The Future Is Now: Age-Progressed Images Motivate Community College Students to Prepare for Their Financial Futures

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Part of the challenge young people face when preparing for lifelong financial security is visualizing the far-off future. Age-progression technology has been shown to motivate young people to save for retirement. The current study applied age progression for motivating socioeconomically diverse community college students as part of a college planning course. We recruited 106 students enrolled in a mandatory "Transitioning to College" course and randomly assigned them to view age-progressed or same-aged digital avatars. Compared to controls, age-progressed participants gave more correct answers and exhibited higher confidence (i.e., fewer "don't know" responses) on a financial literacy test. Confidence mediated the effect of age progression on correct responses, but not the other way around, pointing to financial confidence as a precursor to effective financial education. Students also reported interest in attending more long-term financial planning workshops (e.g., investing and retirement) available through their college. No differences were observed in financial planning for the near term (e.g., student aid and credit cards). The current study demonstrates the viability of age progression as a practical, inexpensive, and scalable intervention. Findings also illustrate the significance of this intervention for reducing pervasive socioeconomic and age disparities in financial knowledge and enhancing long-term financial prospects across future generations.

Public Significance Statement
This study demonstrates a viable path for reducing disparities in financial literacy and enhancing traditional financial education programs. Showing people images of their older selves increases interest in learning about long-term financial planning, and financial confidence, which in turn increases financial knowledge.

Life expectancy nearly doubled in the 20th century, yet social norms and public policies surrounding long-term financial security have changed little. Consequently, Americans face decades-long retirements for which the majority are unprepared (Stanford Center on Longevity, 2018). Young adults could be significantly advantaged by starting to save early in their lives, but relatively few are doing so. Rather, the number of Americans 25 to 34 years of age who have retirement savings accounts has declined in recent years, especially among ethnic minorities and the less socioeconomically advantaged (Stanford Center on Longevity, 2016). Relative to middle-aged people, younger adults in the United States are also less knowledgeable and less confident about finance. Once again, these age differences are especially pronounced among lower income and ethnic minority Americans (Mottola, 2014; Stanford Center on Longevity, 2016). Thus, younger generations are ill-prepared for long-term financial security and disparities are widening.

Many factors contribute to inadequate planning for the long term. Among them is the fact that humans have difficulty

imagining themselves in the distant future. Indeed, people describe their distant futures in relatively general and abstract terms compared to descriptions of the nearer future (Parfit, 1971; Trope, Liberman, & Wakslak, 2007; Wakslak, Nussbaum, Liberman, & Trope, 2008). Moreover, future selves tend to feel like strangers rather than well-known selves displaced in time (Hershfield, 2011). These nebulous conceptions undermine motivation to prepare for long-term goals, such as comfortable retirements. Consistent with this idea, people tend to favor smaller immediate rewards over larger future rewards, a phenomenon termed temporal discounting (Loewenstein, 1996).

Correlational studies show that individuals who report being relatively more connected to their future selves engage in less temporal discounting (Bartels & Rips, 2010) and report having more retirement assets (Ersner-Hershfield, Garton, Ballard, Samanez-Larkin, & Knutson, 2009). There is some evidence that visualizing oneself in the future can help to better connect people to their future selves (Hershfield et al., 2011) and shift priorities from short-term goals to long-term goals (Ersner-Hershfield, Wimmer, & Knutson, 2009; Hershfield, Cohen, & Thompson, 2012; van Gelder, Hershfield, & Nordgren, 2013). In one experiment by our research team, Stanford University undergraduates embodied digitized avatars in immersive virtual reality and then asked to imagine that they had received a hypothetical $1,000 windfall. Compared to students who embodied same-age avatars, those who embodied age-progressed avatars reported that they would save twice as much of that windfall for retirement (Hershfield et al., 2011). While encouraging, it remains unknown whether such hypothetical choices are reflected in actual improvements in financial preparedness.

Replicating and Extending Age Progression Research

The current field experiment builds on prior laboratory research (Hershfield et al., 2011) to examine whether a low-cost, highly scalable age-progression technique that helps people to envision their future selves can improve financial knowledge and interest in long-term financial planning in the context of a college course. Because prior research has shown that age-progressed images lead people to feel more connected to their older selves (Hershfield et al., 2011), we reasoned that students who regularly saw images of their older selves while taking a course about planning would engage more deeply in the material than those who were not exposed to these images. The community college setting allowed for a test of the effectiveness of age-progression techniques outside of the laboratory in a racially and economically diverse sample. Moreover, whereas previous research has relied on responses to hypothetical scenarios, we measured students' actual performance on measures that are known to predict long-term financial security, such as financial literacy (Hogarth & Hilgert, 2002; Lusardi & Mitchell, 2007). Recent applications of age progression appear to influence behavior using more realistic modalities, but so far these tend to focus on people with some level of financial education or prior interest in long-term financial planning (MetLife, 2018). Extending this approach to those with less experience with long-term financial planning is especially important given there are significant disparities in financial literacy and planning more generally. As such, this study may offer an effective approach for potentially eliminating disparities in the U.S.

