people are more likely to change their elections after being treated in pennies versus percent framing, and 2) an analysis of the degree of changes after being treated in pennies versus percent framing. For the first thread of analysis, a change flag indicator variable was constructed as an outcome variable for those who were treated with a value of 1 indicating that the participant changed their rate up or down after 60 days and a value of 0 if their rate stayed the same after 60 days. The independent variables were an indicator variable for the pennies treatment group, demographic controls for age, gender, and income; and plan fixed effects. Results of an OLS regression indicate a marginally significant, simple main effect of participants to change their rate based on pennies treatment condition (β = .027, p = 0.088), and a logistic regression also indicates a marginally significant, simple main effect (B = 0.260, e^{B} = 1.30, p = 0.071).

For the second thread of analyses, a savings rate difference variable was constructed which was set equal to the winsorized savings rate after 60 days minus the winsorized initial submitted savings rate. In other words, a negative savings rate difference indicates the amount a savings rate was decreased after 60 days from initial submission (e.g., a -1.0 indicates a person lowered their savings rates by 1.0%), and a positive savings rate difference indicates the amount that a savings rate was increased after 60 days from initial submission. Using this variable as the outcome variable, three OLS regression model analyses were performed (See Table 2-8). For Model 1, the independent variables were an indicator variable for the pennies treatment condition and demographic controls, and the simple main effect of pennies framing was marginally significant and negatively valenced (β = -0.351, p = 0.095). Model 2 adds an interaction term of the pennies treatment condition and log of winsorized income (mean-centered). For Model 2, the simple main effect is marginally significant (β = -0.357, p = 0.089) and the coefficient on the interaction term is not significant (β = 0.511, p = 0.534). Model 3 adds plan fixed effects, and the simple main effect is not significant and negatively valenced (β = -0.295, p =

0.172). Note that when regression models are run with just demographic controls and plan fixed effects and either pennies treatment or salary is included, salary is a larger driver of savings rate differences (R-squared when adding just pennies treatment indicator = 0.0373 versus R-squared when adding just salary = 0.0404). With demographic controls only, then R-squared = 0.0365. Altogether, this evidence suggests that participants lower their rates on average across both pennies and percent conditions after 60 days. Participants may directionally (not statistically significant) lower their rates moreso on the margin in the pennies treatment condition. However, at the same time, the lowering of rates after 60 days may have less to do with the treatment condition and more to do with income considerations.

As a final analysis, we assess the impact of the COVID-19 pandemic to provide contextual color on both a) initial submitted savings rates (pre- versus post-COVID) and b) 60-day savings rate differences between i) those who initially submitted their savings rates and had their 60-day period elapse before COVID started (i.e., those who submitted their elections before December 31, 2019) and ii) those who initially submitted their savings rates before COVID started but had a 60-day window after COVID started (i.e., those who submitted their elections before March 1, 2020). For both analyses, we assume a COVID event date of March 1, 2020.

In term of the first analysis of the effect of the COVID event on initial submitted savings rate, a covidflag variable was constructed to be equal to 1 if the date the participant submitted their initial savings rate elections happened either on or after the COVID event and 0 otherwise. Then an OLS regression was run with initial submitted savings rate as the outcome variable with pennies treatment condition indicator, demographic controls, plan fixed effects, and covidflag as independent variables (N=1883). The coefficient on covidflag was significant and positive (β = 0.898, p = 0.027), thus indicating that on average participants raised their initial submitted savings rates post-COVID by about 90 basis points. This analysis appears in Table 2-9, Panel A.

The second analysis tries to assess to what extent those who started the process pre-COVID but then got shocked by COVID, changed their rate significantly after 60 days as compared to those who did not get shocked “mid-process”. To perform this analysis, we analyze only those participants who submitted savings rates pre-COVID. Those who had the COVID event happen mid-process were assigned a shockenvironment variable equal to 1 (i.e., these are participants with submitted savings rates between January 1, 2020 and February 28, 2020), and those who neither experienced the COVID event during their initial submission nor the 60-day follow-on period were assigned a shockenvironment variable equal to 0 (i.e., these are participants with submitted savings rates between October 24, 2019 and December 31, 2019). An OLS regression was then run with savings rate differences (i.e., difference in 60-day savings rate and initial submitted savings rate) as the outcome variable and pennies treatment condition indicator, demographic controls, and covidflag as independent variables (N=1393). The coefficient on shockenvironment was not significant ($\beta = 0.236$, $p = 0.364$), suggestive that a COVID event mid-process did not have an incremental effect on observed savings rate differences that occured between the initial submission and 60-days later. This analysis appears in Table 2-9, Panel B.

2.4. General Discussion

2.4.1. Savings Behavior

In the lab study covering a highly educated, high income population (more than 80% with college degrees and average salaries of roughly $100,000), pennies reframing had a positive, simple main effect of dramatically increasing intended savings rate contributions. Results did not include a significant interaction effect, although those with lower subjective numeracy scores directionally boosted their intended savings rates the most. Likely explanations for failing to detect an interaction include both low statistical power and use of a higher-income study population (whereas the pennies intervention seems best suited for those with lower numeracy and lower income). The positive effects on savings intentions were not limited to those with the lowest subjective numeracy, and non-negative effects were observed across the full range of subjective numeracy. It is noteworthy to mention that the correlation between income and subjective numeracy in the lab study was moderate to strong (i.e., $r = 0.42$).

Turning to the field study which covers a population that is comparatively closer in terms of average annual salary (roughly $70,000) to the overall United States population, pennies reframing has a positive, directional, simple main effect on the boosting initial submitted savings rates by 50 basis points (i.e., average savings rate of 8.02% for pennies versus 7.52% for percent). However, this treatment on the treated effect masks heterogeneity with those in the lowest income quintile (average salary of $25,929) being boosted by 156 basis points and those in the next lowest quintile (average salary of $43,413) being boosted by 99 basis points. Based on a floodlight analysis of the interaction between treatment condition and income, those who earn less than around $50,000 seemed to be helped by pennies framing. However, the interaction in the field study reflects the potential for a crossover interaction, as the valence of the interaction switches over for persons with higher income. People earning over $100,000 in annual salary could potentially start to save a bit less in a pennies frame than they would in a percent frame (although the differences are not statistically significant for those with higher income).

In terms of whether there are other side effects of pennies framing, it seems conceivable that people might exit the enrollment process prematurely if they are confused or trust the system less because they are unfamiliar with pennies framing. The evidence suggests that there may marginally be an increased propensity to delay submitting savings elections in a pennies frame (as inferred by the outcome of having a 0% savings rate at the point of the initial encounter). One explanation could be due to a lack of familiarity of seeing savings decisions elicited in a pennies frame. However, while this proposition is plausible, it is also speculative. More importantly, analyses do not suggest that the propensity to submit a 0% savings rate is increased through either using pennies or percent framing to elicit savings rates.

Up to this point, participants have made their initial savings elections in either a pennies or percent frame and had the opportunity to use a decision tool that helps them to assess projected retirement income, monthly deductions, and their take home pay. Furthermore, as part of the process, participants have had to confirm their elections by seeing both what their payroll deductions would be and what their actual take home pay would be in dollars. This helps to minimize possibilities of confusion or improper planning during initial enrollment (regardless of pennies or percent treatment).

However, some participants do change their elections after initial enrollment (i.e., in the ongoing system). Due to research host limitations, the ongoing system could not be modified to implement pennies reframing. As such, any participant who changes their elections after initial submission would do so in a percent framed environment. With those caveats, we next discuss the findings regarding savings rates 60 days out from initial submission. While the general pattern of pennies framing helping those with lower income is directionally apparent after 60 days, differences from percent framing fall outside of statistical significance. To better understand how this might happen, we first see that there is a marginally significant but small, simple main effect for those who were in the pennies treatment condition to change their savings rates. When looking at the magnitude of those changes, there was not a statistically significant difference between conditions, although there is a directional point estimate on the simple main effect of participants lowering their savings rates after 60 days by around 30 basis points more in the pennies frame than the percent condition. However, such behavior is confounded with the fact that those people in the pennies condition are more likely to have submitted higher savings rates in the first place, so then they might decrease their rates later. Potential causes are also confounded by the fact that people initially assigned to the pennies treatment condition who change their rates do so in a percent framing environment; we do not know whether people lower their rates because they see savings decisions in the percent frame. Additional analyses of 60-day savings rate changes suggest that pennies framing is not as large of a driver as income level. In other words, people change their savings rates after 60 days moreso due to income considerations as opposed to the treatment condition they were assigned to. This analysis cannot rule out the possibility that people fail (in both pennies and percent conditions) to forecast properly, such as in terms of how savings will affect take home pay and their day-to-day financial capacity, despite being provided with projection tools, confirmation messages, and the other validating information during the enrollment process.

Given the extreme nature of the COVID-19 event and its impact on organizations, the workforce (such as through work furloughs, suspensions of employer contributions), and life, we tried to characterize and assess the potential effects of the COVID-19 event on study outcomes. Although the analysis performed may be confounded with time of year variations, the effects of the COVID-19 event seem to lift savings rates by an estimated 90 basis points, which is larger than the estimated 50 basis point lift in savings driven by pennies reframing. Given the significant and sizeable COVID-19 event impact on average savings rates, it then made sense to try to see if there were differential impacts of 60-day savings rate on those making savings choices entirely pre-COVID versus those who were shocked mid-process. Again, while confounding time of year variations cannot be separated, the COVID event did not seem to have a differential effect on 60-day savings rate changes. While it is possible that there is no effect on savings rate changes, we cannot rule out the possibility that either shocks have impacts on savings rates changes further out than 60 days from enrollment or participants use other financial sources to buffer shocks and reduce needs to reduce retirement savings rates (e.g., through loans, emergency funds, second job).

2.4.2. Study Limitations and Future Directions

It is worthwhile to highlight several limitations of the research in this chapter and potential for future research. The first limitation is that the pennies framing only occurred for a small portion of the enrollment and ongoing retirement savings processes. It is possible that effects would be different if consistent treatments were provided throughout the entire experience. A second limitation to the field study is that income was used as a moderator instead of subjective numeracy. While such measures are correlated (e.g., as evidenced by the lab study), subjective numeracy seems theoretically appropriate for analyzing pennies interaction effects, and so future studies could more directly explore how the individual behavioral difference of subjective numeracy affects real decision outcomes. A third limitation to the study is that it seems the pennies intervention should preferably be targeted at either those with lower numeracy or those with lower income levels (e.g., due to potential side effects for those with higher income). A fourth limitation to the study is around whether there are significant, undesirable spillover effects associated with getting people to save more (e.g., increased money leaking out of accounts or increased high interest borrowing). Since participants can change their savings rates at any time, these concerns are probably limited but could be explored. An expanded data set and much larger number of study participants would be needed for such an analysis.

2.5. Conclusion

This research is the first scientific examination of pennies versus percent reframing with people making actual retirement savings choices. This intervention is relatively inexpensive and easy to implement, and pennies reframing seems to help those with lower income (often those with lower subjective numeracy) to save more. The main policy caveat is that institutions should consider whether such an intervention should be targeted as opposed to used broadly because of potential crossover effects on those with higher income. Targeting could conceivably be implemented at a plan, demographic (e.g., income), or individual behavioral difference level (e.g., subjective numeracy). In any case, pennies reframing provides an opportunity to democratize savings, by reducing discrimination caused by percent framing and improving outcomes for selected subpopulations.

2.5 References

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2.6 Appendix

Table 2-1. Experimental Balance of Covariates for Pennies X% and 7% Anchor Lab Study

This table summarizes the characteristics of participants for the lab study. Note that the second to last row reports chi-squared statistics for education and the percentage of male. The last row reports for all other covariates both statistical tests for means and variances. For the means, a one-way ANOVA is reported with an F-statistic and p-value. For variances, a Bartlett's test for equal variances is reported. For statistical tests, the null hypothesis is that the groups are equal. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	Mean Age (standard deviation)	Percentage Male † (standard deviation)	Mean Annual Income †† (standard deviation)	Percent Education (% high school / % college / % advanced degree)	Subjective Numeracy (SNS-3) (standard deviation) †††	Observations
Pennies Free	54.66 (9.59)	51.4	10.08 (4.40)	18.57% / 51.43% / 30.00%	15.9 (2.7)	70
Percent Free	53.79 (11.64)	58.2	10.00 (3.88)	17.54% / 43.86% / 38.60%	15.4 (2.8)	57
Pennies Seven Anchor	53.17 (11.12)	75.4	10.46 (4.14)	21.43% / 48.57% / 30.00%	15.5 (3.0)	70
Percent Seven Anchor	54.74 (10.50)	52.8	10.61 (4.26)	15.07% / 34.25% / 50.68%	15.7 (2.8)	73
Overall	54.11 (10.65)	59.4	10.32 (4.18)	18.15% / 44.44% / 37.41%	15.7 (2.8)	270

	Mean Age (standard deviation)	Percentage Male † (standard deviation)	Mean Annual Income †† (standard deviation)	Percent Education (% high school / % college / % advanced degree)	Subjective Numeracy (SNS-3) (standard deviation) †††	Observations
Chi-squared for percentage male and education [p-value]	N/A	10.5 [0.02*]	N/A	9.07 [0.17]	N/A	
(F-statistic for means, Bartlett's χ^2 for variance) [p-value mean, p-value variance]	(0.34, 2.63) [0.79, 0.45]	N/A	(0.29, 0.86) [0.83, 0.84]	N/A	(0.35, 0.74) [0.79, 0.86]	

† Note that this only includes participants reporting either male or female for gender and excludes those reporting "other" or "prefer not to say." Of 270 participants, 4 participants reported a gender of either "other" of "prefer not to say" with 1 in the Pennies Seven Anchor, 2 in the Percent Free, and 1 in the Percent Seven Anchor conditions.

†† Income is ordinally coded into 16 bins with $10,000 increments with a 1 indicating a salary of $9,999 a year or less, 2 indicating salary from $10,000 to $19,999 a year, and 16 indicating a salary of $150,000 a year or more.

††† The SNS-3 is a scale that can range from a minimum of 3 (lowest subjective numeracy) to a maximum of 18 (highest subjective numeracy). Cronbach's alpha for the SNS-3 items were acceptable at 0.796.

Table 2-2. Regression Analysis of Pennies X% and 7% Anchor Lab Study

This table reports the results of ordinary least squares regressions where the outcome variable is the savings rate intentions of the participant. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

Saving Rate	Model 1	Model 2	Model 3	Model 4
	b/se	b/se	b/se	b/se
Pennies Condition Indicator	9.487*** (2.80)	10.426*** (3.00)	10.414*** (3.01)	16.313*** (3.86)
Seven Anchor Condition Indicator	0.937 (2.82)	0.728 (3.04)	0.762 (3.06)	6.457* (2.96)
Age		0.021 (0.14)	0.021 (0.12)	0.012 (0.14)
Gender		-0.080 (1.72)	-0.115 (1.69)	0.348 (1.76)
Income		-0.797+ (0.46)	-0.817+ (0.46)	-0.837+ (0.47)
Education		-0.265 (2.35)	-0.306 (2.40)	-0.435 (2.42)
SNS-3			0.089 (0.54)	0.060 (0.53)
PenniesCondition=1 # SevenAnchorCond=1 (interaction)				-10.844+ (6.15)
Constant	17.566*** (1.76)	24.965** (9.11)	23.898* (11.75)	21.813+ (11.29)
R^2	0.039	0.065	0.065	0.076
dfres	267	235	234	233

For ease of interpreting coefficients for the OLS, contrast coding for gender is used such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender or income are excluded from the analysis with controls. Age is an integer between 18 and 99. Education is coded with high school = 1, college degree = 2, and advanced degree = 3.

Table 2-3. Experimental Balance of Covariates for Pennies X% Field Study

This table summarizes the characteristics of participants for the field study. Note that the second to last row reports chi-squared statistics for gender. The last row reports for all other covariates both statistical tests for means and variances. For the means, a one-way ANOVA is reported with an F-statistic and p-value. For variances, a Bartlett's test for equal variances is reported. For statistical tests, the null hypothesis is that the groups are equal. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	Mean Winsorized Age† (standard deviation)	Percentage Gender (% male / female / unspecified)	Mean Winsorized Annual Income †, †† (standard deviation)	Observations
Pennies	38.25 (11.78)	28.3% / 64.3% / 7.4%	68667.42 (44377.22)	1104
Percent	38.14 (11.90)	28.8% / 64.9% / 6.3%	68489.38 (45115.31)	1151
Overall	38.20 (11.84)	28.5% / 64.6% / 6.9%	68576.51 (44745.81)	2255
Chi-squared for gender [p-value]	N/A	1.0 [0.59]	N/A	
(F-statistic for means, Bartlett's χ^2 for variance) [p-value mean, p-value variance]	(0.10, 0.21) [0.90, 0.90]	N/A	(0.01, 0.31) [0.92, 0.58]	

† Age and annual income are winsorized at the 1% and 99% level. Note that extreme outliers with annual income < $500 or > $1,000,000 were dropped prior to winsorization.

†† 1 observation has a missing value for income in the pennies frame.

Table 2-4. Descriptive Stats on Income Quintiles for Field Study

The income quintiles below were constructed based on the total pool of participants who started the enrollment process and received consistent treatment throughout (N = 2255 with one missing value for income in the pennies treatment group).

Salary Quintile	N	Mean Winsorized Salary ($)	Log Mean Winsorized Salary	Min Winsorized Salary ($)	Max Winsorized Salary ($)
1	462	26,142	4.4	$ 11,340	$ 35,000
2	440	43,413	4.6	$ 35,131	$ 50,552
3	453	58,784	4.8	$ 50,748	$ 66,703
4	449	78,038	4.9	$ 66,954	$ 92,000
5	450	137,164	5.1	$ 92,500	$ 275,000
Total	2254	68,577	4.8	$ 11,340	$275,000

Table 2-5. Spotlight Regression Analysis of Pennies X% Field Study

This table reports the results of ordinary least squares regressions where the outcome variable is the submitted savings rate of the participant and independent variables include an indicator of the treatment condition (1 = pennies, 0 = percent), age mean centered, gender (contrast coded), log of winsorized salary, the interaction of treatment condition and log of winsorized salary, and plan fixed effects. Spotlight analyses are run at the mean salary for quintile 1 (log salary = 4.4), quintile 2 (log salary = 4.6), quintile 3 (log salary = 4.8), quintile 4 (log salary = 4.9), and quintile 5 (log salary = 5.1). +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001. Parentheses reflect p-values.

submitted_savings_rate	Base Model	Model 1: Spotlight Quintile 1	Model 2: Spotlight Quintile 2	Model 3: Spotlight Quintile 3	Model 4: Spotlight Quintile 4	Model 5: Spotlight Quintile 5
Pencond	0.525	1.561**	0.985*	0.409	0.121	-0.455
	(0.121)	(0.009)	(0.016)	(0.229)	(0.749)	(0.409)
age_wmc	0.0394**	0.0394**	0.0394**	0.0394**	0.0394**	0.0394**
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
web_gender_recode	-0.365+	-0.365+	-0.365+	-0.365+	-0.365+	-0.365+
	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)
logweb_salary_wmc	2.733**					
	(0.005)					
pencondxlogsalarywmc	-2.880*					
	(0.030)					
lsalaryspotlight44		2.733**				
		(0.005)				
penxlsalaryspotlight44		-2.880*				
		(0.030)				

submitted_savings_rate	Base Model	Model 1: Spotlight Quintile 1	Model 2: Spotlight Quintile 2	Model 3: Spotlight Quintile 3	Model 4: Spotlight Quintile 4	Model 5: Spotlight Quintile 5
lsalaryspotlight46			2.733**			
			(0.005)			
penxlsalaryspotlight46			-2.880*			
			(0.030)			
lsalaryspotlight48				2.733**		
				(0.005)		
penxlsalaryspotlight48				-2.880*		
				(0.030)		
lsalaryspotlight49					2.733**	
					(0.005)	
penxlsalaryspotlight49					-2.880*	
					(0.030)	
lsalaryspotlight51						2.733**
						(0.005)
penxlsalaryspotlight51						-2.880*
						(0.030)
plan fixed effects	varies	varies	varies	varies	varies	varies
_cons	7.721***	6.738***	7.284***	7.831***	8.104***	8.651***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	1883	1883	1883	1883	1883	1883

Table 2-6. Regression Analysis of Initial 0% Savings Rate Based On First Treatment Encounter

This table reports the results of ordinary least squares regressions where the outcome variable is an indicator variable indicating an effective 0% savings rate based on initial treatment of the participant. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001. Parentheses reflect p-values.

initial_rate_zero_flag	Model 1	Model 2	Model 3	Model 4
pencond	0.0324+	0.0330+	0.0330+	0.0300
	(0.082)	(0.073)	(0.073)	(0.100)
age_wmc		-0.00452***	-0.00454***	-0.00361***
		(0.000)	(0.000)	(0.000)
web_gender_recode		-0.00880	-0.00890	-0.0199+
		(0.395)	(0.389)	(0.063)
logweb_salary_wmc		-0.131***	-0.146**	-0.180***
		(0.000)	(0.003)	(0.001)
pencondxlogsalarywmc			0.0323	0.0499
			(0.652)	(0.486)
plan fixed effects				varies
_cons	0.247***	0.243***	0.243***	0.161***
	(0.000)	(0.000)	(0.000)	(0.000)
N	2249	2248	2248	2248

Table 2-7. Regression Analysis of Initial Submitted 0% Savings Rate

This table reports the results of ordinary least squares regressions where the outcome variable is an indicator variable indicating an initial 0% savings rate submitted in the enrollment system. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001. Parentheses reflect standard errors.

submitted_rate_zero_flag	Model 1	Model 2	Model 3	Model 4
pencond	0.00304	0.00331	0.00287	0.000771
	(0.599)	(0.566)	(0.620)	(0.882)
age_wmc		0.000510*	0.000497*	0.000224
		(0.036)	(0.041)	(0.333)
web_gender_recode		0.00505	0.00487	0.000787
		(0.118)	(0.132)	(0.794)
logweb_salary_wmc		-0.0226*	-0.0377*	-0.00775
		(0.047)	(0.014)	(0.605)
pencondxlogsalarywmc			0.0334	0.0324
			(0.139)	(0.113)
plan fixed effects				varies
_cons	0.0144***	0.0162***	0.0162***	0.00205
	(0.000)	(0.000)	(0.000)	(0.696)
N	1884	1883	1883	1883

Table 2-8. Regression Analysis of Pennies X% Field Study and Saving Rate Differences After 60 Days

This table reports the results of ordinary least squares regressions where the outcome variable is the savings rate differences between the 60-day savings rate and initial submitted savings rate. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001. Parentheses reflect p-values.

savings_rate_difference	Model 1	Model 2	Model 3
pencond	-0.351+	-0.358+	-0.295
	(0.095)	(0.089)	(0.172)
age_wmc	0.0196*	0.0194*	0.0234*
	(0.028)	(0.029)	(0.015)
web_gender_recode	0.0198	0.0171	0.0942
	(0.866)	(0.884)	(0.452)
logweb_salary_wmc	0.888*	0.657	0.830
	(0.032)	(0.238)	(0.183)
pencondxlogsalarywmc		0.511	1.106
		(0.534)	(0.193)
plan fixed effects			varies
_cons	-0.327*	-0.327*	-0.468*
	(0.032)	(0.032)	(0.032)
N	1883	1883	1883

Table 2-9. Regression Analyses of COVID-19 Impact on Field Study Submitted Savings Rate and Incremental Effects on Savings Rates Differences for Those Impacted Mid-Process

These tables report the results of ordinary least squares regressions where the Panel A outcome variable is initial submitted savings rate and covidflag is equal to 1 for all submissions on or after March 1, 2020 (the COVID-19 event date for the purposes of analysis) and 0 otherwise. The Panel B analysis applies only to those participants who initially submitted savings rate pre-COVID and compares those who experienced the COVID-19 event mid-process. The Panel B outcome variable is the savings rate difference between the 60-day savings rate and the initial submitted savings rate. A shock environment variable indicates whether the COVID event date happened between a participant's initial submission and 60-day savings rate date. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001. Parentheses reflect p-values.

Panel A – Impact on Savings Rates Based on Pre- and Post-COVID

submitted_savings_rate_w	β/(p)
pencond	0.510
	(0.131)
age_wmc	0.0405**
	(0.007)
web_gender_recode	-0.361+
	(0.065)
logweb_salary_wmc	1.430+
	(0.060)
plan fixed effects	varies
covidflag	0.898*
	(0.027)
_cons	7.599***
	(0.000)
N	1883

Panel B – Impact on Participant's Savings Rates Differences Based on COVID Shock

savings_rate_difference	β/(p)
pencond	0.157
	(0.491)
age_wmc	0.0101
	(0.307)
web_gender_recode	0.0840
	(0.523)
logweb_salary_wmc	1.066*
	(0.040)
plan fixed effects	varies
shockenvironment	0.236
	(0.364)
_cons	-0.431+
	(0.055)
N	1393

2.7 Online Appendix: Chapter 2, Pennies X% and 7% Anchor Lab Study Materials

Retirement Survey Instructions
In this survey we would like to learn about how you would make a hypothetical retirement savings plan decision.

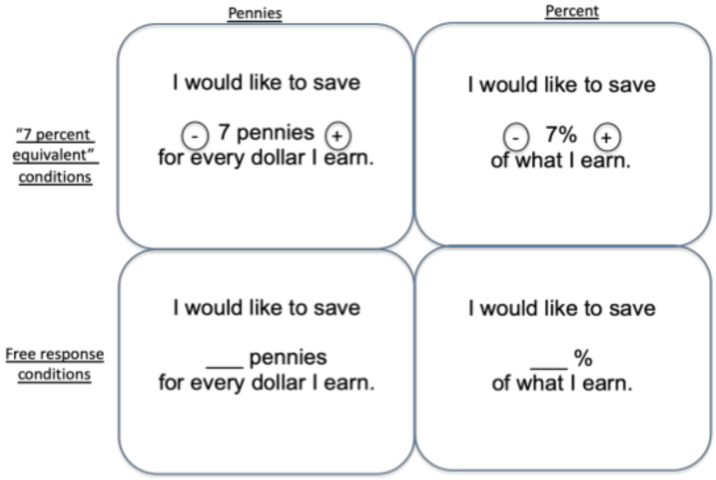
Suppose your employer provides you with an opportunity to participate in a retirement savings plan that enables you to save a portion of your salary each pay period. The plan would enable you to save and invest your money pre-tax (within government limits) until retirement.

Researcher note: 4 conditions (7 pennies | 7% | X pennies | X%)

All questions are forced choice except for Question 9.

Question 1

Suppose that after logging into the retirement savings plan website, you see the following screen (*user sees one of the options below*):



Please enter the amount you would like to save: *(Note only one of the input modes is available based on whether the participant is in one of the pennies or percent conditions.)*

- _______ pennies for every dollar I earn
- _______ % of what I earn

Researcher note: blank must be an integer between 0 and 100.

Question 2

Recall the previous question, where you were given an option to save.

What was your attitude toward this option?

Items	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
a) I found the option to be affordable.	1	2	3	4	5	6
b) I found the description of the option to be clear and understandable.	1	2	3	4	5	6

We would now like to ask you some questions about yourself.

Question 3

Please select an answer for each row:

Items	Not at all good	-	-	-	-	Extremely good
a) How good are you at working with fractions?	1	2	3	4	5	6
b) How good are you at figuring out how much a shirt will cost if it is 25% off?	1	2	3	4	5	6

Question 4

Please answer the following question:

Items	Never	-	-	-	-	Very often
How often do you find numerical information to be useful?	1	2	3	4	5	6

Question 5

What is your age (in years)? ________ *(Research coding note: 18 to 99)*

Question 6

What is your gender?

- ❍ Male
- ❍ Female
- ❍ Other
- ❍ Prefer not to say

Question 7

What is your annual income?

- ❍ $9,999 a year or less
- ❍ From $10,000 to $19,999 a year
- ❍ From $20,000 to $29,999 a year
- ❍ From $30,000 to $39,999 a year
- ❍ From $40,000 to $49,999 a year
- ❍ From $50,000 to $59,999 a year
- ❍ From $60,000 to $69,999 a year
- ❍ From $70,000 to $79,999 a year
- ❍ From $80,000 to $89,999 a year
- ❍ From $90,000 to $99,999 a year
- ❍ From $100,000 to $109,999 a year
- ❍ From $110,000 to $119,999 a year
- ❍ From $120,000 to $129,999 a year
- ❍ From $130,000 to $139,999 a year
- ❍ From $140,000 to $149,999 a year
- ❍ $150,000 a year or more
- ❍ Prefer not to say

Question 8

What is the highest degree or level of school you have completed? If currently enrolled, please indicate highest degree received.

- ❍ High school
- ❍ College degree
- ❍ Advanced degree

Question 9

Please feel free to share any comments on the hypothetical retirement savings plan decision or provide feedback on the survey below (optional): *(Free-form text up to 500 characters)*

Thank you for your participation in this survey!

2.8 Online Appendix: Supplemental SEM Analyses

Table 2S2-1. Structural Equation Modelling Analysis for Pennies X% and 7% Anchor Lab Study

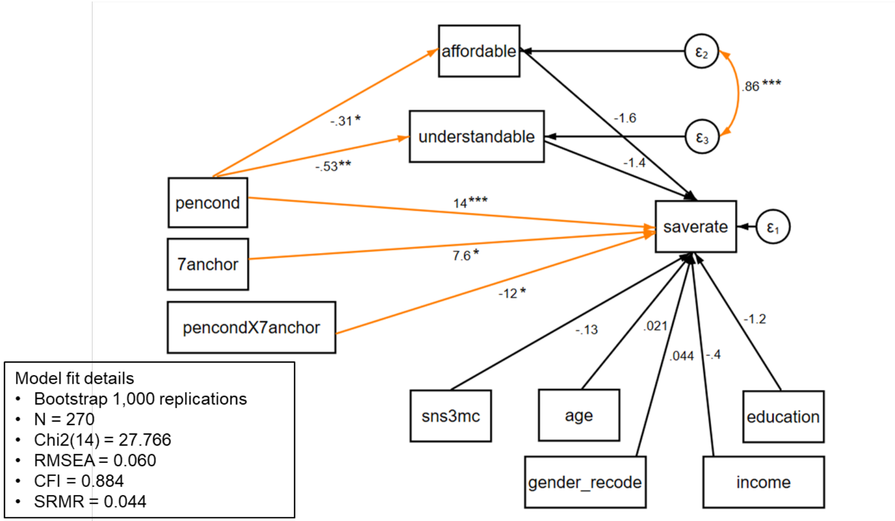
This table explores the effects of pennies framing, 7% anchoring, interactions between the two, demographic control, and mediators of affordability and understandability on savings rate outcomes. For the fitted model, N=270, χ2(14)=27.766, RMSEA=0.060, CFI=0.884, and SRMR=0.044. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

```
Structural equation model                       Number of obs     =        270
Estimation method  = ml                         Replications      =      1,000
Log likelihood     =  -6313.796
```

	Observed Coef.	Bootstrap Std. Err.	z	P>|z|	Normal-based [95% Conf.	Interval]
Structural						
saverate						
affordable	-1.603744	1.622854	-0.99	0.323	-4.78448	1.576991
understandable	-1.441347	1.341506	-1.07	0.283	-4.070651	1.187957
pencond	14.47572	3.578598	4.05	0.000	7.461797	21.48964
sevencond	7.624176	3.02654	2.52	0.012	1.692267	13.55609
age	.02061	.1403754	0.15	0.883	-.2545207	.2957408
gender_recode	.0439511	.3065522	0.14	0.886	-.5568802	.6447824
education	-1.209989	2.091708	-0.58	0.563	-5.30966	2.889682
income	-.4006569	.2778139	-1.44	0.149	-.9451621	.1438484
sns3mc	-.1272561	.5386119	-0.24	0.813	-1.182916	.9284039
pencondXsevencond	-12.37613	5.590447	-2.21	0.027	-23.33321	-1.419058
_cons	34.42164	10.80033	3.19	0.001	13.25338	55.58989
affordable						
pencond	-.3071429	.1459153	-2.10	0.035	-.5931316	-.0211541
_cons	5	.1022885	48.88	0.000	4.799518	5.200482
understandable						
pencond	-.5313187	.1711633	-3.10	0.002	-.8667926	-.1958448
_cons	4.938462	.1157894	42.65	0.000	4.711518	5.165405
var(e.saverate)	525.1014	73.91047			398.5039	691.9166
var(e.affordable)	1.339974	.1603799			1.059783	1.694242
var(e.understandable)	2.152965	.1925043			1.806875	2.565346
cov(e.affordable, e.understandable)	.8611376	.1512064	5.70	0.000	.5647784	1.157497

Figure 2S2-1. Structural Equation Modelling Path Diagram for Pennies X% and 7% Anchor Lab Study

This structural equation model explores the effects of pennies framing, 7% anchoring, interactions between the two, demographic controls, and mediators of affordability and understandability on savings rate outcomes.



Note 1: As a robustness check, two more SEM models were run with either affordable or understandable (but not both) as a hypothesized mediator since the correlation of the errors terms in the base model is very high at 0.86. Mediation continued to be insignificant in both cases.

Chapter 3. Temporal Reframing and Savings Decisions[1]

Abstract

A growing percentage of American workers are now freelancers and thus responsible for their own retirement savings, yet they face a number of psychological hurdles that hamper them from saving enough money for the long-term. Although prior theory-derived interventions have been successful in addressing some of these obstacles, encouraging participation in saving programs is a challenging endeavor for policymakers and consumers alike. In a field setting, we test whether framing savings in more or less granular formats (e.g., saving daily versus monthly) can encourage continued saving behavior through increasing the take-up of a recurring deposit program. Among thousands of new users of a financial technology app, we find that framing deposits in daily amounts as opposed to monthly amounts quadruples the number of consumers who enroll. Further, framing deposits in more granular terms reduced the participation gap between lower and higher income consumers: three times as many consumers in the highest rather than lowest income bracket participated in the program when it was framed as a $150 monthly deposit, but this difference in participation was eliminated when deposits were framed as $5 per day.

