Informing and Improving Retirement Saving Performance using Behavioral Economics Theory-driven User Interfaces

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ABSTRACT
Can human-computer interaction help people make informed and effective decisions about their retirement savings? We applied the behavioral economic theories of endowment effect and loss aversion to the design of novel retirement saving user interfaces. To examine effectiveness, we conducted an experiment in which 487 participants were exposed to one of three experimental user interface designs of a retirement saving simulator, representing endowment effect, loss aversion and control. Users made 34 yearly asset allocation decisions. We found that designs informed by the endowment effect and loss aversion theories and which communicated to savers the long-term implications of their asset allocation choices, led users to adjust their behavior, make larger and more frequent asset allocation changes, and achieve their saving goals more effectively.

Author Keywords
Retirement saving; personal finance; behavioral economics; behavior change; persuasive technology; financial literacy.

INTRODUCTION
Saving for retirement is one of the biggest investments people make in life. Americans are estimated to hold $19.4 trillion in 401(k) retirement accounts [4], however, most Americans have underfunded retirement accounts [9, 17]. Since retirement saving is commonly managed online through user interfaces, HCI can potentially help us understand and inform people who save for retirement. Three aspects of retirement saving make it particularly difficult for non-experts: First, savers have to make repeated decisions about asset allocations that should decrease in risk over time and understand the effects of multiple saving decisions over time. Second, studies show that the majority of people do not assess risk properly [15]. Third, a common mistake retirement savers make is attempting to maximize returns or minimize volatility [15].

To address these issues, in this study we contribute to HCI research by applying the behavioral economic theories of loss aversion and endowment effect to the design of user interface features for retirement saving. The interface highlights saving goals and future investment performance to convey the long-term implications of asset allocation choices. We tested the utility of this approach and measured the effects of different designs on users' behavior.

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RELATED WORK
A number of behavioral economic theories explain how information can be reframed to encourage better choices [7, 11]. Prospect Theory, a branch of behavioral economics, shows that people are prone to *loss aversion*—they have difficulties thinking about the future in present terms, and react more strongly to losses than to gains [10, 11]. Moreover, people tend not to give up what they have even if they get better options, with low costs of switching—a phenomenon known as the *endowment effect*: Kahneman et al showed that after people are given an object they become mentally invested in it [10]. In a financial context, research shows that investors become attached to funds they own and are reluctant to give up what they have [14, 16]. Fryer et al [7] found that employees who were awarded bonuses at the beginning of the year, with the threat of revoking the bonus based on performance, took more action to maintain good performance than employees who were awarded a year-end bonus. Armstrong and Murlis [1] showed that the prospect of getting a bonus can positively influence employee performance if the criteria for determining the rewards are transparent and unbiased.

Prior HCI research explored how to motivate individuals to change their behavior through design interventions in areas such as healthcare informatics and environmental sustainability—sometimes drawing on behavioral economics [6, 13]. Work on persuasive technology [5] has also influenced HCI research studying how technology can change behavior. Lee et al [13] applied the concept of asymmetric comparison in user interfaces to motivate individuals to choose more healthy food choices. Yun et al [19] used intervention techniques for encouraging energy conservation through the use of information dashboards. Similarly, Froehlich et al [6] applied concepts from behavioral economics to promote environmentally sustainable water usage. These studies show that displaying timely feedback and information about deviating from a goal can dramatically affect individual behavior.

Little HCI research, however, focuses on money-saving behavior. In related areas, researchers explore how people manage and think about their money [12, 18], and how real-

time information about simulated financial transactions leads to better understanding of economic transactions [3].

STUDY

Setting

To study the effects of feedback on deviation from retirement goals on users' behavior, we created an interactive retirement saving simulator (Figures 1-3). We asked users to save $1.5M over 34 years (2014-2048), a reasonable goal given average annual returns of 7.5%. In each simulation "year" participants allocated fixed yearly savings of $10,000 among the three basic asset classes of stocks, bonds and cash. Stocks are the riskiest asset type, but provide the greatest return. Bonds are less risky, but provide a lower return. Cash has no risk and provides minimal return [2]. Once users clicked "submit" on their chosen asset allocation, they moved to the next simulation year. Users were then presented with market behavior of the previous year as well as their portfolio's performance (see Figures 1-3). To make the market performance realistic, we used (unknown to the users) the Dow Jones Industrial Average for stock data and the Fidelity Investment Grade Bond for bond data, both from 1980 to 2014. Actual market data from 1980 represented the simulated year of 2014, 1981 represented 2015, and so on, ending with the simulated year 2048.

