

Financial Communications and Asset Allocation Decisions: The Effects of Reading Style, Financial Knowledge, and Individual Differences

Executive Summary

J. Wesley Hutchinson,
The Wharton School
University of Pennsylvania,

Robert Botto,
The Wharton School
University of Pennsylvania,

Gal Zauberman,
Yale University

This research assessed the ability of working adults to comprehend financial communications about retirement saving plans, and how comprehension, along with other factors, affects asset mix decisions. Although financial consultants are often available to workers in large organizations for face-to-face communication, self-education and self-assessment of knowledge are the dominant inputs to retirement decisions. Financial information is complex and unfamiliar compared to information about other types of consumer products, and this makes miscomprehension more likely. This research used eye-tracking technologies and procedures to collect detailed, individual level data about consumer information processing of financial communications. Experimental manipulations of the medium of communication (print vs. online) and information format (graphical vs. text) were used to assess the impact of these factors on reading style, comprehension (i.e., increases in financial knowledge), and personal asset mix decisions.

Reading style emerged as the measure most affected by our manipulations. Print encouraged a more systematic, deeper reading style compared to an online format. Charts attracted more visual attention. Reading style was found to affect comprehension, which in turn affected personal asset allocation decisions. Financial knowledge was found to have two components: conceptual knowledge (e.g., financial literacy) and procedural knowledge about how to make financial decisions. Conceptual and procedural knowledge had different antecedents, but similar and fairly strong effects on personal asset mix decisions. Higher knowledge individuals allocated more to equities compared to fixed income and guaranteed assets. Several other individual difference variables (especially risk tolerance and financial self-confidence) also had large effects on personal asset mix decisions.

The original title of the TIAA Institute and Pension Research Council Partnership grant proposal was “Comprehension of Financial Communications and Asset Mix Decisions: Eye-Tracking Analyses of Text, Tables, and Charts Presented in Print and Online Media”

Any opinions expressed herein are those of the authors, and do not necessarily represent the views of TIAA, the TIAA Institute or any other organization with which the authors are affiliated.

Key findings

- Financial knowledge was found to have two components: conceptual knowledge (e.g., financial literacy) and procedural knowledge about how to make financial decisions.
- Generally speaking, communications media and formats had large effects on reading style and small effects (“nudges”) on financial knowledge and personal asset mix decisions. Print encouraged a more systematic, deeper reading style compared to an online format. Charts attracted more visual attention.
- Reading style was found to have small effects on both conceptual and procedural knowledge and larger effects on personal asset mix decisions.
- Both conceptual and procedural knowledge had large effects on personal asset mix decisions
- Individual differences (especially risk tolerance and financial self-confidence) had large effects on personal asset mix decisions.

1. Introduction

This research assessed the ability of working adults to comprehend financial communications about retirement saving plans, and how comprehension affects asset mix decisions. Although financial consultants are often available to workers for face-to-face communication, self-education and self-assessment of knowledge are the dominant inputs to retirement decisions. The primary media for communications are print (e.g., brochures, reports, newsletters, etc.) and online (e.g., website account management, planning tools, product performance tables, etc.). Additionally, the information formats used in these media are typically a combination of text, tables, and charts. Thus, the communications are complex and unfamiliar compared to communications about other types of products (e.g., advertising, search engine results, consumer rating sites, etc.), and this makes miscomprehension more likely. This research used eye-tracking technologies and procedures to collect detailed, individual-level data about consumer information processing of financial communications. Experimental manipulations of the medium of communication and information format were used to assess the impact of these factors on reading style, comprehension, and personal asset mix decisions.

2. Research questions

Two experiments were conducted to address five research questions, which were highlighted in the TIAA-PRC grant proposal and are listed below.

1. Are current employees with different time horizons relative to retirement able to comprehend complex income products based on the print and online materials commonly provided by employers and financial services companies? Of particular interest is determining whether miscomprehension is due to one or more characteristics of reading style. These characteristics include (a) encoding failure (i.e., did not look at information), (b) insufficient encoding effort (i.e., “skimmed” information without fully processing it), and (c) comprehension failure (i.e., information was fully processed, but motivation, complexity, and/or lack of background knowledge prevented a complete understanding of the presented information).
2. Does comprehension affect decision making? The focal decisions that will be studied are changes in asset mix based on risk tolerance and distance from retirement.
3. Are there differences among communication formats (e.g., text, tables, and charts; print vs. online) in their ease and depth of comprehension?
4. Is comprehension affected by distance from retirement? Are older workers who are closer to retirement more motivated and able to comprehend complex income products than younger workers?
5. What are the patterns of covariation between comprehension and other variables of interest, including age, education, risk attitude, financial literacy, propensity to plan, and intertemporal preferences?

3. Methodology

The methods used in this research were those commonly found in cognitive psychology in the areas of visual attention, text comprehension, judgment and decision making, including those commonly applied by marketing research firms in other consumer domains. However, two aspects of the present research appear to be new to the research literature on personal financial decision making. First, this research uses eye-tracking technologies and procedures to construct individual-level measures of reading style and empirically examine the extent to which reading style can

affect comprehension and personal asset mix decisions. Second, in addition to standard measures of comprehension based on conceptual knowledge (similar in kind to financial literacy measures), this research developed a new measure of procedural knowledge for financial decisions.

Of central importance in this research is the use of eye-tracking methods and data. Thus, a brief introduction to these methods is provided below, and that is followed by an overview of the measures used, research design and analytic framework.

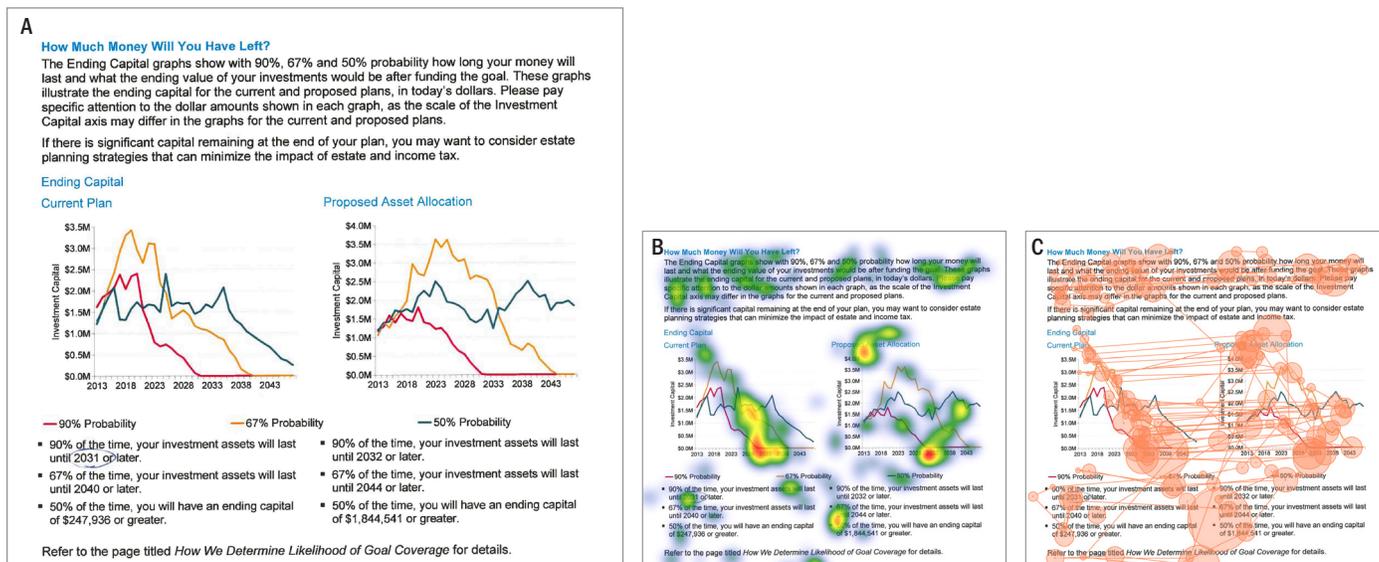
3.1 Background on eye-tracking procedures and measures

Our primary research question (#1 above) concerns reading style as a potential cause of miscomprehension, and its downstream effects. Eye-tracking data is uniquely able to assess reading style (for reviews see Duchowski 2002; Holmqvist et al. 2011; Rayner 1998). Historically, this technology provided measurement methods and data that yielded major breakthroughs in our understanding of reading, which remains relevant today. It has also been a critical source of information in the areas of visual search, scene perception, and spatial navigation in psychology and advertising, package design, retail display, and software/website usability in marketing research. Eye-tracking data is valuable because it is a “gold standard” measure of visual attention. The eye does not work like a camera. Unlike film and digital image sensors that have uniform resolution, the retina at the back of the human eye has a very small, central area of high resolution and color sensitivity called the fovea (about 2 degrees of visual angle or 8 letters at reading distance). Resolution drops rapidly with distance from the fovea. Large shapes, motion, and the “gist” of a scene are apprehended rapidly everywhere in the visual field. However, high-resolution information requires the eye to *fixate* that information on the fovea. Thus, the eye moves 3 to 6 times per second gathering the information the brain determines to be most important, where importance is based on previously fixated information, prior knowledge, expectations, and current goals. High-resolution information includes text, entries in numerical tables, and graphical details. The coherent world we “see” is computationally constructed by the brain from this ongoing, fragmented stream of low-level information.

