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Using eye-tracking to understand individual decision-making

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Abstract

We survey the literature on eye-tracking studies in behavioral economics and finance as well as in accounting and organizational science. Eye-tracking is a methodology that is used to better understand the cognitive processes of decision-makers, doing so by recording eye movements such as eye fixation, saccades, and pupil dilation. Eye-tracking technology is becoming more popular due to the lower barriers to using technology and due to the improved capacity and technology for observation of cognitive eye movements. This survey aims to introduce to what extent eye-tracking technologies can be applied to the research frontiers of individual pension decision-making, such as tailoring pension information to the individual in three phases of pension communication: the trigger phase, the navigation phase, and the content phase.

Samenvatting

In deze studie beschrijven we de eyetracking-literatuur op het gebied van gedragseconomie en financiering alsmede van accounting en organisatie. Eyetracking is een onderzoeksmethode die ons helpt te begrijpen hoe de cognitieve processen van beslissingen te werk gaan. Dit gebeurt door oogbewegingen zoals fixatie, pupildilatatie en saccades (zeer snelle oogbewegingen) te meten en analyseren. Eyetracking is de laatste tijd veel populairder geworden als onderzoeksmethode doordat er grote ontwikkelingen zijn geweest die de barrières om deze technologie te gebruiken hebben verlaagd. Het doel van deze literatuurstudie is om duidelijk te maken in hoeverre eyetracking-technologie kan worden gebruikt in het onderzoek van individuele pensioenbeslissingen. In het bijzonder richten we onze aandacht op hoe eyetracking kan helpen bij het formuleren van op maat gemaakte pensioencommunicatie in verschillende fases, zoals het aandacht trekken van de juiste en relevante informatie, navigatie door de communicatie en de inhoud.

1. Introduction to eye-tracking

Eye-tracking is a technology that tracks a person's eye movements and helps us understand visual attention and decision-making processes. Through information such as the sequence of gaze and the fixation duration, we can observe a person's information acquisition processes and interpret that person's cognitive thinking processes. Eye-tracking has mainly been used in marketing research (Balcombe, Fraser, Williams, & McSorley, 2017; Bigne, Llinares, & Torrecilla, 2016; Chandon, Hutchinson, Bradlow, & Young, 2009; Pieters, Warlop, & Wedel, 2002; Pieters, Wedel, & Zhang, 2007; Zuschke, 2020). Researchers in behavioral economics (Sickmann & Le, 2016), finance (Gödker & Lukas, 2019), and accounting (Chen, Jermias, & Panggabean, 2016; Lynch & Andiola, 2019), as well as in organizational sciences (Claeys, Cauberghe, & Pandelaere, 2016), have been applying eye-tracking for their studies. This relatively novel technology is widely used in other different scientific areas such as cognitive psychology and education. Eye-tracking is also often used in the interaction between humans and computers, such as assistive technology and gaming. For a list of review papers and implications for pension communication, please refer to Table 1. In the column on pension communication implications, we highlight each paper's main takeaways for pension communication design. Even though most papers do not directly relate to pension research, the implications can be drawn from relevant research in fields such as marketing and psychology.

The focus of this survey lies on an overview of research in individual decision-making that uses eye-tracking technologies. The goal is to understand better what kind of additional information eye-tracking technologies can be applied for different pension research frontiers, with particular attention to the communication between pension providers and plan participants. For example, eye-tracking devices can be used to better understand the choices that individuals make, such as in searching and screening, so that their pension-related decisions can be improved, by providing more individually tailored information in the different phases of pension communication: the trigger, navigation, and content phases, as defined in Dinkova, Elling, Kalwij, and Lentz (2018). Recent Netspar research has focused on several areas in this regard. For example, Elling and Lentz (2019) argue that tailoring pension communication, such as segmentation of target groups on age, gender, financial literacy or knowledge, financial wealth, or personalization of pension documents, may help to increase the motivation of pension participants to delve into their pension situation and to improve the finding and comprehension of pension information. Linde (2019) suggests introducing a pension choice architecture, with a module that