3.1 Introduction

People often have difficulty saving money and marketers face problems convincing them to do so, a challenge that exists regardless of whether goals and time horizons are short- or long-term. For example, consumers have trouble saving for long-term goals like retirement (e.g., Benartzi and Thaler, 2013) and college education (Madrian et al., 2017). But, people are also challenged by the prospect of saving for emergencies that may arise in the short-term: in a recent government report, nearly half of adults said they either could not handle an emergency expense of a few hundred dollars or would have to cover the emergency through selling

[1] This chapter is based on the *Marketing Science* journal article, “Temporal Reframing and Participation in a Savings Program: A Field Experiment” by Hal Hershfield, Stephen Shu, and Shlomo Benartzi (Hershfield et al., 2020).

something or borrowing money (Board of Governors of the Federal Reserve System, 2016; see also Lusardi, Schneider, and Tufano, 2011).

Prior behavioral economic interventions have been successful in addressing psychological obstacles that hamper people from choosing to save. Automatically enrolling eligible employees into employer-sponsored saving plans (i.e., defined contribution plans) results in a dramatically greater percentage of employees actively saving (Madrian and Shea, 2001), although some plans still set default savings rates too low relative to what would be more effective (Beshears et al., 2009). The Save More Tomorrow program, for example, directly addresses psychological obstacles to saving, such as myopia, inertia, and loss aversion (Thaler and Benartzi, 2004), by introducing pre-commitment and automatic savings rate escalators that are synchronized with future salary increases. Such programs have helped millions of Americans be more actively prepared for retirement (Benartzi and Thaler, 2013). In similar fashion, global policy efforts have been introduced to help increase participation in saving programs. In the United Kingdom, for example, the Pensions Act 2008 mandates that employers auto-enroll certain employees into retirement savings plans (Parliament of the United Kingdom, 2016). Similarly, in the United States, rulemaking at the federal level has outlined guidance and provided safe harbors that have ultimately facilitated state-level efforts to both overcome roadblocks and start to permit the benefits of auto-enrollment to be expanded to non-employer savings arrangements, namely IRAs (US Department of Labor, Employee Benefits Security Administration, 2016). Despite the success of these and similar programs, consumers and policy-makers still face major hurdles when it comes to encouraging participation in saving programs.

One of these hurdles, as typified in saving for retirement, is that existing solutions have largely focused on employees with access to a retirement savings plan (e.g., 401k plan). Furthermore, the solutions were designed for an era where employees were predominantly employed full-time and tended to receive paychecks on a regular but relatively infrequent basis, such as bi-weekly or monthly. These traditional employment arrangements are increasingly obsolete, as more workers are part of the so-called gig economy, which consists of more self-employed, part-time, and on-demand workers. Indeed, the U.S. Government Accountability Office estimated that "contingent workers" (i.e., on-call, part-time, and self-employed workers) make up more than a third of the total employment workforce (GAO, 2013), and companies considered part of the on-demand economy (e.g., Uber, Lyft, Amazon Mechanical Turk) comprise around 21 million workers internationally (de Stefano, 2015). One assessment even suggests that alternative employment arrangements accounted for nearly 85 percent of employment growth between 2005 and 2013 (Friedman, 2014). This distinction between traditional employment arrangements and alternative arrangements is important as gig economy workers may be paid on more granular time intervals than traditional workers. For example, Uber drivers work when they want and get paid weekly (Cramer and Krueger, 2016), and Amazon Mechanical Turk workers may complete tasks and have them approved by different task requesters in minutes, and request payment distributions and have them paid daily (Paolacci and Chandler, 2014).

Given this shift toward more granular payment structures, we test whether framing savings in more or less granular formats (e.g., saving daily versus monthly) can encourage continued saving behavior through increasing the take-up of a recurring deposit program. Because people may create separate mental accounts for small compared to large losses of money (Thaler, 1985), our specific research objective is to test whether people are less sensitive to present-day losses (which will turn into future gains) when such losses are framed in a smaller, more granular format (e.g., $5 a day) compared to a larger, less granular format (e.g., $150 a month). We draw on three related literatures to generate this hypothesis.

First, financially equivalent sums of money can be presented in formats with different psychological associations. For example, when workers near retirement, they have the option to cash out their savings in a lump sum (e.g., $100,000) or purchase an annuity and receive an equivalent amount, spread out monthly for life (e.g., $500 per month from age 68 onward). Yet, consumers are more sensitive to changes in wealth when income is expressed in a monthly framing compared to a lump sum framing (Goldstein, Hershfield, and Benartzi, 2016; Goda, Manchester, and Sojourner, 2013). This leads to an "illusion of wealth," whereby lump sums seem more adequate than an equivalent monthly income at lower wealth levels (when consumers can adequately perceive just how little a monthly amount would afford), with a reversal of this pattern at higher levels of wealth (when consumers can adequately perceive just how much a monthly amount would afford). That is, at lower wealth levels, a lump sum may seem subjectively larger than its equivalent monthly amount, thus affording a perception of greater adequacy.

In the current investigation, we examine whether this same psychological phenomenon can be used to help people regularly contribute to a savings account in a field setting with consequential outcomes. If consumers perceive that lump sums afford greater spending power than equivalent amounts framed in more granular ways, then it stands to reason that parting with such lump sums should be more psychologically painful than giving up an equivalent amount of money spread out over time in a smaller, more granular format (i.e., a “pennies-a-day” framing; Gourville 1998). Concretely, when consumers enroll in some saving plans, they are given the opportunity to set up a recurring deposit and regularly contribute a given amount of money to their account. These contributions are often framed in terms of a monthly contribution (e.g., $150 a month), likely reflecting traditional paycheck and banking norms where money is only transferred from one account to another on a monthly basis. But these same monthly contributions could be instead represented by weekly (e.g., $35 a week) or even daily (e.g., $5 a day) amounts. Goldstein et al. (2016) found that a lump sum of $100,000 felt subjectively larger than its equivalent annuity of $500 per month. Likewise, larger monthly amounts of money (e.g., $150) may be more psychologically painful to give up than equivalent, smaller weekly (e.g., $35) or daily ($5) amounts of money. As a result, we predict that consumers will be more likely to enroll in a recurring deposit program when deposits are framed in a more granular way (i.e., when parting with the recurring deposit seems less psychologically painful) than when deposits are framed in a less granular way.

Second, in research from the “pennies-a-day” literature, temporally reframing the cost of a product into more granular amounts increased purchase intent in laboratory settings, in part because doing so reduced the perceived cost of the deal

(Gourville, 1998, 1999; Nagle and Holden, 1995). This general preference for less aggregate framing over more aggregate framing extended from days to larger units such as weeks and months (paying $1 per day is preferred to paying $365 per year), but this finding reverses with larger monetary amounts (paying $4,200 per year is preferred to paying $11.50 per day; Gourville, 2003). Although much of the literature on temporal reframing has focused on cost perceptions in purchasing domains, we view these as relevant to saving decisions as well: when deciding whether to save or spend money now, one factor that consumers must consider is how painful it will be to give up (i.e., "pay") a certain amount of money now for larger gains later. Indeed, people at least seem to think that such framing can be helpful in the savings domain: Colby and Chapman (2013), for example, found that consumers thought they would be more likely to forgo small expenditures in order to put money toward a savings goal, but only when such goals were framed in a more granular format. Notably, the literature to date has not investigated the effectiveness of such temporal framing in a field setting with consequential financial outcomes.

Third, a growing body of research has suggested that one barrier to future-oriented behavior is the tension that consumers feel between what they may want to do in the present versus what they think they should do for the future (Bazerman, Tenbrunsel, and Wade-Benzoni, 1998). In an effort to help consumers with such intertemporal dilemmas, researchers have attempted to enhance the sense of emotional connection that is felt between current and future selves: when the future self is made to feel emotionally closer to the current self, consumers are more likely to delay financial rewards (Bartels and Urminsky, 2011) and increase their retirement contributions (Bryan and Hershfield, 2012). However, increasing this sense of connection between selves can be costly and difficult to execute. As a result, another type of intervention may be effective: rather than trying to directly influence the relationship between current and future selves, it may be useful to frame the sacrifices made by the current self as less onerous in nature (Hershfield, 2018). Along these lines, framing savings contributions in less "painful" ways (i.e., in more temporally granular ways) may increase the likelihood that a consumer would be willing to make a present-day sacrifice for future gains.

Given the importance of investigating whether these effects extend to real-world settings, and the growing interest from policy-makers in encouraging participation in saving programs, we set out to conduct a field study with a financial technology company (Acorns) that provides a mobile phone app allowing people to save and invest in small (e.g., spare change) and large amounts (e.g., thousands of dollars). In the course of our research, new users were given the opportunity to set up a recurring deposit program, in an effort to get them to save regularly. Critically, when users were invited to join the recurring deposit program, they were offered deposits in terms of either daily, weekly, or monthly amounts. Drawing on the various literature streams reviewed above, we hypothesized that users would be more likely to enroll in the recurring deposits program when deposits were framed as more granular, and less psychologically painful. That is, the probability of enrolling will be greater for daily over weekly over monthly framing of the same total amounts.

3.2 Method

Participants in the field study were new users to the Acorns app. We aimed to have approximately 2,000 users in each of five conditions or run the sign-up period of the field study for approximately 4 weeks, whichever came first. The sign-up period ran from January 4th to January 31st, 2017, and we concluded with 8,931 total participants.

3.2.1 Sample Characteristics

The average age of participants was 32.81 years (SD = 10.19 years). In terms of household income, 25.4% had less $25,000 a year, 37.8% had between $25,000 and $49,999, 29.5% had between $50,000 and $99,999, 6.9% had between $100,000 and $249,999, and .6% had above $250,000. Users were not required to report their sex, and only 1,737 or 19% of the sample did; of those, 551 were women and 1,186 were men.

To sign up for an Acorns account, a user has to download the Acorns app to his or her smartphone. From there, they must provide an email address for logging in, affirm they are a U.S. resident who is 18 years of age or older, agree to an Acorns program agreement, connect a bank account using their bank credentials, and provide some personal information (e.g., name, home address, phone number, and social security identification) to open an investment account. Users are also asked to furnish information about their income, net worth, and investment goals to help Acorns recommend a pre-designed investment portfolio, which reflects a mix of exchange traded funds (often representing an asset class or index like the S&P 500) in one of five configurations: conservative, moderately conservative, moderate, moderately aggressive, or aggressive. Fees for an Acorns account are $1 per month for an account less than $5,000 and 0.25% per year for an account greater than or equal to $5,000.

3.2.2 Procedure

After signing up for an account with Acorns, users were asked if they wanted to make an initial one-time deposit to their accounts, and were presented with five options for that initial deposit (one of which was a free-response and the other four options were based on the user's income level; See Table 3S1-1 in the Online Appendix for full set of options). If a given user decided to make an initial deposit[2], they were then randomly assigned to receive one of five different treatments, which asked whether they would like to set up a recurring deposit that varied the dollar amount and temporal frame. (We discuss implications of this design in the Discussion section). This message represents the central component of the field study that we conducted. Because randomization was conducted using a truly random allocation procedure, the number of users who were assigned to each condition was not equal across conditions. In three of the conditions, users would deposit a total of approximately $150 a month, but deposits were framed in daily, weekly, or monthly amounts: 1) $5 a day (1,772 users), 2) $35 a week (1,826 users), or 3) $150 a month (1,744 users), and in two additional conditions, users would

[2] Approximately 45% of users opted to make an initial deposit. Although it would have been desirable to compare those who made an initial deposit versus those who did not, we were not given access to data from the users who did not make an initial deposit. Furthermore, it may have been desirable to have an experimental design in which all new users were given access to the recurring deposit program, and not just the users who elected to make an initial deposit. For business reasons, however, it did not make sense to ask users who had declined an initial deposit to then sign up for a recurring deposit program, as doing so may have caused them to exit from the sign-up process.

deposit a total of approximately \$30 a month, framed in weekly or monthly amounts: 4) \$7 a week (1,817 users) and 5) \$30 a month (1,772 users).[3] To check the validity of the random assignment, we compared the distribution of those variables that were reported by all participants and found that random assignment was in fact valid, as there were no differences across condition in terms of age ($F(4, 8926) = .62, p = .65$), initial deposit ($F(4, 8910$[4]$) = .93, p = .44$), or the categorical income variable (χ^2 $(4, N = 8931) = 15.26, p = .51$). See Table 3-1 for descriptive statistics by condition.

Users could elect to either enroll in the recurring deposit program or do so at a later time. Note that when users elect to participate in the recurring deposit program, money is pulled either on a daily, weekly, or monthly basis based on their assigned condition, provided that any weekend day pulls are postponed until the following Monday.

Once users had made their decision regarding recurring deposits, they were free to use the app as they wished. See Figure 3-1 for a flowchart of the sign-up process, including the critical recurring deposit intervention. After this initial sign-up, we continued to monitor users for 3 months at approximately 5-week, 7-week, 8-week, 10-week, and 12-week intervals, during which we were able to assess whether users had left the recurring deposit feature on or turned it off (allowing us to assess retention as a function of condition). During this period of time, we also monitored total account balance[5].

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[3] Note that we were unable to implement \$1 per day due to technical limitations identified by Acorns.

[4] Initial deposit data was missing for 16 participants.

[5] Acorns also monitored weekly logins, number of weekly withdrawals, and average weekly withdrawal amount, though these variables fell outside the scope of the current research project.

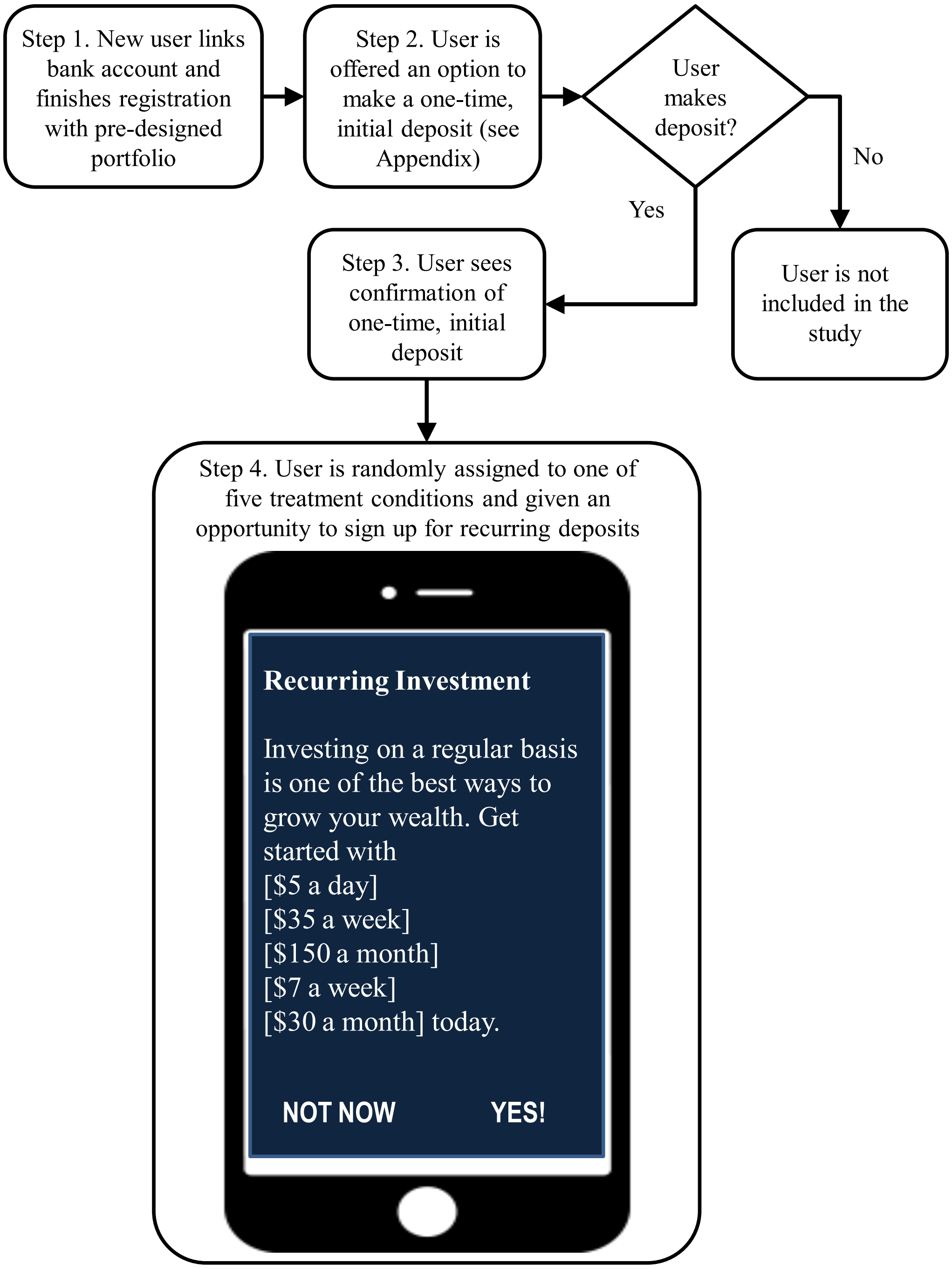

Figure 3-1. Acorns Sign-Up Process and Recurring Deposit Intervention

3.3 Results

Our interest in conducting this field study concerned whether framing monetary contributions in a more granular manner would increase participation in a recurring deposit program. Thus, we treated the first three conditions ($5 a day, $35 a week, and $150 a month) as our primary conditions of interest, and the last two conditions ($7 a week and $30 a month) as a robustness check that was conducted simultaneously. Below, we separately report analyses for these two groupings of conditions.

3.3.1 $5 Per Day, $35 Per Week, and $150 Per Month Conditions

3.3.1.1 Sign-ups

To examine whether sign-up rates for the recurring deposit program differed as a function of condition, we conducted a logistic regression analysis with dummy-coded condition variables. The omnibus effect of condition was significant, Wald $\chi^2(2) = 361.07$, $p < .001$. In line with our hypothesis, the more granular the framing, the more users signed up, with 29.9% signing up under the daily framing, 10.3% signing up under the weekly framing, and 7.1% signing up under the monthly framing. Follow-up contrast tests indicated that significantly more users signed up under daily framing compared to weekly framing (B = 1.31, Wald $\chi^2(1) = 199.13$, $p < .001$), and significantly more users signed up under daily framing compared to monthly framing (B = 1.72, Wald χ^2 (1) = 258.71, $p < .001$). Finally, more users signed up under weekly framing compared to monthly framing (B = .41, Wald $\chi^2(1) = 11.23$, $p < .001$; See Table 3-2, Model 1). The omnibus effect of condition remained significant when we controlled for income and age (Wald $\chi^2(2) = 362.19$, $p < .001$), and all contrast tests also remained significant (Bs > .40, ps < .001; See Table 3-2, Model 2).

3.3.1.2 Retention

We examined retention over three separate time points: approximately one month after registration, two months after registration, and three months after registration (See Figure 3-2 for a graphical depiction of results, and Table 3S1-2 in the Online Appendix for full logistic regression results).

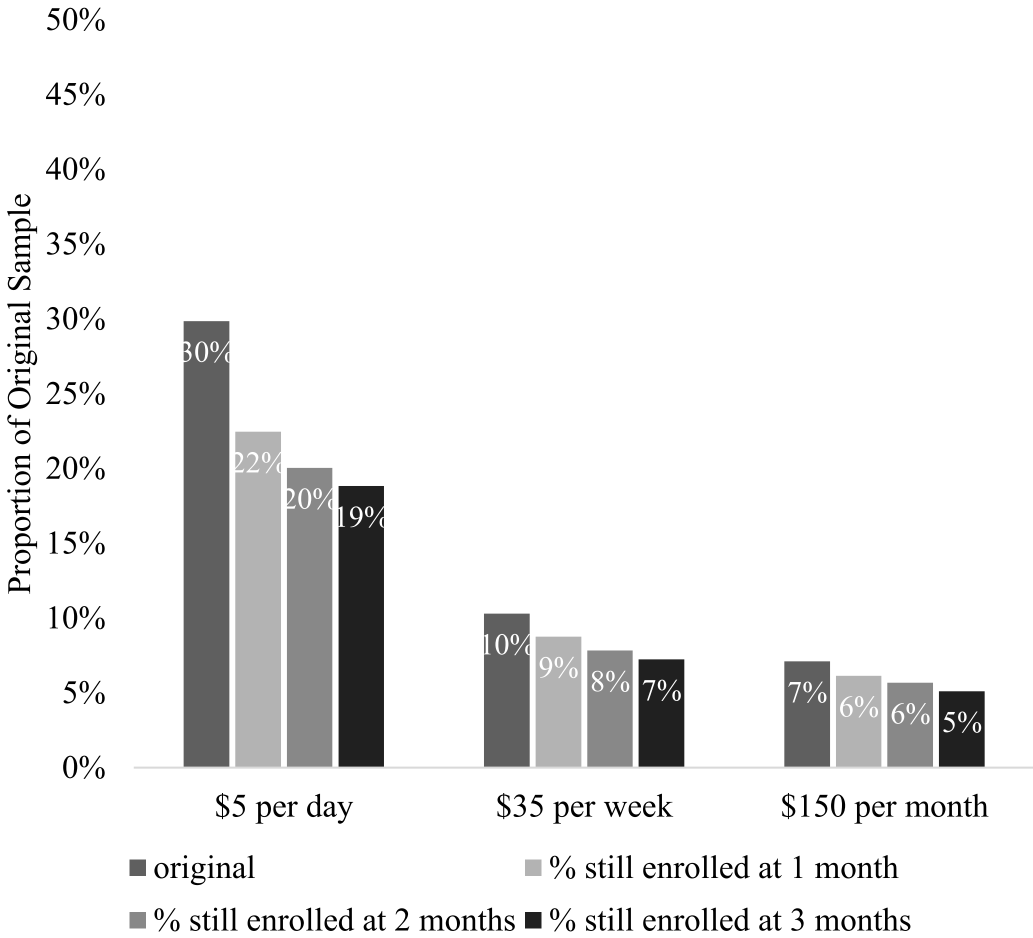

Figure 3-2. Retention at One, Two, and Three Months ($5 Daily, $35 Weekly, & $150 Monthly Conditions)

3.3.1.2.1 Retention at One Month

To examine whether retention differed as a function of condition at one month, we conducted a logistic regression analysis with retention as the dependent variable (1 = still enrolled in recurring deposits; 0 = no longer enrolled in recurring deposits) and condition as a dummy-coded variable. The omnibus effect of condition was significant, Wald $\chi^2(2) = 12.46$, $p < .001$; fewer people remaining enrolled after one month in the daily framing (75%), than in the weekly framing (85%) or monthly framing (86%) conditions. Follow-up contrast tests indicated that significantly more users remained in the weekly framing than the daily framing, ($B = .63$, Wald $\chi^2(1) = 7.66$, $p < .01$), and more users remained in the monthly framing than the daily framing ($B = .73$, Wald $\chi^2(1) = 6.77$, $p < .01$), but that there was no difference in retention rates after one month between the weekly and monthly conditions ($B = -.10$, Wald $\chi^2(1) = 09$, $p = .77$; Table 3S1-2, Model 1). The omnibus effect of condition remained significant when we controlled for income and age (Wald $\chi^2(2) = 8.39$, $p = .02$), and the significant contrast tests also remained significant ($Bs > .53$, $ps < .05$; Table 3S1-2, Model 2). Importantly, we note that even despite lower retention rates in the daily versus weekly and monthly conditions after one month, overall participation in the program was still higher in the daily condition (22%) compared to the weekly (9%) and monthly (6%) conditions ($\chi^2(2, N = 5342) = 249.52$, $p < .001$).

3.3.1.2.2. Retention at Two Months

To assess retention from one month to two months, we again conducted a logistic regression and found no difference in retention between conditions, Wald $\chi^2(2) = 1.04$, $p = .54$, with roughly the same percentage of users remaining enrolled in the recurring deposit program from one month to two months: (daily framing: 89%; weekly framing: 89%; monthly framing: 93%; Table 3S1-2, Model 3). Results held when we controlled for income and age (Wald $\chi^2(2) = 1.05$, $p = .59$; Table 3S1-2, Model 4).

3.3.1.2.3. Retention at Three Months

Finally, we conducted a logistic regression assessing retention from two months to three months. Again, there were no differences in retention between conditions, Wald $\chi^2(2) = 3.31$, $p = .19$, with roughly the same percentage of users remaining enrolled in the recurring deposit program from two months to three months: (daily framing: 94%; weekly framing: 92%; monthly framing: 90%; Table 3S1-2, Model 5). Results held when we controlled for income and age (Wald $\chi^2(2) = 4.29$, $p = .12$; Table 3S1-2, Model 6).

In short, although retention rates differed as a function of condition after one month, for the remainder of the longitudinal study, they remained consistent across conditions.

3.3.1.3. Income

We had hypothesized that one reason why a more granular framing would be effective for encouraging enrollment was because giving up small amounts of money on a daily basis might seem less psychologically painful and more feasible than giving up a large amount of money on a monthly (or weekly) basis. The field study context of this study, however, did not allow us to directly investigate perceptions of psychological pain. Nonetheless, if larger, less granular amounts seem more psychological painful and less feasible, then framing recurring deposits in such terms (i.e., in weekly or monthly amounts) should be primarily appealing to users who have greater financial resources: namely, users who have higher incomes. Thus, we examined whether there were any differences in the decision to enroll in the recurring deposit program as a function of both condition and household income. See Figure 3-3 for a graphical depiction of results, and Table 3S1-3 in the Online Appendix for full regression table results.

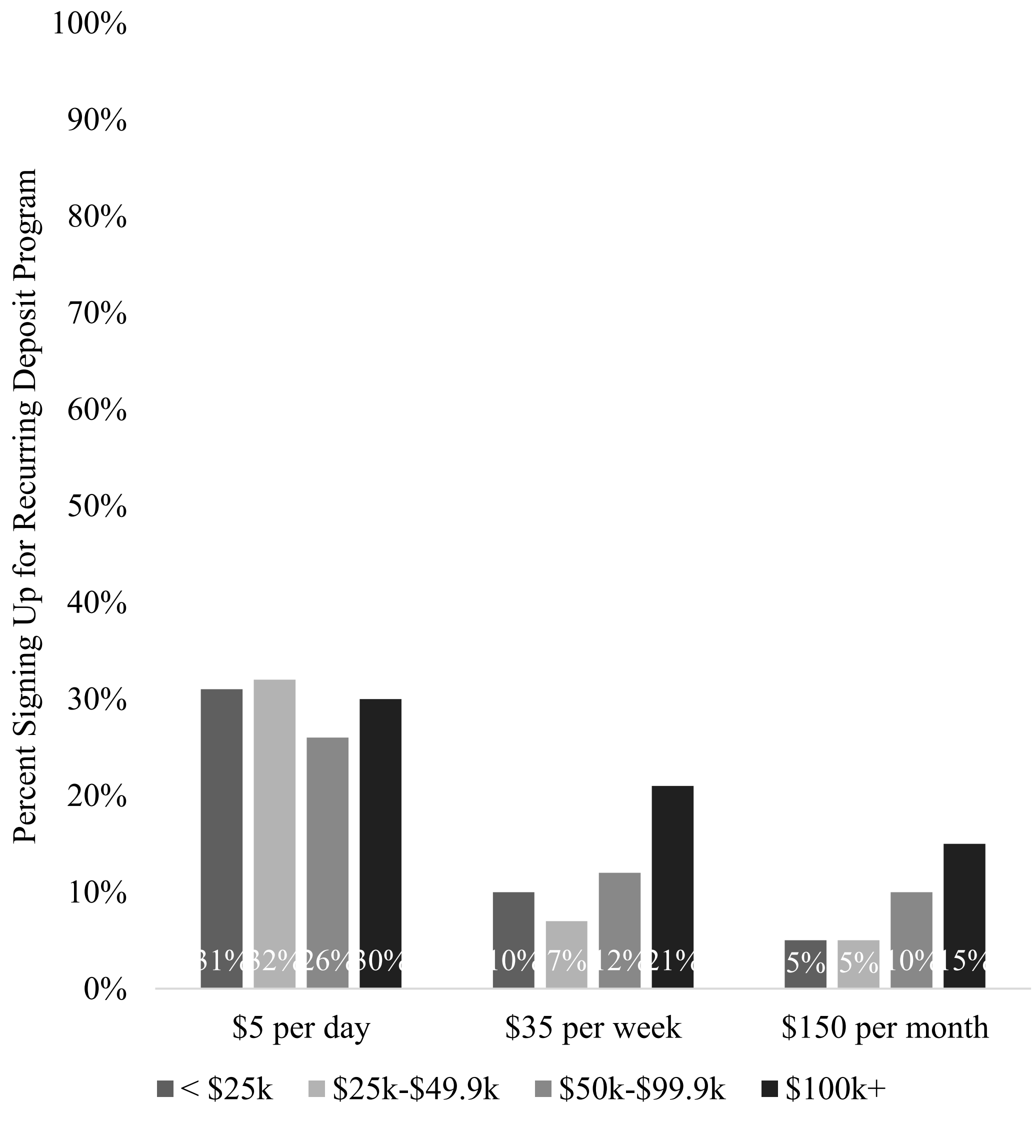

Figure 3-3. Sign-Up Rate by Condition and Income Bracket ($5 Daily, $35 Weekly, & $150 Monthly Conditions)

To do so, we conducted a factorial logistic regression with condition and income bracket as dummy-coded categorical between-subjects factors and decision to enroll as the dependent variable, and contrasts capturing differences in sign-ups for pairs of income brackets and pairs of conditions. Household income was bracketed in five bins (1 = less than \$25,000; 2 = \$25,000 - \$49,999; 3 = \$50,000 - \$99,999; 4 = \$100,000 - \$250,000; 5 = more than \$250,000). Because there were so few consumers in the highest income bracket (i.e., \$250,000+; n = 16), we combined this income bracket with the next highest one (i.e., \$100,000 - \$249,999) for this analysis. Doing so, we obtained an overall interaction between condition and income, Wald $\chi^2(6) = 33.09$, $p < .001$. Before offering a detailed reporting of this interaction below, we first wish to highlight the main takeaway that arises from this interaction. As shown in Figure 3-3, consumers in lower income brackets were less likely to sign up for the automatic savings program when it was framed in a less granular way (i.e., as \$150/month or \$35/week). However, when the automatic savings program was framed in the most granular form – that is, as \$5 per day – then there were no differences in sign-up rates across income brackets.

Follow-up interaction tests indicated that there was a difference between sign-ups for the daily versus monthly conditions when comparing the <\$25,000 income bracket to the \$100,000+ income bracket ($B = -1.27$, Wald $\chi^2(1) = 10.00$, $p < .01$). As shown in the rightmost section of Figure 3-3, under the \$150 per month condition, three times as many consumers in the highest rather than lowest income bracket participated in the program when it was framed as a \$150 monthly deposit ($B = 1.21$, Wald $\chi^2(1) = 13.27$, $p < .001$), but this difference in participation was eliminated when deposits were framed as \$5 per day (see the leftmost section of Figure 3; $B = .05$, Wald $\chi^2(1) = 0.05$, $p = .82$). Likewise, there was a difference in sign-ups for the daily versus monthly conditions when comparing the \$25,000-\$49,999 income bracket against the \$100,000+ income bracket, ($B = -1.23$, Wald $\chi^2(1) = 10.72$, $p < .001$). Again, approximately three times as many consumers in the \$100,000+ rather than the \$25,000-\$49,999 income bracket participated in the program when it was framed as a \$150 monthly deposit ($B = 1.14$, Wald $\chi^2(1) =$

13.67, $p < .001$), but this difference in participation was eliminated when deposits were framed as \$5 per day (B = .09, Wald $\chi^2(1) = .17$, $p = .68$). There was not, however, a difference in sign-ups between daily and monthly conditions when comparing the two top income brackets to each other (B = -.32, Wald $\chi^2(1) = .75$, $p = .39$.

Similar interactions arose when comparing daily to weekly conditions. Namely, there was a difference between sign-ups for the daily versus weekly conditions when comparing the <\$25,000 income bracket to the \$100,000+ income bracket (B = -.93, Wald $\chi^2(1) = 7.40$, $p < .01$): approximately two times as many consumers in the highest rather than lowest income bracket participated in the program when it was framed as a \$35 weekly deposit (B = .88, Wald $\chi^2(1) = 11.39$, $p < .001$), but as noted earlier, this difference in participation was eliminated when deposits were framed as \$5 per day (B = .05, Wald $\chi^2(1) = 0.05$, $p = .82$). Likewise, there was a difference in sign-ups for the daily versus weekly conditions when comparing the \$25,000-\$49,999 income bracket against the \$100,000+ income bracket, (B = -1.26, Wald $\chi^2(1) = 14.51$, $p < .001$). Here, approximately three times as many consumers in the \$100,000+ rather than the \$25,000-\$49,999 income bracket participated in the program when it was framed as a \$35 weekly deposit (B = 1.18, Wald $\chi^2(1) = 21.49$, $p < .001$), but this difference in participation was eliminated when deposits were framed as \$5 per day (B = .09, Wald $\chi^2(1) = .17$, $p = .68$). There was not a difference in sign-ups between daily and weekly conditions when comparing the two top income brackets to each other (B = -.45, Wald $\chi^2(1) = 1.82$, $p = .18$).

No differences emerged for the weekly versus monthly conditions when comparing the lower income brackets to the highest income bracket (Bs < .33, ps > .43).

Framing deposits in the most granular terms (i.e., in terms of daily amounts), then, seems to reduce the participation gap between lower and higher income individuals in this recurring deposit program.

3.3.2. $7 Per Week and $30 Per Month Conditions

3.3.2.1. Sign-ups

We again conducted a logistic regression analysis with a dummy-coded independent variable representing condition. In line with our hypothesis, more people signed up under the weekly framing (39.9%) than the monthly framing (21.8%), B = .87, Wald $\chi^2(1) = 133.86$, $p < .001$. Results held when we controlled for income and age, B = .91, Wald $\chi^2(1) = 141.79$, $p < .001$. (See Table 3-3 for full logistic regression results).