As an example, Panel A in Figure 1 shows some text and charts from a *TIAA Retirement Review*, in which a current asset mix is compared to a proposed asset mix in terms of a Monte Carlo analysis of risk, return, and the likelihood of exhausting all assets. Next to Panel A are two types of eye-tracking data from a single subject in a pilot experiment: a “heat map” of the cumulative time spent fixating on each point (Panel B; i.e., summed fixation durations, which individually last .20 to .40 seconds on average; red indicates long durations, green indicates short durations, blank indicates non-fixated regions) and a “scan path” chart (Panel C) showing the sequence of individual fixations (lines; called *saccades*, which last .03 to .05 seconds and during which no information is acquired) and the duration of each fixation (circle diameter). The heat map shows that (1) the first part of the text at the top of the page was processed fairly well, but the second part was never fixated at all (i.e., encoding failure); (2) a lot of attention was paid to the point at which the 90% curve (red) hit zero Invested Capital for both plans; and (3) moderate attention was paid to the y-axis maximum of both charts. The abundance of horizontal lines in the scan path chart reveals that there were many point-to-point comparisons of the Current Plan and Proposed Asset Allocations. We note that from a normative perspective, the most important aspect of the chart is the large difference between plans for the 50% curves after 2035, which was fixated for the Proposed Asset Allocation but not the Current Plan. Thus, this subject seems to have more concerned with the worst-case than the most likely scenario.

Figure 1 is merely illustrative of the nature of eye-tracking data. The full dataset to be analyzed generally consists of a large, rich, time series of fixation events and associated physiological and behavioral events. Of particular importance, the dataset includes direct measures encoding failures and indirect measures the extent of cognitive processing for every information item presented to the subject. In this research, we use total number of fixations (similar to the heat map) and number of revisits (derived from scan paths) to assess reading style for financial communications.

Figure 1. An example of eye-tracking data collected from a single subject



3.2 Background on measures of financial knowledge and other individual differences

3.2.1 Comprehension and financial knowledge

We investigate the role of two types of knowledge in financial decision making. *Conceptual knowledge* (also called *declarative knowledge*) is knowledge about “what things are.” *Procedural knowledge* (also called *action-centered knowledge*) is knowledge about “how to do things.” For both types of knowledge, the “things” can be concrete or abstract.¹ This distinction is used very broadly in terms of the cognitive systems that serve all types of thought (e.g., Anderson, 2007; Sun, Slusarz, and Terry, 2005) and more narrowly for specific cognitive skills, such as mental calculations (e.g., Rittle-Johnson, Siegler, and Alibali, 2001). The latter seems to be more directly relevant to personal finance, but it is important to acknowledge that this is a fundamental distinction across many areas of cognitive research. Thus, it was important to develop distinct measures for each type of knowledge as related to personal finance, in general, and asset mix decisions, in particular.

Conceptual knowledge. There is a consensus that the financial environment is becoming increasingly complex. In the context of retirement decisions, the shift from defined benefits to defined contribution (e.g., 401(k) accounts) shifts the decision making and risk from employers to employees. Individuals now need to decide whether or not to save, how much to save, how to invest this money, and how then to use it in retirement.

Consequently, there are calls for increased financial literacy and financial education (Lusardi and Mitchell 2007a, Lusardi and Mitchell 2009, Dodd-Frank 2013). However, a recent meta-analysis (Fernandes, Lynch, Netemeyer, 2014) found only weak support for the effectiveness of (tested) financial literacy interventions or the importance of financial literacy over and above other relevant skills (e.g., basic numeracy, self-control, planning, etc.).

Fernandes, Lynch, Netemeyer (2014) define financial literacy as: “... a measure of the degree to which one understands key financial concepts and possesses the ability and confidence to manage personal finances through appropriate

1. Rittle-Johnson, Slusarz, and Alibali (2001) provide the following definitions. “ We define procedural knowledge as the ability to execute action sequences to solve problems. ... In contrast to procedural knowledge, we define conceptual knowledge as implicit or explicit understanding of the principles that govern a domain and of the interrelations between units of knowledge in a domain.”

short-term decision making and sound, long-range financial planning, while mindful of life events and changing economic conditions.”

While financial literacy refers to a set of skills, measures of financial literacy are often about assessment of objective knowledge; for example, questions might ask: “Suppose you had \$100 in a savings account and the interest rate is 20% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total? More than \$200; Exactly \$200; Less than \$200” (Van Rooj, Lusardi, and Alessi 2011). Fernandes, Lynch, Netemeyer (2014) developed a 13-item scale. We use a subset of their items, but also add a ‘subjective knowledge’ scale that assesses the extent of financial literacy individuals believe they have. Subjective knowledge is essentially a measure of financial confidence.

Procedural knowledge. In addition to knowledge about financial concepts and numerical skills, it is important for consumers to know how to apply those concepts to their personal situation and the situations of others. This is procedural knowledge. Although several researchers have assessed procedural knowledge for mathematical skills (e.g., Campbell and Xue, 2001; Rittle-Johnson, Siegler, and Alibali, 2001), we know of no researchers who have investigated procedural knowledge for financial asset mix decisions. Our measure assesses the extent to which asset mix recommendations, made for hypothetical target individuals, conform to conventional wisdom (e.g., less investment in equities for individuals who are older or have low risk tolerance). This new measure also allows separate, individual-level estimation of the strength of beliefs about risk tolerance, age, and other factors such as gender.

3.2.2 Other individual differences

Risk tolerance. Risk tolerance is a critical aspect of investment decisions. It is one factor that may influence the appropriate composition of assets in a portfolio, balancing risk and return for a given individual (Droms, 1987). One could infer risk tolerance from people’s choices, financial or otherwise. However, as common in academic research and the financial industry, self-reported risk tolerance measures are frequently used. Self-reported risk tolerance is a measurement of an individual’s willingness to take on risk. As such, it is a valuable tool for researchers and financial advisors. For academics, many different such scales were

developed (see SJDM dedicated page: http://www.sjdm.org/dmidi/Risk_Attitude.html). For practitioners, TIAA has developed such as questionnaire, as have others in the industry.

When assessing risk attitudes, there are multiple aspects that must be considered. Is risk tolerance stable over situations and time? There is no agreement on this question. However, in our context, the fact that people change their risk tolerance with time is normative. That is, as time horizons to retirement changes, risk tolerance should change, and their available resources (financial and mental) change as well. This is exactly what Hallahan, et al., (2004) found: a non-linear decrease in risk tolerance with age. What about demographics? Hallahan, et al., (2004) found that women have lower risk tolerance than men, as well as lower risk tolerance for those who are married vs. single.

Risk attitudes might change with circumstances and over one’s lifetime, but what about stability of shorter investment periods relevant for investment? A recent study that tracked financial risk tolerance scores over 5 years found only a small annual change (Van de Venter, et al., 2012). They also found a small decrease in financial risk tolerance associated with a decrease in household size and an increase in financial risk tolerance after terminating the services of a financial planner. The authors conclude that financial risk tolerance is largely a stable personality trait.

Intertemporal preferences. Time preference is defined by the tradeoffs between outcomes in the present and outcomes in the future. As a stylized example, consider a person choosing between \$10 today and \$20 in a year? What people choose will depend on their *discount rate*. People with a reasonable discount rate (say, 10% per year), will see the \$20 in a year as worth about \$18 in the present, and will strongly prefer to wait for the “later-larger” amount. However, a large literature on time discounting has found that people’s time preferences in these kinds of choices are not well-explained by normative standards (see Frederick, Loewenstein, & Rabin, 2002; Urminsky & Zauberman, 2016 for detailed reviews).

