



## Full length article

## Easy to shove, difficult to show: Effect of educative and default nudges on financial self-management

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## ABSTRACT

Default nudges tend to improve financial well being. How do educative nudges, providing simple individually targeted financial literacy training, fare in comparison? In a preregistered experiment on the self-management of online retirement accounts, we compared the effects of educative and default nudges on savings, financial errors, and institutional trust. Participants allocated monetary endowments between alternative savings accounts with varying risk and rates of return, some of which were pay-off dominated. Defaults substantially increased savings and decreased errors, but educative nudges had no impact. We explored the cognitive correlates of financial decisions using tests of cognitive reflection, financial institutional knowledge, and financial literacy that distinguish between the comprehension of annual interest and interest compounding. Tendency for cognitive reflection and financial literacy in general and the comprehension of interest compounding in particular predicted successful financial self-management. Educative nudges are promising, but better educative techniques are needed to complement or replace default nudges.

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## 1. Introduction

Online banking made financial self-management popular. While allowing welfare improvements, this has heightened the risk of financial mismanagement. Field studies have associated the rapid financial innovations and the increased complexity of the past thirty years with failures in individual financial decision-making and accumulation of personal debt (Dyner and Kohn, 2007; Gabaix and Laibson, 2006; Lusardi et al., 2018). Here, we study the enablers of successful financial self-management in the controlled environment of an experiment—a method that can provide important insights on the topic (e.g., Bateman et al., 2016; Beshears et al., 2015; Choi et al., 2017).

Some, once widely-held, views in economics predict relevant financial information and experience to alleviate personal financial mismanagement (Binmore and Shaked, 2010; Malkiel and Fama, 1970). However, vital information is routinely ignored in everyday decisions involving money. For example, most participants in a 2018 survey in the US (56%) reported not having compared alternative options when buying a credit card (FINRA,

2019). The likelihood of using such relevant information does not always improve with age, even “among people with years of borrowing experience” (Lusardi et al., 2020). Although experience can improve financial decisions (Agnew and Szykman, 2005), many important occasions such as buying a house or saving for retirement necessarily involve unique experiences for most people (Campbell et al., 2011). In short, information and experience are often insufficient or infeasible solutions to individual financial mismanagement.

Two explanations have emerged to fill this void: the financial illiteracy view and the cognitive biases view. The two views see the cognitive roots of the problem differently. Consequently, they advocate different solutions to the problem of personal financial mismanagement.

According to the financial illiteracy view, the problem stems from a lack of basic competencies required for the effective management of personal finances, including the capacity to make appropriate use of financial information and experience (Mitchell and Lusardi, 2011). Numerous surveys on the comprehension of concepts such as interest, inflation, and risk found widespread and often worsening financial illiteracy across the globe, even in countries with well-established financial markets (Lusardi and Mitchell, 2011a). These gaps in financial competence are linked to inefficiencies in the management of personal finances (Hastings

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et al., 2013; Lusardi and Mitchell, 2011b; Miller et al., 2015). Hence, this view predicts that educational interventions can improve financial well-being through increases in financial literacy (Lusardi and Mitchell, 2007). Financial education holds great promise considering the numerous field experiments that have successfully improved savings through financial literacy education programs (Alan and Ertac, 2018; Bruhn et al., 2016; Frisanchio, 2018; Sayinzoga et al., 2016) as well as the recent analyses of accumulated evidence that show a clear overall positive effect of financial education on financial knowledge and behavior (Kaiser et al., 2020; Kaiser and Menkhoff, 2017, 2020; Miller et al., 2015).

An alternative approach focusing on common cognitive biases recommends nudging—manipulation of the decision environment to direct individuals towards welfare-improving behavior (Thaler and Sunstein, 2008). The most successful nudge interventions in financial decision-making involve defaults, such as the automatic enrollment of employees to retirement accounts, which have been shown to reliably improve long-term savings at little cost (Madrian and Shea, 2001; Thaler and Benartzi, 2004). Default nudges have been widely adopted by policymakers around the world, with large positive effects on financial preparedness (Thaler and Sunstein, 2008). In contrast to the view advocating financial literacy, the nudging approach does not see education as an immediate solution to personal mismanagement, because it posits that the problem stems from inherent cognitive biases, such as the tendency of decision-makers to rely on fast and intuitive responses (Kahneman, 2011). Accordingly, these cognitive shortcuts result in recurrent mistakes that are difficult to learn from. Consistent with this view, various psychological traits and cognitive biases involving impulsivity (Ottaviani and Vandone, 2011), present-bias (O'Donoghue and Rabin, 2015), and overconfidence (Pikulina et al., 2017) have been documented to result in systematic financial mismanagement. Critics of this view have pointed to the benefits of heuristic decision-making and argued that heuristics tend to be harmful only when behavior is not well-adapted to the decision environment, such as when it is novel or uncertain (e.g., Kruglanski and Gigerenzer, 2011). While reliance on ecologically valid intuitions and heuristics can be financially beneficial (Neth et al., 2014), as in the  $1/n$  heuristic (DeMiguel et al., 2009), other, harmful heuristics that persist in financial self-management remains a problem (Gathergood et al., 2019; for an overview of the literature on the reliability of intuitions see Isler and Yilmaz, 2019).

Default nudges tend to be cheap and effective, but they have their own drawbacks: they are paternalistic, opaque, and non-educative (Grüne-Yanoff, 2012). Rather than correcting the underlying cognitive biases and harmful heuristics, default nudges are designed to exploit them. Furthermore, in a population with heterogeneous (e.g., time or risk) preferences, a constant default setting imposed across the population can result in welfare losses for whom the default is incongruent with their preferences (Grüne-Yanoff and Hertwig, 2016; Hertwig and Grüne-Yanoff, 2017). These weaknesses, together with lack of transparency regarding the motivations of policymakers advocating nudging, could negatively affect trust towards the choice architects (Jung and Mellers, 2016; Selinger and Whyte, 2010; Sunstein et al., 2019). In contrast, educational interventions do not suffer from non-transparency or paternalism. However, extensive financial literacy education programs do not provide a feasible, comparable alternative to default nudges because they require significant financial resources and time.