3.3.2.2. Retention

As in the analyses for the $150 conditions, to examine whether retention differed as a function of condition, we conducted a logistic regression analysis with retention as the dependent variable (1 = still enrolled in recurring deposits; 0 = no longer enrolled in recurring deposits) and condition as a dummy-coded independent variable at one month, two months, and three months into the program. See Figure 3-4 for a graphical depiction of results, and Table 3S1-4 in the Online Appendix for full logistic regression results.

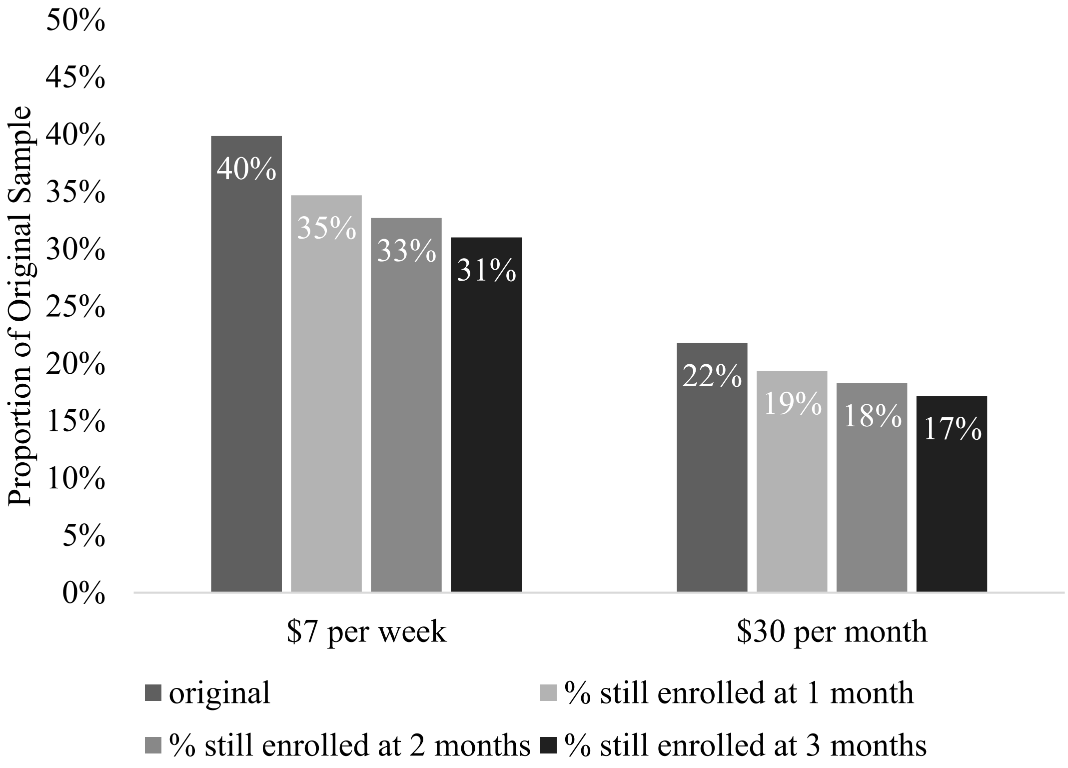

Figure 3-4. Retention at One, Two, and Three Months ($7 Weekly & $30 Monthly Conditions)

3.3.2.2.1. Retention at One Month

Of the participants who signed up for recurring deposits upon registration, retention rates at one month did not differ as a function of condition, B = .17, Wald $\chi^2(1) = 0.79$, p = .37, with roughly the same proportion of people remaining enrolled after one month in the weekly framing (87%) and in the monthly framing (89%) conditions. Results held when we controlled for income and age, B = .10, Wald $\chi^2(1) = 0.24$, p = .62.

3.3.2.2.2. Retention at Two Months

A similar pattern was obtained for retention from one month to two months, B = .03, Wald $\chi^2(1) = 0.01$, p = .91, with 94% being retained in both conditions. Results held when we controlled for income and age, B = -.02, Wald $\chi^2(1) = 0.003$, p = .95.

3.3.2.2.3. Retention at Three Months

Finally, a similar pattern was obtained for retention from two months to three months, with 94% being retained in the monthly condition and 95% being retained in the weekly condition, B = -.29, Wald $\chi^2(1) = 0.90$, $p = .34$. Results held when we controlled for income and age, B = -.33, Wald $\chi^2(1) = 1.20$, $p = .27$.

3.3.2.3. Income

As in the $150 conditions, we examined whether there were any differences in the decision to enroll in the recurring deposit program as a function of condition and income bracket. See Figure 3-5 for a graphical depiction of these results, and Table 3S1-5 in the Online Appendix for full regression table results. Although there was an overall significant interaction between condition and income bracket (Wald $\chi^2(3) = 10.49$, $p = .02$), follow-up tests indicated that no significant interactions emerged for the weekly versus monthly conditions when comparing the lower income brackets to the highest income bracket (Bs < .28, ps > .27), results that were also found when comparing weekly to monthly framings in the $150/month conditions. The significant overall interaction arises from an unpredicted (and theoretically less interesting) comparison: there was a difference in sign-ups for the weekly versus monthly conditions when comparing the $25,000-$49,999 income bracket against the $50,000-$99,999 income bracket, (B = -.59, Wald $\chi^2(1) = 10.43$, $p < .001$). Here, almost two times more consumers in the $50,000-$99,999 income bracket compared to the $25,000-$49,999 income bracket participated in the program when it was framed as a $30 monthly deposit (B = .80, Wald $\chi^2(1) = 33.19$, $p < .001$), but there was only a trend-level difference between these income brackets within the $7 weekly deposit condition (B = .21, Wald $\chi^2(1) = 3.23$, $p = .07$).

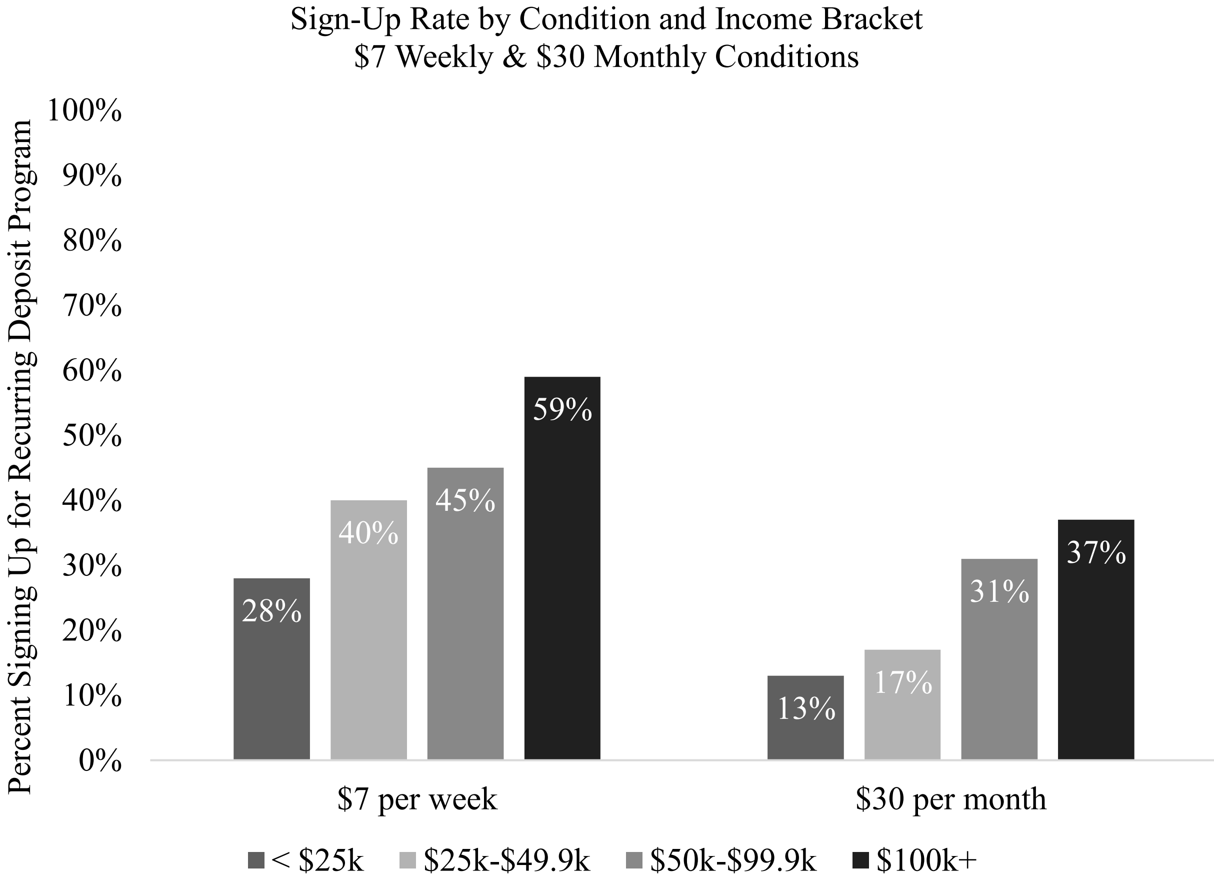

Figure 3-5. Sign-Up Rate by Condition and Income Bracket ($7 Weekly & $30 Monthly Conditions)

3.4 General Discussion

The fields of marketing and behavioral economics have implemented a variety of solutions to help consumers overcome the many obstacles they face in pursuit of saving for the long term. We add to this growing literature by examining the effectiveness of an intervention meant to encourage the take-up of a recurring deposit program. Namely, we asked new users of a financial tech app whether they wished to sign up for a recurring deposit program, but framed those recurring deposits in more or less granular terms. In a departure from the existing literature on temporal framing of financial outcomes, here we examined consequential decisions in a field setting. In what follows, we first review how enrollment behavior and retention differ as a function of temporal framing. We then discuss whether reframing a recurring deposit saving program in more granular terms may seem psychologically less painful, before closing with a discussion of limitations and future directions.

3.4.1 Enrollment Behavior

In the three central conditions, we found that take-up was approximately four times higher when deposits were framed in daily terms (i.e., \$5 per day) compared to monthly terms (i.e., \$150 per month), and approximately three times higher when compared to a weekly framing (i.e., \$35 per week). Further, take-up of the recurring deposit program was almost 1.5 times higher when framed in weekly versus monthly terms. We has a consistent basic finding that more granular framing led to higher take-up with two additional, robustness check conditions that framed deposits in lower overall amounts: take-up was approximately twice as high when deposits were framed as \$7 per week compared to \$30 per month. Taken together, temporally reframing a recurring deposit in a more granular manner led to increased take-up of the program.

It is important to acknowledge that the users who were randomly assigned to the different temporal framing conditions were users who had already decided to make an initial deposit with Acorns. As a result, the overall baseline participation rates in the present study may be inflated relative to what we might observe from a sample of users who had not decided to make an initial deposit. We have no reason to suspect, however, that differences between conditions would be different if we were to have offered the recurring deposit saving program to all users regardless of whether they made an initial deposit. Just the same, future research should implement an experimental design in which all users are offered a recurring deposit program.

3.4.2 Retention

Due to the longitudinal nature of this study, we were also able to investigate the extent to which the initial framing of recurring deposits prompted continued enrollment in the program. Results indicated that after one month, there was a higher drop-out rate in the daily framing condition compared to the weekly or monthly conditions. Whereas approximately a quarter of the consumers who enrolled in the daily condition ended up dropping out after one month, only approximately 15% dropped out in the weekly and monthly conditions. But, as noted above, due to a large difference in enrollment between conditions, even with this higher drop-out rate in the daily amount condition, there were still more consumers from the daily conditions enrolled in the recurring deposits program after one month (and also for the rest of the program) than for the weekly and monthly conditions. At subsequent periods of 2 and 3 months, retention remained the same across conditions. It may be the case, then, that a higher proportion of consumers who sign up for a recurring deposit program when it is framed in a granular way regret doing so after a short period of time (i.e., a month). After this time period, however, enrollment remained stable regardless of initial condition.

We also wish to note here that our robustness check conditions that involved much lower amounts of money ($7 per week and $30 per month) showed no differences in retention at any of the time periods. Although this higher retention rate is promising, these consumers are clearly depositing much lower amounts of money into their accounts than those in the $5 per day/$35 per week/$150 per month conditions.

3.4.3 Possible Psychological Mechanisms

3.4.3.1. Psychological Pain

Drawing on prior work regarding temporal reframing (e.g., Gourville 1999) as well as how consumers view lump sums versus annuitized streams of money (Goldstein et al., 2016), we suggested that one reason why a more granular framing would be effective for encouraging enrollment was because giving up small amounts of money on a daily basis might seem less psychologically painful and more feasible than giving up a large amount of money on a monthly (or weekly) basis. Although the field study context of this study did not allow us to directly probe this psychological mechanism[6], an analysis of average initial deposit as well as enrollment differences as a function of income provided some compelling indirect evidence for this proposition. Namely, if smaller, more granular amounts do in fact

[6] This possible psychological mechanism is more directly explored in Chapter 4.

seem less psychologically painful and more feasible than larger, less granular amounts, then framing recurring deposits in terms of smaller, daily deposits should be appealing to consumers across the income spectrum. Likewise, if larger, less granular amounts seem more psychological painful and less feasible, then framing recurring deposits in such terms should be primarily appealing to a segment with higher income (i.e., a segment that could feasibly make such large deposits). Put differently, signing up for the recurring deposit program when framed in weekly or monthly terms may seem like a more burdensome responsibility, leading to take-up only among consumers who already felt like they had sufficient resources to participate. Indeed, the consumers who participated in the recurring deposit program when it was framed in weekly or monthly terms made higher initial deposits than those who participated when it was framed in daily terms.

More to the point, the recurring deposit program seemed to appeal to a wide set of customers, independent of income, but the weekly and monthly framing only appealed to a segment of higher income customers: as noted above, a significant interaction arose such that when the program was framed as $150/month, significantly more users signed up from the highest income bracket compared to the lowest income brackets. But, when the program was framed as $5/day, there were no differences between income brackets. And, similarly, a significant interaction arose such that when the program was framed as $35/week, significantly more users signed up from the highest income bracket compared to the lowest income brackets. We note, however, that these interactions with income bracket did not arise when making comparisons between the weekly and monthly conditions, both for the $35 per week condition compared to the $150 per month condition, and for the $7 per week compared to $30 per month condition. It may simply be the case that the daily framing is the most powerful form of granular framing when it comes to reducing the income gap in participation in savings programs.

A major issue that faces policy makers concerns how best to encourage engagement in saving programs across the income spectrum. The results of this work suggest that one way to reduce the income gap in saving behavior is by framing recurring savings programs in a granular, daily format: not only did this framing encourage more people to save, it may have encouraged those who tend to struggle the most to start saving.

3.4.3.2. Poor Financial Forecasting

In addition to differences in perceived psychological pain, the more granular framing of saving amounts could have led to higher take-up of the automatic savings program because of poor financial forecasting. It is possible, for example, that consumers made errors when calculating how much $5 per day really amounted to over time, and thus, underestimated how much they would actually be saving. Notably, we did observe a difference in retention rates between the daily condition and the weekly and monthly conditions at one month into the intervention, suggesting that there was some portion of new users who made a forecasting error when estimating how much they could afford to save (and then corrected this error by dropping out of the program after one month). We note, however, that even once this correction took place, there were still significantly more users enrolled in the automatic deposit program who had initially seen the daily (rather than weekly and monthly) framing.

3.4.3.3. Different Considerations of Opportunity Costs

Further, temporally reframing monetary amounts may call to mind different sets of opportunity costs for consumers (Spiller, 2011). For example, when considering saving $5 a day, there may be dozens of expenditures that consumers could consider that cost $5 a day (e.g., a nice coffee, a sandwich, some candy, etc.), but when considering $150/month, there may be relatively few expenditures that cost this much (e.g., one nice dinner out at a restaurant). As a result, a more granular temporal reframing could suggest to a consumer that even though they may have to give up an expenditure or two, there are still plenty of other items that fall under the umbrella of $5 per day that could still be purchased. But when considering what would need to be given up to make a $150 per month contribution to a saving account, there could be fewer comparisons, leading to an overall sense that a contribution of this magnitude would be more restrictive.

3.4.4 Limitations and Future Directions

Despite the promise of temporal reframing on encouraging user take-up of recurring deposit programs, we nonetheless acknowledge the limitations of the current research. First, the research was conducted on a self-selected group of users who were already interested in signing up for a financial technology application. We question whether take-up rates would be quite so high in a sample of users who were not already interested in better organizing their finances. But, even though overall take-up rates may be lower in a broader sample, we suspect that the between-group differences in take-up would remain. Future research should thus examine whether more granular framing is similarly effective for a broader, more representative sample.

Along similar lines, we acknowledge here one possible limitation with our experimental design: as noted above, because the initial deposit amounts that were offered to users were a function of their income, we would expect that those with higher income would make a higher initial deposit. Although we do not have any reason to suspect that this initial difference in the deposit amounts would influence the interaction between income bracket and condition on sign-up behavior, future research could use an experimental design in which all users are offered the same options for their initial deposit.

Notably, in the robustness check conditions (i.e., $7 per week vs. $30 per month), even though sign-up rates differed, initial deposit amount did not differ as a function of condition and the decision to enroll in the recurring deposit program. We can only speculate as to why we observed such differences in the $150 per month conditions, and not in the $30 per month conditions. Again, we treated differences in initial deposits as proxies for differences in how burdensome the recurring deposit saving programs seemed: the more burdensome the program, the more likely it would be that consumers with higher resources would sign up. Even though it may be the case that $7 per week seemed more manageable than $30 per month (as indicated by the higher sign-up rate in the former compared to the latter condition), the overall amount (i.e., $30 per month) may not have been all that burdensome to begin with. The burden imposed by $30 per month compared to $7 per week may have been large enough to result in different sign-up rates, in other words, but not necessarily large enough to then manifest in terms of differences in initial deposits or income bracket. It would thus be prudent for future research to investigate a variety of different recurring deposit amounts to better gauge the boundaries to the effects that were observed in the $150 per month conditions.

Given that more consumers dropped out of the program after one month in the $5 per day condition, but not in the $7 per week condition, future research should also attempt to identify an optimal recurring deposit amount that maximizes overall sign-ups but minimizes drop-outs. Additionally, although we were able to track users for a period of three months, it is possible that retention rates could change over a longer period of time, or one that includes the holiday season or other periods of time when consumers may wish to spend more of their earnings. Future work may thus want to track users over a longer time interval (e.g., a year or longer).

Further, as may be the case with much of the nudging literature, we cannot at this point observe whether the temporal reframing intervention has universally positive effects for all consumers. Although participation in the saving program increased across income brackets as a result of the temporal reframing intervention, doing so may have had unintended consequences: consumers in the lowest income bracket, for example, could have chosen to save money at the expense of paying off high interest. Given that we did not have access to users' other accounts, we cannot address such unintended consequences in this dataset, but future research should attempt to examine the holistic effects of temporal reframing interventions.

Finally, we opened this paper by noting that more workers today are paid in a granular format (i.e., instead of the traditional monthly paycheck, workers are paid weekly or even daily). Our reason for highlighting the so-called gig economy was to acknowledge that payments and deposits from the financial system do not need to be thought of solely in monthly terms, as they once were. However, an open question not addressed by the current research is whether or not more granular framing of a recurring deposit program would have differential effectiveness for workers who are paid in more versus less granular ways. It could be the case, for example, that workers who are paid on a daily basis would actually be less likely to sign up for a recurring deposit saving program when it was framed in daily terms: five dollars per day may feel like a larger amount to workers paid daily rather than those paid monthly simply because people paid daily may have smaller reference points than those paid monthly. Additionally, it could be the case that workers who are paid in a more granular way also have a better sense of their (limited) budget, and such a perception could affect willingness to participate in the automatic savings program. This conjecture suggests a possible interesting question for future research: could the timing of the temporal reframing intervention itself affect take-up likelihood? If the program is advertised immediately after a worker receives their paycheck, for example, they may perceive more slack in their future budget (Lynch, Spiller, and Zauberman, 2015), leading to a greater willingness to participate across temporal reframing conditions; if the program is advertised toward the end of a pay cycle (i.e., when limited budgets are more salient), then the more granular reframing could be more effective. Future research should examine the link between temporal framing of recurring deposit saving programs, payment frequency, and the timing of such interventions.

3.4.5 Conclusion

In summary, this field experiment demonstrates the power of temporal reframing to boost participation in a recurring deposit saving program. Among new users of a savings app who had already agreed to make an initial deposit to their saving accounts, we quadrupled the number of recurring savers by framing a recurring deposit program in daily amounts as opposed to monthly amounts. We also increased the number of low-income savers, and showed that daily framing could eliminate the income gap in saving behavior. While automatic enrollment in 401(k)s has been shown to reduce the income gap in saving behavior (Madrian and Shea, 2001), this temporal reframing intervention can reduce savings disparities among workers without access to an employer-provided retirement plan. These results are especially relevant given current trends in the labor market, as a growing percentage of workers are now freelancers and are responsible for their own retirement savings. By better understanding the information and choice architectures that influence financial decision-making, we can improve the design of websites and apps that will play an increasingly important role in shaping the financial future of American workers.

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3.6 Appendix

Table 3-1. Summary of Conditions, Descriptive Statistics, and Sign-Up Rate

	"$150/Month Conditions" (*n* = 5,342)			"$30/Month Conditions" (*n* = 3,589)	
Condition	$5/Day	$35/Week	$150/Month	$7/Week	$30/Month
	n = 1,772	*n* = 1,826	*n* = 1,744	*n* = 1,817	*n* = 1,772
Mean Age	32.84	32.70	32.80	32.30	32.86
	(10.41)	(10.47)	(10.23)	(9.69)	(10.16)
% < $25,000	25.2%	25.4%	26.4%	25.9%	23.8%
	(n=446)	(n=463)	(n=460)	(n=470)	(n=422)
% $25,000 - $49,999	37.9%	38.4%	37.8%	37.0%	38.5%
	(n=672)	(n=702)	(n=659)	(n=672)	(n=683)
% $50,000 - $99,999	29.9%	28.5%	29.0%	29.6%	30.5%
	(n=529)	(n=521)	(n=506)	(n=537)	(n=541)
% $100,000 - $249,999	6.9%	7.2%	6.5%	7.0%	6.9%
	(n=122)	(n=132)	(n=114)	(n=127)	(n=122)
% $250,000+	0.2%	0.4%	0.3%	0.6%	0.2%
	(n=3)	(n=8)	(n=5)	(n=11)	(n=4)
Sign-Up Rate	29.9%	10.3%	7.1%	39.9%	21.8%

Note: Standard deviation of age listed in parentheses. Percent of condition at each income bracket may not total 100% due to rounding.

Table 3-2. Logistic Regression Predicting Sign-Up Decision, $5/Day, $35/Week and $150/Month Conditions (N = 5,342)

	B	S.E.	Wald	Df	Sig.	Exp(B)	95% C.I. for EXP(B)	
							Lower	Upper
Model 1								
Condition			361.067	2	.000			
$5/Day vs. $150/Month	1.716	.107	258.714	1	.000	5.560	4.511	6.853
$5/Day vs. $35/Week	1.310	.093	199.130	1	.000	3.708	3.091	4.448
$35/Week vs. $150/Month	.405	.121	11.232	1	.001	1.499	1.183	1.900
Constant	-2.570	.093	760.716	1	.000	.077		
Model 2								
Condition			362.185	2	.000			
$5/Day vs. $150/Month	1.720	.107	259.236	1	.000	5.584	4.529	6.884
$5/Day vs. $35/Week	1.318	.093	200.498	1	.000	3.736	3.113	4.484
$35/Week vs. $150/Month	.402	.121	11.023	1	.001	1.494	1.179	1.894
Age	.002	.004	.358	1	.549	1.002	.994	1.010
Income			12.036	3	.007			
Constant	-2.214	.227	95.095	1	.000	.109		

Note: e^B = exponentiated *B*; Income coded on a categorical scale in which 1 = less than $25,000, 2 = $25,000 - $49,999, 3 = $50,000 - $99,999, 4 = $100,000+; original logistic regression models specified contrasts between daily and monthly conditions, and weekly and monthly conditions. An additional logistic regression model was conducted to specify the daily versus weekly contrast.

Table 3-3. Logistic Regression Predicting Sign-Up Decision, $7/Week and $30/Month Conditions (N = 3,589)

							95% C.I.for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Model 1								
$7/Week vs. $30/Month	.866	.075	133.861	1	.000	2.378	2.054	2.754
Constant	-1.278	.058	493.378	1	.000	.278		
Model 2								
$7/Week vs. $30/Month	.911	.076	141.867	1	.000	2.487	2.141	2.889
Age	.012	.004	9.035	1	.003	1.012	1.004	1.020
Income			72.87	3	.000	1.477	1.350	1.615
Constant	-2.590	.152	288.816	1	.000	.075		

Note: e^B = exponentiated *B*. Income coded on a categorical scale in which 1 = less than $25,000, 2 = $25,000 - $49,999, 3 = $50,000 - $99,999, 4 = $100,000+.

3.7 Online Appendix

Initial Deposits ($150/Month Conditions). To complement analyses on income, we examined whether initial deposits differed as a function of condition and the decision to enroll in the recurring deposit program. To do so, we conducted a univariate ANOVA with two between-subjects factors (condition: daily, weekly, monthly; recurring deposit enrollment: enrolled, not enrolled), and initial deposit as the dependent variable. There were 87 participants who had deposits that were 3 or more standard deviations above the mean. These 87 balances were replaced with the closest nonoutlying value in the sample (Tabachnick & Fidell, 2007).

The univariate ANOVA indicated that there was not a main effect of condition (as noted earlier; $F(2, 5326) = .56$, $p = .57$), but that there was a significant main effect of recurring deposit enrollment, ($F(1, 5326) = 241.70$, $p < .001$, $\eta_p^2 = .04$), and a significant Condition x Recurring Deposit Enrollment interaction ($F(2, 5326) = 71.92$, $p < .001$, $\eta_p^2 = .03$). The nature of this interaction is demonstrated in Figure 3S1-1: there are no differences across conditions in initial deposit among those who did not enroll in the recurring deposit program. Among consumers who did enroll, those in the $35 weekly (winsorized *M* = $93.52, *SD* = $124.76) and $150 monthly (winsorized *M* = $102.74, *SD* = $127.57) conditions did not differ in terms of their initial deposit ($t(310) = .63$, $p = .53$), but both had higher initial deposits than those in the $5 a day condition (winsorized *M* = $41.16, *SD* = $73.90; ts > 6.84, *p*s < .001). These results remained significant when we controlled for age and income (*p*s < .001).

Initial Deposits ($30/Month Conditions). We conducted a univariate ANOVA with two between-subjects factors (condition: weekly, monthly; recurring deposit enrollment: enrolled, not enrolled), and initial deposit as the dependent variable. There were 53 participants who had deposits that were 3 or more standard deviations above the mean. These 53 balances were replaced with the closest nonoutlying value in the sample (Tabachnick and Fidell 2007).

Unlike the $150 conditions, the univariate ANOVA only indicated a significant main effect for recurring deposit enrollment, ($F(1, 3579) = 47.25$, $p <$

.001, $\eta_p^2 = .01$), with those who enrolled in the recurring deposit program having a higher initial deposit (Winsorized *M* = \$55.86, *SD* = \$166.59) than those who did not enroll (Winsorized *M* = \$25.34, *SD* = \$91.25). There were no other main effects or interactions (*p*s > .34). Figure 3S1-2 provides a graphical representation of these results.

Table 3S1-1. Initial Deposit Options by Income Band

Income Band				
< $25,000	$25,000 - $49,999	$50,000 - $99,999	$100,000 - $249,999	$250,000+
$100	$250	$500	$1,000	$5,000
$50	$100	$250	$500	$1,000
$20 (default)	$20 (default)	$100 (default)	$100 (default)	$500 (default)
$5	$5	$20	$20	$100
Other amount	Other amount	Other amount	Other amount	Other amount

Table 3S1-2. Logistic Regression Predicting Retention at One, Two, and Three Months, $5/Day, $35/Week and $150/Month Conditions

							95% C.I.for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Model 1 (One Month)								
Condition			12.458	2	.002			
$5/Day vs. $150/Month	-.728	.280	6.774	1	.009	.483	.279	.835
$5/Day vs. $35/Week	-.632	.228	7.658	1	.006	.532	.340	.832
$35/Week vs. $150/Month	-.097	.332	.085	1	.771	.908	.474	1.740
Constant	1.840	.261	49.644	1	.000	6.294		
Model 2 (One Month)								
Condition			8.393	2	.015			
$5/Day vs. $150/Month	-.604	.284	4.527	1	.033	.547	.313	.953
$5/Day vs. $35/Week	-.532	.232	5.253	1	.022	.588	.373	.926
$35/Week vs. $150/Month	-.072	.336	.047	1	.829	.930	.482	1.795
Age	.004	.009	.150	1	.699	1.004	.986	1.022
Income			12.040	3	.007			
Constant	2.739	.618	19.671	1	.000	15.475		
Model 3 (Two Months)								
Condition			1.041	2	.594			
$5/Day vs. $150/Month	-.405	.401	1.016	1	.313	.667	.304	1.465

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
$5/Day vs. $35/Week	-.019	.303	.004	1	.951	.981	.542	1.778
$35/Week vs. $150/Month	-.386	.448	.742	1	.389	.680	.282	1.636
Constant	2.516	.368	46.844	1	.000	12.375		
Model 4 (Two Months)								
Condition			1.054	2	.590			
$5/Day vs. $150/Month	-.396	.407	.950	1	.330	.673	.303	1.493
$5/Day vs. $35/Week	.029	.308	.009	1	.926	1.029	.563	1.882
$35/Week vs. $150/Month	-.425	.451	.888	1	.346	.654	.270	1.582
Age	.022	.015	2.125	1	.145	1.022	.993	1.053
Income			1.259	3	.739			
Constant	2.114	.811	6.794	1	.009	8.280		
Model 5 (Three Months)								
Condition			3.308	2	.191			
$5/Day vs. $150/Month	.744	.412	3.258	1	.071	2.104	.938	4.717
$5/Day vs. $35/Week	.342	.407	.704	1	.401	1.408	.633	3.129
$35/Week vs. $150/Month	.402	.468	.738	1	.390	1.494	.598	3.737
Constant	2.186	.334	42.961	1	.000	8.900		
Model 6 (Three Months)								
Condition			4.289	2	.117			

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
$5/Day vs. $150/Month	.860	.423	4.144	1	.042	2.364	1.033	5.411
$5/Day vs. $35/Week	.400	.472	.720	1	.396	1.492	.592	3.760
$35/Week vs. $150/Month	.460	.417	1.219	1	.269	1.584	.700	3.584
Age	.000	.017	.001	1	.978	1.000	.967	1.035
Income			4.011	3	.260			
Constant	2.396	.902	7.053	1	.008	10.980		

Note: e^B = exponentiated *B*. Income coded on a categorical scale in which 1 = less than $25,000, 2 = $25,000 - $49,999, 3 = $50,000 - $99,999, 4 = $100,000+; original logistic regression models specified contrasts between daily and monthly conditions, and weekly and monthly conditions. For presentation purposes, an additional logistic regression model was conducted to specify the daily versus weekly contrast.

Table 3S1-3. Logistic Regression Predicting Sign-Up As a Function of Condition and Income Bracket, $5/Day, $35/Week and $150/Month Conditions

							95% C.I.for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Condition Main Effect			8.096	2	.017			
Income Main Effect			20.733	3	.000			
Income x Condition			33.085	6	.000			
Daily vs. Monthly X <$25k vs. $25k-$49.9k	.036	.305	.014	1	.907	1.036	.570	1.885
Daily vs. Monthly X <$25k vs. $50k-$99.9k	.945	.298	10.039	1	.002	2.573	1.434	4.616
Daily vs. Monthly X <$25k vs. $100k+	1.265	.400	9.995	1	.002	3.545	1.618	7.768
Daily vs. Monthly X $25k-$49.9k vs. $50k-$99.9k	.909	.264	11.850	1	.001	2.483	1.479	4.167
Daily vs. Monthly X $25k-$49.9k vs. $100k+	1.230	.376	10.724	1	.001	3.421	1.639	7.142
Daily vs. Monthly X $50k-$99.9k vs. $100k+	.320	.370	.751	1	.386	1.378	.667	2.844
Daily vs. Weekly X <$25k vs. $25k-$49.9k	.036	.305	.014	1	.907	1.036	.570	1.885
Daily vs. Weekly X <$25k vs. $50k-$99.9k	-.483	.251	3.699	1	.054	.617	.377	1.009
Daily vs. Weekly X <$25k vs. $100k+	.931	.342	7.401	1	.007	2.537	1.297	4.962
Daily vs. Weekly X $25k-$49.9k vs. $50k-$99.9k	.909	.264	11.850	1	.001	2.483	1.479	4.167
Daily vs. Weekly X $25k-$49.9k vs. $100k+	1.261	.331	14.505	1	.000	3.530	1.845	6.757
Daily vs. Weekly X $50k-$99.9k vs. $100k+	.448	.332	1.822	1	.177	1.565	.817	2.999
Weekly vs. Monthly X <$25k vs. $25k-$49.9k	.366	.348	1.104	1	.293	1.442	.729	2.854

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Weekly vs. Monthly X <$25k vs. $50k-$99.9k	.462	.334	1.910	1	.167	1.587	.824	3.055
Weekly vs. Monthly X <$25k vs. $100k+	.334	.423	.624	1	.429	1.397	.609	3.203
Weekly vs. Monthly X $25k-$49.9k vs. $100k+	.096	.304	.100	1	.752	1.101	.607	1.996
Weekly vs. Monthly X $25k-$49.9k vs. $100k+	-.032	.400	.006	1	.937	.969	.443	2.121
Weekly vs. Monthly X $50k-$99.9k vs. $100k+	-.127	.387	.108	1	.742	.880	.412	1.881
Within Daily Condition								
<$25k vs. $25k-$49.9k	-.071	.276	.067	1	.796	.931	.543	1.598
<$25k vs. $50k-$99.9k	.250	.142	3.084	1	.079	1.283	.971	1.695
<$25k vs. $100k+	.051	.222	.053	1	.818	1.052	.682	1.625
$25k-$49.9k vs. $50k-$99.9k	-.624	.231	7.322	1	.007	.536	.341	.842
$25k-$49.9k vs. $100k+	.087	.213	.166	1	.684	1.091	.718	1.657
$50k-$99.9k vs. $100k+	-.198	.220	.814	1	.367	.820	.533	1.262
Within Weekly Condition								
<$25k vs. $25k-$49.9k	.295	.213	1.912	1	.167	1.342	.884	2.038
<$25k vs. $50k-$99.9k	-.234	.207	1.272	1	.259	.792	.527	1.188
<$25k vs. $100k+	-.880	.261	11.385	1	.001	.415	.249	.692
$25k-$49.9k vs. $50k-$99.9k	-.528	.198	7.137	1	.008	.590	.400	.869
$25k-$49.9k vs. $100k+	-1.175	.253	21.494	1	.000	.309	.188	.508
$50k-$99.9k vs. $100k+	-.646	.248	6.768	1	.009	.524	.322	.853

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	Upper
Within Monthly Condition								
<$25k vs. $25k-$49.9k	-.071	.276	.067	1	.796	.931	.543	1.598
<$25k vs. $50k-$99.9k	-.696	.262	7.034	1	.008	.499	.298	.834
<$25k vs. $100k+	-1.214	.333	13.272	1	.000	.297	.154	.571
$25k-$49.9k vs. $50k-$99.9k	-.624	.231	7.322	1	.007	.536	.341	.842
$25k-$49.9k vs. $100k+	-1.143	.309	13.674	1	.000	.319	.174	.584
$50k-$99.9k vs. $100k+	-.519	.297	3.046	1	.081	.595	.332	1.066
Constant	-1.735	.256	46.035	1	.000	.176		

Note: e^B = exponentiated *B*. Original logistic regression models specified contrasts between daily and monthly conditions, and weekly and monthly conditions, and $100k+ bracket versus other brackets. For presentation purposes, additional logistic regression models were conducted to specify the remaining contrasts.