Present Study

Main Hypotheses

In the present study, we hypothesized that exposure to age-progressed images would increase motivation to engage in long-term financial planning. Specifically, we hypothesized that students who repeatedly viewed age-progressed images of themselves embedded into course materials would score better on a financial literacy quiz, show more confidence in their responses, and indicate more interest in attending workshops on long-term financial planning than comparison participants who viewed images of themselves at their current ages. In addition, we build upon previous research to better understand the mechanisms underlying the path from age progression to financial literacy. Past work has shown that one way that age progression motivates long-term planning is by enhancing people's sense of connectedness to their future selves (Hershfield et al., 2011). In the current study, we examined mechanisms further downstream in the context of financial education. Specifically, we tested financial confidence as a precursory pathway to financial literacy or knowledge. Financial knowledge is thought to enhance financial confidence (Lusardi & Mitchell, 2011), but recent evidence suggests that the opposite may also be true. In a nationally representative sample, people who reported high financial confidence (measured both explicitly and by counting the number of "don't know" responses to a financial literacy quiz) were more likely to have higher scores on a test of financial knowledge (Stanford Center on Longevity, 2018). Knowing whether confidence is a requisite or result of financial knowledge is important for the development of effective financial education programs. Therefore, we tested whether the effects of age progression on financial knowledge are indeed explained by increases in financial confidence. We also tested the reverse pathway to rule out the possibility that greater financial knowledge bolsters financial confidence.

Specificity and Discriminant Validity

We also investigated temporal boundaries as a way of assessing the specificity of this intervention. Previous research has focused on the impact of age progression on retirement planning, but it remains unclear to what extent this effect translates to other financial behaviors that vary in their timing. We hypothesized that the temporal frame at hand focuses people on behaviors that are relevant to that time period. That is, visualizing the long-term future, or old age, likely motivates planning for that point in life, but not necessarily other aspects of financial planning that benefit current (e.g., budgeting) or near-term circumstances (e.g., student aid). In this study, students viewed images of, and reflected on, themselves approximately 45 years into their futures. Accordingly, we hypothesized that viewing age-progressed images would lead to greater motivation to engage in long-term financial planning more than short-term planning. To operationalize long- versus short-term finan-

cial planning activities, we turned to an empirical financial wellness framework developed by Fidelity Investments.[1] Using their record-kept data, they determined that day-to-day or short-term financial planning behaviors (i.e., budgeting and debt management) are foundational, tend to be the area of focus earlier in financial planning, and are initially prioritized over longer-term goals (i.e., savings and insurance). Once these short-term goals are being met, people then shift their focus to what they call "aspirational," or longer-term, financial behaviors. We leveraged a questionnaire administered by the community college measuring interest in attending future courses developed by the community college district, some of which focus on long-term planning and others on short-term planning. For ecological validity, we applied the financial wellness framework to distinguish interest in learning about long-term (vs. short-term) financial planning topics.

In a similar vein, we tested for the discriminant validity of the intervention with other existing measures of financial behavior that measure constructs related to planning, but are not specific to future planning (e.g., budgeting). We hypothesized that there would be no effects of age progression on people's tendencies to engage in day-to day-budgeting or their willingness to take financial risks.

Exploration of Financial Literacy Topics

In addition to the a priori hypotheses stated above, we also performed select exploratory analyses. In particular, we explored whether the effect of age progression was similar across all financial literacy test questions or was driven by certain ones. Because the test was designed to assess financial knowledge as a whole and it is unclear whether individual items are better or worse predictors of different long-term planning behaviors, we did not have predictions about specific questions. Exploring whether some questions were more affected than others, however, may provide insight into what sort of financial topics are most relevant to visualizing the future.

Method

Recruitment and Participants

Because this study aimed to replicate and extend findings by Hershfield et al. (2011), to determine our target sample size, we aimed to recruit at least twice as many participants as the original study. For replications, it is recommended to recruit 2.5× the original sample size (in this case, $N = 125$) to protect against underpowered replications of true effects (Simonsohn, 2015). Due to the field study design, we aimed to recruit more than the recommended 125 for three important reasons: 1) Data collected in field studies are often noisier than controlled lab settings, and thus we wanted to ensure effects held above and beyond covariates if significant, 2) we anticipated course attrition beyond our control and so recruited across two semesters, and 3) for ethical reasons, we did not want to exclude students who were willing and eligible to participate in the study during this time frame.

Students were recruited from a college course at the Community College of Baltimore County. Because most students at the college are first-generation college students and come from economically disadvantaged backgrounds, all are required to enroll in a one-unit "Transitioning to College" course in their first semester to support them in academic, career, and financial planning. Prospective participants were enrolled in the fall of 2014 or spring of 2015. At the start of the semester, students learned about the study in class and were offered either extra credit or a $15 gift card for their participation. Students were also offered an alternate assignment if they did not want to participate, to avoid coercion.

A total of 161 students opted to participate. Of this initial group, we excluded 2 participants over the age of 45 because the particular age progression software we used did not noticeably age their faces (although including these participants did not alter the pattern of findings reported below). An additional 53 participants failed to complete all survey items included in the main analyses. Although 33% of participants did not complete all measures, there was no significant difference in attrition rate by condition ($\chi^2(1, N = 157) = 0.86$, $p = .35$), indicating that being in the age-progression group was not associated with a higher likelihood of dropping out of the study. Moreover, the distribution of grades for students in the participating sample did not differ from the population of all students who took the course, $\chi^2 (4, N = 106) = 6.77$, $p = .15$, suggesting that the sample was representative of the general Community College of Baltimore County student population.

The final sample consisted of 106 participants (63% female; 41.5% European American, 38.7% African American, 8.5% Latino, 2.8% Asian American, 8.5% other; $M_{age} = 20.82$, $SD = 5.35$, range: 17–44). When asked about their subjective socioeconomic status "compared to the rest of the country" (Adler & Stewart, 2007), participants' responses were significantly lower than the midpoint on a 10-point scale ($M = 4.88$, $SD = 2.30$, one-sample $t(105) = -2.78$, $p = .006$). Conditions did not significantly differ on sample characteristics (see Table 1).

Procedure

The study was approved by the Stanford University Institutional Review Board and underwent administrative review at the Community College of Baltimore County. Students were randomly assigned to view a digital avatar of their current self or their age-progressed future self that appeared as an older adult. In an effort to reduce experimental demand in the age-progressed condition, participants were not told they would be age-progressed. Instead, all participants were told their avatar could appear in any number of ways, including a different ethnicity, gender, or age.