First, people’s preferences reflect extremely high discount rates. Many people would, in fact, choose \$10 today over \$20 in a year, despite the more than 100% annual discount rate that would imply. Second, people’s discount rates are not stable. For example, people are more impatient (i.e.

more likely to choose the sooner-smaller outcome over the later-larger outcome) when the amounts are smaller. In particular, people show inconsistency in time preference, often referred to as hyperbolic discounting or present bias, has been proposed as a model of why people have difficulty exercising self-control and making far-sighted choices (Ainslie, 1975; Laibson, 1997; Hoch & Loewenstein, 1991; Zauberman, 2003).

Resource slack. One of the reasons that people would decide to delay engaging in an activity they believe will be beneficial is that they expect they will have more time and money available in the future. More future money means that they can sacrifice less of their current consumption, and more future time means that they will be able to manage their investment portfolio later without sacrificing completion of other tasks requiring the same resource. This idea is predicted by Slack Theory (Zauberman & Lynch, 2005), which explains intertemporal preference, including both the overall rate of discounting and the extent of hyperbolic discounting, using the concept of slack, defined as “the perceived surplus of a given resource available to complete a focal task without causing failure to achieve goals associated with competing uses of the same resource” (p. 23). Within this theory, discount rates (including the extent of hyperbolic discounting) depend on the patterns of how much slack is perceived over time, that is, the growth or contraction between the near and distant future. In general, people perceive more slack in the future than now, and therefore tend to devalue the costs and benefits of future outcomes. This tends to be stronger for time use compared to money use. It is therefore easy to see how the costs of opening up a 401k or 529 account loom larger in the present.

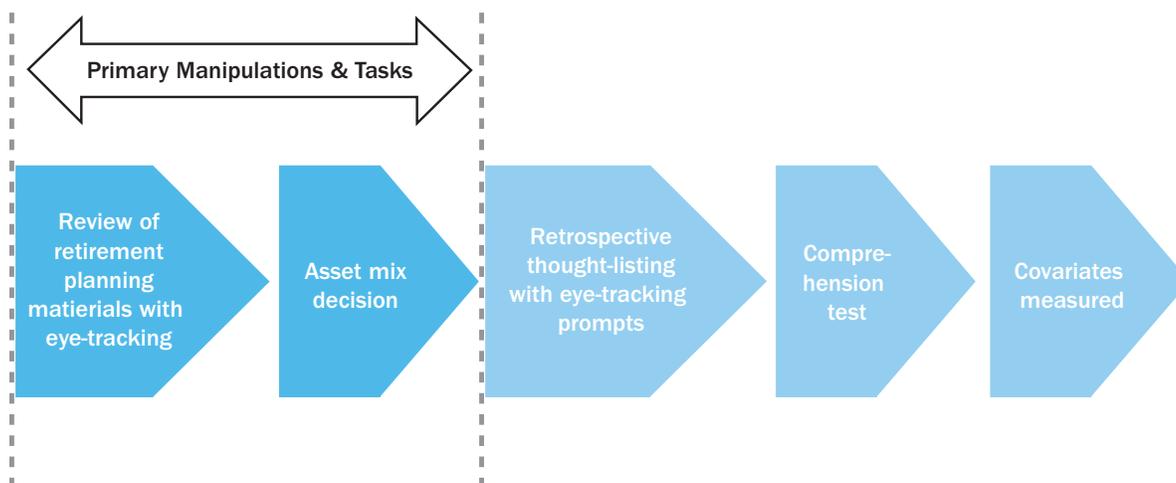
Time perception. Another psychological input that is relevant to intertemporal tradeoffs is the perception of future time itself. This cognitive process is different from the most mechanisms since it moves the focal process from the subjective value of the options to the subjective perception of delay between the outcomes (e.g., Cooper, Kable, Kim, & Zauberman, 2015; Ebert & Prelec, 2007; Kim & Zauberman, 2009; 2013; Zauberman, Kim, Malkoc, & Bettman, 2009). For instance, Zauberman et al. (2009), showed that people’s measured perception of future time durations follows a standard non-linear psychophysical function, rather than an objective linear mapping to calendar time. They then showed that this non-linear time perception accounts for the extent of hyperbolic discounting, and that those who perceived a given duration as longer, also discounted outcomes over that duration more than did those who perceived it as shorter (Kim & Zauberman, 2009). Most people had “near normative” discount rates in subjective time. Thus, time perception, not valuation, may be the primary explanation of hyperbolic discounting.

3.3 General procedure

The research proceeded in three phases: pilot testing, an exploratory experiment (Experiment 1), and a confirmatory experiment (Experiment 2).

Pilot testing identified appropriate print and online materials, and used a student sample without eye-tracking (N= 210) to confirm that the measures to be implemented gave plausible, surface-valid preliminary results.

Figure 2. General procedure used in Experiments 1 and 2



The data collection procedure used in both experiments is shown in Figure 2. Participants initially read financial communications materials while their eye movements were being tracked. Subsequent tasks did not include eye-tracking. After reading the provided materials, participants made asset mix decisions for four hypothetical individuals that differed in age, risk tolerance, and gender (see Figure 3 for an example). Subsequently, these allocations were used to compute an Allocation Score that assessed the extent to which the four allocation recommendations conformed to conventional wisdom that older individuals and those with low risk tolerance should reduce investments in equities. Allocation Score was designed to measure procedural knowledge about how to make asset mix decisions and contrasts with the Comprehension Test given later, which was designed to measure conceptual knowledge.

The specific rule for computing the Allocation Score was as follows, where Low and High refer to risk tolerance, Young

and Old refer to age (below 30 and above 50), and Eq, FI, and GA refer to equities, fixed income, and guaranteed assets, respectively. Each parenthetical inequality was scored as 1 when the recommended allocations conformed to the inequality, and 0 otherwise.

$$\begin{aligned} \text{Allocation Score} = & (\text{HighYoung_Eq} > \text{HighOld_Eq}) \\ & + (\text{HighOld_Eq} > \text{LowYoung_Eq}) \\ & + (\text{LowYoung_Eq} > \text{LowOld_Eq}) \\ & + (\text{LowYoung_FI} > \text{HighYoung_FI}) \\ & + (\text{LowOld_FI} > \text{HighOld_FI}) \\ & + (\text{LowOld_GA} > \text{LowYoung_GA}) \\ & + (\text{HighOld_GA} > \text{HighYoung_GA}) \\ & + (\text{HighYoung_Eq} > \text{HighYoung_FI}) \\ & + (\text{LowOld_FI} > \text{LowOld_Eq}). \end{aligned}$$

Figure 3. Example of an asset mixed decision for a hypothetical individual

Ms. Smith is 53 years old. Her responses to two risk tolerance questions are as follows:

Which of these statements would best describe your attitudes about the **next three years' performance** of this investment?

I don't mind if I lose money
 I can tolerate a loss
 I can tolerate a small loss
 I'd have a hard time tolerating any losses
 I need to see at least a little return

Which of these statements would best describe your attitudes about the **next three months' performance** of this investment?

Who cares? One calendar quarter means nothing.
 I wouldn't worry about losses in that time frame
 If I suffered a loss of greater than 10%, I'd get concerned
 I can only tolerate small short-term losses
 I'd have a hard time accepting any losses

Please use the slide-bars below to make your recommendation about Ms. Smith can best allocate her retirement funds across the three asset classes she is considering (i.e., equities, bonds, and guaranteed annuities).

0 10 20 30 40 50 60 70 80 90 100

Equities (stocks) ● 0

Fixed income (bonds) ● 0

Guaranteed assets (fixed annuities) ● 0

After completing the four asset mix decisions, participants answered the two risk tolerance questions for themselves and then provided personal savings amounts and asset mix decisions for the hypothetical scenario that they had

just moved to a new town and were starting a job that was similar to their current job, including salary and retirement benefits (see Figure 4).

Figure 4. Measures of risk tolerance and personal asset mix decisions used in Experiments 1 and 2 (annotations added here and not present in the survey questions)

Which of these statements would best describe your attitudes about the **next three years' performance** of this investment?

- I don't mind if I lose money
- I can tolerate a loss
- I can tolerate a small loss
- I'd have a hard time tolerating any losses
- I need to see at least a little return

... your attitudes ...

Which of these statements would best describe your attitudes about the **next three months' performance** of this investment?

- Who cares? One calendar quarter means nothing.
- I wouldn't worry about losses in that time frame
- If I suffered a loss of greater than 10%, I'd get concerned
- I can only tolerate small short-term losses
- I'd have a hard time accepting any losses

Please use the slide-bars below to indicate how you would allocate your retirement funds across the three asset classes that are available (i.e., equities, bonds, and guaranteed annuities). You can change these allocations in the future, if you like.