For these reasons, alternatives to both default nudges and standard financial educational programs are needed. Educational nudges, which involve immediate, small-scale, and individually targeted feedback on financial literacy, can provide such an alternative. These interventions provide educational information to

quickly fill gaps in financial decision-making competencies. Because people often rely on heuristics in financial decision-making (Binswanger and Carman, 2012; Choi et al., 2017; DeMiguel et al., 2009), snippets of information involving basic facts and useful rules-of-thumb can be more effective than extensive financial literacy programs involving year-long training workshops (Drexler et al., 2014). Moreover, they can be personalized and provided just-in-time for the relevant decision at hand (Fernandes et al., 2014). Hence, educative nudges conceptually come close to what leading scholars on the topic have in mind when they note that “it may be difficult to enhance numeracy in the older adult population, whereas it may be easier to boost knowledge of a few financial concepts fundamental for making financial decisions” (Lusardi et al., 2020). In addition, transparent short-cuts relying on the conscious awareness of information tend to be viewed as less objectionable compared to default nudges that rely on pre-existing cognitive biases (Jung and Mellers, 2016). If shown to be effective, educative nudges can be easily integrated to automated financial advisors (i.e., robo-advisors) that can substitute human financial advice at scale (Brenner and Meyll, 2020). Despite the added benefits that educative nudges are low-cost and do not suffer from paternalism, effectiveness of this type of nudging is yet to be established in the context of financial self-management.

Our study examines the self-management of online retirement accounts and its cognitive correlates among the general Australian public. As one of the first developed countries to adopt mandatory retirement savings, referred to as superannuation, Australia allows the study of financial self-management in a context where residents are already experienced with managing retirement accounts (Agnew et al., 2013; Bateman et al., 2012).

We introduce the Money Allocation Task (MAT) and experimentally compare the effects of two behavioral interventions—educative and default nudges—on financial self-management and institutional trust. The instructions framed MAT as involving the self-management of a new retirement account held at a hypothetical online financial service provider. MAT elicited allocations of a monetary endowment between a current account and three savings accounts—a conservative account with lower but certain returns and two growth accounts with higher but risky returns. One of the growth accounts was pay-off dominated by the other growth account. The money allocated to the pay-off dominated account indicated the extent of financial errors, whereas welfare-improving savings were measured by the total amount allocated to the other two savings accounts. Because nudge effectiveness is associated with higher levels of trust towards the choice architects (Sunstein et al., 2019) we elicited the perceived trustworthiness of the financial service provider as our third outcome measure. To measure the potential cognitive correlates of financial decisions and institutional trust, participants additionally completed three tests: a standard cognitive reflection test, a test of knowledge of the superannuation system, and a novel financial literacy test that measured comprehension of annual interest and interest compounding as well as inflation, risk diversification, and loans.

Participants were randomly assigned to one of four conditions: *Educative Nudge*, *Default Nudge*, *Combination* or *Control*. *Educative Nudge* provided, after each of the three tests and prior to MAT, personalized educative feedback that included the test scores, the mistakes made, and brief explanations of the correct answers. *Default Nudge* allocated the monetary endowment to non-dominated savings accounts by default, while allowing participants to override these defaults. *Combination* included both the default and the educative nudge manipulations, whereas *Control* included neither manipulation.

Based on this setup, we tested three preregistered hypotheses on the three outcome measures. We predicted that both ( $H_1$ )

the default and ( $H_2$ ) the educative nudges will improve financial decisions (i.e., increase savings and decrease errors). Since we expected defaults to have larger effects than educative nudges, we also predicted ( $H_3$ ) an interaction effect between the two nudges such that an educative nudge will be weaker when there is already a default in place—in other words, that the default nudges will crowd-out the educative nudges. Because the behavioral interventions in our setup were designed to promote financial well being and framed as being administered by the hypothetical financial service provider, we also predicted that the nudges would improve institutional trust as specified in  $H_1$  to  $H_3$ .

## 2. Methods

We obtained informed consent from participants and ethics approval from the Office of Research Ethics and Integrity at Queensland University of Technology. Participants first completed three brief tests of financial knowledge and thinking style and then completed the MAT. The study was preregistered at the Open Science Framework (OSF) (<https://osf.io/e84gy>). The dataset, the experimental materials, and the analysis code can be found at the project site (<https://osf.io/w4xga>). A copy of the instructions given to the participants is also provided in the Supplementary Information.

### 2.1. Participants

We recruited adult Australian residents from Prolific ([www.prolific.ac](http://www.prolific.ac)). We analyze data from 534 participants (age:  $M = 31.0$ ,  $SD = 11.0$ ; gender: 43.6% female, 55.2% male, 1.1% other), excluding 13 participants with incomplete submissions. Including a participation fee of \$4.55, average earning was \$6.91 (Australian Dollars, AUD). Among participants who answered the question ( $n = 523$ ), most reported having one (65.5%) or more (11.7%) retirement accounts. Among those who provided an answer ( $n = 434$ ), 28.3% declared having less than \$5,000 in their retirement accounts, 21.7% declared having \$5,000 to \$20,000, 29.7% declared having \$20,000 to \$100,000, 12.0% declared having \$100,000 to \$500,000, and 2.1% declared having more than \$500,000 (AUD).

### 2.2. Planned sample size

Because of the low numbers of Australian residents on Prolific, we aimed to recruit as many participants as we could during a data collection period of 10 days. With 534 complete observations, our sample size achieves high power ( $1 - \beta = 0.88$ ) to detect a small-to-medium effect size ( $f = 0.15$ ) in a two-way ANOVA model (Faul et al., 2009).

### 2.3. Experimental conditions

We used a 2 (default nudging vs. no default nudging) by 2 (educative nudging vs. no educative nudging) between-subjects design, resulting in the following four conditions.