We created digital avatars for each student using FaceGen software based on photographs taken according to specifications of the program. To create digital avatars, students were asked to e-mail a recent color photograph taken above the shoulders. Participants were given instructions to ensure good photo quality (e.g., no facial accessories, ensure no hair in the face, take the photograph in a well-lit area with a neutral background). Participants recruited in the fall semester were asked to make a neutral expression (i.e., do not smile, mouth closed), and those in the spring semester were asked to make a natural expression (i.e., however

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[1] See https://www.fidelity.com/about-fidelity/employer-services/financial-wellness-score-goes-beyond-the-numbers and https://www.fidelity.com/whatis financialwellness/overview/

Table 1
Descriptive Statistics by Condition

Characteristic	Age progression ($n = 52$)	Controls ($n = 54$)	Test statistic (t)	df	p
Age	20.69 (0.75)	20.94 (0.72)	0.24	104	.81
% Female	61.5	64.8	$\chi^2 = 0.12$	1	.84
% Ethnic minority	65.4	51.9	$\chi^2 = 2.00$	1	.16
Subjective SES	4.69 (0.32)	5.06 (0.31)	0.81	104	.42
% A or B Grade	82.7	79.6	$\chi^2 = 0.04$	1	.85
Conscientiousness	5.42 (1.07)	5.29 (1.36)	0.57	104	.57
Future time perspective	5.27 (0.79)	5.26 (0.88)	0.06	104	.95
State positive affect	3.32 (0.11)	3.29 (0.09)	0.20	104	.84
State negative affect	2.21 (0.10)	2.42 (0.11)	1.39	104	.17

Note. Data presented are means, with standard errors in parentheses, unless otherwise noted. Test statistic reported is *t*-statistic unless otherwise noted. SES = socioeconomic status.

they felt comfortable).[2] If participants submitted a low-quality photograph (e.g., grainy, dark, hair in face), we contacted them to reiterate the instructions and asked them to take another photograph. We then imported the photographs to FaceGen Modeller software (Singular Inversions, 2017). Based on full-face photographs, the software creates digital models of participants' faces without any hair. We manually added hair using existing templates. For men, we added short hair, and for women, we added mid-length straight hair. For participants in the control condition, hair color was matched to their original photograph. For participants in the age-progressed condition, we applied gray hair color templates and morphed the face using the "Generate" feature in FaceGen to approximate an older version of themselves. We then embedded their digital avatar images into five online surveys (see footnote 2) to be administered throughout the course at tri-weekly intervals.

We emailed participants a personalized link to the survey. The first page of the survey displayed their digitized avatar. For the first survey, participants viewed their avatars for the first time and immediately reported their reactions to the avatar and completed measures of hypothetical financial behaviors, personality traits, and demographics, all described below. In order to continuously expose students to their avatar, we asked them to work on building a web profile for their avatar by completing a questionnaire three separate times throughout the course, which included descriptors of their avatar to be added to their profile (e.g., introduction, nicknames, hobbies). At the end of the course, participants viewed their avatar and the profile they built (see Figure 1, sample profiles), and we measured financial planning behaviors and individual characteristics. All dependent variables were measured at the end of the course, with the exception of the hypothetical financial scenarios, which were measured both after the first avatar viewing and at the end of the course. Altogether, the initial viewing, the three emails asking them to build their profile, and the final survey with the completed profile provided students with five opportunities to view their avatar. This helped to ensure students viewed the avatar the same number of times, but due to the nature of field research, we could not control how long students spent looking at their avatar.

Measures

Financial behavior measures. We measured financial knowledge and financial confidence based on measures used in the U.S. Financial Capability Survey (FINRA Investor Education Foundation, 2013). This five-question quiz is specifically designed to assess competency in long-range financial planning on multiple topics including interest rates, inflation, bonds, mortgage payments, and investing, as opposed to short-term money management such as understanding of budgeting and debt principles. The survey has been globally validated and has been administered to over 25,000 Americans age 18 and older across demographic segments. Predictive validity has also been demonstrated, with higher scores shown to be associated with retirement preparedness and engagement in long-term financial planning (Lusardi & Mitchell, 2011). Further description of the survey items can be found in the Appendix.

Quiz responders can attempt to answer the question (and responses are deemed either correct or incorrect) or responders can indicate they don't know the correct response. As instructed by the survey developers, we calculated the proportion of correct answers on the U.S. financial capability survey financial literacy quiz as an indicator of financial knowledge. We also report responses to each question to determine whether effects differ by topic type (e.g., mortgage payments, investing, etc.). We operationalized financial confidence as the proportion of "don't know" responses, consistent with prior research; where more "don't know" responses indicate lower confidence. Indeed, recent research shows that self-reported financial confidence in making major financial decisions like purchasing a home or opening an investment account is significantly correlated with the number of "don't know" responses on this financial literacy quiz (Stanford Center on Longevity, 2018). This operationalization allowed us to estimate the indirect effect of "don't know" responses when measuring the impact of age progression on financial knowledge.