... how would you allocate your retirement funds ...

0 10 20 30 40 50 60 70 80 90 100

Equities (stocks) ● 0

Fixed income (bonds) ● 0

Guaranteed assets (fixed annuities) ● 0

Total: 0

After completing the personal asset mix decisions, participants viewed a video recording of their own eye movements while they were reading the financial communication. They were instructed to stop the video every time they recalled what they were thinking at that moment and record that thought in a text box. After this open-ended task, they viewed the selected video frames again, and classified their thoughts as either “scanning” or “reading.”

Three examples of eye-tracking videos are included as supplements to this report. It is important to note that for the online condition, eye fixations are easily coded from the XY coordinates in the output data file. However, for the print condition, human coding is required because the XY coordinates vary from person to person depending on how they held the brochure that they were reading.

After completing the retrospective thought-listing task, participants answered comprehension questions directly related to the reading material. An example is provided in Figure 5. Finally, participants answered questions that provided measures of objective financial literacy, subjective financial literacy (i.e., financial self-confidence), demographics, numeracy (including the Cognitive Reflection Test), planning propensity, subjective temporal discount rate, resource slack, and time perception. The full set of measures for both experiments is provided in supplements to this report (TIAA-Exp1-TIAA-Questions.docx, Exp2-Questions.docx).

Figure 5. The comprehension test used in Experiment 1

Which asset class usually provides the greatest return on investment?

Equities (stocks)

Fixed income (bonds)

Guaranteed assets (fixed annuities)

Which asset class usually provides the lowest risk?

Equities (stocks)

Fixed income (bonds)

Guaranteed assets (fixed annuities)

Which asset class usually exhibits the largest swings between gains and losses?

Equities (stocks)

Fixed income (bonds)

Guaranteed assets (fixed annuities)

What is a retirement income "floor"?

The maximum expected loss for your retirement portfolio over any 3-year period

The average monthly income from your retirement portfolio during an "average" recession

The least amount of money needed to cover essential expenses, like food, shelter, clothing, and healthcare

A lifetime annuity is a contract between you and an insurance company that

states the amount you pay up front and the amount of guaranteed income payments that will be provided by the insurance company for the rest of your life

states the amount you pay up front and the amount of guaranteed income payments that will be provided by the insurance company for a fixed number of years

states the amount you pay up front and the minimum guaranteed income payments that will be provided by the insurance company for the rest of your life, plus the average expected income payments which will be larger than the stated minimum

3.4 Eye-tracking equipment and data collection

For online conditions, eye movements were tracked using the SMI RED-m Eye-Tracking Device linked via USB to a Dell Inspiron Laptop (i7 CPU and 4 GB RAM) recording samples at a rate of 120Hz. The laptop ran SMI iView X eye-tracking server software for data collection and presented stimuli using SMI Experiment Center version 3.6. The remote RED-m device was attached to the bottom of a participant-facing 17-inch screen having a resolution of 1280 x 1024 pixels.

We instructed participants that the eye-tracking camera needed to be positioned a precise distance from their eyes. Once that distance was established, participants were told to remain in the same position for the duration of eye tracking. Participant posture was monitored by our RAs and verbally corrected if it exceeded the boundaries of the eye tracker "headbox" (approximately a 60-70 cm distance from the screen as judged by the RA; not a physical box). After

this, we performed four-point calibration and proceeded only after achieving a reported accuracy of 1 degree or better from SMI Experiment Center validation. Multiple calibration attempts may be made.

For the paper condition, we fit participants with mobile SMI ETG Eye Tracking Glasses attached via USB to a laptop computer recording at 30Hz using SMI iView ETG software. The glasses consist of small eye tracking devices under each eye and an outward-facing scene camera located above the nose bridge.

Instructions, calibration, and stimuli material were all presented on paper. After fitting the glasses, we ran a three-point calibration routine. Participants held an 8.5 x 11 paper calibration template on which were attached three color-coded dots near the corners. We instructed participants to fixate on each of the three dots and registered these

fixations in iView ETG. In order to validate the accuracy of calibration, the paper also had text printed, and the participant read the text aloud while our RA followed a live gaze cursor overlaid on the scene camera. If the scan path and spoken words matched, we continued on to the rest of the experiment. Otherwise, we repeated calibration.

Raw eye-position data was processed into labeled eye movements (fixations, saccades, and blinks) using SMI BeGaze version 3.6. Data collected from the on-screen environment employed the widely used Dispersion Threshold (IDT) algorithm to detect fixations (SensoMotoric Instruments, 2016). For the paper environment, BeGaze applies a proprietary event-detection algorithm called SMI ETG Event Detection. This differs from IDT by identifying saccades first, indirectly labeling fixations (SensoMotoric Instruments, 2016). This difference, coupled with different sampling rates of 30Hz and 120Hz, could complicate any high temporal resolution comparison between the data sets. For this study, we compared only lower resolution, attentional measures: fixations (200 to 300 milliseconds) and dwells (200 milliseconds to many seconds).

3.5 Experimental designs and materials

Experiment 1 employed a 2x3 between-subjects design that manipulated Medium (online vs. print) and Information Format (Chart vs. Text vs. Control). In the online condition, eye movements were measure using a display-mounted eye-tracker; for the paper condition, mobile eye-tracking glasses were used (see Section 3.2). Information Format was manipulated by adding information about risk and return to a TIAA web page titled “Retirement Preparation and Crucial Decisions” (see Figure 6). In the Text condition, that page was altered as in Figure 7A. In the Chart condition, that page was altered as in Figure 7B. In the Control Condition, no information was added. Figure 7C shows a photo of a participant holding the chart condition print brochure. Participants were recruited from University of Pennsylvania staff by the Wharton Behavioral Lab and were paid \$50 for completing a series of tasks that required less than one hour. The sample size was 199, and demographics are provided in Table 1.

Figure 6. Original TIAA web page used as the control condition reading material in Experiment 1

The image shows a screenshot of a TIAA website page titled "Retirement Preparation and Crucial Decisions". The page layout includes a navigation bar at the top with links like "ACCOUNT HOME", "MANAGE MY PORTFOLIO", "ADVICE & GUIDANCE", "PRODUCTS & SERVICES", and "RESEARCH & PERFORMANCE". The main content area is divided into several sections:

- Retirement Preparation and Crucial Decisions**: An introductory paragraph about retirement planning.
- How should you be invested now?**: A section discussing asset allocation and investment classes.
- Asset Mix**: A list of investment categories: Equities (stocks), Fixed Income (bonds), Money market (cash or CDs), Guaranteed assets (fixed annuities), and Real estate (5 alternatives).
- Retirement Income "Floor"**: A section discussing how to leverage investments as sources of retirement income, including a sub-section "1. How can you create your retirement income 'floor'?" and "2. How does an annuity help cover my expenses during retirement?"

Blue arrows and text labels are overlaid on the screenshot to highlight these key sections. An upward-pointing arrow on the left is labeled "Asset Mix", and a downward-pointing arrow is labeled "Retirement Income 'Floor'".

Figure 7. Risk/Return information added to the TIAA web page reading materials for the text (Panel A) and chart (Panel B) conditions in Experiment 1

Panel A (Text Condition)

How should you be invested now?

Your "asset allocation" - the investment mix for your assets - is as critical during your retirement as it was during your working years, when you were putting away money for your future. The biggest driving force behind an investment portfolio's performance is the way the portfolio is divided up among various asset classes, or investment categories. The primary asset classes are:

Equities (stocks; HIGH RISK & RETURN)

Fixed income (bonds; MEDIUM RISK & RETURN)

Money market (cash or CDs; LOW RISK & RETURN)

Guaranteed assets (fixed annuities; LOW RISK & RETURN)

Real estate (& alternatives; MEDIUM RISK & RETURN)

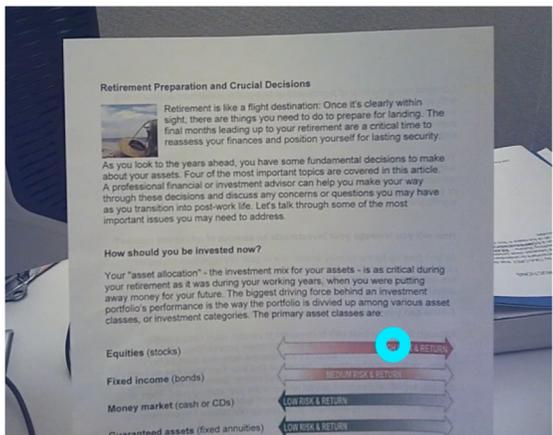
Panel B (Chart Condition)

How should you be invested now?