Table 3S1-4. Logistic Regression Predicting Retention at One, Two, and Three Months, $7/Week and $30/Month Condition

							95% C.I.for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Model 1 (One Month)								
$7/Week vs. $30/Month	-.174	.196	.789	1	.374	.840	.572	1.234
Constant	2.077	.162	164.760	1	.000	7.977		
Model 2 (One Month)								
$7/Week vs. $30/Month	-.098	.199	.241	1	.623	.907	.614	1.340
Age	.019	.011	3.280	1	.070	1.020	.998	1.041
Income			10.570	3	.014			
Constant	1.996	.580	11.854	1	.001	7.356		
Model 3 (Two Months)								
$7/Week vs. $30/Month	-.033	.292	.013	1	.910	.968	.546	1.714
Constant	2.836	.236	144.381	1	.000	17.053		
Model 4 (Two Months)								
$7/Week vs. $30/Month	.017	.295	.003	1	.954	1.017	.571	1.812
Age	.028	.017	2.693	1	.101	1.028	.995	1.063
Income			1.991	3	.574			
Constant	2.555	.906	7.945	1	.005	12.871		

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Model 5 (Three Months)								
$7/Week vs. $30/Month	.285	.301	.895	1	.344	1.330	.737	2.400
Constant	2.721	.231	138.966	1	.000	15.200		
Model 6 (Three Months)								
$7/Week vs. $30/Month	.331	.303	1.196	1	.274	1.393	.769	2.523
Age	.016	.017	.871	1	.351	1.016	.983	1.050
Income			1.729	3	.631			
Constant	2.084	.820	6.467	1	.011	8.039		

Note: e^B = exponentiated *B*. Income coded on a categorical scale in which 1 = less than $25,000, 2 = $25,000 - $49,999, 3 = $50,000 - $99,999, 4 = $100,000+.

Table 3S1-5. Logistic Regression Predicting Sign-Up As a Function of Condition and Income Bracket, $7/Week and $30/Month Conditions

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B) Lower	95% C.I.for EXP(B) Upper
Condition Main Effect	.878	.251	12.199	1	.000	2.406	1.470	3.939
Income Main Effect			69.186	3	.000			
Income x Condition			10.487	3	.015			
Weekly vs. Monthly X <$25k vs. $25k-$49.9k	-.251	.219	1.322	1	.250	.778	.507	1.194
Weekly vs. Monthly X <$25k vs. $50k-$99.9k	.334	.217	2.357	1	.125	1.396	.912	2.138
Weekly vs. Monthly X <$25k vs. $100k+	.059	.307	.036	1	.849	1.060	.581	1.936
Weekly vs. Monthly X $25k-$49.9k vs. $50k-$99.9k	.585	.181	10.426	1	.001	1.795	1.259	2.561
Weekly vs. Monthly X $25k-$49.9k vs. $100k+	.310	.283	1.203	1	.273	1.363	.784	2.373
Weekly vs. Monthly X $50k-$99.9k vs. $100k+	-.275	.282	.954	1	.329	.759	.437	1.319
Within Weekly Condition								
<$25k vs. $25k-$49.9k	-.538	.129	17.269	1	.000	.584	.453	.753
<$25k vs. $50k-$99.9k	-.749	.134	31.028	1	.000	.473	.364	.616
<$25k vs. $100k+	-1.289	.200	41.608	1	.000	.275	.186	.408
$25k-$49.9k vs. $50k-$99.9k	-.211	.117	3.232	1	.072	.810	.644	1.019
$25k-$49.9k vs. $100k+	-.752	.189	15.849	1	.000	.472	.326	.683

							95% C.I.for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
$50k-$99.9k vs. $100k+	-.541	.192	7.914	1	.005	.582	.399	.849
Within Monthly Condition								
<$25k vs. $25k-$49.9k	-.286	.176	2.641	1	.104	.751	.532	1.061
<$25k vs. $50k-$99.9k	-1.082	.171	40.102	1	.000	.339	.242	.474
<$25k vs. $100k+	-1.348	.233	33.435	1	.000	.260	.164	.410
$25k-$49.9k vs. $50k-$99.9k	-.796	.138	33.185	1	.000	.451	.344	.591
$25k-$49.9k vs. $100k+	-1.062	.210	25.484	1	.000	.346	.229	.522
$50k-$99.9k vs. $100k+	-.266	.206	1.665	1	.197	.767	.512	1.148
Constant	-.532	.184	8.375	1	.004	.588		

Note: e^B = exponentiated *B*. Original logistic regression models specified contrasts between $100k+ bracket versus other brackets. For presentation purposes, additional logistic regression models were conducted to specify the remaining contrasts.

Figure 3S1-1. Initial Deposit by Condition and Decision to Enroll ($5 Daily, $35 Weekly, & $150 Monthly Conditions)

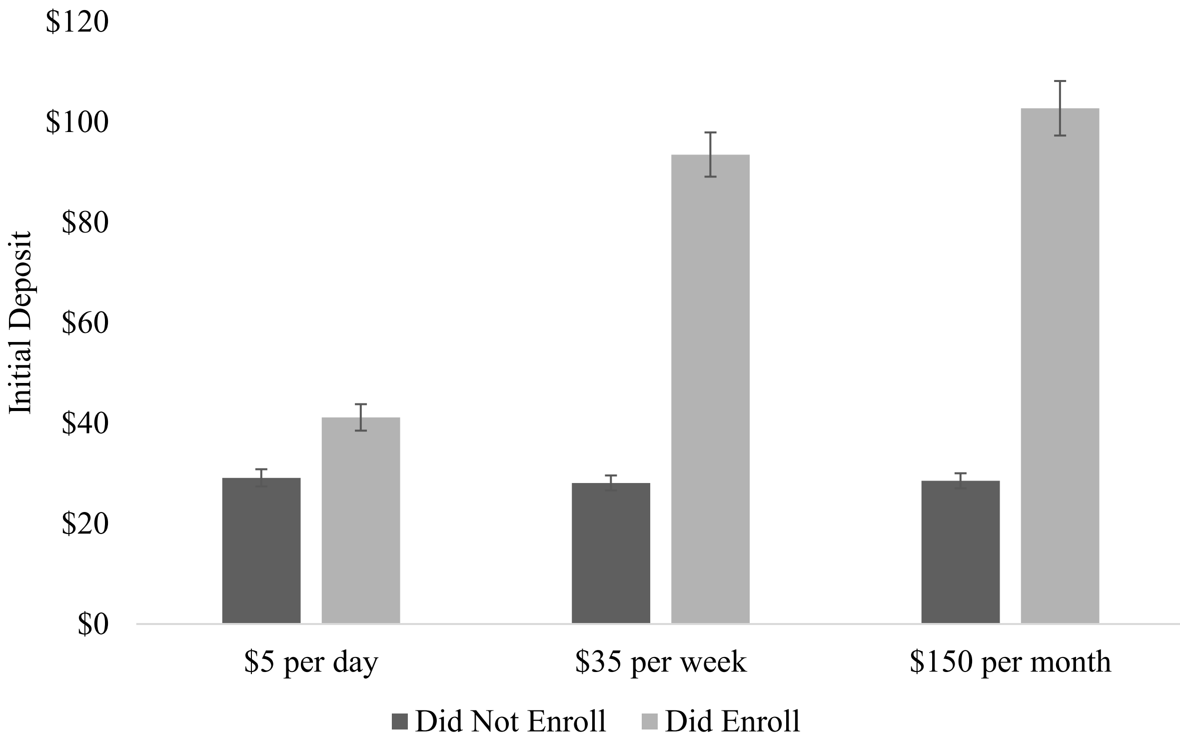
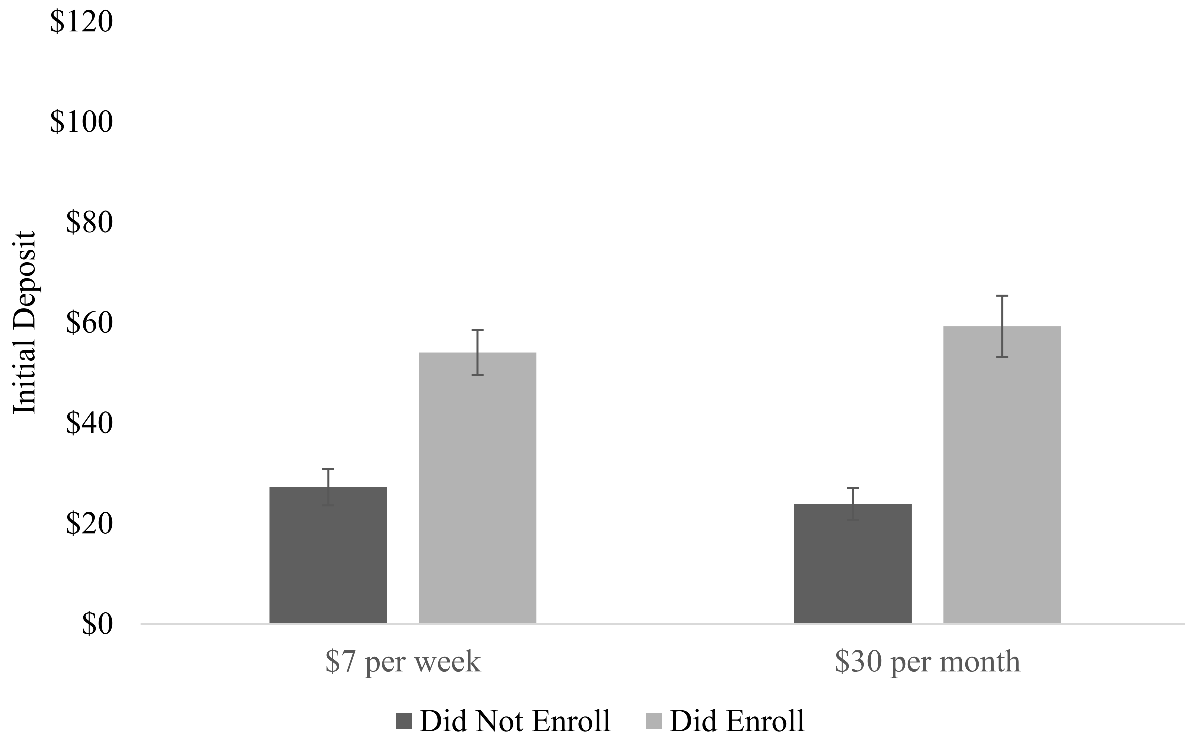


Figure 3S1-2. Initial Deposit by Condition and Decision to Enroll ($7 Weekly & $30 Monthly Conditions)



Chapter 4. Temporal Reframing and Savings Judgments

Abstract

While assessments of the Gig Economy vary in terms of size, growth, and heterogeneity, most studies suggest that this segment of the economy is sizeable, growing, and diverse in terms of types of work. Some concerns in the literature include both the present and future welfare of workers in the Gig Economy. This chapter focuses on a temporal reframing savings context for such workers since those in the Gig Economy often face do-it-yourself financial savings, more granular earnings structures (versus being salaried employees), and proportionally greater financial uncertainty whether real or psychologically perceived.

For the purposes of this chapter, temporal reframing is defined as a continuum that contrasts specific structured savings judgments (e.g., save $5 a day versus $150 a month) and unstructured savings judgments (e.g., how much would you save) with savings judgments that could be elicited using time periods of differing granularity (e.g., how much would you save a day).

The psychology of micro-level, temporal reframing savings judgments are explored in this chapter through two lab studies, including in the context of Gig Economy-type income uncertainty. Furthermore, since workers in the Gig Economy are very diverse and have individual behavioral differences which may not be strongly correlated with their choice of work, the roles of individual behavioral differences such as risk aversion and loss aversion are also considered. The studies show general support for daily framing increasing savings contributions whether framed with specific amounts or simply elicited using a daily frame. The second study also shows general support for precautionary savings under moderate income uncertainty with outcomes reversing for high income uncertainty. The implications of this research include better understanding how workers in the Gig Economy both think about recurring savings and might be better helped with savings decisions.

4.1 Introduction

The motivation for this chapter is severalfold. On the one hand, non-retirement saving is a significant issue and should be addressed. Temporal reframing is a good candidate for savings problems that involve comparatively smaller accumulations relative to that needed for retirement. As a second point, while Chapter 3 addressed temporal reframing and the effects on savings decisions and outcomes, the field study context made it difficult to directly explore the psychology and judgment processes involved; only indirect possibilities could be identified. A goal of this chapter is to build on the research in Chapter 3 and look more directly at judgment processes. Finally, the Gig Economy poses challenges given the diversity of workers and risks associated with working job-to-job and task-to-task. As such, this chapter explores both the role of individual behavioral differences (namely risk aversion and loss aversion) and impacts of exogenous risks (specifically income uncertainty) on temporal reframing and savings decisions.

The paper involves two lab studies. The first Temporal Reframing Lab Study (N=601) mirrors the field study in Chapter 3 in terms of comparing daily, weekly, and monthly framing in a between-subject research design (e.g., structured savings amounts of $5 a day versus $150 a month) and goes further to look at hypothesized mediators of perceptions of affordability and understandability. Consistent with the findings of Chapter 3 on decisions, we see similar evidence with participant judgments. Namely, we find that granular framing increases the likelihood of a participant indicating intentions to participate in recurring savings, especially when comparing daily to monthly framing. In Chapter 3 we hypothesized that reductions in psychological pain of more granular framing may lead to increased uptake. In the Temporal Reframing Lab Study, we find evidence that perceptions of affordability (e.g., one measure of reduced psychological pain) do mediate judgments in a complementary way.

The second Temporal Reframing with Income Uncertainty Lab Study (N=1,081) uses a between-subject research design to examine the impact of "no framing" (e.g., free-response, unstructured framing) versus temporal reframing. In contrast to the prior study which focuses on a fixed amount to be accepted (e.g., save $5 a day), this study looks at to what extent eliciting savings via a temporal frame (e.g., how much would you save a day) has benefits, including relative to no framing at all. The study additionally examines exogenously varying levels of income risk on judgments to participate in recurring saving. The study also looks at perceptions of affordability, riskiness, and individual behavioral differences of risk aversion and loss aversion. The Temporal Reframing with Income Uncertainty Lab Study provides evidence that eliciting savings using more granular temporal frames (e.g., how much would you save per day versus how much would you save per month) also increases savings, but likely through different psychological mechanisms as compared to when savings choices are offered with specific amounts (e.g., save $5 a day). The study also supports the perspective that under moderate income variability, people will increase their precautionary savings, although under high income variability these increases may start to reverse (e.g., inverted U-shaped outcome response to increasing income variability) after controlling for small stakes risk and loss aversion and other demographics.

4.2 Current Literature Review

This section addresses three areas of the literature to provide additional context for the research. These areas are outlined next in Section 4.2.1 The Gig Economy, Section 4.2.2 Risk and Uncertainty, and Section 4.2.3 Savings Under Uncertainty.

4.2.1 The Gig Economy

To better construct an understanding of what the Gig Economy is, it is useful to note that more than 43% of men and 56% of women in the U.S. have work arrangements other than full-time employment (Bureau of Labor Statistics, Department of Labor, 2020). When looking more narrowly at contingent and alternative work arrangements, approximately 16.5 million people could be classified as falling into these classes of work (Bureau of Labor Statistics, Department of Labor, 2018). This amounts to an estimated 3.8 percent of workers holding contingent jobs and 10.1 percent of workers having alternative worker arrangements. Contingent workers consistent of those who do not expect their jobs to last or expect their jobs to be temporary. Alternative worker arrangements consist of independent contractors, on-call workers, temporary help agency workers, and workers provided by contract firms.

Studies of the Gig Economy are also of interest in other areas of the world like Great Britain. When limiting the definition of Gig Economy workers to those who receive payments on a short-term and task basis through matching arrangements between providers and customers using a digital platform, roughly 2.8 million workers or 4.4 percent of the population of Great Britain worked in the Gig Economy within a window of 12 months (Lepanjuuri, et al., 2018). Lepanjuuri et al. also report that Gig Economy workers in Great Britain tend to skew more toward younger workers than the general population with more than half of Gig Economy workers being between the ages of 18 and 34.

As example of types of work in the Gig Economy, Smith and Leberstein compiled a list of major companies and platforms, including estimated sizes of the workforces (Smith and Leberstein, 2015). For example, they reported on transportation companies like Uber, Lyft, and Sidecar, which collectively have more than 200,000 workers. They are also covered companies that facilitate home services such as TaskRabbit and Care.com which have more than 6.5 million workers. In addition, the crowdwork segment of the market, companies like Amazon Mechanical Turk, Crowdflower, Crowdsource, and Clickworker have more than 14 million workers internationally.

We should note that there is likely significant income heterogeneity in the Gig Economy. However, most people who participate in the Gig Economy through digital platforms and perform either work on-demand or crowdwork likely derive a minority of their income from gig work. One study in Great Britain indicated that annual earnings was comparatively low with 87 percent of people in the Gig Economy (specifically those engaged via digital platforms) reporting income of less than 10,000 GBP in the trailing 12 months with roughly two-thirds of survey respondents indicating that gig income comprised less than 5 percent of their total income (Lepanjuuri, et al., 2018). Research on the motivations of workers to pursue gig work seems limited, although some research suggests that most people primarily look for additional income with work flexibility as secondary (Bajwa et al., 2018).

Whether the emergence of Gig Economy jobs stem from desires by those in the public to become more “entrepreneurial” and independent, the shifting arrangements suggest the need for new social policy initiatives. Economists such as Gerald Friedman have posed questions, such as whether the Gig Economy is “an economy without jobs” and suggest that employers may engage in such practices to reduce employment costs while also shifting economic risks to workers (Friedman, 2014). It is important to highlight some of the concrete differences and risks that Gig Economy workers face versus those who are traditionally employed. Gig Economy workers are often employed at arms-length (such as via 1099 arrangements in the US) and not provided with employment security, healthcare benefits, unemployment insurance, labor protections, or retirement benefits (De Stefano, 2016; Donovan et al., 2016; Friedman, 2014; Kuhn, 2016). That said, the work status of some people is in a state of flux, as evidenced by the UK Supreme Court’s recent case with Uber where the court ruled that Uber drivers should be legally classified workers as opposed to merely being classified as self-employed, thus entitling workers to additional rights and protections such as minimum wage (Naughton, 2021).

The notion that Gig Economy workers may operate in less certain, even precarious work situations, has implications on the psychodynamics of Gig Economy work. Based on inductive, qualitative research, Petriglieri et al. essentially found that to grapple with emotional tensions, independent workers needed to construct “holding environments” for themselves since they lacked the direction, support, social connection, and market exposure that they would have otherwise obtained in a traditional work environment (Petriglieri et al., 2019). Independent workers in essence needed to construct personal holding environments by establishing connections to places, people, routines, and purpose. It seems plausible that regular financial savings, the topic of this chapter, would align with the needs of independent workers to build connections with routines (i.e., daily, weekly, or periodically repeating processes).

As a final thought, while there have only been nascent activities on enabling Gig Economy workers to directly interact with retirement savings solutions, such as that announced by Lyft with Honest Dollar (Lyft, 2015), the interest of the financial industry in addressing the Gig Economy is growing as evidenced through recent reports by service providers (Betterment, 2018; Blakstad, et al., 2018; Prudential, 2018). There is also much that could be done relative to behavioral science research and financial savings within the Gig Economy. However, for the moment much of the behavioral work on outcomes related to the Gig Economy has been limited to more direct characteristics of the supply of gig worker labor or the demand by consumers (Greenwood et al., 2017), such that of Uber drivers and surge pricing (Chen and Sheldon, 2015), work flexibility of Uber drivers (Chen et al., 2017), perceived behavioral control of gig workers (Marquis et al., 2018), and online reviews by consumers (Fradkin et al., 2018).

4.2.2 Risk and Uncertainty

In the economics literature, risk has generally been defined as the notion of variable future events with measured probabilities, whereas uncertainty has been defined to cover cases where the likelihood of future events is indefinite or cannot be calculated (Knight, 1921). The notion of risk and part of its impact on an individual's decision making could be illustrated though an example. Consider a person who is given a choice between two options. Option 1 involves a 50% chance of winning $200 or a 50% chance of winning $70 (i.e., an expected value of $135 or premium of 35%). Option 2 involves a certain win of $100. A person who chooses Option 2 over Option 1 is considered risk averse under the expected utility model (and requires a premium of more than 35% relative to certainty). Through a series of choice problems like the example provided here but with differing payoffs, an individual measure of risk aversion can be estimated for a person.

It is also worthwhile to note the concept of ambiguity, introduced by Daniel Ellsberg, that goes further to illustrate how people may be averse to situations where probabilities are unknown (Ellsberg, 1961). Consider the following example, which is modified from Stango et al.'s operationalization of Ellsberg's Paradox (Ellsberg, 1961; Stango et al., 2016):

> Suppose you will draw a single ball from one of two bags. Each bag has a total of 100 balls, and each bag has a different mixture of green and yellow balls. You will win $500 if the ball is green. From which bag would you choose to draw the ball?
>
> Bag 1: Contains 100 balls with 50 green and the rest yellow
>
> Bag 2: Contains 100 balls with unknown numbers of green and yellow

As a thought exercise, many people would be averse to choosing Bag 2, even though it would be reasonable from a purely cognitive perspective, for one to presume as a best estimate (albeit one with low confidence) that the probability and odds of choosing a green ball from Bag 2 would the same as that for Bag 1 (i.e., 50:50). More generally, Ellsberg argued that ambiguity aversion would be higher in cases where there are questions about probabilities, reliability or relevance of information, and conflicting perspectives. For some context on the significance of this concept, in the study by Stango et al. (which had a somewhat different elicitation than that described above, including having people essentially specify the highest number of green balls in Bag 1 that would be required for them to switch preferences to Bag 2) they found that approximately 73% of people had some ambiguity aversion. They also found that 24% of people had a large degree of ambiguity aversion and would select the risky bag (thus avoiding the ambiguous bag) even in the case where the risky bag only contained 25 green balls or less (Stango et al., 2016).

Outside of the realm of neoclassical economics, another important model of decision making under uncertainty includes prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1992). Specific characteristics and implications of prospect theory to this paper include the notions of 1) the utility of decision prospects being evaluated relative to a reference point and 2) the general observation of risk seeking behavior in the domain of losses and risk averse behavior in the domain of gains (Levin et al., 1998). Since decision scenarios to be constructed for this chapter will include both earnings certainty and uncertainty in the domain of gains, prospect theory appears to be less relevant a priori, although it is recognized that sometimes the processes that people use to establish reference points (and thus, their coding of gains and losses) is not always straightforward. For example, they could be subject to anchoring effects (Kahneman, 1992) which may come from any number of sources (e.g., exogenous factors, memories, goals, expectations).

Cognitive perspectives of risk are common; however, it is also worthwhile to mention more psychological perspectives relative to risk attitudes and perceptions. For example, in contrast to the perspective of ambiguity introduced by Ellsberg mentioned previously, Stanley Budner introduced the notion of the intolerance of ambiguity as a personality variable (Budner, 1962). In his definition, he essentially characterizes intolerance of ambiguity as a person's propensity to perceive ambiguous scenarios as sources of threat (e.g., triggering dislike, repression, avoidance behavior, or reconstructive behavior). Via meta study analysis, intolerance of ambiguity has been shown to moderate the occupational role stress-strain relationship (e.g., outcomes of job dissatisfaction or job turnover) (Frone, 1990). Other integrative research has postulated "risks as feelings" and that feelings are not simply an auxiliary outcome variable resulting from cognitive evaluation but rather can be a more richly integrated construct that takes input from other decision factors, such as the vividness of a scenario, immediacy, and a person's mood and not only affect cognitive evaluation itself but also mediate outcomes (Loewenstein et al., 2001).

4.2.3 Savings Under Uncertainty

In economics, savings is the difference between income and consumption, and the first theoretical analysis on precautionary savings, which is extra savings by individuals based on income risk, was done by Haynes Leland (Leland, 1968). In Leland's two-period model, he found that under reasonable assumptions (e.g., marginal convexity of utility), there would be a positive, precautionary demand for saving related to uncertainty of future income. Much of the empirical economics literature finds a positive relationship between uncertainty and precautionary savings, but the findings are mixed, such as relative to the effect size of uncertainty on savings (Lusardi, 1997). For example, using panel data from the National

Longitudinal Survey, Kazarosian found strong effects and that the “doubling of uncertainty increases the ratio of wealth to permanent income by 29%” (Kazarosian, 1997, p.241). On the other hand, when using data from the Italian Survey of Household Income and Wealth, Guiso et al. found that the ratio of wealth to earnings as related to precautionary savings was close to 2 percent of total wealth (Guiso et al., 1992).

Aside from the high-level findings however, it should be noted that the empirical literature is quite varied in terms of the type of data (e.g., macro, micro, geography), how analyses are set up relative to the dependent variables (e.g., consumption, savings, wealth, percentage of risky assets held, etc.), and the independent variables relative to uncertainty (e.g., variance of real income, subjective earnings, subjective probability of job loss, etc.). To provide some high-level perspective on the empirical economics literature, in a survey of forty papers by Luguide et al., seventeen papers address consumption, seventeen address wealth, and twelve address savings as a dependent variable (Lugilde et al., 2017). In terms of the uncertainty measure, roughly twenty-three use a measure connected to income whereas the remainder use other measures such as consumption growth, unemployment insurance, and unemployment rates. Only five of forty papers address both savings and income uncertainty using micro-level data.

As final observations to inform perspectives on the Gig Economy, it is also noteworthy to consider the scant, empirical literature in terms of precautionary savings relative to riskier subpopulations, such as the self-employed. A general perspective in the literature is that these subpopulations encounter higher income variability and hence represent a population with higher income risk. In theory, such people should save more, but the findings relative to precautionary savings for riskier occupations are mixed. In some of the earliest work, Skinner used data from the 1972-73 Consumer Expenditure Survey, and he found contradictory evidence for precautionary savings in that people in populations with riskier income (such as the self-employed) save less than benchmark groups with less risky income (Skinner, 1988). However, he did note that there could be self-selection considerations associated with analyzing correlation data where those with less risk aversion (which is unobserved) may seek higher risk professions. Jappeli and Pagano conduct a similar analysis to Skinner using an entirely different dataset based on 1989 Survey of Household Income and Wealth for households in Italy (Jappelli and Pagano, 1994). Although the dynamics of savings in Italy may differ from the U.S., Jappeli and Pagano likewise do not find a relationship between those with riskier professions and higher precautionary savings (i.e., households with a head that has a riskier occupation do not save more than households with a head that has a less risky profession).

4.3 Temporal Reframing Savings Judgments

We can now explore the questions of whether and how temporal reframing affects how people make judgments about recurring savings, including under conditions of uncertainty.

The key hypotheses we will test are:

- Daily framing will increase savings intentions (i.e., judgments) relative to weekly and monthly framing.
- Subjective affordability will be higher in daily framing versus weekly and monthly framing.
- Subjective understandability will be higher in daily framing versus weekly and monthly framing.
- Financial literacy will moderate savings intentions.
- Subjective numeracy will moderate savings intentions.
- Subjective and objective affordability will partially mediate (complementary mediation) the relationship between framing and savings choices.

Exploratory relationships that will be explored:

- Whether eliciting savings using daily framing (even without specific amounts such as $5 a day) will increase savings intentions (i.e., judgments) relative to "no framing" (i.e., an unstructured, free response elicitation of savings)
- Whether people will intend to save more under conditions of more granular temporal reframing and increasing income uncertainty

- Whether people will intend to save more under conditions of increasing income uncertainty (as generally seen in the empirical economics literature), including after controlling for individual behavioral differences (e.g., risk aversion)
- Whether more granular temporal reframing will decrease perceptions of riskiness
- Whether psychological perceptions of risk (e.g., feelings) will mediate intentions
- Whether individual behavioral difference measures (i.e., small stakes risk aversion and loss aversion) will moderate intentions.

4.4 Temporal Reframing Lab Study

The approach of the Temporal Reframing Lab Study is to complement the field study conducted in Chapter 3 as it examines behavioral outcomes by exploring the psychological differences between framing recurring savings choices as more granular (e.g., $5 per day) versus less granular (e.g., $150 per month). Figure 4-1 summarizes the constructs being examined for the study.

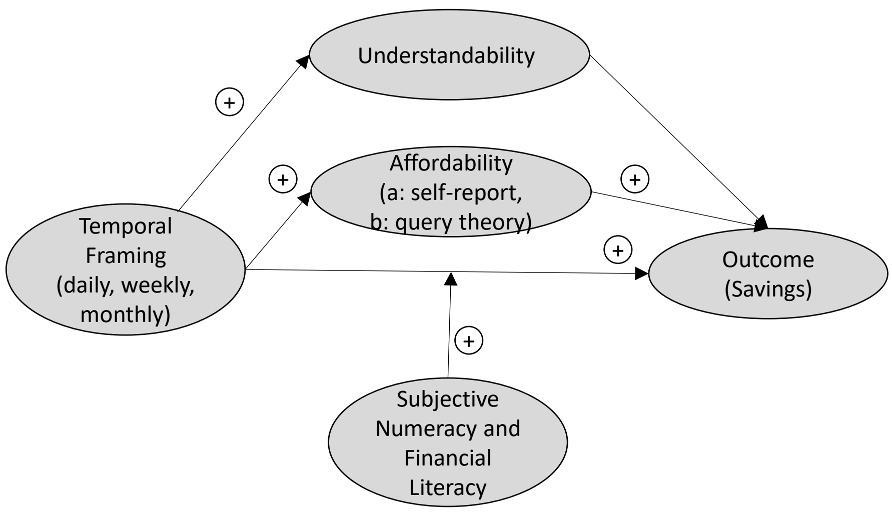


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Figure 4-1. Summary of Constructs for Temporal Reframing Lab Study

4.4.1 Method

In May 2019, 601 online participants were recruited using Amazon TurkPrime with participants randomized using a between subject design into one of three treatment groups which offered participants an opportunity to save either $5 a day, $35 a week, or $150 a month. To qualify for this study, participants needed to satisfy minimum platform use requirements (i.e., have completed more than 500 human intelligence tasks or HITs), have an approval rating of 95% or higher, and be between the ages of 18 and 50 years old. Duplicate IP addresses were blocked by the platform, and participants needed to be within the United States. As a result of prior abuses in the Amazon Mechanical Turk worker community as mentioned in Chapter 1, Amazon implemented additional features which blocked suspicious geocode locations. During recruitment, prospective participants were told that they could take a survey regarding questions about hypothetical financial decisions and their attitudes. The study was expected to take between 6 to 8 minutes, and payment for participation was $0.90. The study was implemented in Qualtrics, and the overall architecture for the study is depicted in Figure 4-2. The detailed stimulus is included in the Online Appendix, Chapter 4, Lab Study Materials, Section A.

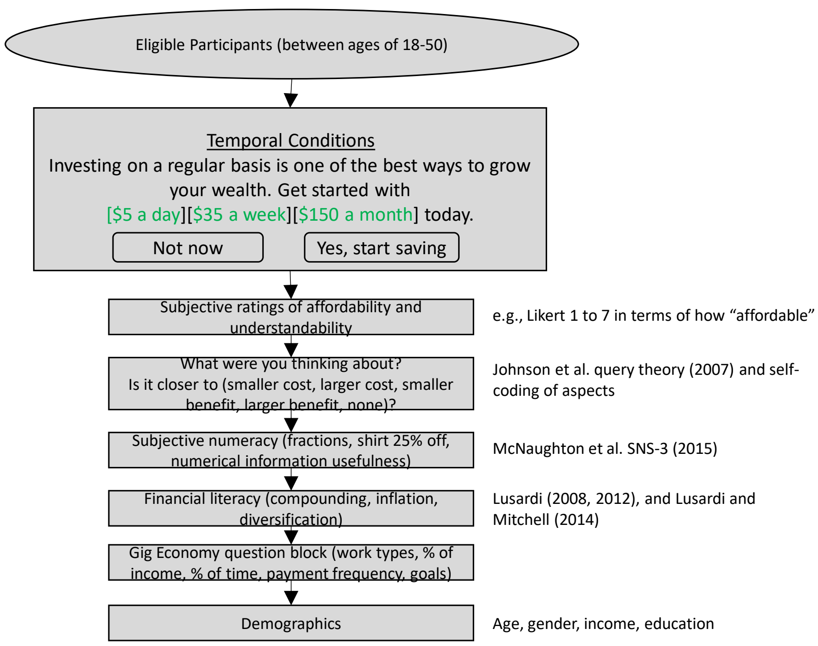

Figure 4-2. Summary of the Temporal Reframing Lab Study

The primary intervention of interest occurred at the start of the survey and was designed to try to replicate the field study in Chapter 3 in a lab setting. The intervention involved presenting participants with the following (brackets indicate the between-subject conditions):

In this survey we would like to learn about how you would make a savings decision.