At the end of the course, the community college administered an exit survey to ascertain interest in learning more about all types of

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[2] Approximately half of the study sample (43%) was recruited from a 7-week course (fall) and randomly assigned to condition at the individual level, and the remainder were recruited from a 14-week course (spring) and randomly assigned to condition at the classroom level. In addition to differences in facial expression that participants were instructed to make, the fall subsample viewed their avatar four times over the course of the semester, whereas the spring subsample viewed their avatar five times over the course of the semester. Notably, there were no significant interactions between condition and phase (fall/spring) for all findings reported, so we do not discuss semester any further.
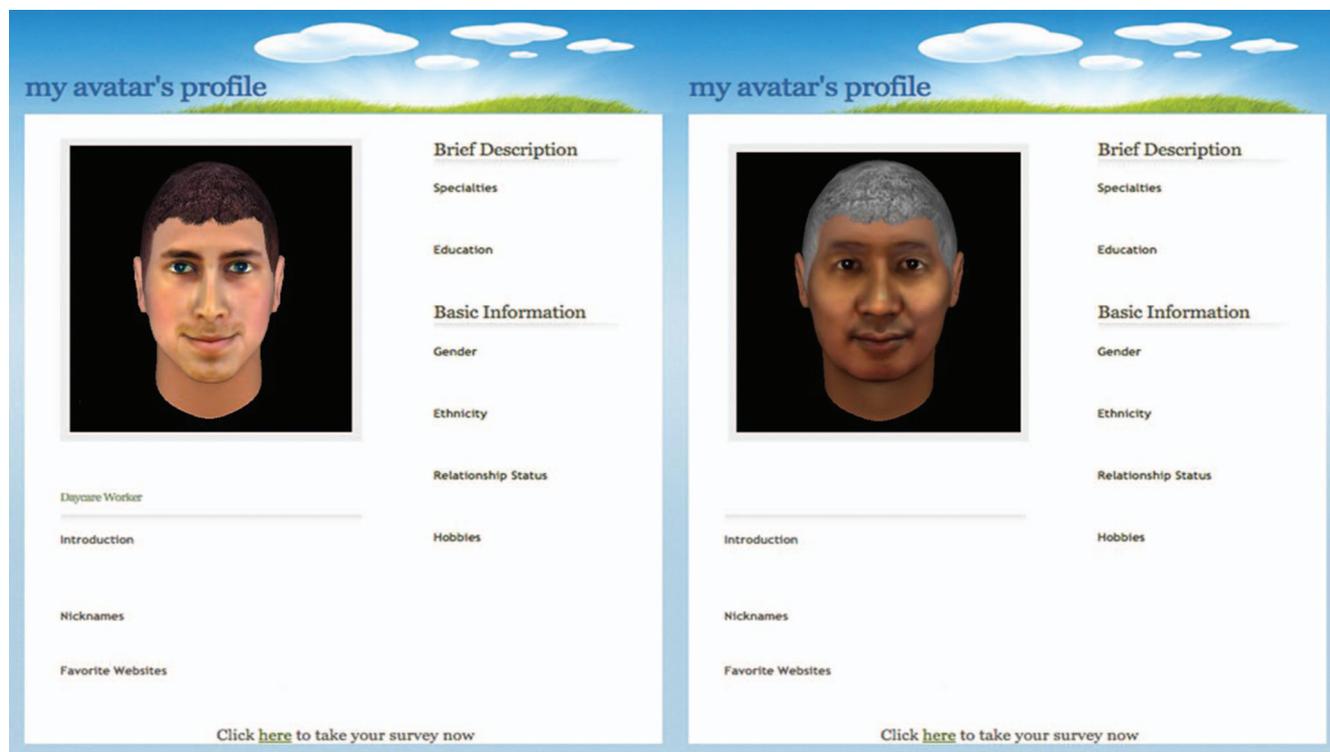
Figure 1. Example profiles and avatar images viewed prior to final survey. To protect participant confidentiality, avatars shown here represent two different research assistants, one of whom is non-aged (left panel) and the other of whom is age-progressed (right panel). See the online article for the color version of this figure.

short- and long-term financial planning topics. We included these exact questions for study participants in the last survey as an ecologically valid measure of interest in the context of the community college district. Students selected which, if any, of 16 financial workshops currently offered at their college they would be interested in attending. Based on the topics in the financial literacy quiz and the Fidelity Investments Financial Wellness framework,[3] we categorized the workshops into long- versus short-term financial planning workshops. This allowed us to assess discriminant predictive validity of the intervention and test our hypothesis that age progression influences interest in learning financial planning for the long term, but not necessarily the short term. Specifically, in line with the framework, we categorized workshop topics into those that focus on meeting day-to-day or short-term financial planning (budgeting, auto insurance, loans/debt, leasing/renting, financial aid qualifications, how to apply for financial aid, different types of financial aid available, student loans, scholarship information, credit cards, and interest rates) and those that focus on long-term financial planning (investing, wills, life insurance, saving, retirement funds). We calculated the proportion of financial workshops that focused on long- (vs. short-) term planning. Because loans/debts could be construed as either, we reasoned that because many other workshops focused on student aid, this topic might be construed as short-term. However, results do not differ if we move this topic to the long-term category or exclude it altogether.

Replication and discriminatory measures. We also tested the rigor and boundary conditions of our intervention by assessing whether the current study replicated effects on hypothetical financial behavioral tasks used in previous research, and by measuring constructs that theoretically should not be influenced by envisioning the distant future. Although there are categorical distinctions between the current intervention and previous age-progression experiments, we included two hypothetical scenarios previously used by Hershfield and colleagues (2011). Participants were asked to imagine that they received a one-time $1,000 windfall and allocated the money however they wanted across four categories: Invest it in long-term savings, Save it to buy a new car/house, Plan a fun and extravagant occasion, Pay off bills. Participants also imagined earning a $100 monthly raise and could allocate the money across the following: Put it into a savings account, Leave it in my checking account, Spend a little extra on myself, Pay off debt. Students responded to these questions both immediately after they viewed their avatars at the beginning of the course (Time 1) and again after the last time they viewed their avatar at the end of the course (Time 2) in order to test for possible decay of the effects over time.