Table 1 – Eye-tracking literature

Study by Journal	Original Topics	Implications for Pension Communication	Research Questions	Key ET-Based Finding	ET System & Environment	Types of Eye-trackers	Sample Size	ET Measures
Journal of Applied Psychology								
Madera and Hebl (2012)	Discrimination	Pension communication designers and researchers can learn the ET experiment designs for information search and decision-making.	Are facially stigmatized applicants discriminated against, and what attentional processes are involved?	Participants with facially stigmatized applicants attended more to the stigma, which led participants to recall fewer interview facts, leading in turn to lower applicant ratings.	Desktop-based ET in the lab	ISCAN RK726/ RK520 HighRes/CR tracker	171	Fixation duration
van Hooft and Born (2012)	Lying	ET can help pension communication designers find out whether participants understand the information clearly or experience difficulty with specific content.	Does ET increase our understanding of the response processes when faking on personality and integrity items, and can faking behavior be identified?	Faking on personality tests is characterized by a faster and less cognitively demanding response pattern. ET was demonstrated to be potentially useful in detecting faking behavior.	Desktop-based ET in the lab	Not disclosed	129	Number of fixations, fixation path analysis
Journal of Business Research								
Bigne, Llinares, and Torrecilla (2016)	Consumer attention	The sequence and structure of the presentation of pension information are essential. Therefore, pension designers should guide pension participants in the navigation phase of pension communication.	How does the time that people spend on examining a brand influence subsequent purchase decisions and brand choices within the same product category?	The critical driver of additional brand choices is the time that buyers spend on the first choice, showing that the allocation of less for the first choice triggers additional purchases within the product category and increases sales.	Mobile ET in virtual reality	SMI eye-tracking glasses with VR	41	Fixation duration, number of fixations per second
Claeys, Cauberghe, and Pandelaere (2016)	Corporate reputation	Pension organizations (POs) need to provide negative information concerning both POs and participants' funding situations to gain trust from pension participants.	Does organizational self-disclosure reduce crisis damage?	When an organization does not self-disclose crisis information, participants pay more attention to subsequent negative publicity from a third party than when they self-disclose the crisis.	Desktop-based ET in the lab	Not disclosed	Study I: 66; Study II: 86	Fixation duration
Lindstrom, Berg, Nordfalt, Roggeveen, and Grewal (2016)	Consumer attention	The experimental design for pension communication research related to financial literacy in pension decisions, which is analogous to fashion knowledge in shopping for clothes, inspires.	Does the impact of mannequin-style on purchase intentions depend on the level of consumers' fashion knowledge?	The eye-tracking results provide further evidence that mannequin style's role on the attention paid to the merchandise depends on the customer's level of fashion knowledge.	Mobile ET in the lab	Tobii glasses	70	Fixation duration