Your "asset allocation" - the investment mix for your assets - is as critical during your retirement as it was during your working years, when you were putting away money for your future. The biggest driving force behind an investment portfolio's performance is the way the portfolio is divided up among various asset classes, or investment categories. The primary asset classes are:

Equities (stocks)	
Fixed income (bonds)	
Money market (cash or CDs)	
Guaranteed assets (fixed annuities)	
Real estate (& alternatives)	

Panel C (Photo Chart Condition in Handheld Print Medium)

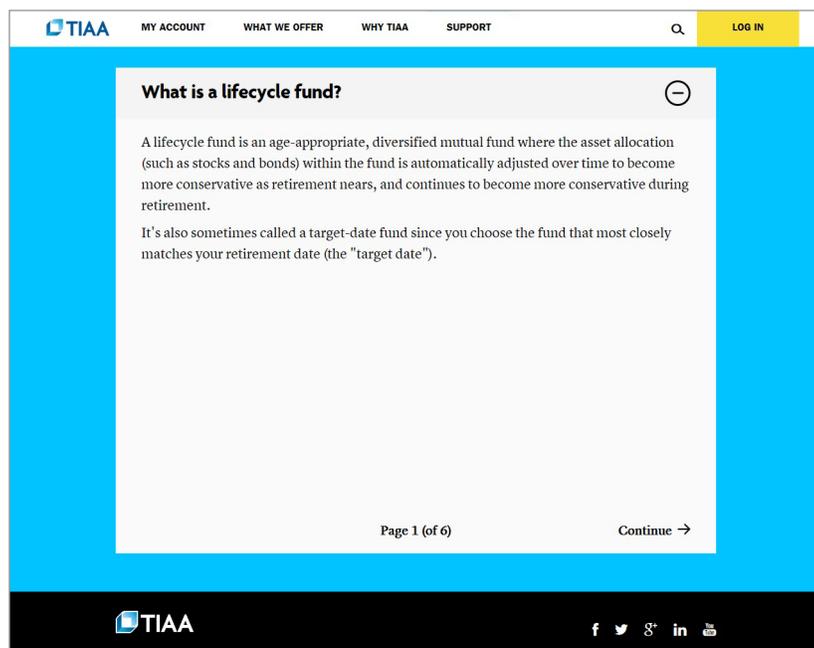


Experiment 2 was confirmatory in the sense that it aimed to conceptually replicate the effects of graphical information formats observed in Experiment 1, but it also explored new issues (see subsequent discussion). It employed a one-factor between-subjects design that manipulated Information Format (Chart and Text, Text Only, Control). The reading materials were taken from a TIAA search result for “lifecycle fund” (see Figure 8). The materials were presented online to all participants. Information Format was manipulated by adding a glide path chart to the third TIAA page (Chart and

Text; see Figure 8, Panel C). In the Text Only condition, no chart was added, and in the Control condition, the third page (which contained the definition of a glide path) was omitted. Importantly, the fourth page provided an example of a glide path, which provided a definition implicitly in the Control condition. Participants were recruited from University of Pennsylvania staff by the Wharton Behavioral Lab and were paid \$50 for completing a series of tasks that required less than one hour. The sample size was 333, and demographics are provided in Table 1.

Figure 8. TIAA web pages used for reading materials in Experiment 2

Panel A (Page 1)



Panel B (Page 2)

TIAA MY ACCOUNT WHAT WE OFFER WHY TIAA SUPPORT Q LOG IN

What is a lifecycle fund?

Lifecycle funds are managed by a professional investment team who aim for a high total return over time while maintaining a diversified, risk-managed exposure across a wide range of asset classes.

When the target date is far off and the investor does not plan to use the money before the target date, most of the assets in a lifecycle fund have a growth objective. Equities (stocks) are the best asset for achieving a growth objective because they offer the highest long run return; however, equities also have the highest level of risk and can exhibit large changes in return from year to year.

← Back Page 2 (of 6) Continue →

TIAA f t g+ in

Panel C (Page 3)

TIAA MY ACCOUNT WHAT WE OFFER WHY TIAA SUPPORT Q LOG IN

What is a lifecycle fund?

When the target date is near, most of the assets in a lifecycle fund have a stability objective. Fixed income (bonds) and guaranteed assets (fixed annuities) are the best assets for achieving a stability objective because they have the lowest level of risk and exhibit smaller changes in return from year to year compared to equities; however, they offer lower long run return. This shifting of assets from higher risk and return to lower risk and return over time is called the lifecycle fund's "glide path."

A Glide-Path for a Lifecycle (or Target Date) Mutual Fund

← Back Page 3 (of 6) Continue →

TIAA f t g+ in

Panel D (Page 4)

The screenshot shows the TIAA website interface. At the top, there is a navigation bar with the TIAA logo, links for 'MY ACCOUNT', 'WHAT WE OFFER', 'WHY TIAA', and 'SUPPORT', a search icon, and a 'LOG IN' button. The main content area has a blue background and features a white box with the heading 'What is a lifecycle fund?' and a close button. Below the heading, the text reads: 'Here's an example of how a fund's glide path works: Suppose you choose a lifecycle fund because you're just entering the workforce and don't expect to retire for 40 years, in one well known lifecycle fund your initial asset allocation would be about 63% domestic stock funds, 27% international stock funds and 10% bond funds. Over the next four decades, this fund would gradually shift your asset allocation to include more bonds and short-term funds and fewer stocks. When you reach retirement in 2056, you would hold about 40% domestic stock funds, 15% international stock funds, 35% bond funds and 10% short-term bond and money market funds. That allocation would continue to become more conservative during your retirement years.' At the bottom of the white box, there are navigation links: '← Back', 'Page 4 (of 6)', and 'Continue →'. The footer contains the TIAA logo and social media icons for Facebook, Twitter, Google+, LinkedIn, and YouTube.

Panel E (Page 5)

The screenshot shows the TIAA website interface, similar to Panel D. The navigation bar and main content area are the same. The white box contains the heading 'What is a lifecycle fund?' and the following text: 'Because the glide path changes the fund's asset allocation, the fund may end up selling at lows and buying at highs. Investors are then less likely to recoup their losses than if they held the same investments outside of a target-date fund and waited to sell until the market improved. Keep in mind, you have the power to adjust your own risk by investing in a fund outside your own retirement timeline. If you want more potential for gains, invest in a fund with a target date further out; for less risk, invest in a fund with a closer target date.' At the bottom of the white box, there are navigation links: '← Back', 'Page 5 (of 6)', and 'Continue →'. The footer contains the TIAA logo and social media icons for Facebook, Twitter, Google+, LinkedIn, and YouTube.

Panel F (Page 6)

The screenshot shows a web browser window with a blue header and a white content area. The header contains the TIAA logo, navigation links for 'MY ACCOUNT', 'WHAT WE OFFER', 'WHY TIAA', and 'SUPPORT', a search icon, and a 'LOG IN' button. The main content area has a blue background with a white box containing the FAQ text. At the bottom of the white box are navigation links: '← Back', 'Page 6 (of 6)', and 'Finished reading this FAQ'. The footer of the browser window is black with the TIAA logo and social media icons for Facebook, Twitter, Google+, LinkedIn, and YouTube.

TIAA MY ACCOUNT WHAT WE OFFER WHY TIAA SUPPORT Q LOG IN

What is a lifecycle fund?

As with all mutual funds, the principal value in a lifecycle fund is not guaranteed. Diversification cannot eliminate the risk of investment losses. Lifecycle funds share the risks associated with the types of securities held by each of the underlying funds in which they invest. In addition to the fees and expenses associated with these funds, there is exposure to the fees and expenses associated with the underlying mutual funds as well. The target date represents an approximate date when investors may plan to begin withdrawing from a lifecycle fund.