In addition to the interest in financial planning workshop measure, we tested whether the effects of age progression were specific to long-term financial planning behaviors, rather than financial behaviors more generally, such as day-to-day money management or willingness to take risks. There is no theoretical reason that viewing age-progressed images of oneself more than 40 years into

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[3] https://www.fidelity.com/whatisfinancialwellness/overview/.

the future would influence risk tendencies outside of long- versus short-term trade-off decisions or affect daily budgeting. Thus, at the end of the course we measured intentions to budget in the near term (i.e., next 1–2 months) using the 6-item Propensity to Plan for Money-Long Run scale (Lynch, Netemeyer, Spiller, & Zammit, 2010) and willingness to make a risky investment "today" questions, which were taken from the 2008 University of Michigan CogEcon survey.[4]

Reactions to avatar. To ensure effects were not due to inherent differences in reactions to the avatar other than perceptions of age, we assessed participant reactions to the avatar after the first viewing. Participants reported the extent to which they believed "the image was created using a photograph of my face," and "I have a hard time remembering what my image looked like," using a 7-point scale (-3 = *strongly disagree*, 3 = *strongly agree*). Participants also reported how positive and how negative they felt on 5-point scales (1 = *not at all*, 5 = *extremely*). As expected, participants agreed (rated significantly higher than midpoint) that "the image was created using a photograph of my face," one-sample $t(105) = 9.87$, $p < .001$, and disagreed (rated significantly lower than midpoint) with "I have a hard time remembering what my image looked like," one-sample $t(105) = -12.04$, $p < .001$. Participants in the age-progressed and control conditions did not differ in how positively or negatively they felt after viewing their avatars (see Table 1).

Possible trait covariates. We also measured several trait-level variables to ensure successful randomization to condition. We measured conscientiousness (Ten-Item Personality Inventory; Gosling, Rentfrow, & Swann, 2003), future time perspective (Carstensen & Lang, 1996), and trait positivity and negativity (Affect Valuation Index; Tsai, Knutson, & Fung, 2006). There were no significant differences between conditions on any of these traits, $ps > .244$, suggesting successful randomization to conditions (see Table 1). None of these traits were found to be significant covariates across analyses, so we do not discuss them further.

Planned Analyses

Across all analyses, we included gender and subjective socioeconomic status as covariates. Age and trait measures were not significant predictors, nor did they differ across conditions, and thus were excluded from the final models for parsimony. To examine the effect of exposure to age-progressed images on financial knowledge, confidence, and interest in long-term financial planning workshops, we conducted separate ANOVAs with condition (between subjects; control vs. age-progressed) as the independent variable. Second, we performed mediation modeling to examine whether financial confidence (i.e., tendency to respond "don't know") accounted for the effect of condition on financial knowledge using SPSS Process macro V3.3 (Hayes, 2018). We estimated the indirect effect of condition on financial knowledge through financial confidence using 5,000 bootstrapped samples, and based significance on whether the 95% confidence interval was greater than zero. We performed an additional mediation reversing the order of financial knowledge and financial confidence to estimate the potential indirect effect of condition on financial confidence through financial knowledge using the same technique. This allowed us to discern whether the mechanism of the effect is uniquely due to improvement in financial confidence.

Next, we examined whether exposure to age-progressed images affected responses to hypothetical financial scenarios used in previous research ($1,000 windfall and $100 monthly raise). Because these were the only measures assessed both after the first avatar viewing and at the end of the course, we conducted two $2 \times 2 \times 4$ mixed-design ANOVAs, with amount of money allocated as the dependent variable. In the first model for the $1,000 windfall measure, we entered condition (age-progressed, control) as a between-subjects factor, time (1: after first avatar viewing, 2: after last avatar viewing) and allocation categories (save for car/house, long-term savings, fun occasion, pay bills) as the two within-subjects factors. The second model was identical, except that we entered allocation of the $100 raise (savings, checking, spend, pay debt) as the second within-subjects factor.

Finally, we examined the effect of condition on the two discriminant measure outcomes, which were assessed at the end of the course. We conducted two between-subjects ANOVAs with condition (age-progressed vs. control) as the independent variable, and propensity to plan for money and risky investment "today" preference as dependent variables, respectively.

Results

Effect of Age Progression on Financial Behaviors

Table 2 shows bivariate correlations, raw means, and standard deviations for the three financial behavior outcomes collapsed across the sample. As shown in Figure 2, visualizing future selves enhanced performance on financial behavior measures, such that students who viewed age-progressed (vs. same-age) avatars had a higher proportion of correct responses on the financial literacy quiz, a lower proportion of "don't know" responses, and interest in a higher proportion of long-term financial planning workshops relative to all financial education workshops offered by the community college. For financial knowledge, there was a significant main effect of condition on financial literacy scores, $F(1, 102) = 5.67$, $p = .019$, $\eta_p^2 = .053$. Age-progressed participants performed better on the financial literacy quiz ($M = 51.7\%$, $SE = 0.04$, 95% CI [0.44, 0.59]) than control participants ($M = 39.5\%$, $SE = 0.04$, 95% CI [0.32, 0.47]), and more comparably to the U.S. young adult population (46%; FINRA Investor Education Foundation, 2013). Further exploration of quiz responses shown in Table 3 revealed a trend such that participants in the age-progressed group were slightly more likely to score correctly on questions about inflation, compounded interest, and home mortgages compared to control participants. The two questions with the lowest correct response rate were about investing in bonds and stocks. When looking at incorrect only (excluding "don't know") responses, we found no significant differences except for the stocks question, in which age-progressed participants were twice as likely to answer incorrectly, perhaps because they were less likely to respond "don't know," which we test below.