Study by Journal	Original Topics	Implications for Pension Communication	Research Questions	Key ET-Based Finding	ET System & Environment	Types of Eye-trackers	Sample Size	ET Measures
Menon, Sigurdsson, Larsen, Fagerstrom, and Foxall (2016)	Consumer attention	Pension information designers need to highlight the information (with position and saliency) such as costs and benefits of pension plans in all three pension communication phases.	How do price points, price position, and price saliency influence attention to price in social commerce?	Besides utility effects, stimulus-driven processes substantially affect the attention to the price.	Desktop-based ET in the lab	Tobii 1750	31	Fixation duration
Wästlund, Otterbring, Gustafsson, and Shams (2015)	Heuristics and biases	In the trigger phase of pension communication, it is essential to raise the awareness of pension planning (goals) for the participants. This can avoid the adverse effects of inappropriate design in the navigation and content phases.	How does a customer's shopping task specificity influence the amount of visual attention that is directed to task-relevant in-store stimuli?	Differences exist in viewing behavior, based on whether shopping goals are planned or unplanned. Shopping goals lead to increased in-store stimuli.	Mobile ET (glasses-like) in the field	Tobii glasses	Study I: 190; Study 2: 98; Study 3: 66	Number of fixations, number of different AOIs fixated
Management Science								
Pieters, Warlop, and Wedel (2002)	Consumer attention	The originality of content and pension communication design in the trigger phase is more likely to lead pension participants into the navigation phase.	What is the influence of ad originality on attention to advertising and recall of brands?	Ad originality enhanced information memory storage about the advertised brand by increasing the attention devoted to it. The positive impact of ad originality on information storage was even higher for familiar, original advertisements.	Desktop-based ET in the lab	Undisclosed types of equipment used by Verify International (Rotterdam, Netherlands)	119	Number of fixations, Fixation duration
Pieters, Wedel, and Zhang (2007)	Consumer attention	The design characteristics of feature ads in the trigger phase of pension communication can be cost-efficient.	How do design characteristics of feature ads affect consumers' visual attention?	Significant improvements in attention to feature advertising can be achieved without an increase in costs. The resulting optimal feature ad designs create win-win opportunities for manufacturers and retailers.	Desktop-based ET in the lab	Undisclosed types of equipment used by Verify International (Rotterdam, Netherlands)	About 100	Fixation likelihood (attention selection), Fixation duration (attention engagement)
Shi, Wedel, and Pieters (2013)	Consumer attention	Pension participants may have limited attention. Therefore, pension communication designers should avoid information overload and focus on a particular pension plan's most essential features step-by-step.	How do consumers gather product and attribute information over time?	Consumers frequently switch between acquisition strategies, and they obtain information on only two or three attributes or products in a particular acquisition strategy before switching.	Desktop-based ET in the lab	Tobii 1750	108	Number of fixations, number of saccades

Study by Journal	Original Topics	Implications for Pension Communication	Research Questions	Key ET-Based Finding	ET System & Environment	Types of Eye-trackers	Sample Size	ET Measures
Raveendran, Puranam, and Warglien (2015)	Labor division	Graphical representations of object-based information are more informative compared to those for activity-based information. It may be more useful to have graphical representations of goals in the trigger phase of pension communication.	What aspects of the problem capture participants' attention as they engage in choosing the division of labor?	Individuals displayed more significant fixation time on the graphical representations of object-based than on activity-based instructions.	Desktop-based ET in the lab	Tobii T60	16	Fixation duration
Organizational Behavior and Human Decision Processes								
Lohse and Johnson (1996)	Comparison between two tracking methods	It may be more beneficial to conduct experiments with ET and mouse tracking software such as Mouselab.	Are Mouselab and eye-tracking equally suited for the investigation of decision processes?	Mouselab increases the amount of time needed to acquire information and induces more systematic information acquisition behavior than eye-tracking.	Desktop-based ET in the lab	Eyegaze	36	Fixation duration, search index
Fiedler, Glockner, Nicklisch, and Dickert (2013)	Cooperative behavior (social value orientation, SVO)	This paper is about cooperative behavior, which is not very relevant to pension communication.	Are differences in social value orientation reflected in gaze behavior and specific attention patterns?	Differences in social value orientation are reflected in stable differences in attention patterns and preferences for specific types of information in strategic and non-strategic social decision-making.	Desktop-based ET in the lab	Not disclosed	Study I: 38; Study II: 36	Number of fixations, a search index (only in Study I)
Venkatraman, Payne, and Huettel (2014)	Heuristics and biases	Information search and risky decision-making	What strategies do decision-makers use in complex mixed gambles?	The overall probability of winning (Pwin) heuristic is a frequently used strategy, but variability in decision preferences was associated with systematic differences in information acquisition and processing.	Desktop-based ET in the lab	Study I–II: Tobii 1750; Study III: Tobii T60XL	Study I: 36; Study II: 15; Study III: 42	Number of fixations, search index
Journal of Marketing								
Chandon, Hutchinson, Bradlow, and Young (2009)	Consumer attention	The information design in the trigger phase of pension communication is relevant, as we learn from in-store marketing.	Does in-store marketing have effects on consumers' visual attention and brand consideration?	They show that out-of-store factors directly influence evaluation and are not mediated by the attention, whereas in-store factors primarily influence attention.	Desktop-based ET in the lab	Not disclosed	344	Fixation duration