**Default Nudge.** One hundred and thirty-eight participants were assigned to the *Default Nudge* condition ( $n = 138$ ). The endowment of 100 experimental monetary units (EMU) was automatically distributed across one or both of the non-dominated savings accounts at the outset, accompanied by a message that the default allocation reflects recommendation by the financial service provider and that it can be overridden by the participant. The default allocations were counterbalanced across three settings: (1) 100 EMU in the conservative account, (2) 100 EMU in the non-dominated growth account, (3) 50 EMU in the non-dominated growth account and 50 EMU in the conservative account.

**Educative Nudge.** One hundred and fifteen participants were assigned to the *Educative Nudge* condition ( $n = 115$ ), where

participants received feedback after each test. Feedback included the number of correct answers on the test, the answers given by the participants as well as the correct answers, and brief explanations of the correct answers. For example, the explanation to the first question on the financial literacy test (see below) was “The annual interest rate denotes the percentage rate of return to your savings guaranteed by your bank. When the interest rate is 2%, you would therefore earn an additional \$2 in interest for each \$100 saved. In total, your savings account would increase to \$102”. To facilitate understanding, incorrect answers were displayed in red font and correct answers were displayed in green font.

**Combination.** One hundred and twenty-nine participants were assigned to the *Combination* condition ( $n = 129$ ), where participants first received feedback after each of the three tests (i.e., as in *Educative Nudge*) and then completed the MAT with default allocations in non-dominated savings accounts (i.e., as in *Default Nudge*).

**Control.** One hundred and fifty-two participants were assigned to the *Control* condition ( $n = 152$ ), where participants received neither an *Educative Nudge* nor a *Default Nudge*.<sup>1</sup>

### 2.4. Procedure

The experiment was programmed using the Qualtrics survey software ([www.qualtrics.com](http://www.qualtrics.com)). The instructions put participants in the role of a new employee who registers for and manages an online retirement account. Representing the website of the hypothetical financial service provider, participants first completed three tests in randomized order measuring their financial literacy, their knowledge of superannuation, and their tendency for cognitive reflection. Participants then completed the MAT, framed as involving the initial self-management of the savings account, rated the perceived trustworthiness of the financial service, and answered a single-item question measuring task comprehension. Participants finally completed a brief demographic questionnaire.

**The Financial Literacy Test.** We used modified versions of the standard Big Three financial literacy test items on the comprehension of interest, inflation, and risk diversification designed by Lusardi and Mitchell (2011b) and two additional questions on interest compounding and loan durations. The first question in the Big Three (“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?”) does not clearly distinguish between annual interest and interest compounding because the correct answer is “More than \$102” even if one does not take interest compounding (i.e., interest earned on interest) into account. Therefore, we modified this question to specifically test comprehension of annual interest (see Q1 below) and used another question, also originally designed by Lusardi and Mitchell (2007), to specifically test comprehension of interest compounding (see Q4 below). Q2 in our test is taken directly from the Big Three. The risk diversification question in Big Three refers to “buying units in a managed share fund”. 33.7% of participants in a survey reported

<sup>1</sup> Most participants who did not receive an educative nudge (108 in *Default Nudge* and 112 in *Control*) participated in the MAT after taking the tests, whereas a minority (30 in *Default Nudge* and 40 in *Control*) took the tests after the MAT. These latter participants were given the tests at the end of the study with the initial goal to identify any order effects between the MAT and the tests. However, data collection for this additional control was stopped at the end of the second day of the study due to slow overall recruitment. No analysis was conducted before finalization of data collection. No order effects were found after data collection was finalized, and we include in our analyses these 70 participants who took the tests after the MAT. Our confirmatory findings are robust to their exclusion (see Footnote 3).



they “do not know” the answer to this question (Lusardi and Mitchell, 2011a), which suggests that this question can be difficult to understand. Instead, we used a more general question from the OECD International Network on Financial Education (INFE, 2011) survey about “an investment with a high return” (see Q3 below). In our sample, only 3.4% of participants indicated “do not know” on this question. The fifth question (see Q5 below) is a simplified version of a question in the Programme for International Student Assessment (PISA) test (OECD, 2018), which measures comprehension of the effect of loan duration on the amount of monthly payments and total interest due.

Our financial literacy test includes the following five multiple choice questions, with the correct answers noted in square parentheses: (Q1) “Suppose you had \$100 in a savings account without bank fees and the interest rate was 2% per year. How much would you have in the account after 1 year?” [Exactly \$102], (Q2) “Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?” [Less than today], (Q3) “‘An investment with a high return is likely to be high risk.’ Is this statement true or false?” [True], (Q4) “Suppose you had \$200 in a savings account without bank fees and the interest rate was 10% per year. How much would you have in the account after 2 years?” [More than \$240], (Q5) “Suppose you need to loan \$1000 from your bank. You have the option to repay the loan in either 2 or 3 years. Suppose that the interest rate is the same in either option. Which of the following is correct?” [The monthly repayments will be lower and the total interest paid will be higher for the 3 year loan].

*The Superannuation Knowledge Test.* Inspired by tests of financial institutional knowledge shown to be insightful in other country contexts (e.g., Behrman et al., 2012), we created a test of knowledge of various rules and regulations about the Australian pension system. The test included five multiple choice questions (Q1–Q5), each with single correct answers: (Q1) “Is superannuation mandatory?” [Correct answer: Yes], (Q2) “What is Superannuation Guarantee?” [The minimum amount employers are required to pay into their eligible employees’ super accounts], (Q3) “What is the current Superannuation Guarantee amount?” [9.5%],<sup>2</sup> (Q4) “Is it a good idea to have multiple super fund accounts?” [No, because if you have multiple super funds you are paying unnecessary fees], (Q5) “Besides the mandatory amount of super, how else can you contribute to super?” [By forming a salary sacrifice arrangement with your employer or making a tax-deductible deposit].

*The Cognitive Reflection Test.* Individual thinking style was measured by eliciting open-ended answers to the four-item (Q1–Q4) alternate Cognitive Reflection Test (CRT-2, Thomson and Oppenheimer, 2016; for the original CRT, see Frederick, 2005). These questions are designed such that fast and intuitive responses tend to be incorrect. For example, the intuitive but incorrect answer to the first question (Q1) “If you’re running a race and you pass the person in second place, what place are you in?” is “first place”, while the reflective and correct answer is “second place”. Therefore, the number of correct answers on the test measures the individual tendency to override spontaneous responses through cognitive reflection.