We also found a significant main effect of condition on financial confidence, $F(1, 102) = 10.94$, $p = .001$, $\eta_p^2 = .097$. The percentage of "don't know" responses when taking the financial literacy quiz was twice as high for control participants ($M = 32.1\%$, $SE =$

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[4] http://ebp-projects.isr.umich.edu/CogEcon/docs/C1_questions.pdf.

Table 2
Bivariate Correlations Among Dependent Variables, Means, and Standard Deviations

Financial behavior	1	2	3
1. Financial literacy quiz % correct	—		
2. Financial literacy % "don't know" responses	−.62***	—	
3. % long- (vs. short-) term financial planning workshops selected	.04	−.16†	—
M (*SD*)	45% (.27)	24% (.26)	37% (.26)

† $p < .10$. *** $p < .001$.

0.03, 95% CI [0.25, 0.39]) compared to age-progressed participants ($M = 15.8\%$, $SE = 0.04$, 95% CI [0.09, 0.23]), suggesting that participants who saw their future selves were more confident in their financial knowledge than controls.

Similarly, age-progressed participants reported interest in taking significantly more long-term financial planning workshops relative to other financial workshops ($M = 44.4\%$, $SE = 0.03$, 95% CI [0.38, 0.51]) compared to control participants ($M = 29.5\%$, $SE = 0.03$, 95% CI [0.23, 0.36]), $F(1, 102) = 10.47$, $p = .002$, $\eta_p^2 = .093$. Post hoc analyses confirmed that the difference in proportion of financial workshops selected was driven by a significant difference in long-term workshops chosen (age-progressed: $M = 2.39$, $SE = 0.20$, 95% CI [2.00, 2.79]; control: $M = 1.85$, $SE = 0.20$, 95% CI [1.46, 2.23]), whereas there was no significant difference in workshops not specific to long-term planning (age-progressed: $M = 3.92$, $SE = 0.45$, 95% CI [3.03, 4.82]; control: $M = 3.77$, $SE = 0.44$, 95% CI [2.89, 4.65]).

Indirect Effects of Age Progression on Financial Behaviors

The pattern we observed above for correct and "don't know" responses may suggest that as students become more confident in their financial knowledge, they are more likely to deliver correct responses to the financial literacy quiz. Mediation analysis confirmed that the significant direct effect of condition on financial knowledge was eliminated after controlling for confidence, and there was a significant indirect effect of condition on financial knowledge through financial confidence (indirect effect = 0.40, $SE = 0.13$, 95% CI [0.17, 0.66]). This supports our hypothesis that bolstering financial confidence is necessary to improve financial knowledge and performance. These findings are also consistent with the finding that there were no differences by condition in the proportion of incorrect answers given by respondents, $F(1, 104) = .82$, $p = .37$, $\eta_p^2 = .008$ (see Table 3).

We also explored whether interest in learning about long-term financial planning was a potential mediator, but effects of age progression on financial knowledge and confidence remained significant when including this variable in the model. Thus, interest in learning about long-term financial planning did not mediate the effect of condition on financial knowledge. Moreover, when examining financial knowledge as a mediator, the significant direct effects of condition on financial confidence and interest in learning about long-term financial planning topics remained significant. This pattern suggests that neither interest nor financial knowledge accounted for effects of the age progression intervention.
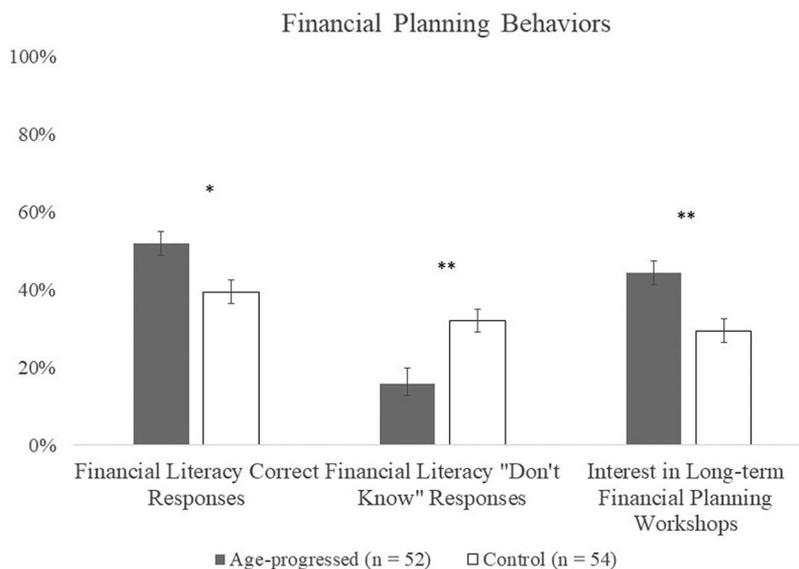

Figure 2. From left to right: proportion of correct responses, "don't know" responses, and long-term financial planning workshops selected. * $p < .05$. ** $p < .01$.

Table 3

Percentage of Financial Literacy Quiz Respondents Answering Correctly or "Don't Know" by Condition and Compared to National Average

Question	Age-progressed (n = 52)			Controls (n = 54)			U.S. young adults[a]
	% Correct	% Incorrect	% Don't know	% Correct	% Incorrect	% Don't know	% Correct
Q1: Compound interest	73[†]	19	8[*]	56	18	26	68
Q2: Inflation	50[†]	36	14[*]	33	32	35	42
Q3: Bond price	29	59	12[†]	22	52	26	21
Q4: Home mortgage	71[†]	14	15	57	22	21	64
Q5: Stocks	37	32[*]	31[*]	30	16	54	36
M	52[*]	32	16[*]	40	28	32	46

Note. Significant differences between age progression and control conditions are denoted in first % Correct, % Incorrect, and % Don't Know columns.
[a] U.S. young adult data are from the 2012 National Financial Capability Study (only % correct were reported), found here: https://www.usfinancialcapability .org/downloads/FinancialCapabilityofYoungAdults.pdf.
[†] $p < .10$.   [*] $p < .05$.