Suppose you have just signed up to use a financial services app provided by a trustworthy company for use on your mobile phone. The mobile app allows you to:

- *save spare change by rounding up purchases to the next dollar,*
- *make one-time deposits into your account at any time you choose, and*
- *invest all or a portion of your money into pre-designed financial portfolios that are tailored to your goals, such as by degree of risk and return.*

Imagine you are using the app, and it tells you "Investing on a regular basis is one of the best ways to grow your wealth. You can get started with [$5 a day][$35 a week][$150 a month] today."

I choose:

- *Not now*
- *Yes, start saving*

Participants were then asked to rate their attitude towards the choice option in terms of affordability (Likert scale of 1 to 7 with 7 being most affordable) and understandability (Likert scale of 1 to 7 with 7 being most understandable).

Next participants were asked, consistent with Query Theory approaches (Johnson et al., 2007), to list three things that they were thinking about when they were offered the savings choice and then self-code each thing they listed as either a “smaller cost”, “a larger cost”, “a smaller benefit”, “a larger benefit”, or “none of the above”.

Questions relative to the hypothesized moderators were then asked, namely those related to subjective numeracy (McNaughton et al., 2015) and financial literacy (Lusardi, 2008; Lusardi, 2012; Lusardi and Mitchell, 2014).

Before questions related to demographics and controls were elicited from users, exploratory questions (related to potential future research) were asked to shed additional light on each participant’s experiences with the Gig Economy. These questions included what type of Gig work the participant does, where the rough proportion of their income comes from, where their proportion of time is spent relative to Gig work, how frequently they get paid, and why the participant performs Gig work. The answers to these questions are not analyzed for this chapter.

Users then responded to demographic questions identifying their age, gender, income, and educational levels.

4.4.2 Summary Statistics and Experimental Balance

Table 4-1 outlines summary statistics for participants relative to the three treatment groups. Based on random assignment, 195 participants were assigned to the \$5 a day condition, 210 participants to the \$35 a week condition, and 196 participants to the \$150 a month condition. The mean age of participants was 34.29 years with a standard deviation of 7.24. An F-test does not reject the null hypothesis that the means for age are the same between conditions, and a Bartlett’s chi-squared test does not reject the null hypothesis that the variances are the same. Slightly more than half of the participants identify male (52.3%), and a chi-squared test does not reject the null hypothesis that each condition has the same proportion of males. Income bands were ordinally coded in buckets of approximately \$10,000 from \$9,999 to \$150,000 or more where the mean income was 5.2 (which lies between the “from \$40,000 to \$49,999 a year” and “from \$50,000 to \$59,999 a year” income bands). For income, an F-test for means does not reject the null hypothesis that distributions are the same between conditions, although a Bartlett's chi-squared test indicates a marginally significant difference in the variances (p = 0.08). For overall education levels, 26.29% have a high school education, 59.40% have a college education, and 14.31% have an advanced degree, and a chi-squared test does not reject the null hypothesis that each condition has the same proportions. For financial literacy, the overall mean was answering 2.36 questions out of 3 with a standard deviation of 0.91. For financial literacy, an F-test for means does not reject the null hypothesis that distributions are the same between conditions, although a Bartlett's chi-squared test indicates a marginally significant difference in the variances. Finally, for subjective numeracy (SNS-3), the overall mean was 13.96 on a scale from 3 (low subjective numeracy) to 18 (high subjective numeracy) with a standard deviation of 3.12. For the SNS-3, Cronbach's α is 0.7751, and the correlation between SNS-3 and financial literacy was moderate at 0.4187. An F-test does not reject the null hypothesis that the means for subjective numeracy are the same between conditions, and a Bartlett's chi-squared test does not reject the null hypothesis that the variances are the same.

In summary, randomized assignment seems to be successful with only marginally significant differences observed for variances in annual income and financial literacy.

4.4.3 Results

To assess the effect of temporal reframing on intentions to participate in recurring savings, one main outcome variable and two secondary variables are examined. The first outcome variable is an indicator of whether a participant has indicated an intention to participate in recurring savings (chose to save = 1 ; chose not to save = 0). A second outcome variable is self-reported affordability, which is elicited by instructing the participant to recall their option to save [$5 a day][$35 a week][$150 a month] and then indicating their attitude toward the option based on a Likert-scale response to the statement, "I found the option to be affordable" (strongly disagree = 1; strongly agree = 7). The third outcome variable is self-reported understandability, which is elicited through a Likert-scale response to the statement, "I found the description of the option to be clear and understandable" (strongly disagree = 1; strongly agree = 7).

When using monthly framing as the reference point and logistic regressions, there is a positive main effect of daily framing on savings participation rates both without controls ($B=0.635$, $p=0.003$) and with demographic controls of age, gender, income, and education ($B=0.716$, $p=0.002$). However, there is only directional evidence of weekly versus monthly framing without or with demographic controls ($Bs>0.216$, $ps>0.14$). See Table 4-2, Panel A for more details. When using weekly framing as the reference point and logistic regressions, there is a marginally significant, positive main effect of daily framing both without controls ($B=0.418$, $p=0.053$) and with controls ($B=0.404$, $p=0.068$). Monthly framing is directionally negative relative to weekly framing both without and with controls ($Bs<-0.216$, $ps>.142$). See Table 4-2, Panel B for more details.

When looking at self-reported affordability as the outcome variable of interest using OLS regressions and monthly framing as the reference point, there is a positive main effect of daily framing both without controls ($\beta=1.212$, $p<0.001$) and with controls ($\beta=1.234$, $p<0.001$). There is also a positive main effect with weekly relative to monthly framing both without ($\beta=0.547$, $p=0.004$) and with controls ($\beta=0.607$, $p=0.001$). See Table 4-3, Panel A for more details. When changing the focus point to weekly framing as the reference point, there is a positive main effect of daily framing both without controls ($\beta=0.664$, $p<0.001$) and with controls ($\beta=0.627$, $p<0.001$). Relative to weekly framing, monthly framing had a negative main effect both without controls ($\beta=-0.548$, $p=0.004$) and with controls ($\beta=-0.607$, $p=0.001$). See Table 4-3, Panel B for more details.

With self-reported understandability as the outcome using OLS regressions and monthly framing as the reference point, daily framing has a positive main effect both without controls ($\beta=0.494$, $p<0.001$) and with controls ($\beta=0.491$, $p=0.001$). Weekly framing also has a positive main effect both without controls ($\beta=0.444$ $p=0.002$) and with controls ($\beta=0.445$, $p=0.002$). See Table 4-4, Panel A for more details. Shifting the reference point to weekly framing, daily framing does not have an effect without or with controls ($\beta s<0.051$, $ps>0.677$). However, monthly framing has a significant, negative main effect without controls ($\beta=-0.444$, $p<0.001$) and with controls ($\beta=-0.445$, $p=0.002$). See Table 4-4, Panel B for more details.

To explore the moderating role of financial literacy on intentions to participate in recurring savings, logistic regressions are conducted on the daily versus monthly conditions. The decision to save is used as the outcome variable with independent variables for a daily framing indicator (daily=1, monthly=0), financial literacy score, the interaction between daily framing indicator and financial literacy score, and demographic controls of age, gender, income, and education. The coefficient on the interaction term is negative and marginally significant without controls (B=-0.439, p=0.090) and is negative but not significant with controls (B=-0.405, p=0.134). To better explore the moderating effect, floodlight analyses are performed consistent with behavioral methods for simple effect testing in moderated regressions (Spiller et al., 2013). Using logistic regressions with controls to compare daily to monthly framing indicates significant treatment differences through the range of financial literacy, with daily framing having a positive effect on savings intentions for those with the lowest financial literacy (B=1.771, p=0.012 at financial literacy score = 0). The treatment difference is significant and positive even for those with the highest financial literacy (B=0.555, p=0.043 at financial literacy score = 3). A complete floodlight is depicted in Table 4-5. Analyses of the daily versus weekly conditions are included in the Online Appendix: Chapter 4 Supplemental Analyses, Table 4S2-1, and the interaction term is negatively valenced, although not significant.

Next, the moderating role of subjective numeracy on intentions to participate in recurring savings was explored using logistic regressions between the daily versus monthly conditions. The decision to save is used as the outcome variable with independent variables for a daily framing indicator (daily=1, monthly=0), SNS-3 score, the interaction between daily framing indicator and the SNS-3 score, and demographic controls of age, gender, income, and education. The coefficient on the interaction term is negative but not significant without controls (B=-0.065, p=0.362) and is negative but not significant with controls (B=-0.067, p=0.359).

To explore the mediating roles of affordability and understandability on savings, a generalized structural equation model (GSEM) was constructed using maximum likelihood estimation and a binomial logit outcome variable (where save = 1 and not save = 0). The model assumes correlated residuals for affordability and understandability. Since prior analyses have generally indicated that daily, weekly, and monthly framing results in a likelihood of savings that moves from higher to lower as temporal reframing granularity decreases, to ease modeling interpretability, contrast coding was used for treatment condition with daily = 1, weekly = 0, and monthly = -1.

Based on the GSEM without controls, self-reported affordability significantly mediates (partial, complementary mediation) the effect between temporal framing and the decision to save. The indirect effect using unstandardized coefficients is 0.79 (i.e., 0.61 x 1.3). Error terms for affordability and understandability are correlated ($r=0.56$, $p<0.001$). There is also a significant positive direct effect of temporal reframing on self-reported understandability ($b=0.2474$, $z=3.65$, $p<0.001$) but the absence of a direct effect of understandability on the outcome ($b=0.0913$, $z=0.99$, $p=0.322$). Notably, the direct path of temporal reframing to savings outcome is negative and significant ($b=-0.4698$, $z=-2.75$, $p=0.006$), which suggests that while affordability is a primary, complementary mediator, a hidden, undiscovered competitive mediator also exists that works in the opposite direction. The pattern of results is largely the same with controls for age, gender, income, and education. Direct effects are provided in Table 4-6, Panels A (without controls) and B (with controls), and corresponding path diagrams are provided in Figure 4-3 and Figure 4-4.

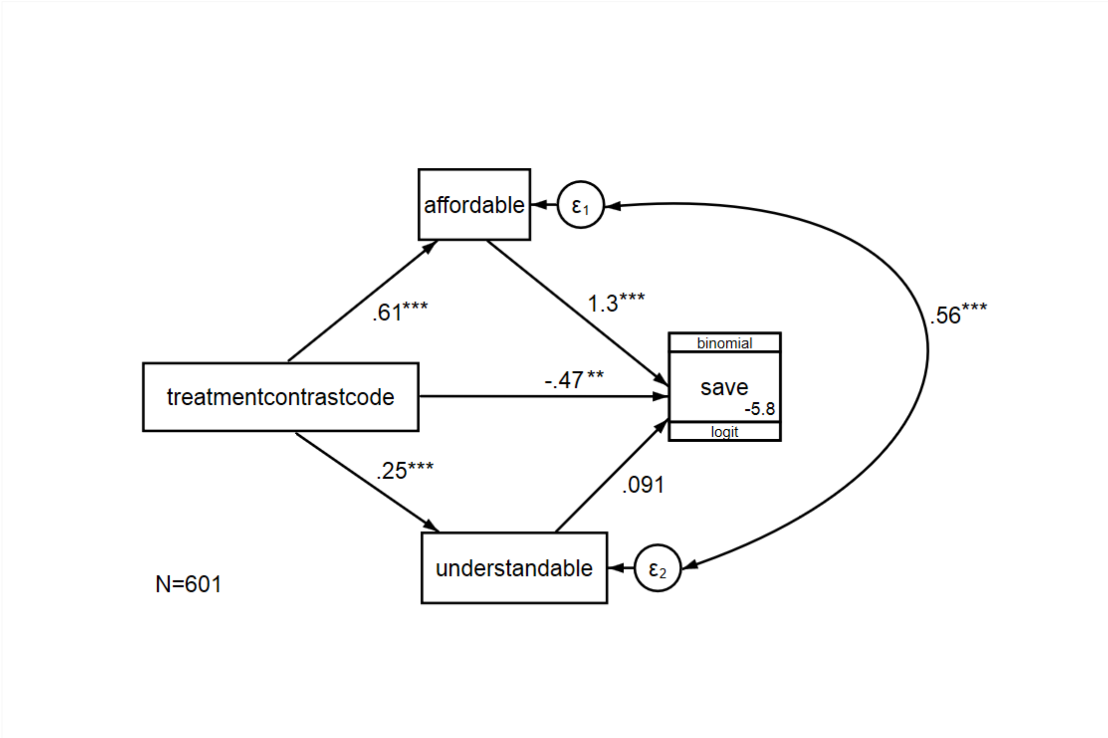

Figure 4-3. Mediation Analysis Path Diagram for Temporal Reframing Lab Study Without Controls

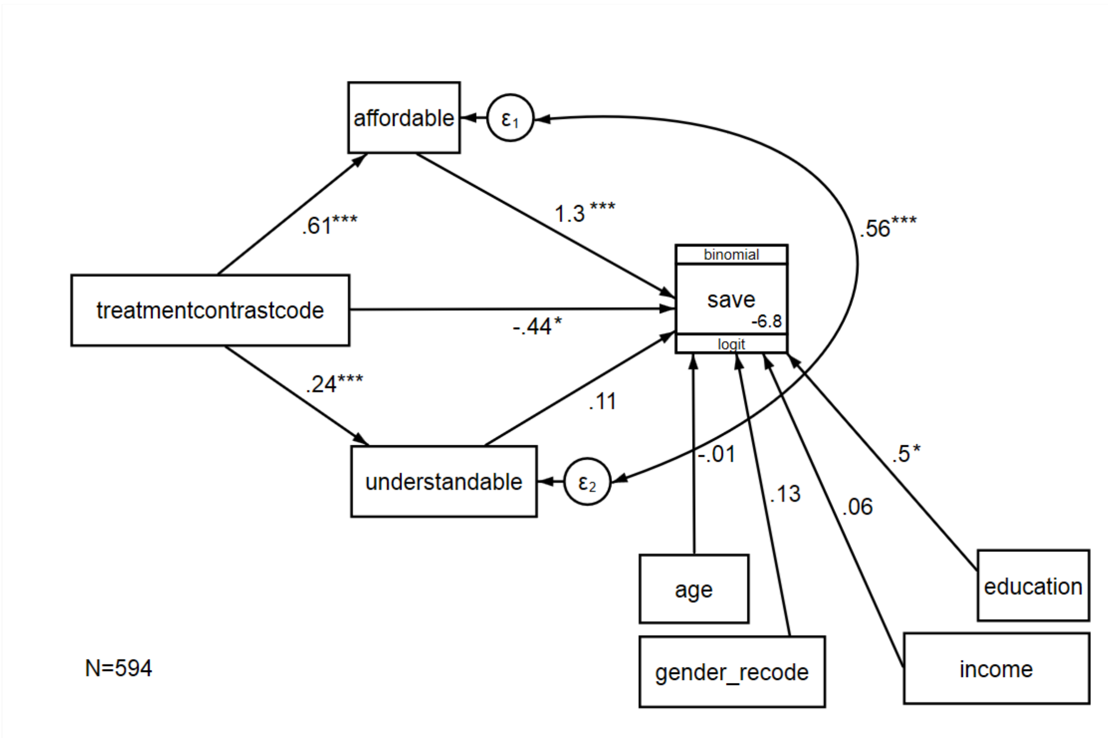

Figure 4-4. Mediation Analysis Path Diagram for Temporal Reframing Lab Study With Controls

In terms of analyzing objective affordability, participants are asked to list three things (called "aspects" according to Query Theory) that they were thinking about when making the savings judgment. They then self-code the aspects that they were thinking about, which mirrors the procedure used in Chapter 1. Since the hypothesis is that aspects associated as either smaller costs or larger benefits would increase perceptions of affordability, the following scheme was used to code participant responses for each of the aspects: a smaller cost (cost = +1, benefit = 0), a larger cost (cost = -1, benefit = 0), a smaller benefit (cost = 0, benefit = -1), a larger benefit, (cost = 0, benefit = 1), none of the above (cost = 0, benefit = 0). In other words, each aspect is coded with a cost variable and a benefit variable. This results in six variables comprising objective affordability, and these are used as independent variables within regression analyses.

Logistic regressions were run with savings as the outcome variable (save = 1, not save = 0) and independent variables of treatment indicators for daily (daily framing = 1, else = 0) and weekly (weekly framing = 1, else = 0), Query Theory variables, demographic controls, and with and without subjective numeracy. Regressions generally indicate that mental associations of smaller costs and larger benefits matter in terms of increasing the intentions to save. All significant coefficients for the aspects have positive valence ($Bs_{aspect1\_cost}>0.706$, $ps<0.001$; $Bs_{aspect1\_benefit}>0.601$, $ps<0.001$; $B_{aspect2\_benefit}>0.407$, $ps<0.01$; $B_{aspect3\_benefit}>0.529$, $ps<0.001$). See Table 4-7 for more details.

To analyze the simultaneous effects of temporal reframing, mediation pathways (subjective affordability, objective affordability, subjective understandability), demographic controls, and subjective numeracy on intentions to save, both SEM and GSEM models were constructed (both for robustness checks and since measures of fit are not available for GSEM). For the SEM model, the direct effect of temporal reframing on savings rate is significant and negative in the presence of mediators ($b=-0.0340$, $z=-1.99$, $p=0.047$) indicative of the existence of an undiscovered, competitive mediator. For the mediation path for subjective affordability, the factor from temporal reframing condition to subjective affordability is significant ($b=0.6132$, $z=6.78$, $p<0.001$), and the factor from subjective affordability to savings intentions is significant (b=0.1788, z=21.82, p<0.001), thus indicating complementary mediation. For the mediation path for aspect 1 cost, the factor from temporal reframing condition to aspect 1 cost is significant (b=0.1742, z=4.91, p<0.001) and the factor from aspect 1 cost to savings intentions is significant (b=0.0438, z=2.24, p=0.025). Other mediation paths are not significant. See Table 4-8 for more details for the SEM model. A path diagram of the SEM model is depicted in Figure 4-5.

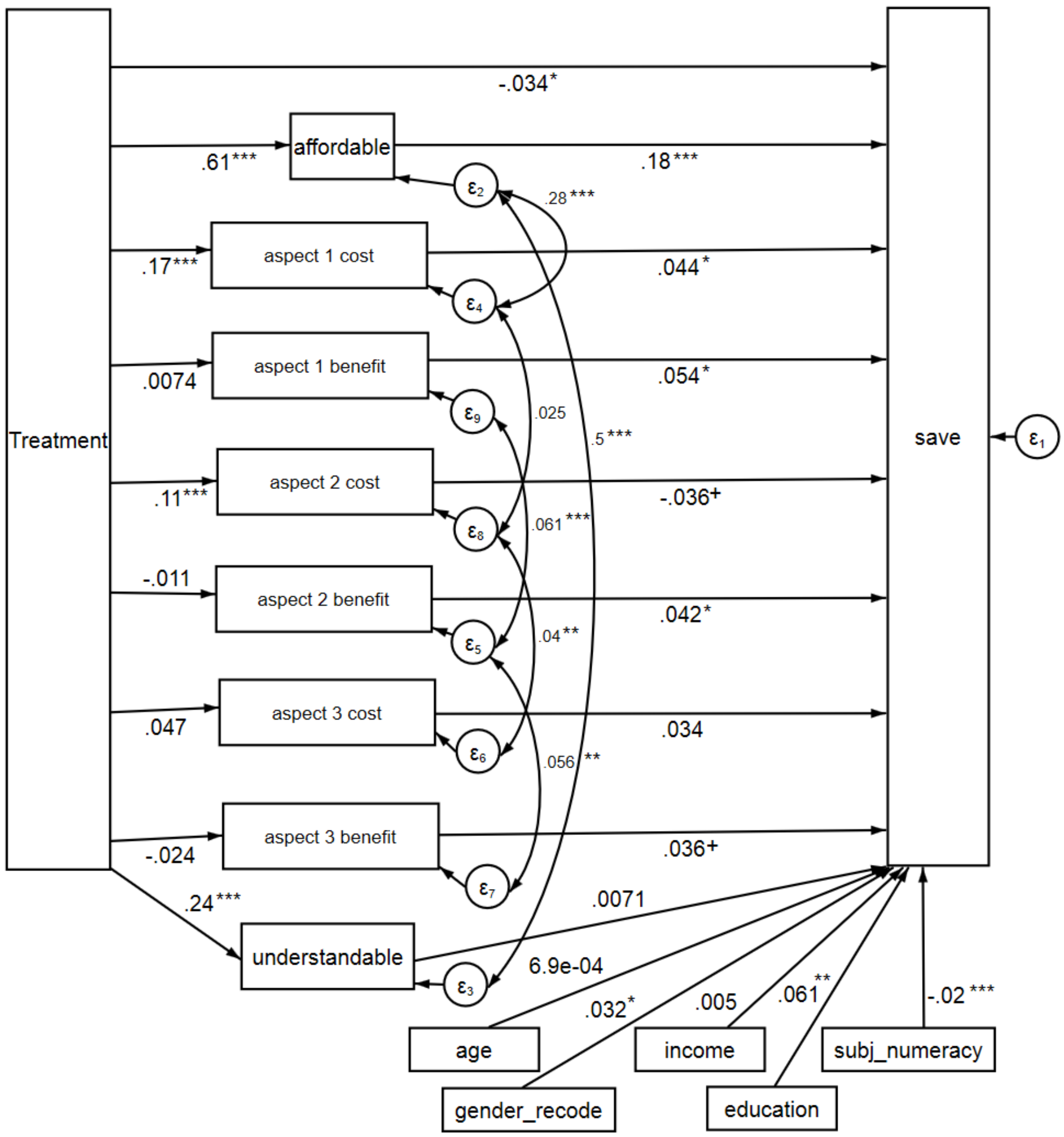

Figure 4-5. Mediation Analysis Path Diagram for Temporal for Both Subjective and Objective Psychological Measures Affecting Savings for the Temporal Reframing Study

The pattern of results is similar for GSEM modeling. However, the mediation path for objective affordability weakens in terms of significance with the factor from temporal reframing condition to aspect 1 cost being significant (b=0.1742, z=4.91, p<0.001) but the factor from aspect 1 cost to savings intentions being only marginally significant (b=0.3851, z=1.87, p=0.061). See Table 4-9 for GSEM results. A path diagram of the GSEM model is depicted in Figure 4-6.

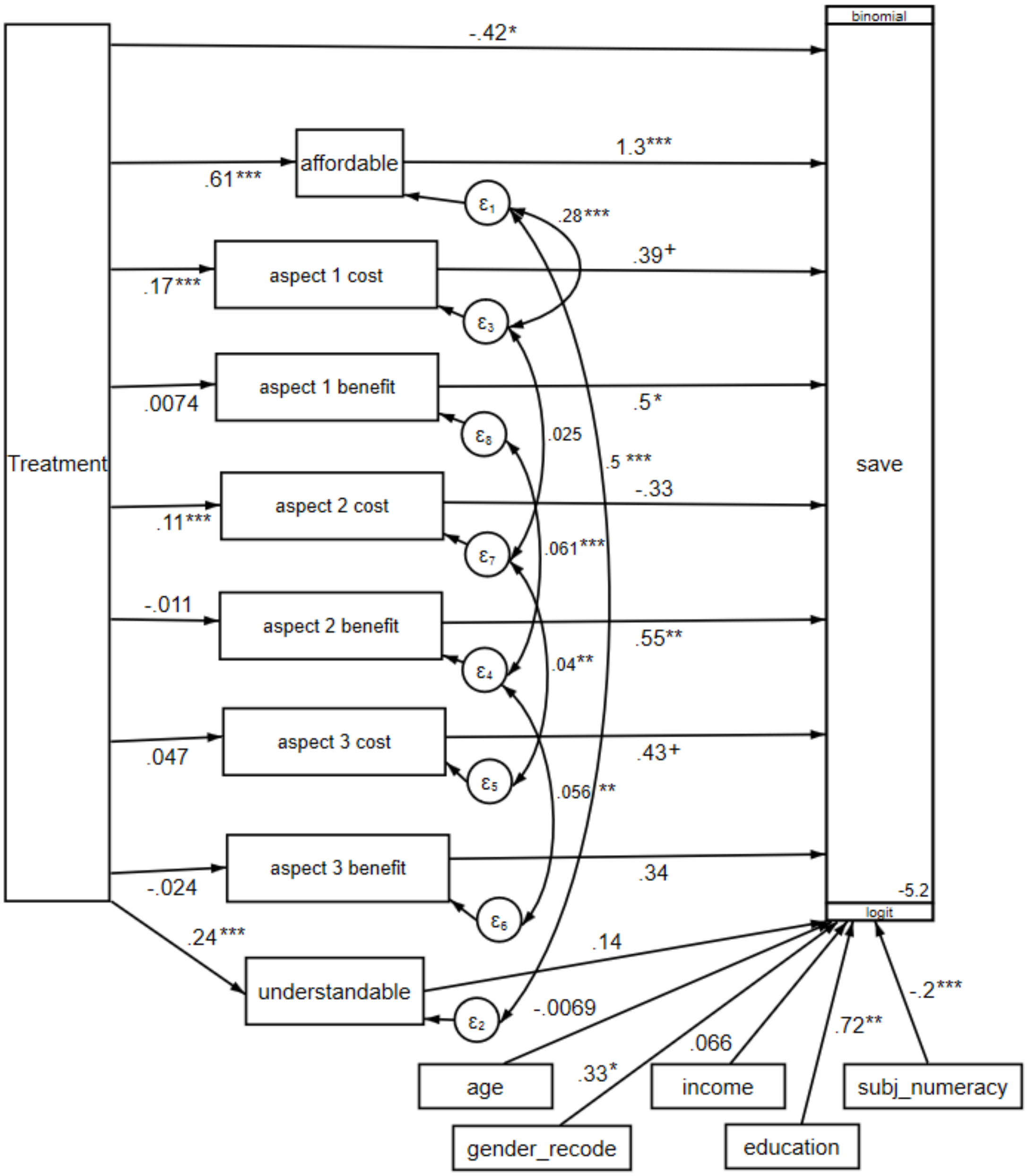

Figure 4-6. Mediation Analysis Path Diagram Using Generalized Structural Equation Modeling (GSEM) for Both Subjective and Objective Psychological Measures Affecting Savings for Temporal Reframing Study

As an additional robustness check, since subjective affordability correlates with certain objective thoughts of affordability, an additional GSEM model was run that excluded subjective affordability and focused on objective thoughts only obtained via Query Theory. In this case, the direct main effect of framing on outcomes becomes positive (b=0.2814, z=2.27, p=0.023) and the mediation pathway of aspect 1 cost becomes significant and complementary. See Table 4-10 for GSEM details. A path diagram of the GSEM model is depicted in Figure 4-7.

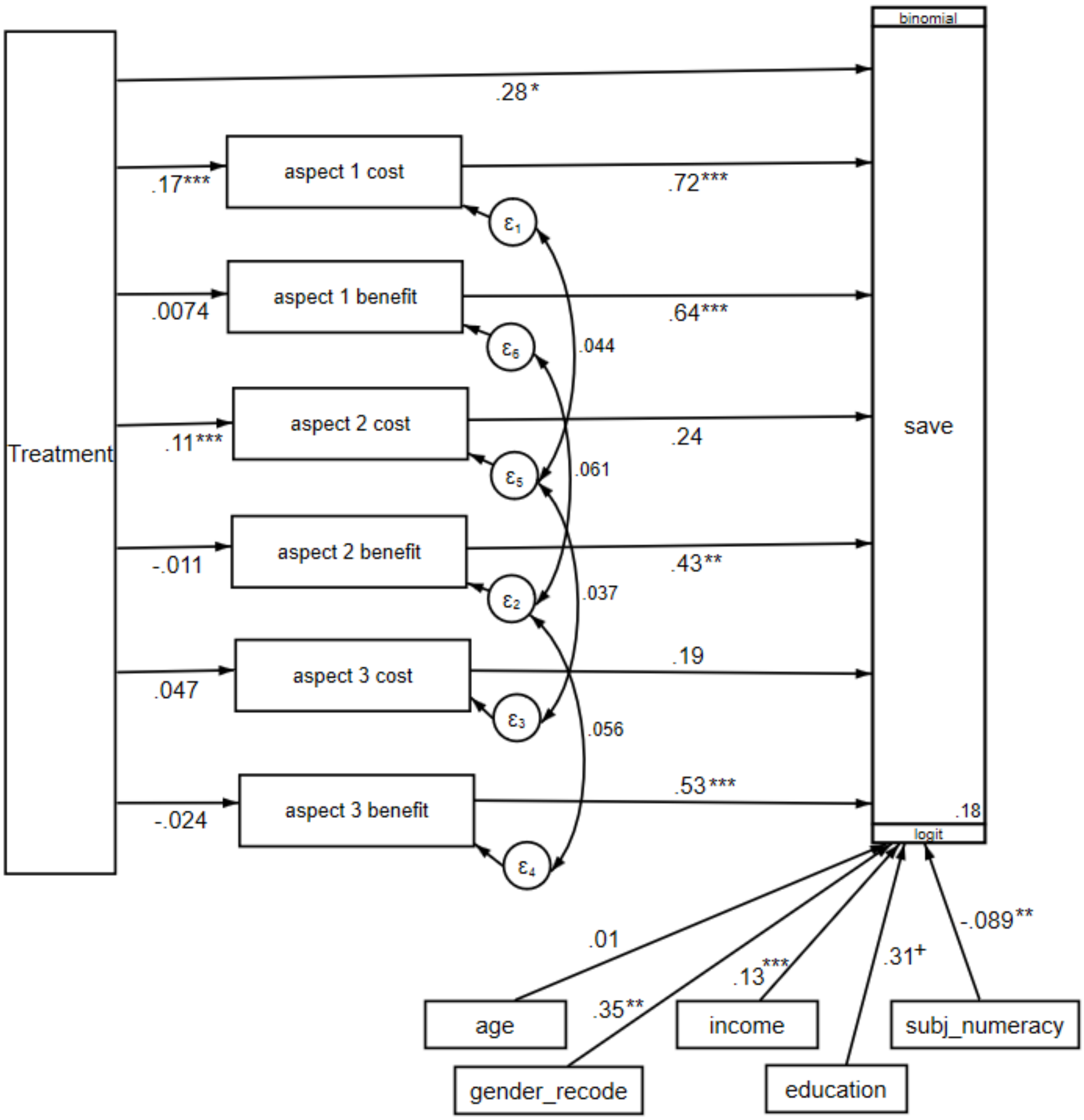

Figure 4-7. Mediation Analysis Path Diagram Using Generalized Structural Equation Modeling (GSEM) for Objective Psychological Measures Affecting Savings for Temporal Reframing Study

4.4.4 Temporal Reframing Lab Study Discussion

The primary purpose of the Temporal Reframing Lab Study was to provide more direct evidence of psychological mechanisms and the role of individual behavioral differences on savings intentions, all of which could not be explored in the field study covered in Chapter 3. More granular framing does appear to increase savings intentions, and the differences were most stark between daily and monthly framing. Subjective affordability and understandability appear to be higher with more granular framing. Financial literacy moderated savings intentions (marginally significant) with the greatest, positive treatment difference on the less financially literate. On the other hand, subjective numeracy did not appear to moderate savings intentions, and this possibly makes some sense to the effect that the SNS-3 measure has more to do with both how comfortable people are working with fractions and percentages; and how useful people find numerical information, a more distant connection to the savings judgment under study.

In terms of psychological mediation pathways, several multilevel analyses were run. Collectively the analyses suggest that subjective and objective affordability partially mediate (complementary mediation) the relationship between temporal framing and savings intentions. When only subjective affordability is included as a mediator, the direct main effect of temporal reframing was negative. However, when only objective affordability was included as a mediator, the direct main effect of temporal reframing remained positive. One interpretation is that objective affordability does not explain as much of the variance in outcomes as does subjective affordability. Furthermore, the negative main effect in the presence of subjective affordability suggests an undiscovered competitive mediator. For example, temporal reframing might make the savings seems more affordable (smaller costs and larger benefits). However, perhaps the unbundling of savings into smaller, more frequent amounts could also trigger feelings of loss aversion, thus working (to a lesser extent) the psychology in the other direction (e.g., unbundling of losses feels more painful than bundled losses).

4.5 Temporal Reframing with Income Uncertainty Lab Study

The approach of the Temporal Reframing with Income Uncertainty Lab Study is to explore the savings intentions and psychological differences by addressing two primary new dimensions as compared to the prior study. First, rather than anchoring people on a specific amount to save (e.g., $5 a day), this study explores whether eliciting savings in temporal frames may make a difference even without specific amounts (e.g., how much would you like to save per day). Second, the study adds the contextual element of income uncertainty (e.g., none to medium to high) as an exogenous factor to see whether people intend to save more under income uncertainty and to what extent psychological perceptions and individual differences play a role. Figure 4-8 summarizes the constructs being examined for the study.