Reward mechanism

We recruited via Amazon Mechanical Turk and limited participation to U.S. users with a record of at least 100 tasks at an approval rate exceeding 99%. To motivate users to achieve a retirement goal rather than maximize returns or evade risks [15], we rewarded goal-driven moderate risk. Consequently, users' compensation was $1.00 default pay and a maximum bonus of $4.00 if they met the $1.5 million retirement goal. Deviation from the goal either positively or negatively led to a proportionally lower bonus. This 4/1 bonus/default compensation ratio represents substantial incentive to achieve the savings goal rather than trying to maximize returns with riskier behavior.

Experimental conditions

The simulator presented asset allocation, and the overall value of the user's investments over time (Figures 1-3). In addition, it included an interactive feature enabling users to check the potential outcomes of asset allocation alternatives before locking in their allocation choice for the year. We randomly assigned users to one of three conditions that applied simplified versions of the behavioral economic concepts of loss aversion and endowment effect. We compared these two conditions to a third control condition. All conditions used an annually compounded future value interest formula to estimate investment performance.

The *endowment effect condition* (Figure 1) displayed the savings goal, the estimated outcome of total retirement funds at retirement based on current asset allocations, and the difference between the goal and estimate. The emphasis on the difference between the goal and the estimated outcome implied that the goal is an endowment. Our application of the endowment effect was based on studies showing how investors become attached to funds and how they react to bonuses [1, 7, 14, 16]. The intervention had elements of loss aversion such that participants saw negative values of lost capital in some cases, viewed negatively by loss-averse users [11]. We expected users to view the $1.5M as an endowment that serves as a reference point [8], and showed them how their choices translate into potentially giving up some of their endowment. We expected users to actively preserve the endowment by adjusting their allocations over time, and allocate more savings toward stocks earlier in their career.

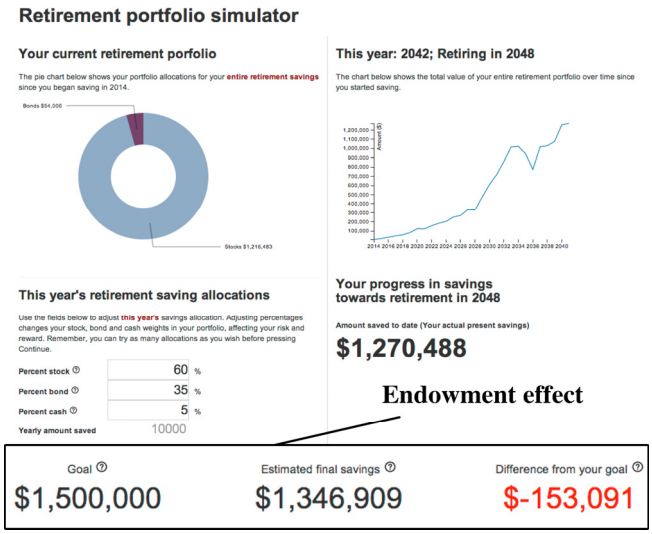

Figure 1. Endowment effect condition.

In the condition emphasizing *loss aversion* (Figure 2), we presented to users three estimates of how the yearly saving ($10,000) would perform in the long run given the time remaining until retirement: worst case value, expected value and best case value. Showing these amounts helps illustrate potential gains or losses. Using an interactive feature of the simulator, participants could adjust the allocation of their savings, to instantly see the long-term performance implications of their choices. The scenarios for low performance are shown and users can also see what happens in an underperforming market, where underperformance in the worst-case scenario can be perceived as a potential loss. The poor performance of cash-dominant allocations can also be perceived as a loss in comparison to high performing stocks. We expected these factors to lead users to save more in stocks and bonds within reason. Our application of loss aversion took into account Odean's [16] study of investors' reluctance to make changes to their portfolios due to hope that depressed values return to their former values over time. To counteract this typical investor behavior we explicitly showed how maintaining underperforming asset allocations could hurt the investor over time.

The *control condition* (Figure 3) presented a UI similar to that of typical commercial online retirement systems, where

in addition to the charts, users can modify asset allocations for the current year. We did not present additional information such as estimated savings outcomes.