*The Money Allocation Task.* In the MAT, each participant allocated an endowment of 100 EMUs worth \$1 (AUD) between a current account, a conservative savings account with lower but certain returns and two growth accounts with higher but risky returns. Any money allocated to the current account was paid to the participant within 1 week after the end of data collection,

whereas any return from the savings accounts was paid 11 weeks later. On the screen describing the MAT, the two growth accounts were displayed in counterbalanced order after the current account and the conservative account. The instructions framed the differences in account maturities and rates of return as representing the high returns to retirement savings over a long-term duration. The conservative account doubled the money invested, whereas returns to the growth accounts depended on the probabilistic market outcome. Specifically, participants were informed that the return to savings in both growth accounts depended on the same market outcome, which would be either good or bad with equal likelihood. It was common knowledge that while the bad market outcome simply returned the invested amount as a whole, the good market outcome multiplied the invested amount by a factor of 4 in one of the growth accounts and by a factor of 5 in the other one. Because the former account is state-by-state pay-off dominated by the latter account (i.e., giving at least as good and sometimes better results than the former), the percentage of endowment invested in the former account provides a measure of *financial error* that does not depend on risk preferences. On the other hand, the sum of the allocations made to the conservative account and the non-dominated growth account as a percentage of the endowment provides a measure of *welfare-improving savings*.

*Institutional Trust.* Immediately after completing MAT, participants rated on a scale from 0 (“not at all”) to 10 (“very much”) how much they trusted the hypothetical financial service provider that held their savings accounts. The trust measure was transformed to range from 0 to 100 for analysis.

*Task Comprehension.* Instructions for MAT explicitly stated that the same market outcome (whether good or bad) would apply to all three savings accounts. Because perception of the pay-off dominance relationship between the two growth funds depends on the correct understanding of this statement, we measured comprehension of this statement by a multiple-choice question and used it as a control in exploratory regression analysis.

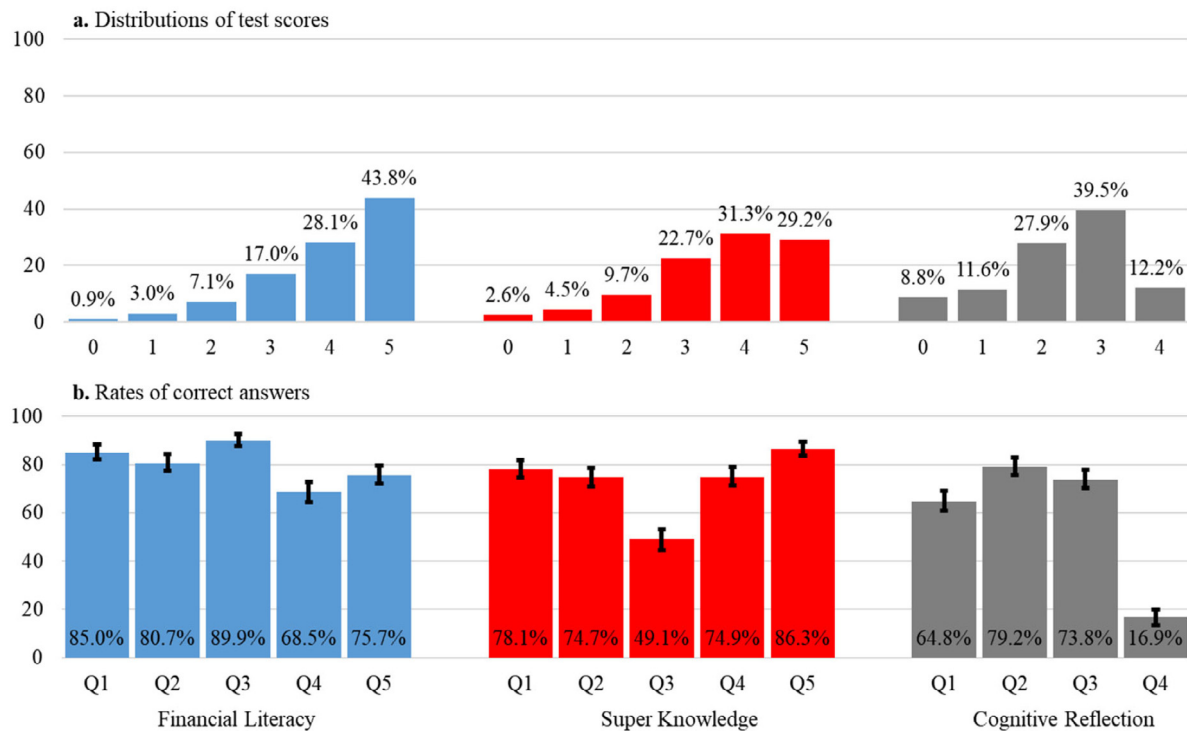
*Survey.* A brief survey at the end of the study elicited the number, duration and value of superannuation accounts that the participants held at the time of the study as well as demographic information including gender and age (see *Participants*). Participants were also asked to report their highest level of education by choosing one of five options: “less than undergraduate degree” (34.3%), “undergraduate degree” (45.1%), “Master’s degree” (12.7%), “doctorate” (3.8%) or “other” (4.1%).

### 3. Results

#### 3.1. Test performance

Fig. 1 (a) depicts the distributions of scores on tests of financial literacy, knowledge of superannuation and cognitive reflection. On average, participants correctly answered 4.00 of 5 questions on the financial literacy test with 95% CI = [3.90, 4.10], and 3.63 [3.52, 3.74] of 5 questions on the superannuation knowledge test. The average score on the cognitive reflection test was 2.35 [2.25, 2.44] out of 4 questions. Financial literacy ( $r = .13$  [.05, .21],  $P = .003$ ) and superannuation knowledge ( $r = .13$  [.05, .21],  $P = .002$ ) tended to increase with age whereas cognitive reflection tended to decline with it ( $r = -.11$  [-.19, -.02],  $P = .014$ ). Financial literacy was higher among males (4.19) than females (3.77;  $t$ -test:  $P < .001$ ,  $d = 0.37$  [0.20, 0.54]), whereas no difference between males and females was found in either cognitive reflection or superannuation knowledge ( $P$ s  $\geq .315$ ). Superannuation knowledge and cognitive reflection did not differ across educational attainment categories (one-way ANOVAs:  $P$ s  $\geq .549$ ), but financial literacy did differ ( $F(4, 529) = 2.47$ ,  $P$

<sup>2</sup> The Australian Superannuation Guarantee amount was increased to 10.0% in July 2021, after data collection.