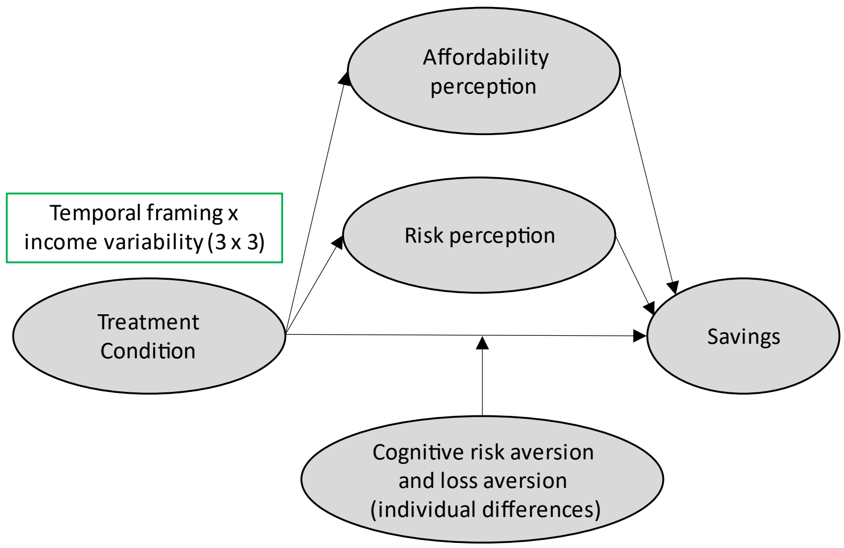

Figure 4-8. Summary of Constructs for Temporal Reframing with Income Uncertainty Lab Study

4.5.1 Method

In January 2021, 1,801 online participants of at least 18 years of age from the United Kingdom (England, Wales, Scotland, Northern Ireland) were recruited using

Prolific, a dedicated research subject pool (Palan and Schitter, 2018), with participants randomized using a between subject design into one of nine treatment groups in 3x3 factorial cross of framing (daily, monthly, free response) by income variability (none, medium, high). During recruitment for the study, prospective participants were told that they could take part in a study which was designed to better understand how people make financial decisions and their attitudes toward certain choices. The study was expected to take between 4 to 6 minutes to complete, and payment for participation was £0.85.[1] The study was implemented using Qualtrics, and the complete, detailed stimulus is included in the Online Appendix, Chapter 4, Lab Study Materials, Section B.

The primary intervention for the study occurred at the beginning and first asked people to imagine they had a part-time contract role. Based on randomized assignment, participants were either put into a scenario of either no, medium, or high income variability (i.e., the first factorial cross). The scenario was described as follows (brackets indicate the between-subject conditions):

In this survey we would like to learn about how you would make a financial decision.

> *Imagine that you are hired to work on a part-time contract basis, and this work serves as your primary source of income.*
>
> *The company that you work for is a new business, and sales for the company are driven by external factors outside of their control. However, you earn fifteen pounds (£15) per hour that you work, and your contract specifies that…*
>
> *[you will get a guaranteed 30 hours of work per week. In the last five weeks, you have had 30 hours of work every week.] (No Income Variability Condition)*

[1] Average time to complete the study turned out to be about 6 minutes and 18 seconds, which resulted in an hourly compensation rate of about £9.50, which is very good according to Prolific's ethical scale during study configuration (£5.00 is rated low, £7.50 is rated good, and £10.00+ is rated great).

[you will get an uncertain amount of work between 20 to 40 hours of work per week. In the last five weeks, you have had 40, 20, 20, 40, and 30 hours of work.] (Medium Variability Condition)

[you will get an uncertain amount of work between 10 to 50 hours of work per week. In the last five weeks, you have had 50, 10, 10, 50, and 30 hours of work.] (High Income Variability Condition)

Participants were then told about a hypothetical mobile app they had access to and the ability to save for a rainy day or emergency fund:

Now suppose that you have access to a financial services app provided by a trustworthy company for use on your mobile phone. The mobile app allows you to:

• make one-time deposits into your account at any time you choose,

• invest all or a portion of your money into pre-designed financial portfolios that are tailored to your goals, such as amount of risk and return, and

• start to set aside a rainy day or emergency fund that would cover your expenses for a few months.

Finally, participants were reminded about their income prospects just prior to the elicitation regarding savings:

Recall that you earn fifteen pounds (£15) per hour that you work, and your contract specifies that [you will get a guaranteed 30 hours of work per week. In the last five weeks, you have had 30 hours of work every week.] [you will get an uncertain amount of work between 20 to 40 hours of work per week. In the last five weeks, you have had 40, 20, 20, 40, and 30 hours of work.] [you will get an uncertain amount of work between 10 to 50 hours of work per week. In the last five weeks, you have had 50, 10, 10, 50, and 30 hours of work.]

Finally, participants were randomly assigned to the second factorial cross for the savings judgment (i.e., either a daily frame, monthly frame; or a free response frame). Differences between conditions are highlighted in bold:

Daily condition:

How much would you choose to save into either a rainy day or emergency fund for yourself?

(If you do not wish to save, please enter the number 0 in the field below and press the next button.)

(If you wish to save a different amount, please leave the field below blank and press the next button.)

£____ per day

Monthly condition:

How much would you choose to save into either a rainy day or emergency fund for yourself?

(If you do not wish to save, please enter the number 0 in the field below and press the next button.)

(If you wish to save a different amount, please leave the field below blank and press the next button.)

£____ per month

Free response condition:

How much would you choose to save into either a rainy day or emergency fund for yourself?

(If you do not wish to save, please enter the number 0 in the field below and press the next button.)

[Text is deleted that offers an option to save different amount since it is not applicable]

____

Thus, participants in either the daily or monthly conditions had the same intervention with the exception that they could either choose to specify the amount the wanted to save in either pounds per day or pounds per month (via fill in the blank), choose not to save, or choose to save a different amount. Participants in the free response condition could choose to specify how they wanted to save (using any free form text they chose) or choose not to save. Similarly, participants from the daily and monthly conditions that chose to save a different amount (i.e., neither in the daily or monthly frame) were essentially routed to the same experience as those assigned to the free response condition where they could enter free form text indicating how much they wanted to save (or also indicate if they did not want to save, which is exactly the same as the free response condition).

Participants in the free response condition (as well as those from the daily and monthly conditions who chose to save a different amount) then proceeded to answer two follow-up questions. The first follow-up question asked participants to specify the equivalent annual amount they expected to save (in pounds) based on the free form text they previously entered. The second follow-up question asked the participant to clarify how they arrived at their annualized savings amount.[2] To

[2] The research design was intended to provide as close of a comparison between daily, monthly, and free response framing as possible, recognizing the difficulties of normalizing the outcomes of open-ended, free responses from participants. As a preview of the data analysis, the research design allows a common outcome variable of annualized savings to be constructed across all treatment conditions (including those assigned to daily and monthly conditions that chose to save a different amount via entering free text). For the free text responses, a research coder was used to validate

clarify the relationships between the conditions and the question flow experienced by the participant, a summary of the study architecture is depicted in Figure 4-9.

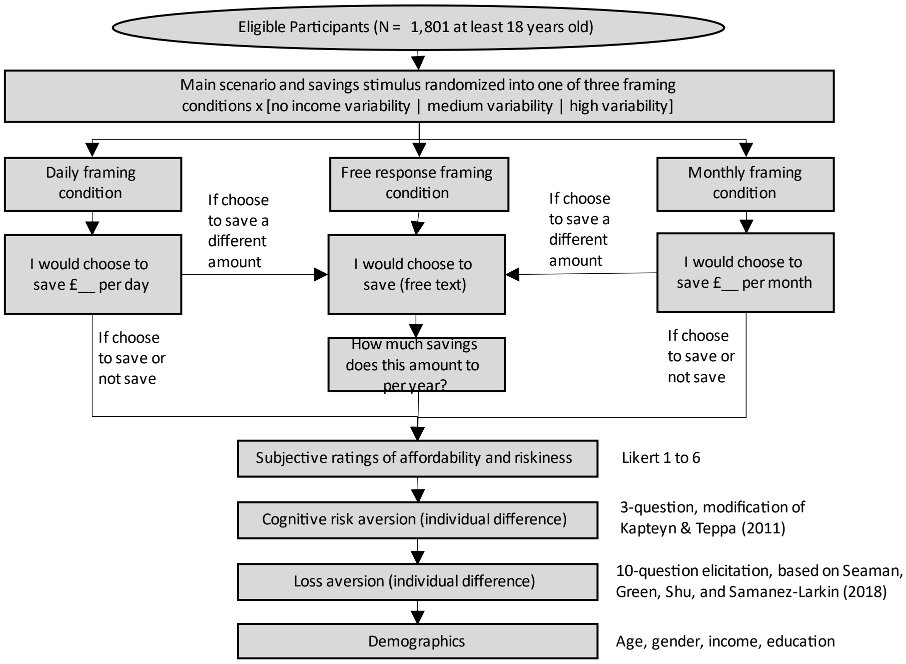

Figure 4-9. Summary of the Temporal Reframing with Income Uncertainty Lab Study

The next part of the research design included exploratory mediators for the judgment processes. Participants were asked to reflect on the savings scenario and report their perceptions regarding the option to save in terms of to what extent it was affordable (on a Likert scale of 1 to 6) and risky (also on a Likert scale of 1 to 6).

The next part of the stimulus involved measuring the individual behavioral difference of risk aversion. The method is adapted[3] from that used by Kapteyn and Teppa and uses a series of three questions to triangulate a risk premium that is required for an individual to select a risky prospect versus a certain outcome in the

the annualized savings amount. In cases where validation was not reasonably possible, null values were assumed.

[3] In the adaptation, instead of choosing job with income for life of Y (current income) which is a wealth-level affecting decision, instead a small stakes gamble with a base case of Y=£100 is used. Arguably a small stakes choice better mirrors the stimulus which addresses short run variability in earnings (e.g., over several weeks).

domain of gains (Kapteyn and Teppa, 2011). For example, suppose an individual is offered an option to choose between:

- Choice 1: A guaranteed win of £100
- Choice 2: A single coin flip with a 50% chance of landing heads and a 50% chance of landing tails. If the coin lands on heads you win £200. If the coin lands on tails you only win £70.

If the person opts for Choice 1, then they require a risk premium greater than 35% in order to choose the risky prospect (based on expected outcomes for the risky prospect). Risk aversion scores can range from 1 (representing a required risk premium ≤12.5%) to 6 (representing a required risk premium of > 45%). A logical summary of the method for calculating a person's cognitive risk aversion score is depicted in Figure 4-10.

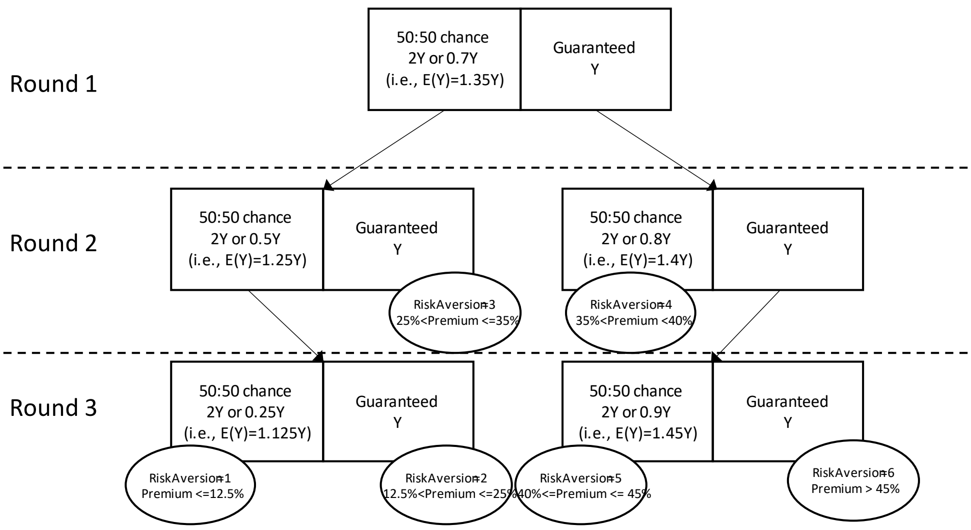

Figure 4-10. Summary of Method to Assess the Individual Behavioral Difference of Risk Aversion

The next part of the survey included a series of ten questions to assess the individual behavioral difference of loss aversion, which is essentially a loss magnification ratio of how a person feels about monetary losses relative to gains.

Details of this method are outlined in other behavioral research studies (Payne et al., 2015; Seaman et al., 2018), and the core concept behind the method is described next. For each of the ten questions that the participant is asked, they must indicate their choice between two gambles, each of which has three equally likely outcomes. See Figure 4-11 for an example. For each question, one of the gambles is referred to as the Loss Averse Gamble, where the participant has an equal chance of winning £100, neither winning nor losing any money, or losing £100, denoted here as gamble (100, 0, -100). The other gamble is referred to as the Gain Seeking Gamble, and in Figure 4-11, the participant has an equal chance of winning £500, neither winning nor losing any money, or losing £300, denoted here as gamble (500, 0, -300). Suppose an individual prefers the Loss Averse Gamble (100, 0, -100) over the Gain Seeking Gamble (500, 0, -300). Then presuming the individual consistently would choose \$A over \$B for all A > B ≥ 0, then the individual's loss aversion would be at least as high as 2.0 since $-\frac{(500-100)}{(-300--100)} = 2.0$, which is the marginal ratio of gains to losses between the two gambles. If the user switches preferences from the Loss Averse Gamble to the Gain Seeking Gamble when the positive outcome of the Gain Seeking Gamble is increased to (600, 0, -300), then the individual's loss aversion is less than or equal to 2.5 since $-\frac{(600-100)}{(-300--100)} = 2.5$. In this case, a person is estimated to have a loss aversion of 2.25 (i.e., the average of 2.0 and 2.5 since their switchover point is somewhere in-between).[4] Note that questions are presented in random order to avoid sequencing effects, and gambles are presented on either the left or right in random order as well to avoid primacy effects. The lowest possible loss aversion score is 0.5 and the highest possible loss aversion score is 10.0 (using the stimulus outlined in the Online Appendix, Chapter 4, Lab Study Materials, Section B).

[4] An individual's loss aversion can also be estimated when a person makes inconsistent choices, such as if they prefer gamble (400, 0, -300) but don't prefer gamble (500, 0, -300). This can be done through identifying the piecewise consistent ranges of the loss aversion curve and averaging the highest loss aversion score for the lowest piecewise consistent range and the lowest loss aversion score for the highest piecewise consistent range.

Figure 4-11. Sample Gamble Pair Used to Assess the Individual Behavioral Difference of Loss Aversion

In the final set of questions, participants are asked to identify their age, gender, income, and education.

4.5.2 Summary Statistics and Experimental Balance

Table 4-11 summarizes the statistical balance across the randomly assigned temporal treatment factor, which is the primary factor under study (with degree of income variability a secondary factor). A total of 1,081 participants were recruited with 371 assigned to the daily, 381 assigned to the monthly, and 329 assigned to the free response treatment factor. Table 4-12 summarizes the assignment of participants to both temporal treatment and income variability factors. The mean age of participants for the study was 40.87 years with a standard deviation of 13.44. Statistical tests on age do not reject the null hypotheses that the means and variances are the same between treatment factors. The percentage of males was 39.9%, and a chi-squared test does not reject the null hypothesis that each treatment factor had the same proportion of males. Income bands were ordinally coded in buckets of approximately £5,000 (detail coding in the footnotes of Table 4-11), and mean income on the coded scale was 6.15, which reflects an annual income that is closer to the lower end of the range of £25,000 and £34,999. Statistical tests on income do not reject null hypotheses that the means and variances are the same between temporal reframing factors. With respect to educational levels of participants, 14.81% attained GCSE, 24.43% A-Levels, 39.25% undergraduate degree, and 21.51% postgraduate degree (these stats exclude less than 2% of the sample which identified other education levels, with examples such as City & Guilds, trade apprenticeship, and National Vocational Qualification). A chi-squared test for education does not reject the null hypothesis that each temporal factor has the same proportions. Next, we consider the individual behavioral difference covariates of risk aversion and loss aversion. The mean risk aversion score was 3.32, which indicates that individuals require a risk premium that is somewhat closer to the lower end of the range between the endpoints of 25% and 40% (details on the score to risk premium mapping are provided in the footnotes of Table 4-11). Statistical tests on risk aversion do not reject the null hypotheses that the means and variances are the same between treatment factors. Finally, the mean loss aversion score was 4.67 (median value of 3.5) after excluding 263 participants of 1,081 who made inconsistent choices in the loss aversion assessment (approximately 24% of the sample, which is not unusual in terms of percentage of people who fail to make consistent choices across ten gamble pair choices). Statistical tests on loss aversion do not reject the null hypotheses that the means and variances are the same between treatment factors. As a final note, the median loss aversion measured in the sample population is somewhat higher than observed in other studies and meta-analyses, although not unusual (Brown et al., 2021; Seaman et al., 2018; Tversky and Kahneman, 1992; Walasek et al., 2018).

In summary, randomized assignment was successful.

4.5.3 Results

To assess to what extent savings intentions are different based on different elicitation methods, we look at the main outcome variable of annualized savings amount. This annualized saving amount variable is constructed using the following procedure:

- For users who are assigned to a daily treatment condition who then enter their intended savings per day, an annualized savings amount is computed by multiplying the daily savings amount by 360 (this is consistent with the ratios used for temporal reframing in the field study of Chapter 3).
- For users who are assigned to a monthly treatment condition who then enter their intended savings per month, an annualized savings amount is computed by multiplying the monthly savings amount by 12.
- For users in either the daily or monthly treatment conditions who choose to enter a different amount using free response text, a coding procedure is used (as described next) for the free response treatment condition.
- For users in the free response treatment condition (and for those in the other conditions who enter free form text regarding their savings), the annualized amount as calculated by the participant is used to the extent that a research coder[5] is able to plausibly confirm the annualized amount indicated by the participant using two other pieces of information entered by the participant, namely the free text regarding intended savings and the stated method for calculating the annualized savings amount. In cases where the annualized amount cannot be plausibly confirmed, then the annualized savings amount was coded as a null value.
- As a robustness check, since some participants in the free response condition indicated that they would save based on working 50 weeks in a year and setting aside two non-earning weeks for vacation, annualized savings amounts were also constructed for both the daily condition by multiplying daily amounts by 346 days (i.e., 360 less 14 days) and the monthly condition by multiplying the monthly amounts by 11.5 months (i.e., 12 months less a half a month).

[5] Given resource limitations, for this task the author served as the coder to confirm the annualized savings amount for those indicating savings via free response text. In the future, a process involving one or more independent coders could be used with a dispute resolution process.

- Finally, the annualized savings amounts (including the robustness check version) were winsorized at the 99% level.

When looking at the means of annualized savings amounts by treatment condition (see Table 4-13), two patterns are noteworthy. The first pattern is that daily framing appears to result in higher annualized savings amounts with those in the daily framing treatment having mean annualized savings of £8,178 versus £2,816 in the monthly framing treatment and £3,887 in the free response treatment. The second pattern is that there may be an inverted U-shaped pattern to the influence of income variability with medium income variability increasing intended savings but the increase starting to reverse for high income variability. For example, consider the daily framing condition where mean annualized savings are £6,239 for no income variability, £10,110 for medium income variability, and £8,299 for high income variability. Additional statistical tests are performed later in this subsection.

To better explore the effects of eliciting savings in different temporal frames and the impact of income variability, five OLS regression models are outlined next and detailed in Table 4-14. The first model uses winsorized annualized saving amount as the outcome variable with independent variables of treatment indicators for daily and free response framing (monthly framing is used as the base reference point). The second model adds income variability level (0 – no income variability, 1 – medium income variability, 2 – high income variability) to the regression. The third model addresses the potential inverted U-shape of some income variability increasing savings but too much variability reversing savings (namely, the third model adds income variability level squared to the regression). The fourth model adds demographic controls of age (mean centered), gender (contrast coded with male = 1, female = -1, and other = 0), and education. Finally, the fifth model controls for individual behavioral differences of risk aversion and loss aversion (excludes participants who answered the loss aversion questions inconsistently). The coefficient on the daily treatment indicator is significant in all five models (βs > 4993.2, $ps<.001$). The valence on free response treatment indicator is positive, although not statistically significant (βs > 924.4, $0.200 < ps < 0.304$). As can be seen from Models 3 through 5, evidence for the inverted U-shaped impact of income variability is visible with the coefficient on the first order term being positive and the coefficient on the second order term being negative (note significance for the coefficient on income variability level for Models 3 and 4 where βs > 2976.2, ps<.047). When adding controls for risk and loss aversion in Model 5, the coefficient on income variability level is still positive and marginally significant (β > 3028.3, p<.097). The coefficient patterns and significance levels hold when using a robustness-check version of annualized savings that assumes a shorter period of days and months per year as described previously (see Online Appendix: Chapter 4 Supplemental Analyses, Table 4S2-2).

To explore psychological perceptions as impacted by temporal reframing, we first examine affordability as the outcome variable of interest using OLS regressions and monthly framing as the reference. The same five model structures are used as those for analyzing the annualized savings amount. Unlike the prior study which had temporal reframing-based savings with a specific amount (e.g., $5 per day), eliciting savings using a temporal frame (e.g., save ___ per day) did not seem to increase perceptions of affordability. For daily framing, the coefficients on treatment were not significant for Models 1 through 5, and for free response framing, the coefficients on treatment were not significant either (see Table 4-15). Note that for Model 2, higher income variability seems to lead to lower perceptions of affordability (β=-0.154, p<0.001) and this holds with true when controls are added for demographics and individual behavioral differences of risk and loss aversion (β=-0.187, p<0.001).

Next, we examine perceptions of riskiness as the outcome variable of interest using OLS regressions and monthly framing as the reference point using the same five model structures as used for annual savings amount and perceptions of affordability. See Table 4-16 for results. Temporal framing does not seem to have a significant effect on perceptions of riskiness, although the coefficient is negatively valenced for daily framing across all models (e.g., Model 5: β=-0.143, p<0.13). When running a modified regression for Model 5 that drops the second order term of income variability level squared, these directional results remain the same (β= -0.143, p<0.13). In Model 2, higher income variability seems to increase perceptions of riskiness (β=-0.237, p<0.001), and this remains the same after controlling for demographic controls and individual behavioral differences (β=-0.237, p<0.001).

We also look at to what extent individual behavioral differences of risk aversion and loss aversion moderate temporal reframing to affect annualized savings amount. Four OLS regression models were constructed with winsorized annualized savings amount as the outcome variable. For all models, the independent variables were the daily and free response treatment conditions (i.e., monthly treatment was the base condition), income variability level, income variability level squared, and demographic controls for age, gender, income, and education. Models 1 through 4 then included the following interactions: 1) risk aversion and daily treatment indicator, 2) risk aversion and free response treatment indicator, 3) loss aversion and daily treatment indicator, and 4) loss aversion and free response treatment indicator. No significant interactions were detected for any of the models, and hence, these individual behavioral differences do not seem to moderate outcomes of annualized savings rate. See Online Appendix: Chapter 4 Supplemental Analyses, Table 4S2-3 for more information.

For the next analysis, we explore total effects of daily framing, income variability level (and income variability squared), demographic controls, and individual behavioral differences on winsorized annualized savings amount in the context of perceptions of riskiness as potential mediator. Table 4-17 and Figure 4-12 include results and path diagram of a structural equation model (SEM) that uses maximum likelihood estimation with robust standard errors. Like the prior analyses, the SEM model reflects a significant direct effect of daily reframing on annualized savings amount (b=4736.9, z=4.43, p<0.001). Also as seen prior, there is also some evidence of precautionary savings with income variability level having a marginally significant influence (b=3090.3, z=1.66, p=0.097). In terms of pathways involving perceptions of riskiness as a mediator, there does not appear to be evidence that riskiness mediates the pathway from temporal reframing as the path from daily framing to riskiness is insignificant (b=-0.106, z=-1.27, p=0.203). Income variability does have a significant effect on perceptions of riskiness (b=0.268, z=5.42, p<0.001. However, the pathway from riskiness to the outcome variable is not significant (b=-468, z=-1.21, p=0.226).

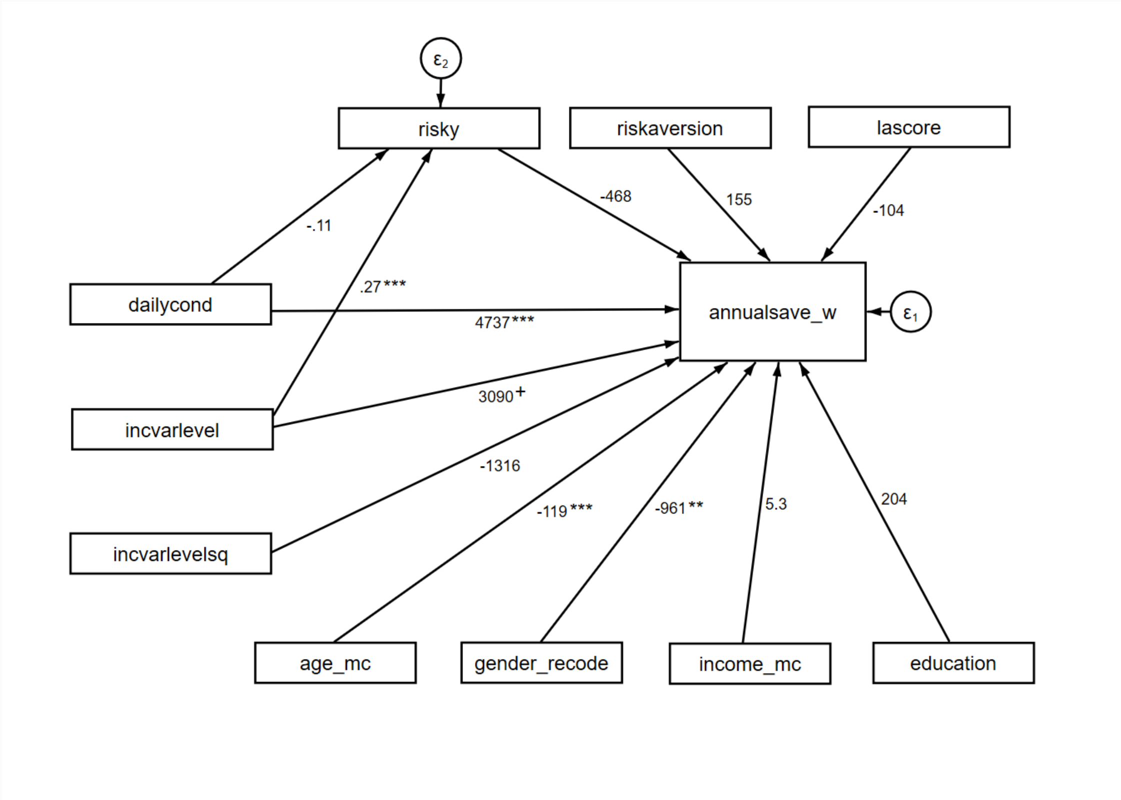

Figure 4-12. Structural Equation Model Path Diagram for Temporal Reframing Under Uncertainty Study

4.5.4 Temporal Reframing with Income Uncertainty Lab Study Discussion

The purposes of this study were severalfold. First, there was a desire to explore whether simply eliciting savings rates with a temporal frame would have a positive effect of increasing savings intentions (as opposed to anchoring people on a specific amount like $5 a day). There clearly seems to be a main effect and benefit of eliciting savings using daily framing as compared to free response and monthly framing (at least in the context of rainy day and emergency savings within a Gig Economy context). Secondly, there also seems to be a precautionary savings effect with medium income variability driving increased intentions to save, even after controlling for individual behavioral differences such as small stakes risk and loss aversion (which were previously unobserved in the larger literature). Income variability may result in an inverted U-shaped savings outcome distribution with an initial increase in income variability resulting in higher savings but then savings starting to reverse if income variability goes too high (potentially because the probability of near-term income shortfalls increases too much for individuals). In terms of the psychology involved, people do seem to find the savings decisions riskier with greater income variability. However, neither perceptions of affordability nor riskiness (as measured) appear to mediate outcomes.

4.6 General Discussion

4.6.1 Savings Behavior

The Temporal Reframing Lab Study covered a population of crowdworkers in the United States and demonstrated that people's intentions to save increased when they were offered more granular, specific savings amounts such as $5 per day as opposed to less granular savings amounts $150 a month. The lab study main effect findings replicate the field study main effect findings in Chapter 3. In the lab study, evidence was provided that financial literacy moderated savings (marginal significance) with the least financially literate being helped in the sense of increased likelihoods to save on a recurring basis. Note that financial literacy was not tested in the field study of Chapter 3 (only moderating effects of income).

On the other hand, the Temporal Reframing with Income Uncertainty Lab Study covered a population of crowdworkers in the United Kingdom. The intervention context was specifically around hypothetical work in the Gig Economy and opportunities to save for rainy day and emergency funds. From a behavioral perspective, the elicitation was fundamentally different in that people were not asked to accept or reject a specific savings amount but were instead asked how much they wanted to save in either a £ per day, £ per month, or free response framing (with fill in blank responses for all cases). Evidence shows that granular temporal reframing in terms of savings per day outperformed both monthly and free response framing to increase savings as a main effect.

The Temporal Reframing with Income Uncertainty Lab Study also provides evidence regarding savings judgments under income uncertainty. Specifically, the lab study supports the general, macroeconomic empirical evidence in the literature regarding precautionary savings, although there has been a debate about effects in more entrepreneurial, temporary work, etc. subpopulations where risk preferences may be confounded with occupation choice.

The second lab study in this chapter provides microeconomic-level evidence that people in a Gig Economy context increase their intended savings under moderate degrees of income variability which may then reverse for high degrees of income variability. Furthermore, these effects are present when controlling for individual behavioral differences of small stakes risk and loss aversion as well as other demographic variables (e.g., age, gender, income, education). Notably, there was no evidence of small stakes risk or loss aversion moderating savings outcomes relative to temporal reframing. As alluded to earlier in this chapter, loss aversion was unlikely to play a role as participants were not cued with a specific reference point in the stimulus that would trigger feelings of loss aversion; participants were likely in the mindset of gains and getting fluctuating income. With respect to risk aversion not moderating outcomes relative to temporal framing, it is plausible that risks are less associated with the temporal frame as opposed to income variability itself.

4.6.2 Savings Psychology

Given the field study covered in Chapter 3, the primary purpose of the Temporal Reframing Lab Study was to directly investigate psychological mechanisms that could not be explored in the field. Evidence was offered that indicated that both subjective and objective perceptions of affordability and understandability were raised by using more granular temporal framing. Perceptions of affordability (both subjective and objective) mediate outcomes in a complementary way with subjective affordability explaining more of the variance in outcomes. When modeling subjective affordability as a complementary mediator, a negative main effect of temporal framing was detected, suggestive of an undiscovered competitive mediator. As a point of speculation, the undiscovered competitive mediator could be loss aversion; while unbundling savings makes savings feel more affordable, the frequency of savings may magnify the feeling of losses.

Shifting focus to the Temporal Reframing with Income Uncertainty Lab Study, it is important to note one critical difference in the behavioral choice architecture since perceptions of affordability were not found to mediate outcomes in this second study in the chapter. On the one hand, unlike the first study in this chapter where a specific amount to evaluate was offered (e.g., $5 a day), in the elicitation for the second study, participants chose what they wanted to save. As such, the savings amount was in some sense by definition affordable to them (likely compressing variability in the affordability measure as compared to the situation where a specific amount had been offered). Relative to perceptions of riskiness and why such perceptions may not have mediated outcomes, participants were asked to evaluate the riskiness of the savings decision which could potentially be viewed as a risk in the present. As an alternate proposition, it may be that the psychology driving people to save is more about planning and the desire to become more resilient against future emergency risks. The author of this chapter is unaware of direct causal evidence of such psychological mechanisms, although using survey-based data Anderson and colleagues correlate perceived financial literacy (not competency) with precautionary savings (Anderson et al., 2017), and they suggest that planning may drive perceived literacy (e.g., feelings) which may then increase precautionary savings.

4.6.3 Study Limitations and Future Directions

The lab studies in this chapter provide additional evidence that temporal reframing has a significant main effect using different elicitation forms, such as for specific or unspecified amounts. Simple text descriptions were used for all the interventions. Future research could explore more engaging (e.g., visual forms) of temporal reframing, especially since people have different conceptualizations of time. Other possibilities for future research include personalized temporal savings interventions which take into account demographic differences, especially since a diverse set of people work in the Gig Economy.

These studies also shed light on the psychology involved with temporal savings decisions, including under income uncertainty. Whereas the temporal reframing psychology for specified amounts was partially explained, the psychology relative to unspecified amounts remains unknown, although this research provides evidence to rule out explanations being related to how people feel about the savings decision itself in terms of affordability and riskiness. With that as context, future research may find it useful to explore the psychology around forward-looking motivations to save, such as goals (e.g., future risk mitigation for rainy days and emergencies). Future research may also want to look at the psychology longitudinally over time since the studies in this chapter were limited to the initial savings choice; as was demonstrated in the field study of Chapter 3, people may churn out of savings conditions at different rates over time. By better understanding the psychology over time, there may be opportunities to help keep people on track with savings over the longer run.

4.6.4 Conclusion

The research in this chapter is a natural extension to that explored in Chapter 3, and this research goes further to explore different forms of temporal reframing and the psychology involved. Given the era of COVID-19 and growth of the Gig Economy, the research topic of savings and precautionary savings is particularly relevant. At least in terms of shorter-term savings, such as that for rainy day and emergency savings, it seems advantageous for choice architects to provide some structure to Gig Economy workers and have them think about saving regularly on a daily basis (at least compared to monthly and complete, open-ended framing), even in light of increased precautionary savings associated with income variability.

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4.8 Appendix

Table 4-1. Demographic, Financial Literacy, and Subjective Numeracy Balance Across Randomly Assigned Conditions for Temporal Reframing Lab Study

This table summarizes the characteristics of participants in terms of the three treatment groups (i.e., $5 a day, $35 a week, and $150 a month). Note that the second to last row reports chi-squared statistics for education and the percentage of male. The last row reports for all other covariates both statistical tests for means and variances. For the means, a one-way ANOVA is reported with an F-statistic and p-value. For variances, a Bartlett's test for equal variances is reported with a $\chi^2(2)$ for gender or $\chi^2(4)$ for education, and p-value. For statistical tests, the null hypothesis is that the groups are equal, and underline formatting in the table indicates cases where the null hypothesis is rejected at α=0.05 (i.e., treatment groups are not equal).