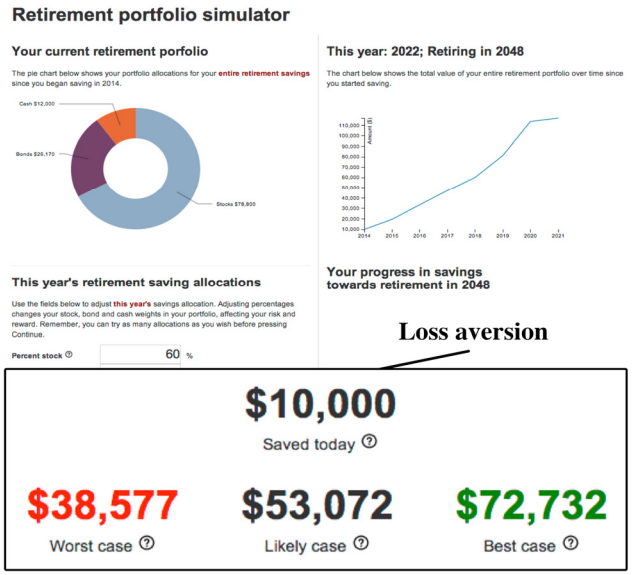

Figure 2. Loss aversion condition.

Both the loss aversion and endowment conditions make users aware of deviating from the goal. What makes these conditions different from a simple goal (and from each other) is how the conditions quantify loss aggregated over time, and show users an amount they could have versus what they will have if they don't change their allocations.

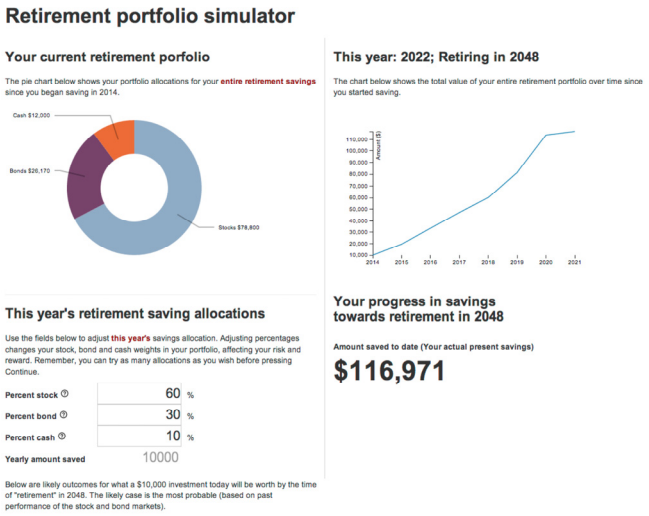

Figure 3. Control condition.

487 users (average age = 34.5, 46.2% women) participated in a between-subjects experiment, divided between the conditions of loss aversion (N=162), endowment effect (N=158) and control (N=167). We recorded gaps between users' savings and their goal, as well as the number and size of asset allocation changes. We compared these using ANOVA and a Bonferroni post-hoc test. In addition, we compared the changes made in yearly allocation: first, we compared the extent to which users changed their allocation during their career. Second, we compared the number of changes made by users throughout the years, across the experimental conditions using ANOVA and a Bonferroni post-hoc test. Finally, we compared the average proportion of stocks across conditions using a chi-square test.

RESULTS

The gap between participants' goal and saving (Table 1) was smallest, on average, in the endowment effect condition ($118k) and bigger (though not significantly) in the loss aversion condition ($124k). Both gaps were significantly smaller ($p<0.05$) than the gap in the control condition ($164k). Users in the loss aversion and the endowment groups made more adjustments to their asset allocations ($p<0.05$), and bigger year-to-year changes in their asset allocations ($p<0.05$) than users in the control group. Users in the endowment group kept more of their savings in stocks, compared to others ($p<0.05$).

In addition, there was a significant difference between the endowment effect and loss aversion conditions, including a difference in the average total saving achieved by users (endowment: 1.501M, loss aversion: 1.443M; $p<0.05$), as well as the likelihood of users to achieve their saving goal (endowment: 0.68, loss aversion: 0.46; $p<0.001$).