**Fig. 1.** Performance on the financial literacy test (blue bars), the superannuation knowledge test (red bars) and the cognitive reflection test (gray bars). The top panel (a) displays the distribution of scores for each test. The bottom panel (b) displays the rates of correct answers on each test question. The financial literacy test included questions about comprehension of annual interest (Q1), inflation (Q2), risk diversification (Q3), interest compounding (Q4), and loans (Q5). The superannuation knowledge test included questions on whether superannuation is mandatory (Q1), what (Q2) and how much (Q3) the employer guarantee is, whether it is beneficial to hold multiple super accounts (Q4), and how personal contributions can be made to super accounts (Q5). The cognitive reflection test included the standard CRT-2 questions (Thomson and Oppenheimer, 2016). Error bars show 95% confidence intervals.

$= .044$ ,  $\eta_p^2 = .018$  [.001, .040]) such that the highest scores were among those with doctorate (4.30), Master's (4.21), and undergraduate degrees (4.03) and the lowest scores were among those with "less than undergraduate degrees" (3.91) and "others" (3.45).

Fig. 1 (b) depicts the rate of correct answers for each individual test question. In the financial literacy test, correct answers were most frequent for the risk diversification (Q3; 89.9%), second most frequent for the annual interest questions (Q1; 85.0%), and least frequent for the question on interest compounding (Q4; 68.5%). In the superannuation knowledge test, participants were most knowledgeable about the option for making voluntary contributions (Q5; 86.3%) and least knowledgeable about the required level of guaranteed employer contributions (Q3; 49.1%). Average cognitive reflection test scores in the original study that introduced the CRT-2 (Thomson and Oppenheimer, 2016) was similar to our sample (2.25 vs. 2.35) and so were the highest and lowest scoring test questions (83.2% vs. 79.2% on Q2 and 16.1% vs. 16.9% on Q4).

### 3.2. Behavioral interventions

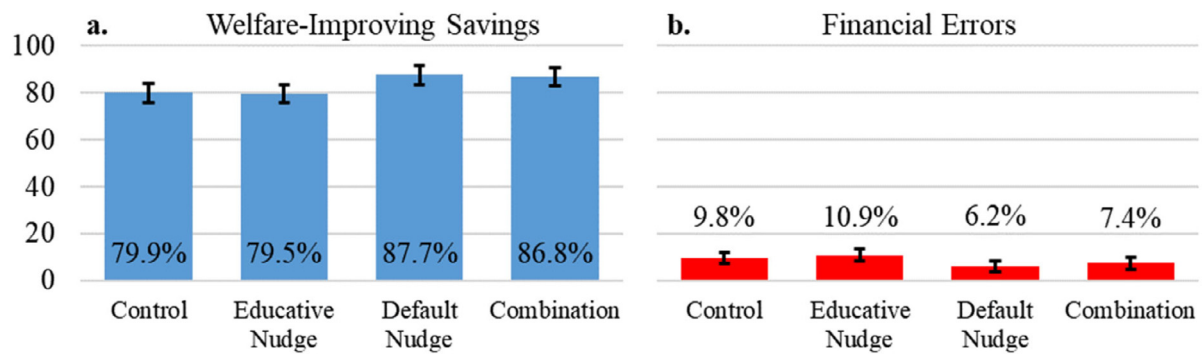
*Default nudges increase welfare-improving savings, educative nudges do not.* Fig. 2a depicts the welfare-improving savings made in the MAT across the experimental conditions. Most participants (97.8%) saved money in at least one of the two non-dominated savings accounts, and average savings in these accounts as a percentage of endowments was 83.5% among all participants. (H<sub>1</sub>) Defaults increased welfare-improving savings by 7.5 [3.5, 11.5] percentage points (pp) (two-way ANOVA:  $P < .001$ ,  $\eta_p^2 = .025$  [.005, .056]). (H<sub>2</sub>) Welfare-improving savings rates did not depend on the presence (83.4%) or absence (83.6%) of educative

nudges ( $P = .760$ ,  $\eta_p^2 < .001$  [0, .009]). (H<sub>3</sub>) There was no interaction between the two nudge types ( $P = .913$ ,  $\eta_p^2 < .001$  [0, .005]).

*Default nudges decrease financial errors, educative nudges do not.* Fig. 2b depicts the financial errors made in the MAT across the experimental conditions. Approximately one in every three participants (33.7%) erroneously allocated money in the dominated savings account, amounting to 25.3% of their endowment. (H<sub>1</sub>) The defaults decreased financial errors by 3.4 [1.1, 5.8] pp (two-way ANOVA:  $P = .004$ ,  $\eta_p^2 = .016$  [.002, .042]). (H<sub>2</sub>) Financial errors did not depend on the presence (9.1%) or absence (8.1%) of educative nudges ( $P = .347$ ,  $\eta_p^2 = .002$  [0, .016]). (H<sub>3</sub>) There was no interaction between the two nudge types ( $P = .954$ ,  $\eta_p^2 < .001$  [0, .002]).