Study by Journal	Original Topics	Implications for Pension Communication	Research Questions	Key ET-Based Finding	ET System & Environment	Types of Eye-trackers	Sample Size	ET Measures
Journal of Accounting Research								
Chen, Jermias, and Panggabean (2016)	Balanced-scorecard performance	Raising the awareness of pension planning goals could be valuable in the trigger phase regardless of the way the information is formed.	How is decision quality affected by the time managers spend looking at linked measures? Does understanding of a firm's strategy and presentation format affect managers' strategic focus?	They find that managers' awareness of the goals was more important than the information format in focusing their attention on the strategically linked performance measures.	Desktop-based ET in the lab	Locarna Systems	60	Number of fixations, Fixation duration
Journal of Consumer Psychology								
Duclos (2015)	End-anchoring	Financial information structure, such as past returns, can affect pension participants' information searching behavior and investment decision-making.	Do visual biases in data interpretation impact financial decision-making and risk-taking, and if so how?	Five experiments find that the last trading day(s) of a stock have disproportionate (and undue) high impact on investment behavior, a phenomenon we call end-anchoring. Specifically, a stock price that closes upward (downward) fosters upward (downward) forecasts for tomorrow and, accordingly, more (less) investment today. Substantial investment asymmetries (up to 75%) emerge even as stock-price distributions were generated randomly to simulate times when the market conjuncture was hesitant. No real upward or downward trend can be identified.	Desktop-based ET in the lab	Not disclosed	Study I: 155; Study II: 202; Study III: 48; Study IV: 50; Study V: 162	Fixation duration
Journal of Economic Behavior & Organization								
Balcombe, Fraser, Williams, and McSorley (2017)	Consumer preferences	Information search and consumer choice	Do people pay more visual attention to high-value attributes (more attractive)? Can that attention be used to infer higher value across attributes or individuals?	Their results reveal weak relationships between the eye-tracking data, their stated preference results and various attribute use questions. Although respondents with higher visual attendance levels value specific attributes more positively, the relationship's strength is relatively weak. Therefore, while they maintain that eye-tracking is useful, they argue that there needs to be greater clarity about the aims and purpose of using eye-tracking in stated preference research.	Mobile (Head-mounted) ET in the lab	Eyelink II, SR Research	99	Fixation duration

Study by Journal	Original Topics	Implications for Pension Communication	Research Questions	Key ET-Based Finding	ET System & Environment	Types of Eye-trackers	Sample Size	ET Measures
American Economic Review								
Reutskaja, Nagel, Camerer and Rangel (2011)	Dynamic search models	Information search and consumer choice	(i) What computational processes are deployed by consumers during the search and decision processes, and to what extent are they compatible with standard economic search models? (ii) How do the processes, and their performance, change with the number of options? (iii) Do the computational processes exhibit systematic biases that can be exploited by sellers to manipulate their choices?	They find that items with a higher value are not more likely to be noticed within a choice set. Meanwhile, they find that subjects' stopping rule to terminate the search process is qualitatively consistent with the hybrid model, but not with the satisfaction or optimal search models. Their experimental design also allows them to show that an item is selected based on the display location. They find that subjects exhibit a bias to look first and foremost to items placed in certain regions of the display, which they also choose more often.	Desktop-based ET in the lab	Tobii 1750	41	Fixation duration
Wang, Spezio, and Camerer (2010)	Strategic games	Strategic information transmission	What causes the behavior patterns of level-k models in sender-receiver games?	They find experiment evidence on level-k models. They find that subjects pay attention to the payoff structure and their payoffs, focus more on actual state payoffs, and have cognitive difficulties or experience guilt for deceptive behavior.	Desktop-based ET in the lab	Eyelink II, SR Research	10 (45 rounds among the two players)	Fixation duration and pupil dilation
Working Paper								
Gödker and Lukas (2019)	Heuristics and biases	Financial information structure, such as past returns, especially extreme returns, can affect pension participants' information searching behavior and investment decision-making.	Do extreme stock returns attract investors' attention and bias their investment decisions?	They find a strong asymmetry, as shares of stocks with recent extreme negative returns are more likely to be purchased than shares of stocks with recent less extreme negative returns. Still, comparable patterns are not observed for stocks with positive returns. They further track the subjects' eye movements and show that individual visual attention mediates our treatment effect. Interestingly, the results show that attention-driven purchase behavior occurs even when it reduces subjects' expected return.	Desktop-based ET in the lab	Tobii Pro X2-60	114 (117)	Fixation duration