← Back Page 6 (of 6) Finished reading this FAQ

TIAA f t g+ in y

Table 1. Sample demographics for Experiments 1 and 2

	Experiment 1		Experiment 2	
	N	%	N	%
Total	199	100%	333	100%
Age				
18-34	102	51%	172	52%
35-54	66	33%	133	40%
55+	31	16%	28	8%
Education				
1-High School or less	1	1%	11	3%
2-Some College	22	11%	38	11%
3-College Degree	82	41%	168	50%
4-Advanced Degree	94	47%	116	35%
Income				
under \$30,000	10	5%	17	5%
\$30,000 - \$60,000	107	54%	193	58%
over \$60,000	78	39%	107	32%
no answer	4	2%	16	5%
Gender				
Female	159	80%	241	72%
Male	40	20%	92	28%
Status				
Married	77	39%	131	39%
Other	122	61%	202	61%
Race				
White	129	65%	215	65%
Other	70	35%	118	35%

3.6 Comments on sample characteristics

The sample plan and obtained sample have strengths and weaknesses. The most important strengths are (1) all participants are working adults with access to an employer-sponsored retirement plan, including TIAA, and (2) many potentially confounding background factors are controlled (employer, financial communications from the employer and asset management firms, geographic factors, etc.). However, the same narrowness that controls for confounding factors means that the results might be different for other populations. Strictly speaking, the fixed effects statistical models we use to analyze our results only generalize to replications with same set of participants. Therefore, it is left to the reader's judgment how these results might generalize to broader populations. We note that this sample is very high in education and income compared to national averages; thus, this sample should be considered a "best-case scenario" for retirement planning and financial literacy. Finally, males and adults aged 55 or older are not heavily represented in this sample (despite efforts to target recruitment at older Penn staff). Samples sizes for these demographics do, however, provide sufficient power for traditional statistical tests.

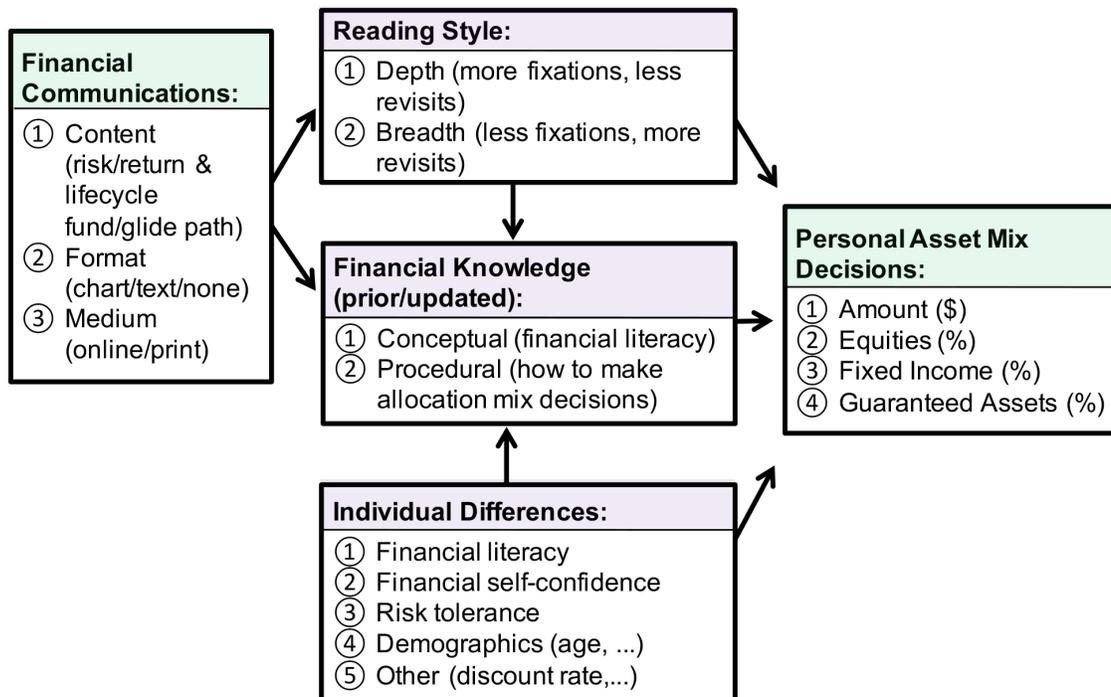
3.7 Analytical framework

The general analytic framework for this research is the *bounded rationality* perspective of human decision making (Kahneman and Tversky 1973, 1979; Simon 1957). More specifically, we rely on information processing models to assess visual attention, comprehension, and decision making in the tasks we employ in this research. This approach is exemplified by the work of Jerome Busemeyer and colleagues (Busemeyer and Townsend 1993; Busemeyer, Pothos, Franco, and Trueblood, 2011) for standard

decision-making tasks and the work of Colin Camerer and colleagues for behavioral game theory (Camerer and Ho 1999; Camerer, Lowenstein, and Prelec 2005; Johnson, Camerer, Sen, and Rymon 2002). In our prior research, this approach is exemplified in papers on visual attention and search for retail displays (Chandon, Hutchinson, Bradlow, and Young 2007, 2009), repeated price search (Huang and Hutchinson 2013), statistical inference from tables and charts (Hutchinson and Alba 1997; Hutchinson, Alba, & Eisenstein 2010), the intuitive statistics of extreme values (Hutchinson, Meyer, and Brenner 2015), consumer learning and knowledge (Alba and Hutchinson 1987, 2000; Bradlow, Hoch, and Hutchinson 2002; Eisenstein and Hutchinson 2006), intertemporal preferences (Cooper, Kable, Kim, Zauberman 2013; Zauberman, Kim, Malkoc, and Bettman 2009), and assessments of current and future capacities for time commitments (Zauberman and Lynch 2005).

Although it is difficult to determine what asset mix is optimal for any given individual, normative approaches to decision making require that information media and formats should have no effect on asset mix decisions, assuming that the information content is the same for all media and formats. We use the informal causal path model presented in Figure 9 to guide our assessments of whether decision biases exist and to explore possible mediators of any observed biases. Importantly, financial knowledge is represented in the model as two-dimensional. The first dimension is conceptual knowledge as measured by the Comprehension Test (which is very similar to standard measures of financial literacy; see Lusardi and Mitchell 2007ab). The second dimension is procedural knowledge, which is knowledge about how to make financial decisions and was measured by Allocation Scores.

Figure 9. A causal path model of the effects of financial communications on personal asset mix decisions



4. Results

The results of both experiments will be discussed simultaneously so that converging results can be highlighted.²

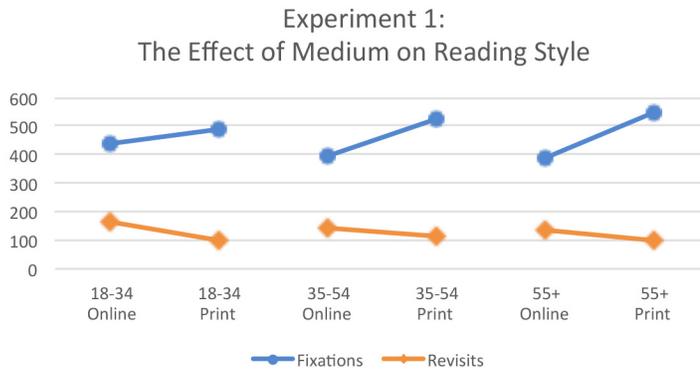
4.1 The simple effects of age and experimental manipulations on reading style, financial knowledge, and personal asset mix decisions

Only Experiment 1 manipulated communications medium, so we report those results first. Medium had a strong, reliable effect on Reading Style. As can be seen in Figure 10, print

media increased the total number of fixations compared to online media (indicating more information extracted from the reading materials) and decreased revisits (indicating better comprehension during the first encounter with a phrase or sentence). Thus, print encouraged a more systematic, deeper reading style compared to an online format. Fewer fixations and more revisits suggest that the online format encouraged more “skimming.”

2. To improve exposition and conserve space, the details of the statistical tests supporting our conclusions are not reported here, but are available upon request from the authors.

Figure 10. The effect of medium on eye movement measures of reading style in Experiment 1



Experiments 1 and 2 both manipulated information format by including a chart in one condition that either substituted for or enhanced the text (Experiments 1 and 2, respectively). The control condition in each experiment omitted the material expressed by the target chart and text (i.e., asset risk/return characteristics for Experiment 1 and the definition of “glide path” for Experiment 2). Because age is a critical factor for retirement planning, our baseline descriptive analysis of the results consisted of a two-way

Analysis of Variance that had Medium and Age as main effects, plus the interaction of Medium and Age. Table 2 shows the means for reading style (i.e., Total Fixations and Total Revisit Fixations), conceptual knowledge (i.e., Comprehension Test Scores), procedural knowledge (i.e., Allocations Scores), and personal asset mix decisions (i.e., percent of personal allocations in equities).