*No effect of nudges on institutional trust was found.* Neither default nor educative nudges were found to affect, whether negatively or positively, the perceived trustworthiness of the hypothetical financial service provider. Institutional trust was similar (H<sub>1</sub>) with (61.3%) or without (60.6%) defaults (two-way ANOVA:  $P = .639$ ,  $\eta_p^2 < .001$  [0, .011]) and (H<sub>2</sub>) with (60.7%) or without (61.2%) educative nudging ( $P = .707$ ,  $\eta_p^2 < .001$  [0, .010]). (H<sub>3</sub>) There was no interaction effect ( $P = .574$ ,  $\eta_p^2 = .001$  [0, .012]).<sup>3</sup>

<sup>3</sup> Robustness of confirmatory tests: The confirmatory test results are robust to the exclusion of the 70 participants who took the tests after the MAT (see Footnote 2), showing the effect of defaults on welfare-improving savings ( $P = .002$ ,  $\eta_p^2 = .021$  [.003, .053]) and financial errors ( $P = .010$ ,  $\eta_p^2 = .014$  [.001, .043]). Likewise, the evidence for the effects on savings and errors are robust to adjusting for multiple hypothesis testing, as they sustain Bonferroni correction, a conservative test that rejects any of the nine hypotheses if  $P < .050 \div 9 \approx .006$ . Moreover, these results are robust to controlling for age, gender, education, and task compression, as described in the following exploratory analysis.



**Fig. 2.** The left panel (a) displays welfare-improving savings (i.e., average monetary allocations in the non-dominated savings accounts as a percentage of initial endowment) across the experimental conditions. The right panel (b) displays financial errors (i.e., average monetary allocations in the dominated savings account as a percentage of initial endowment) across the experimental conditions. Error bars show 95% confidence intervals.

### 3.3. Exploratory analysis

*Financial literacy and cognitive reflection explain financial self-management.* We use three OLS regression models to explore the cognitive and demographic correlates of financial behavior in the MAT and institutional trust (see Table 1).<sup>4</sup> As covariates, these models include the experimental conditions, the three test scores, and various demographic factors and individual traits that have the potential to predict financial decisions (i.e., age, gender, education, and task comprehension).

The model estimates of the nudge effects are consistent with the confirmatory tests reported in the previous section. Focusing on the test scores, one-point increase in financial literacy scores above average was associated with 5.3 [3.2, 7.3] pp increase in welfare-improving savings, 1.9 [0.7, 3.2] pp decrease in financial errors, and 1.7 [0.2, 3.4] pp increase in institutional trust. One-point increase in cognitive reflection scores above average showed 1.7 [-0.1, 3.5] pp increase in welfare-improving savings and 1.4 [0.2, 2.6] pp decrease in financial errors. Superannuation knowledge, task comprehension, and demographic variables were not predictive of financial decisions or institutional trust.

*Comprehension of interest compounding predicts higher savings, lower errors, and higher trust.* We next consider the relationship between performance on individual test questions and financial self-management. For this purpose, we estimated modified versions of the models on Table 1 by replacing test scores with dichotomous variables indicating correct answers on each test question (see Table 2).

In the financial literacy test, comprehension of interest compounding (Q4) simultaneously predicted 6.9 [2.1, 11.8] pp higher welfare-improving savings, 3.0 [0.1, 6.0] pp lower financial errors, and 5.5 [1.4, 9.6] pp higher institutional trust. In addition, comprehension of annual interest (Q1) and loan duration (Q5) predicted higher welfare-improving savings (10.7 [3.7, 17.6] pp and 6.1 [0.1, 11.1] pp respectively).

*Default nudges help those low on financial literacy and cognitive reflection.* While the results above show that defaults improve financial self-management overall, the question remains whether they are particularly helpful for those with low financial literacy or cognitive reflection. To explore this question, we separated participants in high- and low-scoring groups by dividing them at the median scores of these two variables.

<sup>4</sup> We report Tobit regressions with model specifications corresponding to the OLS regressions in Tables 1 and 2 in the Supplementary Information (see SI Tables 1 and 2). These Tobit models take into account of the fact that our dependent variables are bounded at 0 and 100, with concentrations of observations at these limiting values (Tobin, 1958). The results of the Tobit regressions are consistent with those of the OLS regressions.

**Table 1**  
Correlates of financial self-management and institutional trust.

	(1) Welfare-Improving savings (%)	(2) Financial errors (%)	(3) Institutional trust (%)
Experimental Condition			
Default Nudge	7.43** (2.88)	-3.47** (1.58)	-0.75 (2.30)
Educative Nudge	-0.75 (2.58)	1.08 (1.62)	-1.96 (2.42)
Combination	6.13** (2.70)	-2.42 (1.74)	-0.62 (2.32)
Financial Literacy	5.26*** (1.02)	-1.92*** (0.63)	1.70** (0.85)
Super Knowledge	-0.52 (0.83)	0.55 (0.51)	-0.45 (0.68)
Cognitive Reflection	1.67* (0.91)	-1.44** (0.61)	-1.03 (0.84)
Age	-0.08 (0.09)	0.08 (0.06)	-0.03 (0.09)
Gender			
Female	1.60 (2.03)	1.84 (1.24)	-0.32 (1.74)
Other	4.27 (7.56)	2.61 (6.19)	6.90 (8.30)
Education			
Undergraduate	-1.46 (2.16)	0.43 (1.35)	1.67 (1.93)
Master's	-7.24** (3.63)	0.72 (2.01)	-2.40 (3.13)
Doctorate	1.09 (5.47)	-1.20 (2.97)	-0.75 (4.42)
Other	1.53 (6.25)	-2.47 (2.90)	3.12 (3.40)
Task Comprehension			
Correct	2.20 (2.04)	-1.64 (1.19)	-0.47 (1.72)
Constant	80.03*** (2.60)	9.54*** (1.66)	61.46*** (2.35)
N	534	534	534

**Notes:** Table reports OLS regressions on total savings in the non-dominated accounts (Model 1), savings in the dominated account (Model 2), and self-reported trust of the financial service provider (Model 3). All continuous variables are mean-centered. Base level is "Control" for Experimental Condition, "Male" for Gender, "Less than undergraduate degree" for Education, and "Incorrect" for Task Comprehension. Robust standard errors are in parentheses.

\* $p < .10$ .

\*\* $p < .05$ .

\*\*\* $p < .01$ .