	Mean Age (standard deviation)	Percentage Male *	Mean Annual Income ** (standard deviation)	Percent Education (% high school / % college / % advanced degree)	Financial Literacy (standard deviation)†	Subjective Numeracy (SNS-3) (standard deviation)	Observations
$5 per day	33.74 (7.31)	55.2	5.36 (3.24)	28.21% / 60.51% / 11.28%	2.38 (0.91)	14.10 (3.01)	195
$35 per week	34.46 (7.55)	49.3	5.14 (2.94)	25.24% / 61.90% / 12.86%	2.40 (0.84)	14.13 (3.09)	210
$150 per month	34.65 (6.83)	52.6	5.37 (3.44)	25.51% / 55.61% / 18.88%	2.30 (0.98)	13.64 (3.25)	196
Overall	34.29 (7.24)	52.3	5.29 (3.20)	26.29% / 59.40% / 14.31%	2.36 (0.91)	13.96 (3.12)	601
Chi-squared for percentage male and education [p-value]	N/A	1.42 [0.49]	N/A	5.56 [0.24]	N/A	N/A	

	Mean Age (standard deviation)	Percentage Male *	Mean Annual Income ** (standard deviation)	Percent Education (% high school / % college / % advanced degree)	Financial Literacy (standard deviation)†	Subjective Numeracy (SNS-3) (standard deviation)	Observations
(F-statistic for means, Bartlett's χ^2 for variance) [p-value mean, p-value variance]	(0.86, 2.03) [0.43, 0.36]	N/A	(0.31, 4.95) [0.74, 0.08]	N/A	(0.74, 5.16) [0.48, 0.08]	(1.49, 1.18) [0.23, 0.55]	

* Note that this only includes participants reporting male or female for gender and excludes those reporting "other" or "prefer not to say." However, note that of 601 participants that 8 participants reported a gender of either "other" of "prefer not to say" and that these observations were split between the $5 a day (3 observations), $35 a week (1 observation), and $150 a month (4 observations) conditions. In the gender column, there are a total of 593 observations.

****** Income is coded as follows:

1: $9,999 a year or less
2: From $10,000 to $19,999 a year
3: From $20,000 to $29,999 a year
4: From $30,000 to $39,999 a year
5: From $40,000 to $49,999 a year
6: From $50,000 to $59,999 a year
7: From $60,000 to $69,999 a year
8: From $70,000 to $79,999 a year
9: From $80,000 to $89,999 a year
10: From $90,000 to $99,999 a year
11: From $100,000 to $109,999 a year
12: From $110,000 to $119,999 a year

13: From $120,000 to $129,999 a year

14: From $130,000 to $139,999 a year

15: From $140,000 to $149,999 a year

16: $150,000 a year or more

-1: Prefer not to say

Those who preferred not to report their income (2 total observations from $150 a month condition) have been excluded from these statistics.

† If a participant answered “refuse to answer” for any of the financial literacy questions, these have been excluded from these statistics. A total of 3 participants refused to answer at least one of the financial literacy questions (1 observation for $5 per day condition and 2 observations for the $150 a month condition).

Table 4-2. Main Effect on Savings Participation for Temporal Reframing Lab Study

These tables report the results logistic regressions where the outcome variable is an indicator variable whether the participant has chosen to save. Column 1 reports logistic regressions without controls, and Column 2 reports logistic regressions with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001. e^B = exponentiated *B*.

PANEL A (Logistic Regression with $150 a month treatment condition used as the base condition)

	(1)				(2)			
Predictor	*B*	*SE B*	*P>|z|*	e^B	*B*	*SE B*	*P>|z|*	e^B
Daily Condition Indicator	0.6350522**	0.216683	0.003	1.89	0.7161928**	0.2257286	0.002	2.05
Weekly Condition Indicator	0.2166235	0.2042825	0.289	1.24	0.3121654	0.212615	0.142	1.37
Age					0.0065041	0.012042	0.589	1.01
Gender‡					0.2317096*	.0902722	0.010	1.26
Income					0.1271924***	0.0331883	0.000	1.14
Education					0.207469	0.1547754	0.180	1.23
Constant	0.350483*	0.1451771	0.016	1.42	-0.9791062+	0.5258244	0.063	0.38
N	601				594			
χ^2		8.72				38.12		
Df		2				6		

PANEL B (Logistic Regression with $35 a week treatment condition used as the base condition)

	(1)				(2)			
Predictor	*B*	*SE B*	*P>|z|*	e^B	*B*	*SE B*	*P>|z|*	e^B
Daily Condition Indicator	0.4184287+	0.2158896	0.053	1.94	0.4040274+	0.2217506	0.068	1.50
Monthly Condition Indicator	-0.2166235	0.2042825	0.289	-1.06	-0.3121654	0.212615	0.142	0.73
Age					0.0065041	0.012042	0.589	1.01
Gender‡					0.2317096*	.0902722	0.010	1.26
Income					0.1271924***	0.0331883	0.000	1.14
Education					0.207469	0.1547754	0.180	1.23
Constant	0.5671065***	0.1437183	0.000	3.95	-0.6669407	0.5174011	0.197	0.51
N	601				594			
χ^2		8.72				38.12		
df		2				6		

†† Note that when running regressions with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients, I use contrast coding for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 4-1.

Table 4-3. Main Effect of Framing on Self-Reported Affordability for Temporal Reframing Study

This table reports the results of ordinary least squares regressions where the outcome variable is a self-reported 7-point, Likert assessment by the participant (strongly disagree = 1 to strongly agree = 7) in reaction to the question, “I found the option to be affordable” performed after the main stimulus of the savings choice. Column 1 reports OLS without controls, and Column 2 reports OLS results with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

PANEL A (OLS Regression with $150 a month treatment condition used as the base condition)

	(1)			(2)		
	Self-Reported Affordability	Robust St. Err.	p-value	Self-Reported Affordability	Robust St. Err.	p-value
Daily Indicator	1.212062***	0.1769957	0.000	1.234335***	0.1759014	0.000
Weekly Indicator	0.5479592**	0.1877542	0.004	0.6071415**	0.184391	0.001
Age				0.0086995	0.0095744	0.364
Gender‡				0.2066833**	0.0715789	0.004
Income				0.1099526***	0.0233766	0.000
Education				-0.0243063	0.122125	0.842
Constant	4.352041***	0.1376932	0.000	3.463429***	0.4165963	0.000
R^2	0.0702			0.1264		
N	601			594		

PANEL B (OLS Regression with $35 a week treatment condition used as the base condition)

	(1)			(2)		
	Self-Reported Affordability	Robust St. Err.	p-value	Self-Reported Affordability	Robust St. Err.	p-value
Daily Indicator	0.6641026***	0.1692935	0.000	0.6271931***	0.1644639	0.000
Monthly Indicator	-0.5479592***	0.1877542	0.004	-0.6071415**	0.184391	0.001
Age				0.0086995	0.0095744	0.364
Gender‡				0.2066833**	0.0715789	0.004
Income				0.1099526***	0.0233766	0.000
Education				-0.0243063	0.122125	0.842
Constant	4.900000***	0.1276409	0.000	4.070571***	0.4043515	0.000
R^2	0.0702			0.1264		
N	601			594		

†† Note that when running OLS with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients for the OLS, I use contrast coding for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer. Income is coded as indicated for Table 4-1.

Table 4-4. Main Effect of Framing on Self-Reported Understandability for Temporal Reframing Study

This table reports the results of ordinary least squares regressions where the outcome variable is a self-reported 7-point, Likert assessment by the participant (strongly disagree = 1 to strongly agree = 7) in reaction to the question, "I found the description of the option to be clear and understandable" performed after the main stimulus of the savings choice. Column 1 reports OLS without controls, and Column 2 reports OLS results with controls††. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

PANEL A (OLS Regression with $150 a month treatment condition used as the base condition)

	(1)			(2)		
	Self-Reported Understandability	Robust St. Err.	p-value	Self-Reported Understandability	Robust St. Err.	p-value
Daily Indicator	0.494427***	0.1407057	0.000	0.4911717**	0.1415489	0.001
Weekly Indicator	0.4438776**	0.1399154	0.002	0.4446977**	0.1407876	0.002
Age				0.0059686	0.0069726	0.392
Gender‡				-0.0218471	0.0564221	0.699
Income				0.0294725+	0.0168569	0.081
Education				-0.0327162	0.0908089	0.719
Constant	5.413265***	0.1110665	0.000	5.109921***	0.3445341	0.000
R^2	0.0265			0.0319		
N	601			594		

PANEL B (OLS Regression with $35 a week treatment condition used as the base condition)

	(1)			(2)		
	Self-Reported Understandability	Robust St. Err.	p-value	Self-Reported Understandability	Robust St. Err.	p-value
Daily Indicator	0.0505495	0.1212554	0.677	0.046474	0.1215981	0.702
Monthly Indicator	-0.4438776 **	0.1399154	0.002	-0.4446977**	0.1407876	0.002
Age				0.0059686	0.0069726	0.392
Gender‡				-0.0218471	0.0564221	0.699
Income				0.0294725+	0.0168569	0.081
Education				-0.0327162	0.0908089	0.719
Constant	5.857143***	0.0850914	0.000	5.554619***	0.3291727	0.000
R^2	0.0265			0.0319		
N	601			594		

†† Note that when running OLS with controls, observations have been excluded in cases where participants prefer not to report their income and in cases where participants prefer not to say their gender.

‡ For ease of interpreting coefficients for the OLS, I use contrast coding for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer. Income is coded as indicated for Table 4-1.

Table 4-5. Floodlight Analyses of Framing Differences on Savings Intentions for Temporal Reframing Study Across the Range of Financial Literacy

These tables explore the moderating role of financial literacy on savings (i.e., in terms of choosing to save) based on series of spotlight analyses (i.e., collectively a floodlight). In this case, the regression coefficient on an independent, indicator variable for the treatment condition is analyzed separately across the range of the moderator (i.e., financial literacy score) with separate focus points. The table covers daily versus monthly logit comparisons with controls for age, gender, income, and educational level. From a methodological perspective, since these analyses cover the marginal differences between two conditions, when a comparison between two conditions is analyzed, data for the third condition is dropped since it is deemed irrelevant to the focal points (e.g., when looking at the daily versus weekly differences, the monthly data is excluded). +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

($5 a day versus $150 a month comparisons with controls)

Financial Literacy	Logit Treatment Difference for Savings (Daily vs. Monthly)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z(382)	P>|z|
0	1.771*	0.388	3.156	2.51	0.012
1	1.366**	0.466	2.267	2.97	0.003
2	0.961***	0.443	1.479	3.64	0.000
3	0.555*	0.018	1.093	2.03	0.043

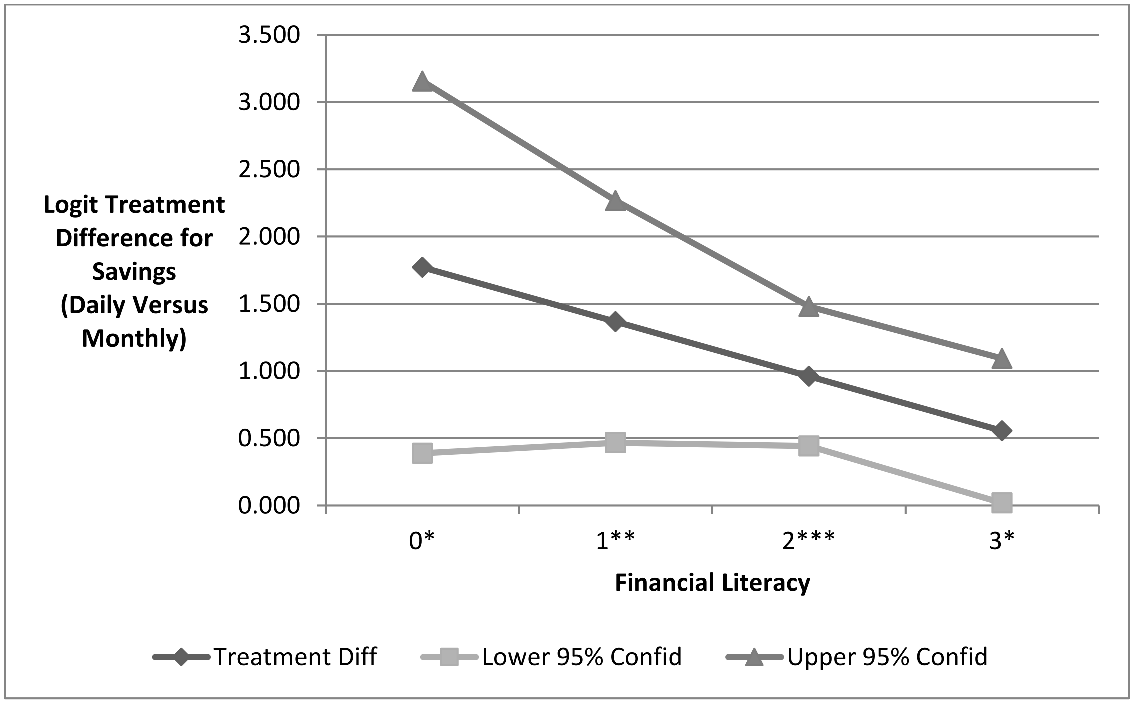

Table 4-6. Analyses for Temporal Reframing Lab Study with Affordability and Understandability Mediating Outcomes of Savings Intentions

These tables explore the mediating roles of affordability and understandability on savings using generalized structural equation modeling (GSEM) using Stata 15, maximum likelihood estimation, and binomial logit outcome variable (where save = 1 and not save = 0). The model assumes correlated residuals for affordability and understandability. Panel A includes the analysis for without controls and Panel B includes the analysis with controls for age, gender, income, and educational level. Since prior analyses have generally yielded the result that daily, weekly, and monthly framing result in a percentage of savers that moves from higher to lower, to ease modeling interpretability we have contrast coded the treatment condition as daily = 1, weekly = 0, and monthly = -1. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

PANEL A (without controls, N=601)

Direct Effects (unstandardized)	b	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Save <-					
- Affordable	1.2633***	1.0685	1.4582	12.71	0.000
- Understandable	0.0913	-0.0893	0.2720	0.99	0.322
- Treatment Contrast Code	-0.4698**	-0.8043	-0.1353	-2.75	0.006
Affordable <-					
- Treatment Contrast Code	0.6060***	0.4293	0.7826	6.72	0.00
Understandable <-					
- Treatment Contrast Code	0.2474***	0.1147	0.3801	3.65	0.000

PANEL B (with controls, N=594)*

Direct Effects (unstandardized)	b	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Save <-					
- Affordable	1.2610***	1.0596	1.4624	12.27	0.000
- Understandable	0.1074	-0.0774	0.2922	1.14	0.255
- Treatment Contrast Code	-0.4350*	-0.7762	-0.0938	-2.50	0.012
- Age	-0.0105	-0.0460	0.0251	-0.58	0.564
- Gender	0.1302	-0.1246	0.3850	1.00	0.317
- Income	0.0600	-0.0300	0.1500	1.31	0.191
- Education	0.4977*	0.0600	0.9353	2.23	0.026
Affordable <-					
- Treatment Contrast Code	0.6132***	0.4351	0.7913	6.75	0.00
Understandable <-					
- Treatment Contrast Code	0.2422***	0.1091	0.3755	3.57	0.000

"*" For the analysis with controls, 7 observations were dropped in cases where the participant declined to provide either income or gender information.

Table 4-7. Main Effect of Objective Affordability on Intentions to Save for Temporal Reframing Study

The table reports the results of logistic regressions where the outcome variable is whether a participant indicated that their intention is to save, and the base condition is the monthly treatment group. There are three pairs of independent variables which are a measurement of objective affordability (as measured according to Query Theory, with one pair (a cost and benefit, labeled respectively as “Aspect N Cost” and “Aspect N Benefit” where N represents the order in which the aspect was recalled by the participant) associated with each of the three aspects mentally identified by the participant. The following coding applies for each aspect: a smaller cost (cost = +1, benefit = 0), a larger cost (cost = -1, benefit = 0), a smaller benefit (cost = 0, benefit = -1), a larger benefit, (cost = 0, benefit = 1), none of the above (cost = 0, benefit = 0). Column 1 reports logit regressions with controls for age, gender, income, and educational status, and Column 2 reports adds a control for numeracy (SNS-3). +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	(1)			(2)		
	Save	Robust St. Err.	P>|z|	Save	Robust St. Err.	P>|z|
Daily Indicator	0.5210965*	0.2458241	0.034	0.5654707*	.2474594	0.022
Weekly Indicator	0.1809036	0.2349727	0.441	0.229168	0.2392232	0.338
Aspect 1 Cost	0.7061826***	0.1482603	0.000	0.7257815***	0.1450354	0.000
Aspect 1 Benefit	0.6019675***	0.1553374	0.000	0.6413393***	0.1604119	0.000
Aspect 2 Cost	0.2205741	0.1531075	0.150	0.2342107	0.153742	0.128
Aspect 2 Benefit	0.4077671**	0.1395795	0.003	0. 431917**	0.1407947	0.002
Aspect 3 Cost	0.1788342	0.1808614	0.334	0.1847759	0.1822473	0.311
Aspect 3 Benefit	0.5295773***	0.1360285	0.000	0.5319841***	0.1372997	0.000
Age	0.0063578	0.0128981	0.622	0.0105146	0.0129144	0.416
Gender‡	0.2810611**	0.0990632	0.005	0.3458199**	0.1036998	0.001
Income	0.1206043**	0.0349671	0.001	0.1287132***	0.0355427	0.000
Education	0.2637073	0.1688892	0.118	0.312045+	0.1715339	0.069
Subjective Numeracy (SNS-3)				-0.0885238**	0.0328773	0.007
Constant	-1.009318+	0.5790837	0.081	-0.0843523	0.6751843	0.901
N	594			594		
χ^2		98.24			101.45	
df		12			13	

‡ For ease of interpreting coefficients, contrast coding is used for gender such that male = 1, female = -1, and other = 0. Those who prefer not to report their gender are excluded from the analysis with controls.

Age is an integer between 18 and 99. Control variables for income and education are coded as indicated for Table 4-1.

Table 4-8. Mediation Analyses for Both Subjective and Objective Psychological Measures Affecting Savings for the Temporal Reframing Study

To provide some sense of goodness of fit due to limitations of generalized structural equation (GSEM) modeling not supporting goodness of fit measures, structural equation modeling (SEM) was first used. This table explores the mediating roles of both subjective and objectives psychological measures on savings using structural equation modeling using Stata 15, maximum likelihood estimation, and an outcome variable (save = 1 and not save = 0) modeled as a continuous outcome measure per SEM. To ease modeling interpretability contrast codingis used with daily = 1, weekly = 0, and monthly = -1. For the fitted model, N=594, $\chi^2(62)=189.91$, RMSEA=0.059, CFI=0.840, and SRMR=0.063. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

Direct Effects (unstandardized)	b	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Save <-					
- Affordable	0.1787694***	0.1627138	0.194825	21.82	0.000
- Aspect 1 Cost	0.0438141*	0.0055565	0.0820717	2.24	0.025
- Aspect 2 Cost	-0.0355443+	-0.0771144	0.0060257	-1.68	0.094
- Aspect 3 Cost	0.0337565	-0.0116909	0.0792039	1.46	0.145
- Aspect 1 Benefit	0.0539907*	0.009753	0.0982285	2.39	0.017
- Aspect 2 Benefit	0.0419556*	0.0033734	0.0805379	2.13	0.033
- Aspect 3 Benefit	0.036273+	-0.003766	0.076312	1.78	0.076
- Understandable	0.0070719	-0.0129982	0.0271421	0.69	0.490
- Treatment Contrast Code	-0.0339702*	-0.0674498	-0.0004906	-1.99	0.047
- Age	0.0006864	-0.002896	0.0042689	0.38	0.707
- Gender	0.0315592*	0.0046731	0.0584453	2.30	0.021
- Income	0.0049787	-0.0036969	0.0136544	1.12	0.261
- Education	0.0609222**	0.0181767	0.1036677	2.79	0.005
- Subjective Numeracy (SNS-3)	-0.019589***	-0.0282035	-0.0109745	-4.46	0.000
Affordable <-					
- Treatment Contrast Code	0.6131952***	0.4359637	0.7904268	6.78	0.000
Aspect 1 Cost <-					
- Treatment Contrast Code	0.1741667***	0.1047131	0.2436202	4.91	0.000
Aspect 2 Cost <-					
- Treatment Contrast Code	0.1144261***	0.051897	0.1769553	3.59	0.000
Aspect 3 Cost <-					
- Treatment	0.0466966	-0.0103707	0.1037639	1.60	0.109

Direct Effects (unstandardized)	b	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Contrast Code					
Aspect 1 Benefit <-					
- Treatment Contrast Code	0.007438	-0.0522277	0.0671038	0.24	0.807
Aspect 2 Benefit <-					
- Treatment Contrast Code	-0.0106302	-0.0780686	0.0568083	-0.31	0.757
Aspect 3 Benefit <-					
- Treatment Contrast Code	-0.0238534	-0.0897844	0.0420777	-0.71	0.478
Understandable <-					
- Treatment Contrast Code	.2422766***	0.1090833	0.37547	3.57	0.000
Modeled Residual Covariances					
- Affordable & Understandable	.4996611***	0.3090313	0.6902908	5.14	0.000
- Affordable & Aspect 1 Cost	0.2783806***	0.1768327	0.3799286	5.37	0.000
- Aspect 1 Cost & Aspect 2 Cost	0.0248746	-0.0100808	0.0598299	1.39	0.163
- Aspect 2 Cost & Aspect 3 Cost	0.0399228**	0.0106747	0.0691708	2.68	0.007
- Aspect 1 Benefit & Aspect 2 Benefit	.0610571***	0.0283336	0.0937807	3.66	0.000
- Aspect 2 Benefit & Aspect 3 Benefit	.0563915**	0.0204779	0.092305	3.08	0.002

Table 4-9. Mediation Analyses Using Generalized Structural Equation Modeling (GSEM) for Both Subjective and Objective Psychological Measures Affecting Savings for Temporal Reframing Study

This table explores the mediating roles of both subjective and objectives psychological measures on savings using generalized structural equation modeling (GSEM) using Stata 15, maximum likelihood estimation, and a binomial logit outcome variable (where save = 1 and not save = 0). To ease modeling interpretability contrast coding is used for treatment condition with daily = 1, weekly = 0, and monthly = -1. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

Direct Effects (unstandardized)	B	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Save <-					
- Affordable	1.324234***	1.095803	1.552665	11.36	0.000
- Aspect 1 Cost	0.3851237+	-0.0183925	0.78864	1.87	0.061
- Aspect 2 Cost	-0.3251632	-0.7638603	0.1135339	-1.45	0.146
- Aspect 3 Cost	0.4319941+	-0.0606255	0.9246136	1.72	0.086
- Aspect 1 Benefit	0.5043177*	0.0500136	0.9586218	2.18	0.030
- Aspect 2 Benefit	0.552469**	0.1352989	0.9696392	2.60	0.009
- Aspect 3 Benefit	0.3353734	-0.0747524	0.7454992	1.60	0.109
- Understandable	0.143493	-0.0590808	0.3460668	1.39	0.165
- Treatment Contrast Code	-0.4192463*	-0.7861059	-0.0523867	-2.24	0.025
- Age	-0.0069428	-0.0446849	0.0307993	-0.36	0.718
- Gender	0.3333399*	0.0516913	0.6149886	2.32	0.020
- Income	0.0656691	-0.0328804	0.1642187	1.31	0.192
- Education	0.7209854**	0.2379266	1.204044	2.93	0.003
- Subjective Numeracy (SNS-3)	-0.199721***	-0.2954239	-0.1040182	-4.09	0.000
Affordable <-					
- Treatment Contrast Code	0.6131952***	0.4359637	0.7904268	6.78	0.000
Aspect 1 Cost <-					
- Treatment Contrast Code	0.1741667***	0.1047131	0.2436202	4.91	0.000
Aspect 2 Cost <-					
- Treatment Contrast Code	0.1144261***	0.051897	0.1769553	3.59	0.000
Aspect 3 Cost <-					

Direct Effects (unstandardized)	B	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
- Treatment Contrast Code	0.0466966	-0.0103707	0.1037639	1.60	0.109
Aspect 1 Benefit <-					
- Treatment Contrast Code	0.007438	-0.0522277	0.0671038	0.24	0.807
Aspect 2 Benefit <-					
- Treatment Contrast Code	-0.0106302	-0.0780686	0.0568083	-0.31	0.757
Aspect 3 Benefit <-					
- Treatment Contrast Code	-0.0238534	-0.0897844	0.0420777	-0.71	0.478
Understandable <-					
- Treatment Contrast Code	.2422766***	0.1090833	0.37547	3.57	0.000
Modeled Residual Covariances					
- Affordable & Understandable	.4996611***	0.3090313	0.6902908	5.14	0.000
- Affordable & Aspect 1 Cost	0.2783806***	0.1768327	0.3799286	5.37	0.000
- Aspect 1 Cost & Aspect 2 Cost	0.0248746	-0.0100808	0.0598299	1.39	0.163
- Aspect 2 Cost & Aspect 3 Cost	0.0399228**	0.0106747	0.0691708	2.68	0.007
- Aspect 1 Benefit & Aspect 2 Benefit	.0610571***	0.0283336	0.0937807	3.66	0.000
- Aspect 2 Benefit & Aspect 3 Benefit	.0563915**	0.0204779	0.092305	3.08	0.002

Table 4-10. Mediation Analyses Using Generalized Structural Equation Modeling (GSEM) for Objective Psychological Measures Affecting Savings for Temporal Reframing Study

Since subjective affordability measures correlate with certain objective psychological thoughts as elicited from participants through Query Theory, the analysis summarized in this table provides a robustness check to see to what extent objective psychological thoughts on their own mediate savings. The analysis involves generalized structural equation modeling (GSEM) using Stata 15, maximum likelihood estimation, and a binomial logit outcome variable (where save = 1 and not save = 0). Since prior analyses have generally yielded the result that daily, weekly, and monthly framing result in a percentage of savers that moves from higher to lower, to ease modeling interpretability we have contrast coded the treatment condition as daily = 1, weekly = 0, and monthly = -1. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

Direct Effects (unstandardized)	B	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
Save <-					
- Aspect 1 Cost	0.7233787***	0.4465693	1.000188	5.12	0.000
- Aspect 2 Cost	0.2380664	-0.061024	0.5371567	1.56	0.119
- Aspect 3 Cost	0.1854602	-0.1478464	0.5187669	1.09	0.275
- Aspect 1 Benefit	0.6415076***	0.3128148	0.9702004	3.83	0.000
- Aspect 2 Benefit	0.4293921**	0.1361417	0.7226425	2.87	0.004
- Aspect 3 Benefit	0.5335965***	0.2393066	0.8278864	3.55	0.000
- Treatment Contrast Code	0.2813959*	0.0387024	0.5240894	2.27	0.023
- Age	0.0104927	-0.0161457	0.0371311	0.77	0.440
- Gender	0.3479627**	0.1483809	0.5475445	3.42	0.001
- Income	0.1289438***	0.0596086	0.1982791	3.64	0.000
- Education	0.311926+	-0.011494	0.6353461	1.89	0.059
- Subjective Numeracy (SNS-3)	-0.0889436**	-0.1540364	-0.0238508	-2.68	0.007
Aspect 1 Cost <-					
- Treatment Contrast Code	0.1741667***	0.1045406	0.2437927	4.90	0.000
Aspect 2 Cost <-					
- Treatment Contrast Code	0.1144261***	0.051941	0.1769113	3.59	0.000
Aspect 3 Cost <-					
- Treatment Contrast Code	0.0466966	-0.0103707	0.1037639	1.60	0.109
Aspect 1 Benefit <-					

Direct Effects (unstandardized)	B	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z	p-value
- Treatment Contrast Code	0.007438	-0.0522277	0.0671038	0.24	0.807
Aspect 2 Benefit <-					
- Treatment Contrast Code	-0.0106302	-0.0780686	0.0568083	-0.31	0.757
Aspect 3 Benefit <-					
- Treatment Contrast Code	-0.0238534	-0.0897844	0.0420777	-0.71	0.478
Modeled Residual Covariances					
- Aspect 1 Cost & Aspect 2 Cost	0.0441053*	0.0085865	0.0796241	2.43	0.015
- Aspect 2 Cost & Aspect 3 Cost	0.0372759*	0.0081454	0.0664064	2.51	0.012
- Aspect 1 Benefit & Aspect 2 Benefit	0.0610572*	0.0283337	0.0937808	3.66	0.000
- Aspect 2 Benefit & Aspect 3 Benefit	.0563915**	0.020478	0.0923051	3.08	0.002

Table 4-11. Experimental Balance Across Randomly Assigned Treatment Conditions for Temporal Reframing with Income Uncertainty Lab Study

This table summarizes the characteristics of participants in terms of the treatment conditions (i.e., daily, monthly, and free response framing). Note that the second to last row reports chi-squared statistics for education and the percentage of male. The last row reports for all other covariates both statistical tests for means and variances. For the means, a one-way ANOVA is reported with an F-statistic and p-value. For variances, a Bartlett's test for equal variances is reported with a $\chi^2(2)$ for gender or $\chi^2(6)$ for education, and p-value. For statistical tests, the null hypothesis is that the groups are equal, and underline formatting in the table indicates cases where the null hypothesis is rejected at $\alpha=0.05$ (i.e., treatment groups are not equal).

	Mean Age (standard deviation)	Percentage Male *	Mean Annual Income ** (standard deviation)	Percent Education (GCSE / A-Levels / Undergrad / Postgrad) †	Risk Aversion (standard deviation) ††	Loss Aversion (standard deviation) †††	Observations
Daily	40.23 (13.24)	38.4	6.09 (3.60)	13.74% / 25.82% / 39.56% / 20.88%	3.30 (1.33)	4.71 (3.26)	371
Monthly	41.91 (13.83)	40.6	6.18 (3.41)	15.55% / 25.74% / 37.53% / 21.18%	3.38 (1.35)	4.92 (3.38)	381
Free Response	40.39 (13.16)	40.8	6.20 (3.40)	15.17% / 21.36% / 40.87% / 22.60%	3.28 (1.33)	4.32 (3.22)	329
Overall	40.87 (13.44)	39.9	6.15 (3.47)	14.81% / 24.43% / 39.25% / 21.51%	3.32 (1.34)	4.67 (3.30)	1,081
Chi-squared for percentage male and education [p-value]	N/A	0.53 [0.77]	N/A	3.01 [0.81]	N/A	N/A	

	Mean Age (standard deviation)	Percentage Male *	Mean Annual Income ** (standard deviation)	Percent Education (GCSE / A-Levels / Undergrad / Postgrad) †	Risk Aversion (standard deviation) ††	Loss Aversion (standard deviation) †††	Observations
(F-statistic for means, Bartlett's χ^2 for variance) [p-value mean, p-value variance]	(1.75, 1.09) [0.18, 0.58]	N/A	(0.10, 1.48) [0.91, 0.48]	N/A	(0.49, 0.09) [0.61, 0.95]	(2.25, 0.68) [0.11, 0.71]	

* Note that this only includes participants reporting male or female for gender and excludes those reporting "other" or "prefer not to say." However, note that of 1,801 participants that 14 participants reported a gender of either "other" of "prefer not to say" and that these observations were split between the daily (4 observations), monthly (7 observations), and free response (3 observations) conditions. So, in the gender column there are a total of 1,067 observations.

****** Income is coded as follows:

1: £4,999 a year or less

2: From £5,000 to £9,999 a year

3: From £10,000 to £14,999 a year

4: From £15,000 to £19,999 a year

5: From £20,000 to £24,999 a year

6: From £25,000 to £29,999 a year

7: From £30,000 to £34,999 a year

8: From £35,000 to £39,999 a year

9: From £40,000 to £44,999 a year

10: From £45,000 to £49,999 a year

11: From £50,000 to £54,999 a year

12: From £55,000 to £59,999 a year

13: From £60,000 to £64,999 a year

14: From £65,000 to £69,999 a year

15: From £70,000 to £74,999 a year

16: From £75,000 to £79,999 a year

17: From £80,000 to £84,999 a year

18: From £85,000 to £89,999 a year

19: £90,000 a year or more

-1: Prefer not to say

Those who preferred not to report their income (38 total observations with 15 in daily, 13 in monthly, and 10 in free response conditions) have been excluded from these statistics.

† If a participant answered "other" for the education question then they were excluded from these statistics. A total of 21 respondents indicated other (7 in daily, 8 in monthly, and 6 in free response conditions).

†† For individual behavioral difference of risk aversion (small stakes), the following scale applies:

1 indicates risk premium <=12.5%

2 indicates 12.5%< risk premium <=25%

3 indicates 25%< risk premium <=35%

4 indicates 35%< risk premium <40%

5 indicates 40%<= risk premium <= 45%

6 indicates risk premium > 45%

††† For the individual behavioral difference of loss aversion, this number reflects an estimate of a person's sensitivity to losses versus gains, in essence a "loss magnification ratio" for the individual. The numbers in the column exclude participants who made inconsistent choices during the loss aversion assessment. Of 1,081 participants, 263 participants made inconsistent choices (89 in daily, 89 in monthly, 85 in free response), and so this column reflects 818 participants who made consistent choices. Note that the median loss aversion for these participants was 3.5, which is somewhat higher than loss aversion measured in other populations but not unusual.

Table 4-12. Summary of Participant Assignment to Temporal Reframing and Income Level Variability Factors

	No Income Variability	Medium Income Variability	High Income Variability	Total
Daily	129	122	120	371
Monthly	133	123	125	381
Free Response	106	105	118	329
Total	368	350	363	1,081

Table 4-13. Summary of Mean Annualized Savings Amounts By Treatment Condition

This tables summarizes means and standard errors of annualized savings amounts (in UK pounds) by treatment condition. Standard errors are in parentheses. N = 1,075 with 6 null values for savings rates.