Condition	Mean gap from goal ($) / Likelihood of reaching goal	Average number of asset allocation changes	Mean yearly change in asset allocation (%)	Average % of stocks
Endowment effect	118,098* / 0.68*	18.39*	10.24*	70.8*
Loss aversion	124,002* / 0.46	17.68*	9.79*	61.4
Control	*164,640* / 0.45	*15.00*	*7.46*	*61.5*

Table 1. Comparison between experimental conditions; *significant difference ($p<0.05$) from the control group.

Plotting average stock proportions over time for all conditions shows a decreasing stock portion (Figure 4), such that the endowment effect and loss aversion lines have similar slopes, but the latter is shifted down by 10%.

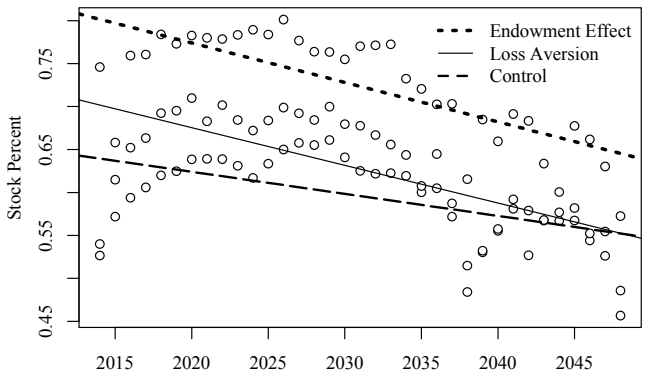

Figure 4. Stock allocation over time: regression lines for endowment effect (top dotted line) loss aversion (middle solid line) and control condition (bottom dashed line).

Participants in the endowment group allocated, on average, the most towards stocks at all points in the study. Loss aversion users allocated 8% more to stocks than the control users at the start of the study, but this difference decreased to zero by the end of the study.

Overall, these comparisons between the conditions and the plotted data illustrate the relationship between experimental conditions, elicited behaviors, and goal attainment.

DISCUSSION AND CONCLUSION

There are many ways to reach a retirement goal through changes in asset allocations over time. Our goal was to inform users as they modified their behavior, enabling them to follow a path to a retirement goal that is most consistent with their risk preferences. On average, users could best reach their savings goal when using the endowment effect interface, followed by the loss aversion interface. The control condition, which is most similar to popular retirement saving interfaces, was least effective. The $1.5M goal required allocation towards stocks, however, increased proportion of stocks is not in itself more risky in the long run, since the alternative—allocating more to "safer" (but lower yield) assets—decreases the likelihood of achieving the goal. Our objective was not to elicit more or less risky behavior, but, given a saving goal, lead participants to take appropriate risks and stay on track toward their goal.

In the endowment condition, we showed a lump sum to the user as the amount she would have saved. The simulator's interactive features showed the endowment being taken away from the user if she made poor choices. Consistent with prior research [8, 10], this framing was likely to make users focus on their goal rather than on maximizing returns, behave as if they were awarded their goal amount, and act to prevent losing it. The results confirmed our hypothesis: users made larger and more frequent allocation changes, and allocated a higher proportion of savings to stocks (see Table 1), suggesting that they were aware of the long-term impacts of their choices. The effects of asset allocation adjustments were transparent to users with changes seen instantly as the user made allocation adjustments. This transparency was likely to influence users in similar ways to unbiased bonuses resulting in behavior analogous to how loss-aversion is applied to bonuses in Fryer's [7] study.

The weaker performance of the loss aversion group can be explained by the fact that users were shown only the likely outcomes of investing the yearly $10,000. In comparison, in the endowment effect condition we showed the likely impact of allocation decisions on the entire portfolio amount. As prior research shows [6], feedback provided at a decision point helps users make better decisions. Providing easy to understand information about long-term outcomes communicated an abstract concept of risk and return, and helped savers make effective asset allocations. Specifically, in the endowment effect and loss aversion conditions the negative outcomes associated with investing too heavily in bonds or cash quickly became evident.

Prior research [17] showed real world applications of behavioral economic theory can help improve retirement saving. Our application of HCI interventions has important design implications: institutions who regulate and manage retirement saving can help the public by utilizing design. In particular, displaying information that emphasizes goals, deviation from goals, and long-term scenarios can be highly effective. Such an approach can help non-expert savers make informed decisions. The findings are also applicable to other contexts of long-term saving or long-term debt.

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