**Table 2**  
Role of individual test questions.

	(1) Welfare- Improving Savings (%)	(2) Financial Errors (%)	(3) Institutional Trust (%)
Experimental Condition			
Default Nudge	7.54*** (2.89)	−3.21** (1.58)	−0.82 (2.33)
Educative Nudge	−0.60 (2.64)	1.48 (1.61)	−1.76 (2.42)
Combination	5.95** (2.71)	−2.14 (1.71)	−0.53 (2.33)
Financial Literacy			
Q1	10.67*** (3.52)	−0.50 (1.80)	3.80 (2.58)
Q2	3.20 (2.67)	−1.60 (1.79)	−1.46 (2.51)
Q3	−2.19 (3.30)	1.68 (2.09)	0.98 (2.84)
Q4	6.93*** (2.47)	−3.05** (1.53)	5.47*** (2.09)
Q5	6.08** (3.04)	−2.59 (2.05)	1.60 (2.23)
Super Knowledge			
Q1	0.45 (2.47)	1.43 (1.40)	1.80 (2.19)
Q2	0.88 (2.66)	1.14 (1.61)	1.08 (2.37)
Q3	−3.37 (2.16)	1.85 (1.36)	−0.06 (1.87)
Q4	1.17 (2.40)	0.71 (1.39)	−1.59 (2.16)
Q5	−0.28 (3.23)	−3.05 (2.14)	−4.86* (2.80)
Cognitive Reflection			
Q1	−0.46 (2.19)	−0.87 (1.34)	−0.45 (1.76)
Q2	3.31 (2.87)	−3.22* (1.78)	−1.59 (2.22)
Q3	2.56 (2.46)	−1.92 (1.53)	−1.90 (1.97)
Q4	1.01 (2.62)	0.39 (1.67)	−1.23 (2.27)
Age	−0.09 (0.10)	0.09 (0.06)	0.01 (0.09)
Gender			
Female	1.50 (2.13)	2.07 (1.29)	0.31 (1.79)
Other	3.19 (8.31)	2.01 (6.47)	7.63 (7.93)
Education			
Undergraduate	−1.39 (2.14)	0.51 (1.35)	1.53 (1.95)
Master's	−7.70** (3.67)	0.81 (2.05)	−3.01 (3.20)
Doctorate	0.62 (5.16)	−0.33 (2.94)	−0.42 (4.47)
Other	0.69 (6.32)	−2.42 (3.06)	2.63 (3.61)
Task Comprehension			
Correct	1.64 (2.08)	−1.50 (1.20)	−0.59 (1.69)
Constant	80.40*** (2.68)	9.08*** (1.68)	61.33*** (2.38)
Observations	534	534	534

**Notes:** Table reports OLS regressions on total savings in the non-dominated accounts (Model 1), savings in the dominated account (Model 2), and self-reported trust of the financial service provider (Model 3). All continuous variables are mean-centered. Base level is "Control" for Experimental Condition, "Male" for Gender, "Less than undergraduate degree" for Education, and "Incorrect" for Task Comprehension. Robust standard errors are in parentheses.

\* $p < .10$ .

\*\* $p < .05$ .

\*\*\* $p < .01$ .

Among those with financial literacy scores less than 5 ( $n = 300$ ), default nudges increased welfare-improving savings by 12.0 [6.6, 17.5] pp ( $t$ -test:  $P < .001$ ,  $d = 0.50$  [0.27, 0.73]). In contrast, there was no effect of defaults on those who scored 5 ( $n = 234$ ;  $P = .966$ ,  $d = 0.01$  [−0.25, 0.26]). Similarly, defaults lowered financial errors by 4.9 [1.5, 8.2] pp among those with below-median financial literacy scores ( $P = .005$ ,  $d = 0.33$  [0.10, 0.56]), but there was no effect on those with above-median scores ( $P = .601$ ,  $d = 0.07$  [−0.19, 0.33]).

Turning to cognitive reflection and considering those with scores less than 3 ( $n = 258$ ), defaults increased welfare-improving savings by 11.2 [5.4, 17.1] pp ( $P < .001$ ,  $d = 0.47$  [0.22, 0.72]), while there was no clear effect on those who scored 3 or 4 ( $P = .111$ ,  $d = 0.19$  [−0.04, 0.43]). Likewise, defaults lowered financial errors by 6.7 [3.2, 10.1] pp among those with low cognitive reflection scores ( $P < .001$ ,  $d = 0.48$  [0.23, 0.72]), but there was no effect for those high in cognitive reflection ( $P = .650$ ,  $d = 0.05$  [−0.18, 0.29]). In contrast to default nudges, educative nudges were ineffective regardless of financial literacy and cognitive reflection levels ( $P$ s  $\geq .362$ ).

#### 4. Discussion

In an online experiment with participants from the general Australian public, we tested the effects of educative and default nudges on financial self-management and explored its cognitive and demographic correlates. We used a novel experimental task, the MAT, to incentivize and observe financial decisions in a controlled setting, as well as a novel financial literacy test designed to distinguish between the comprehension of annual interest and interest compounding. As predicted, default nudges increased welfare-improving savings and decreased financial errors in the MAT. However, failing to support our hypotheses, no effect of educative nudges on financial behavior was identified and both nudges failed to influence institutional trust. Financial literacy in general and comprehension of interest compounding in particular were predictive of higher welfare-improving savings, lower financial errors, and higher institutional trust. Reliance on cognitive reflection additionally explained increases in welfare-improving savings and avoidance of financial errors.

Accumulated evidence shows that default nudges can substantially improve decision-making (Jachimowicz et al., 2019). The clear success of defaults in our experiment further attests to their effectiveness in improving financial behavior (Thaler and Sunstein, 2008). Overall, default nudges in our experiment increased welfare-improving savings by 9.4% and decreased financial errors by 34.0% as compared to conditions without defaults. While substantial, these effect sizes are smaller than the median effect size (50%) identified for default nudges in a recent meta-analysis of twenty-one previous studies (see Table 7 in Hummel and Maedche, 2019). It is likely that baseline levels of high savings and low errors, as indicated by the control condition, prevented larger improvements in financial behavior.