	No Income Variability	Medium Income Variability	High Income Variability	Total
Daily	6238.9 (1036.13)	10109.6 (1930.9)	8298.9 (1692.38)	8177.7 (913.5)
Monthly	2769.1 (230.9)	3108.9 (845.9)	2574.7 (283.9)	2815.8 (300.2)
Free Response	3963.4 (338.6)	4383.3 (404.7)	3373.2 (315.3)	3886.8 (204.3)
Total	4335.7 (394.5)	5931.5 (762.0)	4726.4 (590.8)	4986.1 (344.7)

Table 4-14. Main Effect of Temporal Framing and Income Uncertainty on Annual Savings Amounts

This table reports the results of ordinary least squares regressions where the outcome variable is winsorized annual savings amount. Parentheses indicate p-values. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	Model 1	Model 2	Model 3	Model 4	Model 5
dailycond	5361.9***	5363.4***	5356.2***	4993.2***	5264.8***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
freecond	1071.0	1056.5	1060.1	924.4	1044.2
	(0.200)	(0.207)	(0.205)	(0.273)	(0.304)
incvarlevel		238.6	2976.2*	3008.1*	3028.3+
		(0.562)	(0.047)	(0.047)	(0.097)
incvarlevelsq			-1370.4+	-1287.9+	-1362.8
			(0.057)	(0.077)	(0.121)
age_mc				-99.35***	-117.3***
				(0.000)	(0.000)
gender_recode				-789.9*	-954.7*
				(0.026)	(0.029)
income_mc				-34.86	-3.673
				(0.737)	(0.977)
education				373.8	165.1
				(0.309)	(0.710)
riskaversion					144.5
					(0.660)
lascore					-100.9
					(0.434)
_cons	2815.8***	2582.3***	2140.7**	918.9	1640.0
	(0.000)	(0.000)	(0.004)	(0.455)	(0.391)
N	1075	1075	1075	1013	769

Table 4-15. Main Effect of Temporal Framing and Income Uncertainty on Self-Reported Perceptions of Affordability

This table reports the results of ordinary least squares regressions where the outcome variable is self-reported perceptions of affordability. Self-reported perceptions of affordability are measured using a Likert scale of 1 to 6 where a 1 indicates strongly disagree and 6 indicates strongly agree with the statement "I found the option to be affordable"). Parentheses indicate p-values. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	Model 1	Model 2	Model 3	Model 4	Model 5
dailycond	0.0256	0.0251	0.0248	0.0569	0.0485
	(0.731)	(0.734)	(0.736)	(0.452)	(0.569)
freecond	0.00216	0.0110	0.0112	0.0507	0.0975
	(0.977)	(0.885)	(0.883)	(0.516)	(0.274)
incvarlevel		-0.154***	-0.0780	-0.132	-0.194
		(0.000)	(0.567)	(0.349)	(0.224)
incvarlevelsq			-0.0381	-0.0188	0.00352
			(0.562)	(0.781)	(0.964)
age_mc				-0.000687	-0.00128
				(0.775)	(0.638)
gender_recode				-0.0455	-0.0857*
				(0.166)	(0.025)
income_mc				-0.0127	-0.0267*
				(0.187)	(0.015)
education				-0.0899**	-0.100*
				(0.008)	(0.011)
riskaversion					-0.0413
					(0.152)
lascore					-0.0264*
					(0.020)
_cons	4.648***	4.799***	4.787***	5.022***	5.334***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

	Model 1	Model 2	Model 3	Model 4	Model 5
N	1081	1081	1081	1018	772

Table 4-16. Main Effect of Temporal Framing and Income Uncertainty on Self-Reported Perceptions of Riskiness

This table reports the results of ordinary least squares regressions where the outcome variable is self-reported perceptions of risky. Self-reported perceptions of riskiness are measured using a Likert scale of 1 to 6 where a 1 indicates strongly disagree and 6 indicates strongly agree with the statement "I found the option to be risky"). Parentheses indicate p-values. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	Model 1	Model 2	Model 3	Model 4	Model 5
dailycond	-0.0669	-0.0661	-0.0656	-0.115	-0.143
	(0.427)	(0.426)	(0.429)	(0.176)	(0.135)
freecond	-0.0237	-0.0373	-0.0376	-0.0771	-0.0938
	(0.785)	(0.663)	(0.661)	(0.379)	(0.348)
incvarlevel		0.237***	0.0884	0.123	0.124
		(0.000)	(0.565)	(0.435)	(0.489)
incvarlevelsq			0.0742	0.0523	0.0746
			(0.316)	(0.491)	(0.389)
age_mc				-0.00493+	-0.00276
				(0.067)	(0.367)
gender_recode				-0.00104	-0.00173
				(0.977)	(0.968)
income_mc				-0.00116	0.0118
				(0.915)	(0.338)
education				0.0259	0.0288
				(0.498)	(0.511)
riskaversion					0.0179
					(0.579)
lascore					0.0175
					(0.168)
_cons	2.619***	2.388***	2.412***	2.362***	2.165***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

	Model 1	Model 2	Model 3	Model 4	Model 5
N	1081	1081	1081	1018	772

Table 4-17. Structural Equation Model for Temporal Reframing Under Uncertainty Study

The table and path diagram below depict the results of structural equation modeling using maximum likelihood estimation with robust standard errors and winsorized annualized savings amount as the outcome variable. Independent variables include daily treatment indicator, income variability level (and the squared variable), demographic controls, and individual behavioral differences. Additionally, perceptions of riskiness are modelled for evaluation as a mediator. N = 769 which reflects participant exclusions for those who choose not to report gender, choose not to report income, choose to report other for education, and make inconsistent choices for the loss aversion assessment. SRMR = 0.011 for the model. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf. Interval]	
Structural						
annualsave_w						
risky	-468.1313	386.2689	-1.21	0.226	-1225.204	288.9417
dailycond	4736.864	1070.035	4.43	0.000	2639.634	6834.095
incvarlevel	3090.288	1863.123	1.66	0.097	-561.3655	6741.941
incvarlevelsq	-1316.043	962.2269	-1.37	0.171	-3201.973	569.8868
age_mc	-119.4235	32.52395	-3.67	0.000	-183.1693	-55.67774
income_mc	5.294592	95.45694	0.06	0.956	-181.7976	192.3868
gender_recode	-960.8586	359.5033	-2.67	0.008	-1665.472	-256.2451
education	204.4781	349.084	0.59	0.558	-479.7139	888.6701
riskaversion	154.7285	447.5066	0.35	0.73	-722.3684	1031.825
lascore	-103.5256	135.7142	-0.76	0.446	-369.5207	162.4694
risky						
dailycond	-0.1058874	0.0831275	-1.27	0.203	-0.2688143	0.0570396
incvarlevel	0.2683645	0.0495181	5.42	0.000	0.1713107	0.3654182

4.9 Online Appendix: Chapter 4 Lab Studies Materials

Section A – Stimulus for Temporal Reframing Lab Study

Instructions

Please read all instructions in this survey carefully. In this survey we would like to learn about how you would make a savings decision.

Suppose you have just signed up to use a financial services app provided by a trustworthy company for use on your mobile phone. The mobile app allows you to:

- save spare change by rounding up purchases to the next dollar,
- make one-time deposits into your account at any time you choose, and
- invest all or a portion of your money into pre-designed financial portfolios that are tailored to your goals, such as by degree of risk and return.

Question 1

Imagine you are using the app, and it tells you "Investing on a regular basis is one of the best ways to grow your wealth. You can get started with [$5 a day][$35 a week][$150 a month] today."

I choose: (side-by-side design)

- Not now
- Yes, start saving

Question 2

Recall the previous question, where you were given an option to save [$5 a day][$35 a week][$150 a month] today.

What was your attitude toward this option?

Items	Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
a) I found the option to be affordable.	1	2	3	4	5	6	7
b) I found the description of the option to be clear and understandable.	1	2	3	4	5	6	7

Question 3

Please list three things you were thinking about when you were given an option to save [$5 a day][$35 a week][$150 a month] today.

1: {Item1}

2: {Item2}

3: {Item3}

Question 4a to 4c (4a – Item1, 4b – Item 2, 4c – Item 3):

As the {first, second, or third} item you listed, you wrote:

“{Item1, Item 2, or Item3}”

Would you characterize this item as closest to:

- a smaller cost
- a larger cost
- a smaller benefit
- a larger benefit
- none of the above

We would now like to ask you some questions about yourself.

Question 5

Please select an answer for each row:

Items	Not at all good	-	-	-	-	Extremely good
a) How good are you at working with fractions?	1	2	3	4	5	6
b) How good are you at working with percentages?	1	2	3	4	5	6
c) How good are you at calculating a 15% tip?	1	2	3	4	5	6
d) How good are you at figuring out how much a shirt will cost if it is 25% off?	1	2	3	4	5	6

Question 6

Please answer the following question:

Items	Never	-	-	-	-	Very often
How often do you find numerical information to be useful?	1	2	3	4	5	6

Now we would like to ask you a few additional financial questions.

Question 7

Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

- More than $102
- Exactly $102
- Less than $102
- Do not know
- Refuse to answer

Question 8

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy more than, exactly the same as, or less than today with the money in this account:

- More than today
- Exactly the same as today
- Less than today
- Do not know
- Refuse to answer

Question 9

Do you think that the following statement is true or false? “Buying a single company stock usually provides a safer return than a stock mutual fund.”

- True
- False
- Do not know
- Refuse to answer

We would now like to ask you some questions about the type of work you do.

Question 10

Take a moment to think about all of the work you do. Now please carefully read all of the items below, and select *all* of the items that apply to you.

- ☐ **I work directly with an employer and have a manager.** (This means that you are typically paid by an employer and issued a W-2 tax form.)
- ☐ **I do independent contract work, but not obtained through an online platform.** (This means that you are typically paid by a customer and issued a 1099 tax form.)
- ☐ **I do crowdwork through an online platform.** (This means that you work to complete tasks which are typically performed remotely, such as those obtained through Upwork, Crowdflower, Amazon MTurk, etc.)
- ☐ **I do work on demand via apps.** (This means that you do traditional work which is typically performed in-person and obtained through an app. Examples include but are not limited to transport, repair services, cleaning, errands, etc. such as through apps like Uber, Lyft, TaskRabbit, etc.)
- ☐ **I earn money through the "sharing economy" and through an online platform.** (This means that you earn money through sharing resources, such as renting a room in your home through platforms like Airbnb.)

Question 11

Approximately what percent of your *annual income* is from each of the following sources? (Total must sum to 100):

- Work directly with an employer ____%
- Independent contract work ____%
- Crowdwork ____%
- Work on demand via apps ____%
- Sharing economy ____%
- Other ____%

Question 12

Approximately what percent of your *work time* is spent on each of the following? (Total must sum to 100):

- Work directly with an employer ____%
- Independent contract work ____%
- Crowdwork ____%
- Work on demand via apps ____%
- Sharing economy ____%
- Other ____%

Question 13

How frequently do you receive payment for your work related to each of the following?

Work directly with an employer	- Annually - Monthly - 2 times per month - Weekly - Daily - Per task, job, or project - Other - Does not apply
Independent contract work	*Same dropdown list as above*
Crowdwork	*Same dropdown list as above*
Work on demand via apps	*Same dropdown list as above*
Sharing economy	*Same dropdown list as above*
Other	*Same dropdown list as above*

Question 14

Which of the following best describes why you perform crowdwork or work on demand via apps?

(Note: This question only applies for those that answered "Crowdwork" or "Work on demand via apps" for Question 11)

☐ I need to get by

☐ It enables me to have a good quality of life (e.g., flexibility, independence, control)

☐ I like to earn some money on the side

☐ Other (Please specify)

Question 15

What is your age (in years)? ________ *(Research coding note: 18 to 99)*

Question 16

What is your gender?

- Male
- Female
- Other
- Prefer not to say

Question 17

What is your annual income?

- $9,999 a year or less
- From $10,000 to $19,999 a year
- From $20,000 to $29,999 a year
- From $30,000 to $39,999 a year
- From $40,000 to $49,999 a year
- From $50,000 to $59,999 a year
- From $60,000 to $69,999 a year
- From $70,000 to $79,999 a year
- From $80,000 to $89,999 a year
- From $90,000 to $99,999 a year
- From $100,000 to $109,999 a year
- From $110,000 to $119,999 a year
- From $120,000 to $129,999 a year
- From $130,000 to $139,999 a year
- From $140,000 to $149,999 a year
- $150,000 a year or more
- Prefer not to say

Question 18

What is the highest degree or level of school you have completed? If currently enrolled, please indicate highest degree received.

- High school
- College degree
- Advanced degree

Thank you for your participation in this survey!

Section B – Stimulus for Temporal Reframing Lab with Income Uncertainty Study

Instructions

Please read all instructions in this survey carefully. In this survey we would like to learn about how you would make a financial decision.

Imagine that you are hired to work on a part-time contract basis, and this work serves as your primary source of income.

The company that you work for is a new business, and sales for the company are driven by external factors outside of their control. However, you earn fifteen pounds (£15) per hour that you work, and your contract specifies that
[you will get a guaranteed 30 hours of work per week. In the last five weeks, you have had 30 hours of work every week.]
[you will get an uncertain amount of work between 20 to 40 hours of work per week. In the last five weeks, you have had 40, 20, 20, 40, and 30 hours of work.]
[you will get an uncertain amount of work between 10 to 50 hours of work per week. In the last five weeks, you have had 50, 10, 10, 50, and 30 hours of work.]

Now suppose that you have access to a financial services app provided by a trustworthy company for use on your mobile phone. The mobile app allows you to:

- make one-time deposits into your account at any time you choose,
- invest all or a portion of your money into pre-designed financial portfolios that are tailored to your goals, such as amount of risk and return, and
- start to set aside a rainy day or emergency fund that would cover your expenses for a few months.

Question 1:

Daily condition:

Recall that you earn fifteen pounds (£15) per hour that you work, and your contract specifies that [you will get a guaranteed 30 hours of work per week. In the last five weeks, you have had 30 hours of work every week.] [you will get an uncertain amount of work between 20 to 40 hours of work per week. In the last five weeks, you have had 40, 20, 20, 40, and 30 hours of work.] [you will get an uncertain amount of work between 10 to 50 hours of work per week. In the last five weeks, you have had 50, 10, 10, 50, and 30 hours of work.]

How much would you choose to save into either a rainy day or emergency fund for yourself?

(If you do not wish to save, please enter the number 0 in the field below and press the next button.)

(If you wish to save a different amount, please leave the field below blank and press the next button.)

£____ per day

(if the latter option is selected, then branch to free response condition with the pretext, "By entering a blank for the answer to the previous question, you have indicated that you wish to save a different amount.")

Monthly condition:

Recall that you earn fifteen pounds (£15) per hour that you work, and your contract specifies that [you will get a guaranteed 30 hours of work per week. In the last five weeks, you have had 30 hours of work every week.] [you will get an uncertain amount of work between 20 to 40 hours of work per week. In the last five weeks, you have had 40, 20, 20, 40, and 30 hours of work.] [you will get an uncertain amount of work between 10 to 50 hours of work per week. In the last five weeks, you have had 50, 10, 10, 50, and 30 hours of work.]

How much would you choose to save into either a rainy day or emergency fund for yourself?
(If you do not wish to save, please enter the number 0 in the field below and press the next button.)
(If you wish to save a different amount, please leave the field below blank and press the next button.)
£____ per month
(if the latter option is selected, then branch to free response condition with the pretext, "By entering a blank for the answer to the previous question, you have indicated that you wish to save a different amount.")

Free response condition:
Recall that you earn fifteen pounds (£15) per hour that you work, and your contract specifies that [you will get a guaranteed 30 hours of work per week. In the last five weeks, you have had 30 hours of work every week.] [you will get an uncertain amount of work between 20 to 40 hours of work per week. In the last five weeks, you have had 40, 20, 20, 40, and 30 hours of work.] [you will get an uncertain amount of work between 10 to 50 hours of work per week. In the last five weeks, you have had 50, 10, 10, 50, and 30 hours of work.]

How much would you choose to save into either a rainy day or emergency fund for yourself?
(If you do not wish to save, please enter the number 0 in the field below and press the next button.)

____

Question 1 follow-up part 1 *(conditionally displayed)***:**
<Page break>
For no anchor conditions (or daily and monthly conditions which branch through the free response condition) where users fills in a free-text response:
In the previous answer regarding how much you would choose to save, you indicated
"<user text>".

Based on that, approximately what would your projected total amount of savings be for the year?

Total savings for the year in pounds (£) ______

Question 1 follow-up part 2 *(conditionally displayed)*:

Please briefly describe how you calculated total savings for the year. ___________

Question 2

Recall the previous scenario related to savings.

What was your attitude toward this option?

Items	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
c) I found the option to be affordable.	1	2	3	4	5	6
d) I found the option to be risky.	1	2	3	4	5	6

Question 3

Suppose you are offered the following choice.

- Choice 1: A guaranteed win of £100
- Choice 2: A single coin flip with a 50% chance of landing heads and a 50% chance of landing tails. If the coin lands on heads you win £200. If the coin lands on tails you only win £70.

Which would you choose?

- Choice 1
- Choice 2

(Note: If user chooses Choice 1, then branch to Question 4.2. Otherwise, branch to Question 4.1.)

Question 4

Question 4.1:

Suppose you are offered the following choice.

- Choice 1: A guaranteed win of £100
- Choice 2: A single coin flip with a 50% chance of landing heads and a 50% chance of landing tails. If the coin lands on heads you win £200. If the coin lands on tails you only win £50.

Which would you choose?

- Choice 1
- Choice 2

(Note: If user chooses Choice 1, then RiskAversion=3 and branch to Question 6. Otherwise, branch to Question 5.1.)

Question 4.2

Suppose you are offered the following choice.

- Choice 1: A guaranteed win of £100
- Choice 2: A single coin flip with a 50% chance of landing heads and a 50% chance of landing tails. If the coin lands on heads you win £200. If the coin lands on tails you only win £80.

Which would you choose?

- Choice 1
- Choice 2

(Note: If user chooses Choice 1, then branch to Question 5.2. Otherwise, RiskAversion=4 and branch to Question 6.)

Question 5

Question 5.1:

Suppose you are offered the following choice.

- Choice 1: A guaranteed win of £100
- Choice 2: A single coin flip with a 50% chance of landing heads and a 50% chance of landing tails. If the coin lands on heads you win £200. If the coin lands on tails you only win £25.

Which would you choose?

- Choice 1
- Choice 2

(Note: If user chooses Choice 1, then RiskAversion=2 and branch to Question 6. Otherwise, RiskAversion=1 and branch to Question 6.)

Question 5.2:

Suppose you are offered the following choice.

- Choice 1: A guaranteed win of £100
- Choice 2: A single coin flip with a 50% chance of landing heads and a 50% chance of landing tails. If the coin lands on heads you win £200. If the coin lands on tails you only win £90.

Which would you choose?

- Choice 1
- Choice 2

(Note: If user chooses Choice 1, then RiskAversion=6 and branch to Question 6. Otherwise, RiskAversion=5 and branch to Question 6.)

Questions 6 through 15

On each of the following 10 pages, you will see a pair of gambles. Each gamble has three equally likely outcomes. As an example, if you were to choose the following gamble

£500
£0
-£300

Then you would have an equal chance of either:

- winning £500
- neither winning nor losing any money or
- losing £300

For each page, please choose which gamble you prefer.

[The next ten screens consist of pairs of a Loss Averse (LA) gamble and Gain Seeking (GS) gamble being presented one pair at a time, randomly drawn from a pre-determined set of 10 gamble pairs without replacement. For each pair, whether the LA gamble or GS gamble appears on the left or right should also be randomized based on a coin flip.]

SCREENS 1 to 10 (Loop until all gamble pairs presented in random order):

Gamble pair #1:

Each gamble has three equally likely outcomes. Which gamble would you take?

£200	£100
£0	£0
-£300	-£100

Gamble pair #2:

Each gamble has three equally likely outcomes. Which gamble would you take?

£300	£100
£0	£0
-£300	-£100

Gamble pair #3:

Each gamble has three equally likely outcomes. Which gamble would you take?

£350	£100
£0	£0
-£300	-£100

Gamble pair #4:

Each gamble has three equally likely outcomes. Which gamble would you take?

£400	£100
£0	£0
-£300	-£100

Gamble pair #5:

Each gamble has three equally likely outcomes. Which gamble would you take?

£500	£100
£0	£0
-£300	-£100

Gamble pair #6:

Each gamble has three equally likely outcomes. Which gamble would you take?

£600	£100
£0	£0
-£300	-£100

Gamble pair #7:

Each gamble has three equally likely outcomes. Which gamble would you take?

£700	£100
£0	£0
-£300	-£100

Gamble pair #8:

Each gamble has three equally likely outcomes. Which gamble would you take?

£900	£100
£0	£0
-£300	-£100

Gamble pair #9:

Each gamble has three equally likely outcomes. Which gamble would you take?

£1100	£100
£0	£0
-£300	-£100

Gamble pair #10:

Each gamble has three equally likely outcomes. Which gamble would you take?

£2100	£100
£0	£0
-£300	-£100

Question 16

What is your age (in years)? ________ *(Research coding note: 18 to 99)*

Question 17

What is your gender?

- Male
- Female
- Other
- Prefer not to say

Question 18

What is your annual income?

- £4,999 a year or less
- From £5,000 to £9,999 a year
- From £10,000 to £14,999 a year
- From £15,000 to £19,999 a year
- From £20,000 to £24,999 a year
- From £25,000 to £29,999 a year
- From £30,000 to £34,999 a year
- From £35,000 to £39,999 a year
- From £40,000 to £44,999 a year
- From £45,000 to £49,999 a year
- From £50,000 to £54,999 a year
- From £55,000 to £59,999 a year
- From £60,000 to £64,999 a year
- From £65,000 to £69,999 a year
- From £70,000 to £74,999 a year
- From £75,000 to £79,999 a year
- From £80,000 to £84,999 a year
- From £85,000 to £89,999 a year
- £90,000 a year or more
- Prefer not to say

Question 19

What is the highest degree or level of school you have completed? If currently enrolled, please indicate highest degree received.

- General Certificate of Secondary Education (GCSE)
- Advanced (A Levels) or equivalent
- Undergraduate
- Postgraduate
- Other _______ (please specify)

Thank you for your participation in this survey!

4.10 Online Appendix: Chapter 4 Supplemental Analyses

Table 4S2-1. Floodlight Analyses of Framing Differences on Savings Intentions for Temporal Reframing Study Across the Range of Financial Literacy

To explore the moderating role of financial literacy on intentions to participate in recurring savings, logistic regressions are conducted on the daily versus weekly conditions. The decision to save is used as the outcome variable with independent variables for a daily framing indicator (daily=1, monthly=0), financial literacy score, the interaction between daily framing indicator and financial literacy score, and demographic controls of age, gender, income, and education. The coefficient on the interaction term is negative but not significant without controls (B=-0.427, p=0.118) and is negative but not significant with controls (B=-0.296, p=0.302).

($5 per day versus $35 per week comparisons with controls)

Financial Literacy	Logit Treatment Difference for Savings (Daily vs. Weekly)	Lower 95% Confidence Interval	Upper 95% Confidence Interval	z(401)	P>|z|
0	1.148	-0.317	2.614	1.53	0.125
1	0.852+	-0.095	1.799	1.76	0.078
2	0.556*	0.032	1.080	2.08	0.037
3	0.261	-0.271	0.792	0.96	0.337

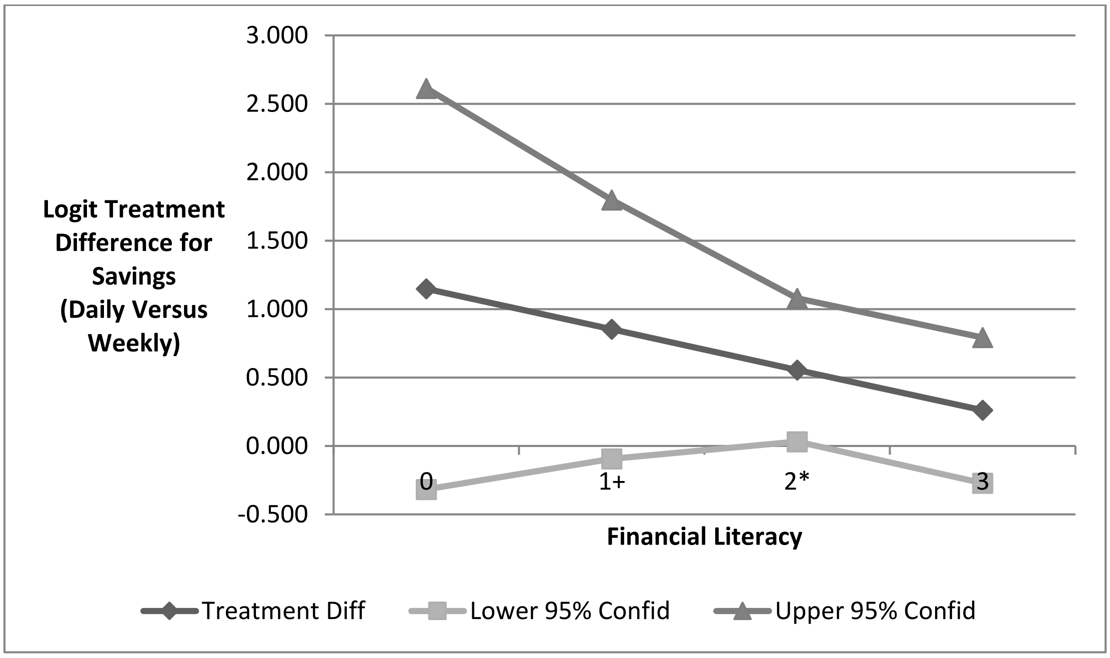

Table 4S2-2. Robustness Check of Main Effect of Temporal Framing and Income Uncertainty on Annual Savings Amounts

This table reports the results of ordinary least squares regressions where the outcome variable is winsorized annual savings amount (robustness check case where instead of 360 days per year, 346 days are used and instead of 12 months per year, 11.5 months are assumed for the annualized amounts). Parentheses indicate p-values. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	Model 1	Model 2	Model 3	Model 4	Model 5
dailycond	5270.3***	5271.6***	5264.6***	4910.0***	5175.6***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
freecond	1182.2	1168.1	1171.6	1038.9	1161.5
	(0.147)	(0.153)	(0.151)	(0.207)	(0.241)
incvarlevel		231.2	2916.4*	2945.0*	2963.1+
		(0.565)	(0.046)	(0.047)	(0.096)
incvarlevelsq			-1344.2+	-1262.5+	-1334.8
			(0.056)	(0.076)	(0.119)
age_mc				-96.76***	-114.3***
				(0.000)	(0.000)
gender_recode				-768.6*	-927.9*
				(0.026)	(0.029)
income_mc				-33.89	-3.630
				(0.738)	(0.976)
education				369.7	166.6
				(0.302)	(0.701)
riskaversion					141.8
					(0.658)
lascore					-98.59
					(0.434)
_cons	2704.6***	2478.3***	2045.2**	841.5	1541.3
	(0.000)	(0.000)	(0.004)	(0.484)	(0.409)

	Model 1	Model 2	Model 3	Model 4	Model 5
N	1075	1075	1075	1013	769

Table 4S2-3. Exploratory Analysis of Risk Aversion and Loss Aversion as Moderators

This table reports the results of ordinary least squares regressions where the outcome variable is winsorized annual savings amount. Parentheses indicate p-values. +, p<0.10; *, p<0.05; **, p<0.01; ***, p<0.001.

	Model 1	Model 2	Model 3	Model 4
dailycond	4527.9*	4989.7***	6360.6***	5254.3***
	(0.022)	(0.000)	(0.000)	(0.000)
freecond	918.1	999.4	1105.6	743.3
	(0.277)	(0.623)	(0.278)	(0.643)
incvarlevel	3008.9*	3009.4*	2994.3	3026.5+
	(0.048)	(0.048)	(0.101)	(0.097)
incvarlevelsq	-1289.8+	-1288.7+	-1350.8	-1361.1
	(0.077)	(0.078)	(0.124)	(0.121)
age_mc	-98.48***	-98.48***	-115.8***	-115.4***
	(0.000)	(0.000)	(0.000)	(0.000)
gender_recode	-810.4*	-809.9*	-998.8*	-987.9*
	(0.025)	(0.025)	(0.020)	(0.022)
income_mc	-35.90	-36.16	-7.607	-9.443
	(0.730)	(0.729)	(0.951)	(0.940)
education	363.7	366.3	145.9	154.6
	(0.324)	(0.320)	(0.742)	(0.727)
riskaversion	-127.5	-71.90		
	(0.695)	(0.819)		
dailyxriskaversion	139.9			
	(0.797)			
freexriskaversion		-23.80		
		(0.966)		
lascore			-14.59	-111.4

	Model 1	Model 2	Model 3	Model 4
			(0.925)	(0.459)
dailyxlascore			-230.0	
			(0.379)	
freexlascore				67.38
				(0.806)
_cons	1369.5	1174.4	1732.2	2184.2
	(0.416)	(0.479)	(0.296)	(0.183)
N	1013	1013	769	769

Chapter 5. Conclusion: Investigations of Pennies, Percent, and Temporal Reframing to Improve Savings

Conclusion

Savings is an important topic as people face many issues in terms of both behavioral challenges (e.g., psychologically viewing savings as more difficult than it is, even considering earnings constraints) and their status of outcomes (e.g., having too little savings or and being on the wrong savings trajectory). These challenges include longer-term savings horizons, such as related to retirement, which may require deliberate savings choices in the present that may have uncertain, yet important implications many decades into a person's future. Challenges also include shorter-term savings horizons, such as related to rainy day savings, where many people fail to have short-term financial reserves and would be unable to pay a few hundred dollars in an emergency. While shorter-term challenges affect a broad swathe of people, the challenges are particularly relevant to workers in the Gig Economy who generally face both more uncertainty working conditions and variable income flows.

The investigations presented in this thesis cover two main threads of behavioral interventions that can be used as part of an implementation or policy "toolkit" for savings choices: 1) pennies reframing and 2) temporal reframing. The investigations include a mixture of lab and field study work. Lab studies have generally been used to explore psychological constructs of human judgment, as well as to provide a controlled environment to test ideas which either may be new to the field or go against the grain of what is currently implemented in the world. Field studies have generally been used to explore human decisions, outcomes, and effect sizes in real-world settings with actual money at stake. Thus, the combination of lab and field studies provide a rich mix of perspectives to explore not only human judgments but also decisions and outcomes, the breadth of which could not be explored through using a narrower set of research methods.

For the pennies-based reframing interventions explored in Chapters 1 and 2, the main conclusions in this thesis are that pennies-based reframing can be used to improve savings rates choices by individuals as compared to the current, status quo use of percent-based framing throughout the financial services industry. The impact is the biggest for lower income earners who could use the most help to save more. One of the primary mechanisms as to why pennies-based reframing works is that it helps to reduce the psychological pain (e.g., perceived costs) of savings judgments. The evidence also suggests that the pennies intervention particularly helps nudge those with lower numeracy or financial literacy (e.g., people who have self-reported that they are less comfortable with working with percentages) toward better savings outcomes. Since pennies-based reframing simply involves transforming how information is presented, it is a relatively inexpensive method to implement as compared to other methods that have been either used or considered in the retirement savings space, such as financial incentives, contribution matching dollars, tax code changes, new technology process flows, or future-self age progression technologies.

For the temporal reframing interventions explored in Chapters 3 and 4, the main conclusions in this thesis are that granular temporal reframing can be used to improve both participation rates in recurring savings and intended savings rates. Similar to the pennies-based reframing studies, granular temporal reframing seems to have the greatest impact on helping lower income earners to save. Evidence of the utility of granular temporal reframing is also demonstrated under conditions of income uncertainty, which is prevalent in the Gig Economy and present in the broader economy as evidenced by the COVID-19 impact on non-Gig Economy work. Notably, a pattern of precautionary savings is observed with an inverted U-shaped pattern of savings increasing with increasing income uncertainty and then starting to reverse with high income uncertainty. The patterns are robust when controlling for individual behavioral differences of risk and loss aversion which have not been previously controlled for in the precautionary savings literature. Granular temporal reframing has an impact on savings whether using a specific, anchored amount (e.g., $5 a day) or using a temporal frame without a specific, anchored amount (e.g., how much do you want to save per day). One primary psychological mechanism that seems apparent for the case of using specific, anchored amounts is that temporal reframing can help to reduce the psychological pain (e.g., perceived costs) of making savings decisions, thus increasing participation in savings. In contrast, when using temporal reframing without a specific, anchored amount, the outcome was not that more people participated but rather that people chose higher savings rates, which were in some sense affordable by definition. The temporal reframing approaches investigated involve modest transformations to the information architecture of a decision environment, and as such, are relatively inexpensive to implement as compared to other methods.

Having been immersed in the research community and applied areas of finance within larger companies for the past few years on pennies reframing work, numerous future research possibilities exist. For example, more work could be pursued to try to isolate the psychology of interventions on exclusively the initial savings rate or the escalator rate. The lab studies run in this thesis involved joint initial savings rate and escalator choices only, and companies may want to explore other retirement interventions, such as only increasing the escalator annual increment rate (e.g., from 1% per year to 2% per year). Given the heterogeneity of effects, research could also be done around personalized targeting of the pennies reframing intervention (e.g., based on demographics, individual behavioral differences, or hybrid machine learning methods). Research could also be done around addressing heterogeneity between hourly and salaried workers, the former of which may find it even more relatable to think about savings pennies for every dollar they earn per hour. Work could also be done to capitalize on the less abstract nature and physicality of pennies (as compared to percentages). For example, static or dynamic imagery could be used around pennies and how small things can multiply and compound over time. There may also be possibilities around using other monetary denominations (e.g., 5 pennies versus 1 nickel).

Natural possibilities for future research around temporal reframing include exploring even more granular temporal reframing (e.g., such as per hour versus per day savings), especially since there may be limits to granularization (e.g., loss aversion may competitively mediate net outcomes at some point). The concept of earning per task or job is common in some Gig Economy jobs (e.g., crowdwork on Amazon Mechanical Turk, work on demand via Instacart), and other academics have expressed curiosity relative to heterogeneity of either earnings or pay schedule (e.g., task versus weekly pay) in the context of temporal reframing. Future research could also address the motivational aspects of temporal-based savings for rainy days (e.g., desires to plan, mitigate future risk), role of underlying risk components (e.g., protection for health versus financial adverse events), and individual behavioral differences. Insights into these areas might help with designing behavioral solutions to increase the adoption and use of rainy day savings accounts or even other products (e.g., insurance).