Replicability and Discriminatory Effects of Age-Progressed Images

Of the two hypothetical monetary allocation tasks, we replicated effects of one task but not the other. Specifically, we found no effect of condition on how much of the $1,000 windfall was allocated to savings, $F(1, 102) = 0.004$, $p = .947$, $\eta_p^2 = .000$, which was consistent across both time points and savings options (i.e., save for car/house or for the long term). However, across time points, we found a significant effect of condition on allocating a $100 monthly raise to savings, $F(1, 102) = 6.23$, $p = .014$, $\eta_p^2 = .058$ (the other three options did not differ by condition). Students exposed to an age-progressed avatar allocated more money to savings ($M = \$48.09$, $SE = 3.38$, 95% CI [41.38, 54.80]) than those in the control condition ($M = \$36.24$, $SE = 3.32$, 95% CI [29.66, 42.82]). These results suggest that responses to the $1,000 windfall scenario could depend on different factors from the monthly raise scenario. For example, a lower income population may perceive a windfall of this size to have a small impact on the long-term future compared to a regular ongoing raise.

Finally, we confirmed that the effects of age progression in the far-off future are beneficial for long-term financial planning, but not necessarily all types of financial behavior. In particular, there was no significant main effect of condition on budgeting, $F(1, 102) = 0.42$, $p = .518$, $\eta_p^2 = 0.04$. Age-progressed participants intended to budget in the near future to a similar degree ($M = 4.18$, $SE = 0.13$, 95% CI [3.92, 4.45]) as control participants ($M = 4.06$, $SE = 0.13$, 95% CI [3.80, 4.32]). There was no significant main effect of condition on willingness to make a risky investment, $F(1, 102) = 0.02$, $p = .899$, $\eta_p^2 = 0.00$. Age-progressed participants were willing to take a risky investment to a similar degree ($M = 0.24$, $SE = 0.04$, 95% CI [0.17, 0.31]) as control participants ($M = 0.25$, $SE = 0.03$, 95% CI [0.18, 0.32]). These results suggest that age progression is not an all-encompassing financial intervention, but rather targets a specific time frame. Visualizations at different stages of life could facilitate engagement in other types of financial decisions when most relevant.

Discussion

As Americans live longer, long-term financial security is growing in importance. Despite institutional programs, such as default retirement accounts, young adults are not saving enough to finance a lifetime (Stanford Center on Longevity, 2018). Applying age-progression technology to help people better visualize their own long-term futures has shown promise in improving planning for long-term financial stability. For the first time, the current study demonstrated that repeatedly viewing and engaging with an age-progressed image online in an academic setting motivates financial planning in a diverse sample of young adults. In support of our hypothesis, students who viewed age-progressed images of themselves via an online survey scored 31% higher on a test of financial literacy than students who saw same-aged images. Compared to the financial literacy scores of American Millennials (46%; FINRA Investor Education Foundation, 2013), the age-progressed intervention group scored six percentage points higher, whereas the control group had a six-point deficit. The control group performance is lower than the national average, which is consistent with scores among lower income, ethnic minority young adults in the U.S. population (FINRA Investor Education Foundation, 2013). Using age progression paired with a course that contained a unit on financial education, we raised the scores of the community college students in this study to exceed the U.S. average, a score typically reflective of mainstream middle-class White Americans. These findings replicate and extend prior laboratory-based studies on this topic with more affluent samples (Hershfield et al., 2011) and suggest that using age progression generalizes to the context of financial education among less affluent and more diverse groups, who arguably are most in need of financial planning assistance.

We also found support for the mechanism driving improvements in financial literacy. Students in the age-progressed group exhibited more confidence by being half as likely to respond "don't know" across all questions on the financial literacy test compared to control participants. Mediation analyses demonstrated that increases in financial confidence explained financial knowledge, but not the other way around. This is consistent with other studies showing that financial confidence may be a necessary precursor for good financial decision-making by encouraging persistence (Peters et al., 2019; Stanford Center on Longevity, 2018). Taken together, these findings suggest that lack of confidence—and not necessarily lack of knowledge—could be one reason that particular demographic groups, such as

younger, lower income, and ethnic minority adults, traditionally underperform on tests of financial literacy. Thus, building confidence appears to be a key pathway to building financial knowledge and minimizing pervasive disparities in financial outcomes. Future studies could further test whether this path from age progression to financial confidence to financial knowledge continues toward enhancing long-term planning behaviors such as opening a savings account and increasing savings contribution rates.

In addition to examining generalizability of age progression effects on financial behaviors, we also tested for specificity and boundary conditions of these effects. First, we found that like financial literacy and confidence, age-progressed students exhibited interest in attending more workshops focused on long- versus shorter-term financial planning. As expected, there was no difference in expressed interest toward shorter-term financial planning workshops. We also observed that interest in long-term planning workshops was uncorrelated with financial knowledge and only marginally correlated with confidence, pointing to their independence. Although other work has found financial literacy to be associated with long-term financial planning behaviors (e.g., Hogarth & Hilgert, 2002), less is known about attitudes toward them. Although not hypothesized, our research indicates that age progression may influence two distinct pathways to financial security: one that strengthens financial skills (i.e., financial knowledge) through greater confidence, and the other that increases motivation to learn (i.e., interest or positive attitude toward financial planning actions). Interventions designed to test these pathways separately and in concert can illuminate whether they are indeed distinct and whether tapping into both provides an additive impact on equipping people to successfully prepare for their financial futures.