The failure of educative nudges in our experiment is disappointing, especially considering the evidence that educational interventions in finance often do work (Kaiser et al., 2020) and that providing financial rules-of-thumb can outperform extensive financial education training (Drexler et al., 2014). Nevertheless, it is important to note that the failure of educative nudges in our study does not put in doubt the effectiveness of intensive financial literacy education manipulations that are more commonly used in the literature. Likewise, the promise of using small-scale educative interventions remains, since the behavioral effectiveness and the psychological saliency of our experimental manipulations can be strengthened in various ways.

In particular, boosting methods can allow improvements in educative interventions (Hertwig and Grune-Yanoff, 2017). While



our educative nudges focused on providing immediate, small-scale feedback to foster information awareness (i.e., “knowing that”), the boosting approach focuses on enhancing personal agency by improving the understanding of procedural knowledge (i.e., “knowing how”) (Grüne-Yanoff and Hertwig, 2016). For example, future research can study how to improve procedural knowledge (e.g., presentation of visual information via fact boxes vs. icon arrays) and test the potential moderators of effective boosting (e.g., basic numeracy and graph literacy).

We introduced a five-item financial literacy test that clearly distinguishes between the comprehension of annual interest (Q1) and interest compounding (Q4). Exploratory analysis indicated that miscomprehension of interest compounding, unlike any other aspect of financial literacy that was measured, simultaneously explained lower welfare-improving savings, higher financial errors, and lower institutional trust. These findings are consistent with previous literature that has linked the underestimation of exponential growth with low levels of financial literacy and savings (Almenberg and Gerdes, 2012; Stango and Zinman, 2009) and suggest that improvements in this aspect of financial literacy can benefit consumers as well as service providers in finance. As a pivotal component of financial literacy, future research should measure and attempt to improve the comprehension of interest compounding. Relatedly, the explanatory powers of alternative financial literacy tests used in the literature, including ours, should be systematically compared in future studies.

In addition to insights on financial literacy, our study revealed an important role for cognitive reflection in driving successful financial self-management. Research shows that avoidable financial errors can be systematic and widespread (for a review see Hastings et al., 2013). For example, Gathergood et al. (2019) recently showed that people rely on what they refer to as the “balance-matching heuristic”, as they repay multiple credit card loans according to the relative size of debt held across the cards rather than the cost-minimizing strategy of first paying-off the loan with the highest interest. In our sample, the individual tendency for cognitive reflection was associated with avoidance of costly financial errors in the MAT. This association can be explained by the classic dual-process models (e.g., Evans, 2003), which posit that people who tend to rely on reflective thinking are more likely to notice and correct mistakes in their spontaneous decisions. Because the pay-off relevant financial decisions involving interest and risk in the MAT mimic actual money allocation tasks performed in online banking, we expect the association found between cognitive reflection and avoidance of financial errors in the MAT to have strong external validity. Furthermore, replicating the age-related decline in cognitive abilities (Finke et al., 2017; Gamble et al., 2015), cognitive reflection scores in our sample decreased with age. These exploratory results suggest that interventions activating reflection (e.g., by prompting decision justification or training analytic thinking; see Isler et al., 2020) can be used to improve financial behavior. Nevertheless, to what extent measures of financial literacy and cognitive reflection capture distinct phenomenon in the context of financial decision-making is an ongoing debate (see Hung et al., 2009; Lusardi et al., 2010; Stolper and Walter, 2017). Pointing to their close association, we found both measures to moderate the effects of default nudges, helping in particular the low-scoring participants to save more and avoid errors. We recommend future studies on individual financial decision-making to elicit measures of both thinking style and financial literacy to allow additional comparisons.

Our study has three main limitations. First, 79.9% of the endowment was allocated to welfare-improving savings in the control condition, which may have increased the difficulty of detecting the effects of educative nudges. Since default nudges

increased savings despite these high baseline levels, there was no clear ceiling effect overall. However, we cannot rule out the possibility that educative nudges are effective when saving rates are lower. Future studies employing the MAT can set lower rates of return to achieve lower savings rates in the control conditions. Second, we used convenience rather than representative sampling, which restricts the generalizability of our results. Nevertheless, the demographic correlates of financial literacy in our sample were in general consistent with evidence from Australia (Agnew et al., 2013; Bateman et al., 2012) as well as from around the world (Lusardi and Mitchell, 2011b). For example, education level was positively associated with financial literacy, and younger participants and females tended to have lower financial literacy scores. In line with the results of a representative Australian sample (Agnew et al., 2013), but unlike the global trends (Finke et al., 2017; Gamble et al., 2015), financial literacy was not lower among senior participants in our study. Third, the educative nudges employed in our experiment may have been too weak to influence financial behavior. We provided simple personalized educational explanations as feedback to increase financial literacy, knowledge of institutional rules and regulations, and cognitive reflection. Future research should design and test stronger educative nudging and boosting interventions and implement manipulation checks to measure their effectiveness.

We found that it is easier to improve financial self-management by “showing” decision-makers in the right direction with defaults than by “showing” them the right direction with educative nudges. Educative nudges continue to promise substantial benefits. Until effective educative nudges are developed, it is advisable to continue to use, together with reasonable safeguards and governance structures, default nudges that reliably increase long-term savings to promote social welfare.

#### CRedit authorship contribution statement

**Ozan Isler:** Conceptualization, Methodology, Software, Data curation, Data analysis, Visualization, Writing – original draft, Writing – review & editing. **Andres Rojas:** Conceptualization, Writing – review & editing. **Uwe Dulleck:** Conceptualization, Writing – review & editing.

#### Declaration of competing interest

Ozan Isler and Uwe Dulleck declare no competing interests. Andres Rojas is employed by Sunsuper ([www.sunsuper.com.au](http://www.sunsuper.com.au)). The research was funded by Sunsuper and the Think Forward Initiative (a partnership between ING Bank, Deloitte, Dell Technologies, Amazon Web Services, IBM, and the Center for Economic Policy Research – CEPR), but the funders had no role in the study design, the data collection or the analysis of results. The views expressed in this paper are solely those of the authors and do not necessarily reflect the official policy or position of the funders.

#### Appendix A. Online Supplementary Information

Supplementary information related to this article can be found online at <https://doi.org/10.1016/j.jbef.2022.100639>.

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