Table 2. The effects of information format and age on knowledge and asset mix decisions

	N	Reading Style (Total Eye Fixations)	Reading Style (Total Revisit Fixations)	Conceptual Knowledge (Comprehension Score)	Procedural Knowledge (Allocation Score)	Personal Asset Mix Decision (% Equities)
Experiment 1: Risk Return Information	199					
Age: 18-34	102	464	131	4.4	7.0	38%
Chart	35	492	146	4.3	7.2	37%
Text	37	463	129	4.5	6.8	40%
Control (no risk/return)	30	436	119	4.3	7.1	39%
Age: 35-54	66	463	126	4.3	7.1	50%
Chart	22	475	125	4.0	6.9	44%
Text	20	450	141	4.4	7.2	56%
Control (no risk/return)	24	462	111	4.5	7.2	49%
Age: 55+	31	467	117	4.5	6.5	39%
Chart	13	472	103	4.8	6.7	27%
Text	8	486	126	4.7	6.5	53%
Control (no risk/return)	10	442	122	3.9	6.4	38%
Experiment 2: Lifecycle Fund/Glide Path	333					
Age: 18-34	172	560	241	7.4	5.9	41%
Chart and Text	52	621	279	7.8	6.2	46%
Text Only	66	573	242	7.3	5.6	41%
Control (no definition)	54	487	202	7.1	6.0	37%
Age: 35-54	133	482	208	7.3	6.2	49%
Chart and Text	49	536	244	7.5	6.3	52%
Text Only	43	487	209	6.9	6.1	48%
Control (no definition)	41	424	171	7.4	6.2	47%
Age: 55+	28	531	245	7.5	6.1	40%
Chart and Text	9	563	258	6.4	5.1	33%
Text Only	10	521	245	7.8	7.5	38%
Control (no definition)	9	510	232	8.2	5.8	47%

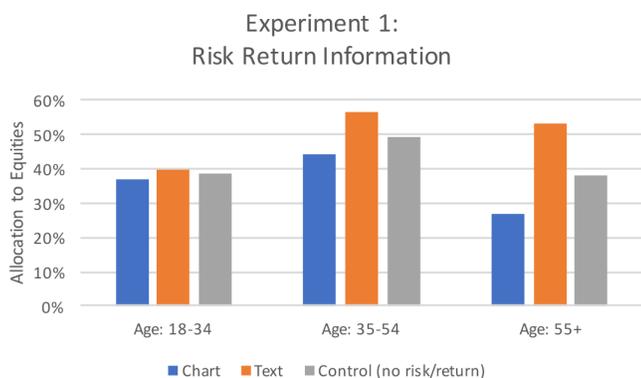
Six effects were reliable and of particular interest for understanding financial communications and asset mix decisions. *First*, in Experiment 1, older participants exhibited a deeper reading style (i.e., more total fixations and fewer revisits) than did younger and middle-aged participants. This pattern was particularly evident for text. *Second*, in Experiment 2, younger and older participants devoted more overall attention (i.e., more total fixations and revisits) to the reading materials than did middle-aged participants. *Third*, there were no large effects of our experimental manipulations on conceptual knowledge, except that for older participants, charts helped comprehension in Experiment 1, but hurt comprehension in Experiment 2. *Fourth*, although there were no effects of age or format on procedural knowledge in Experiment 1, the Allocation Scores of older participants were hurt by the inclusion of the chart in Experiment 2. *Fifth*, in both experiments, middle-aged participants allocated more to equities than did younger and older participants. *Finally*, compared to

text, charts decreased allocations to equities in Experiment 1 (presumably reflecting heightened awareness of risk; see Figure 11A), but in Experiment 2, charts increased allocations to equities for younger and middle-aged participants and decreased allocations to equities for older participants (presumably because this fits the glide path recommendation; see Figure 11B).

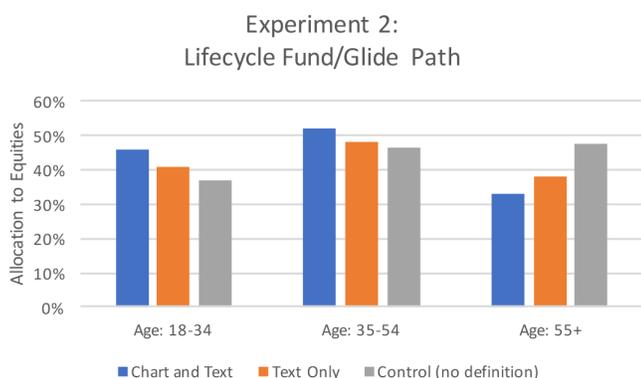
Overall, the simplest and most important result is that the manipulations of information format had reliable effects on reading style, financial knowledge, and personal asset mix decisions. Moreover, older adults appear to exhibit stronger effects than other age groups (especially for asset mix decisions). We emphasize that this type of research is in a very early stage, so conclusive implications about format-based decision biases awaits further research that examines a wider variety of manipulations of content, media, and format.

Figure 11. The effects of age and information format on personal asset mix decisions

Panel A



Panel B



4.2 Exploratory investigation of the factors affecting reading style, financial knowledge, and personal asset mix decisions

To provide preliminary insights about which of the many possible mediating factors exerted the strongest effects (see Figure 9), we conducted stepwise regressions for our measures of reading style, financial knowledge and asset mix decisions in which the independent variables included our experimental manipulations, a wide variety of eye-tracking measures, plus the measures outlined in Section 3.2. That is, the regressions for Reading Style variables (i.e., total fixations and total revisits) included only our experimental manipulations and individual differences variables (including financial literacy, financial self-confidence, risk tolerance, demographics, and the other financial measure discussed in Section 3.2), the regressions for Financial Knowledge variables (i.e., Comprehension Test Score and Allocation Score) included our experimental manipulations, individual differences variables, and a wide variety of eye-tracking measures (including total fixations and total revisits), and the Personal Asset Mix regressions included our experimental manipulations, individual differences variables, the Financial Knowledge variables, and a wide variety of eye-tracking measures. This approach lets a large set of factors “compete” to explain the observed variation.

Again, we emphasize that this type of research is in a very early stage, so conclusive implications about mediation of the observed effects awaits further research that examines a wider variety of possible mediators, including research that directly manipulates the hypothesized mediators, uses appropriate instrumental variables, or employs appropriate structural equation models.

4.2.1 Drivers of reading style

In Experiment 1, the online medium decreased total fixations, but this negative effect was reduced for the chart format. In contrast, the online medium increased total revisits, and this positive effect was increased for the chart format. In Experiment 2, the addition of a chart increased total fixations and revisits, and omitting the glide path definition page reduced total fixations and revisits. Financial self-confidence reduced total fixations and revisits. Age reduced total fixations (but not revisits).

3. It is natural to assume that financial literacy is relatively stable characteristic of the individual and comprehension is a transient state that occurs during reading. However, the causality could go the other way. Someone with good comprehension skills might better understand the presented material and this might help them better answer the financial literacy questions that occur later. At this point, the data support a strong association, but the direction of causality is open.

4.2.2 Drivers of conceptual and procedural knowledge

In Experiment 1, comprehension scores were strongly enhanced by financial literacy.³ There was also a small positive effect of reading style (total fixations). Allocation scores were hurt by a reading style that focused fixations on a smaller-than-average number of items (fixation intensity), plus propensity to plan was associated with lower scores. In Experiment 2, comprehension scores were strongly enhanced by financial literacy and risk tolerance. There was also a strong positive effect of number of fixations on the chart (which was necessarily close to zero in the Text Only and Control conditions). This result illustrates the value of using more precise eye-tracking measures, since it implies that among those exposed to the chart, the more a person looked at the chart, the better they scored on the comprehension test. Allocation scores were increased by financial literacy and were higher for females than males. There was also a negative effect of fixations “wasted” on the blue page borders (see Figure 8) for both comprehension and allocation scores.

4.2.3 Drivers of personal asset mix decisions

In Experiment 1, personal allocations to equities was strongly and positively affected by risk tolerance, financial self-confidence, comprehension scores (i.e., conceptual knowledge), and allocation scores (i.e., procedural knowledge). There were also effects of reading style. Total fixations lowered allocations to equities, and fixation intensity increased allocations to equities. In Experiment 2, as in Experiment 1, personal allocations to equities was strongly and positively affected by risk tolerance, financial self-confidence, comprehension scores (i.e., conceptual knowledge), and allocation scores (i.e., procedural knowledge). Additionally, financial literacy had a positive effect. Again, there were effects of reading style. Revisit fixations on the chart increased allocations to equities, and there was a small negative effect of fixations on the “Stability objective” portion of the chart (see Figure 8C).

5. Conclusions

This research and research of this type are in a very early stage, so conclusive implications about decision biases due to communication media and formats awaits further research that examines a wider variety of manipulations of content, media, and format and measures or manipulates a wider variety of possible mediators. However, even at this early stage, the results of the two experiments we conducted suggest answers to the five questions that motivated the research:

1. Are people able to comprehend complex income products based on the print and online materials?

Yes, but communications media and formats can affect reading style and both conceptual and procedural knowledge.