Second, and as predicted, we found no effect of age progression on propensity to plan for money in the short term or preferences for risky investments. This supports the idea that visualizing one's distant future self (at approximately 65 years old) does not necessarily inspire financial behaviors in general, but only those relevant to the distant future. Moreover, while we replicated results of a hypothetical savings scenario when students were told they received a $100 monthly raise, we did not replicate one of the scenarios focusing on a $1,000 windfall. The fact that effects were not found consistently across all self-report measures provides some evidence that effects on long-term financial planning behaviors are unlikely to have been explained by experimenter demand. This pattern of findings also demonstrates the limitations of the intervention. The $1,000 windfall scenario may have been less realistic for our targeted population compared to previously studied populations who are relatively more affluent and have a higher expectation that this may be possible. Finally, exploratory analyses showed that effects of age progression on financial literacy were driven by topics of inflation rates, compound interest in savings, and home ownership, whereas smaller, nonsignificant effects were found for topics of stocks and bonds. These topics may be less relevant for younger populations, whose long-term goals may be more about savings and home ownership as opposed to other investments.

Limitations and Future Research

In order to use an ecologically valid approach to test our hypotheses, some limitations were introduced to the study. First, the attrition rate was moderate, as expected in a field experiment, and may have resulted in a selected sample. A 33% attrition rate may indicate that observed effects are limited to a select sample of exceptionally motivated or conscientious students. Students who dropped the study were indeed more likely to drop the class or get Fs. However, study drop-out is more likely to be attributed to course dropout and not the other way around. Importantly, attrition rate did not significantly differ by condition, indicating that viewing age-progressed images (or same-age image) did not drive students to drop out of the study or course. Furthermore, observed study effects remained above and beyond course grade and conscientiousness ratings. Effects of condition were also not moderated by course grade or conscientiousness. As such, differences between age-progressed and control participants cannot be explained by these factors.

While we investigated the mechanism underlying age progression and financial literacy, more research is needed to understand exactly how age progression works further upstream and just how far it can go. For instance, in this study, we did not attempt to replicate prior research findings that viewing age-progressed images promotes long-term planning by helping people to feel more connected to their future selves (Hershfield et al., 2011). Thus, it is unclear whether this same mechanism is also at play here. Future research investigating this possibility can determine whether connectedness is key for this population, in this context, and with respect to the financial behaviors assessed in this study. Another possible mechanism that may account for differences by condition is the experience of stereotype threat given that financial knowledge is related to math performance in many ways and our sample comprises groups who may feel anxious about their scores. However, as stated above, test scores in the control group were on par with what would be expected based on national reports of younger, socioeconomically diverse samples (FINRA Investor Education Foundation, 2013). Participants also did not differ between conditions in their negative feelings after viewing their images, which is a key mechanism of stereotype threat (Steele, 1997). Future studies could more explicitly test this possibility and the role of threatened identities in the context of finance. Finally, we only focused on financial decision making, but recent research has found that envisioning future selves is relevant to health behaviors as well (Raposo & Carstensen, 2020; Rutchick, Slepian, Reyes, Pleskus, & Hershfield, 2018). Future research could examine both types of behaviors in a single study to adequately compare effect sizes and the generalizability or specificity of this effect to other future-oriented behaviors.

The current study was the first to integrate age-progression technology into a community college financial planning course curriculum, advancing our understanding that motivation is key in financial education. The benefits of financial education alone vary considerably, with many programs being ineffective (Miller, Reichelstein, Salas, & Zia, 2015). Pairing future applications of age-progression technology to motivate behavior alongside financial education programming is likely to be more effective than either intervention applied on its own (Peters et al., 2019). Notably, the observed effect sizes in this field study using an ethnically and economically diverse community college student sample were

comparable to studies in relatively more controlled settings. Along with other visualization interventions, connecting younger people to their future selves appears effective across multiple intervention modalities as well as levels of immersion. Because our effects were consistent across 7- and 14-week courses, it may be that frequency of exposure is less important than depth of exposure and the contextual relevance of the intervention. As advances in technology are moving quickly, applying new techniques like age-progression real-time video immersion (i.e., "deep fakes") to connect with one's future self has great potential to motivate young adults to engage in long-term planning behaviors. Follow-up studies could also examine whether more intensive age-progression interventions could have even larger, more generalized effects on long-term outcomes, either through more experiential interaction with age-progressed avatars (e.g., embodying future self while learning about financial planning) or through intersection interventions (e.g., bridging age progression and financial education with decision support tools).

Conclusion

Building financial security is more critical for younger generations than ever before as they are living longer lives during a time of financial uncertainty. Yet most young people spend little time thinking about how to best prepare themselves for older age. Enhancing financial education using age-progression technology can motivate young people to financially prepare for the future by transforming long-term financial planning from an imaginary afterthought to an imperative reality. While lower-income, minority populations might be less financially secure today, improving financial education in diverse communities by helping students clearly envision their long-term futures will yield returns over a lifetime.

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Appendix

FINRA Financial Capability Questions (Correct Responses Denoted With [*])

Question	Response options
Suppose you have $100 in a savings account earning 2 percent interest a year. After five years, how much would you have?	More than $102[*] Exactly $102 Less than $102 Don't know
Imagine that the interest rate on your savings account is 1 percent a year and inflation is 2 percent a year. After one year, would the money in the account buy more than it does today, exactly the same or less than today?	More Less[*] Same Don't know
If interest rates rise, what will typically happen to bond prices? Rise, fall, stay the same, or is there no relationship?	Rise Fall[*] Stay the same No relationship Don't know
True or false: A 15-year mortgage typically requires higher monthly payments than a 30-year mortgage but the total interest over the life of the loan will be less.	True[*] False Don't know
True or false: Buying a single company's stock usually provides a safer return than a stock mutual fund.	True False[*] Don't know