2. Does comprehension affect asset mix decision making?

Yes, measures of both conceptual and procedural knowledge affected asset mix decisions almost as much as did risk tolerance and financial self-confidence.

3. Are there differences among communication formats?

Yes, the addition of graphical charts to financial communications can have strong effects on reading style that “intensify” the effects of content, as does the choice of communication medium.

4. Is comprehension affected by distance from retirement?

Yes, older participants were often more sensitive to experimental manipulations than middle-aged and younger participants.

5. What are the patterns of covariation between comprehension and other variables of interest?

Beyond the effects of comprehension on asset mix decisions, comprehension was enhanced by financial literacy and risk tolerance. Comprehension was also affected by reading style—sometimes for better, and sometimes for worse.

References

- Alba, Joseph W. and J. Wesley Hutchinson (1987), "Dimensions of Consumer Expertise," *Journal of Consumer Research*, 13 (March), 411-454.
- Alba, Joseph W. and J. Wesley Hutchinson (2000), "Knowledge Calibration: What Consumers Know and What They Think They Know," *Journal of Consumer Research*, 27 (September), 123-156.
- Anderson, J.R. (2007) *How can the human mind occur in the physical universe?* Oxford University Press.
- Bradlow, Eric T., Stephen J. Hoch, and J. Wesley Hutchinson (2002) "An Assessment of Basic Computer Proficiency Among Active Internet Users: Test Construction, Calibration, Antecedents and Consequences," *Journal of Educational Measurement*, 27 (Fall) 237-253.
- Bussemeyer, J. R., & Townsend, J. T. (1993) Decision Field Theory: A dynamic cognition approach to decision making. *Psychological Review*, 100, 432-459.
- Bussemeyer, J. R., Pothos, E. & Franco, R., Trueblood, J. S. (2011) A quantum theoretical explanation for probability judgment 'errors'. *Psychological Review*, 108, 193-218.
- Camerer, Colin F. and Teck-Hua Ho. "Experience-weighted attraction (EWA) learning in normal-form games." *Econometrica* 1999, 67: 827-874.
- Camerer, Colin F., George Loewenstein and Drazen Prelec. "Neuroeconomics: How neuroscience can inform economics." *Journal of Economic Literature* March 2005, 34(1): 9-65.
- Campbell and Xue, 2001
- Chandon, Pierre, J. Wesley Hutchinson, Eric Bradlow, and Scott H. Young (2009), "Does In-Store Marketing Work? Effects of the Number and Position of Shelf Facings on Brand Attention and Evaluation at the Point of Purchase," *Journal of Marketing*, 73 (November), 1-17.
- Chandon, Pierre, J. Wesley Hutchinson, Eric Bradlow, and Scott H. Young (2007), "Measuring Value of Point-of-Purchase Marketing with Commercial Eye-Tracking Data," in *Visual Marketing: From Attention to Action*, eds., Michel Wedel and Rik Peters, Mahwah, NJ: Lawrence Erlbaum Associates, 225-58.
- Cooper, Nicole, Joseph W. Kable, B. Kyu Kim, and Gal Zauberman (2013). Brain Activity in Valuation Regions while Thinking about the Future Predicts Individual Discount Rates. *The Journal of Neuroscience*. 33 (32). 13150-13156.
- Duchowski Andrew T., (2002) "A breadth-first survey of eye-tracking applications," *Behavior Research Methods, Instruments, & Computers*, 34 (4), 455-470
- Eisenstein, Eric and J. Wesley Hutchinson (2006) "Action-Based Learning: Goals and Attention in the Acquisition of Market Knowledge." *Journal of Marketing Research*. 43 (May), 244-258.
- Holmqvist, K., Nystrom, M., Andersson, R., Dewhurst, R., Jarodzka, H., & van de Weijer, J. (2011). *Eye Tracking: A Comprehensive Guide to Methods and Measures*. Oxford University Press.
- Huang, Yanliu and Hutchinson, J. Wesley (2013), "The Roles of Planning, Learning, and Mental Models in Repeated Dynamic Decision Making," *Organizational Behavior and Human Decision Processing*, 122, 163-176.
- Hutchinson, J. Wesley, Joseph W. Alba, and Eric Eisenstein (2010) "Heuristics and Biases in Data-Based Decision Making: The Effects of Experience, Training, and Graphical Data Displays," *Journal of Marketing Research*, Vol. 47(August 2010), 627-642.
- Johnson, Eric, Colin F. Camerer, Sankar Sen, and Talia Rymon. "Detecting failures of backward induction: monitoring information search in sequential bargaining." *Journal of Economic Theory* May 2002, 104(1): 16-47.

- Kahneman, D., & Tversky, A. (1973). On the psychology of prediction. *Psychological Review*, 80(4), 237-251.
- Kahneman, Daniel and Amos Tversky (1979), "Prospect Theory: An Analysis of Decision under Risk", *Econometrica*, 263-91.
- Lusardi, A., O. S. Mitchell. 2007a. Financial and retirement preparedness: Evidence and implications for financial education. *Bus. Econom.* 42(1) 35–44.
- Lusardi A., O. S. Mitchell. 2007b. Baby boomer retirement security: The role of planning, financial literacy, and housing wealth. *J. Monetary Econom.* 54 205–224.
- Rayner, Keith (1998), "Eye Movement in Reading and Information Processing: 20 years of Research," *Psychological Bulletin*, 124 (3), 372-422.
- Rittle-Johnson, Siegler, and Alibali, 2001
- SensoMotoric Instruments GmbH (SMI), BeGaze Manual Version 3.6, (May 2016), 316-329.
- Simon, Hebert (1957), *Models of Man*. John Wiley.
- Sun, Slusarz, and Terry, 2005
- Zauberman, Gal, B. Kyu Kim, Selin A. Malkoc, and James R. Bettman (2009). Discounting Time and Time Discounting: Subjective Time Perception and Intertemporal Preferences. *Journal of Marketing Research*. 46 (4), 543-556.
- Zauberman, Gal and John G. Lynch, Jr. (2005). Resource Slack and Propensity to Discount Delayed Investments of Time Versus Money. *Journal of Experimental Psychology: General*. 134 (1). 23-37.

About the Authors

J. Wesley Hutchinson is Stephen J. Heyman Professor and Professor of Marketing at the Wharton School of the University of Pennsylvania. His research focuses on consumer and managerial decision making, particularly the interrelationships among attention, learning, confidence, decision making, and expertise in repeated choice environments. His recent research projects include modeling the effects of visual attention at the point of purchase on in-store decisions using eye-tracking data, developing new measures of consumer responses to advertising, mass customization of product aesthetics, and intuitive statistical reasoning as part of decision making.

A past president of the Association for Consumer Research, Professor Hutchinson has published articles in a variety of top-tier journals in business and psychology. He is on the editorial review boards of the *Journal of Consumer Research*, the *Journal of Marketing Research*, and *Marketing Science*, and he has won several academic awards. Professor Hutchinson's teaching interests include courses in New Product Development (UG and MBA), the Social Impact of Marketing (UG and MBA), Research Methods (Ph.D.), and teaching Essentials of Marketing for Wharton's Executive Education program.

He received his Ph.D. in psychology from Stanford University and his BS in psychology from Duke University. Significant personal failures include never really learning to speak Spanish or play the guitar, among others too numerous to list.

Robert Botto is the technical lead for the Wharton Behavioral Lab, specializing in eye tracking research methods. Prior to the Wharton Behavioral Lab, he worked as a software engineer at Thompson Reuters Scientific. He holds a Master of Science in Engineering from the University of Pennsylvania in Computer Science.

Gal Zauberan is a Professor of Marketing at Yale University. He was previously the Laura and John J. Pomerantz Professor of Marketing and Professor of Psychology at The University of Pennsylvania's Wharton School. His academic background includes a B.A. with Highest Honors in Psychology and Economics from The University of North Carolina, Chapel-Hill, and a Ph.D. in Marketing from Duke University.

Professor Gal Zauberan studies consumer behavior, time in judgment and decision making, financial decision making, and enjoyment and memory of experiences. He won numerous awards, including the William O'Dell and the Paul Green best paper awards, and the 2007 Early Career Award for Distinguished Contributions to Consumer Psychology, Society for Consumer Psychology. His research has been published in top-tier academic journals including the *Journal of Consumer Research*, *Journal of Experimental Psychology: General*, the *Journal of Marketing Research*, *Management Science*, and *Psychological Science*, and received international media coverage, including the *New York Times*, *Scientific American*, and others.