Study by Journal	Original Topics	Implications for Pension Communication	Research Questions	Key ET-Based Finding	ET System & Environment	Types of Eye-trackers	Sample Size	ET Measures
Lahey and Oxley (2018)	Heuristics and biases	Information search and hiring decision-making	Does age*race intersectionality exist? How do screeners process resumés, and, importantly, why there might be hiring discrimination?	They find evidence of intersectionality for race by age. In terms of screening results and mechanics, they also find evidence of level-based statistical discrimination and variance-based discrimination against black people, but they cannot rule out taste-based discrimination.	Desktop-based ET in the lab	D6 eye-tracking system (Applied Science Laboratory)	Not disclosed	Fixation duration

uses nudges to encourage pension saving and that considers behavioral differences between self-employed persons and employees. Finally, a recent Netspar topicality project (Van Bilsen, Ponds, & Bonekamp, 2019) seeks to document existing choices regarding early retirement, such as a lump sum payout and the high-low pension payout scheme, and the researchers intend to develop proposals that will prevent undesirable choice behavior. Lately, eye-tracking research has become more prevalent in experimental economics and individual decision-making research. Therefore, this survey will focus on these examples to document how to conduct research using eye-tracking equipment and what we can learn from previous eye-tracking experiments. Many of these applications will be relevant to research in the pension communication and choice field. Pension providers can apply the learnings from experimental settings and results to test the various pension communication phases before rolling out new practices into the field to improve communication efficiency.

The increasing use of eye-tracking in economics and finance reflects a growing interest among academics as well as practitioners to examine the processes involved in decision-making as a way to improve our understanding of cognitive processes (Caplin, 2016; Caplin & Dean, 2015; Willemsen & Johnson, 2011; Woodford, 2014). In the words of Caplin (2016, p. 1): "Yet standard economic data does not reveal what was noticed or considered, only what was chosen. This issue is fundamental and essentially universal. Observing final choices alone is inadequate once one makes allowance for incomplete information and its attentional grounding .... We will have no choice but to face up to this limitation explicitly, and to work on data enrichments that liberate separate understanding of learning and choice."

In addition to field evidence and traditional economic experiments, eye-tracking experiments can provide information on the underlying decision-making processes. Eye trackers can record various eye activities, including eye fixations, saccades, and pupil dilation. Eye fixations are the locations that a subject focuses on, while saccades are rapid movements (discrete sequences) of the eye between fixation points. The saccades can reflect a subject's attention paths and orders related to a subject's information-gathering process. In addition to information gathering, some eye trackers can also record pupil dilation, which is usually associated with arousal, pain, and cognitive difficulties of the respondent.

Wang, Spezio, and Camerer (2010) use pupil dilation to understand truth telling and deception and to test the level-k model[1]. Similarly, researchers can use pupil dilation to observe an individual's difficulties in understanding pension product information. With a combination of different eye activities, eye-tracking can lead to various kinds of additional information to standard observed data. Therefore, eye-tracking is an appealing method that is relatively cheap and simple for experimental research in the various phases of pension communication: the trigger phase, the navigation phase, and the content phase, as defined in Dinkova et al. (2018).

With the recent emergence of eye-tracking literature in economics and finance, a comprehensive literature review of the relevant studies summarizes the central insights of eye-tracking, identifies exciting research questions, and defines research frontiers, especially in the field of pension communication. After introducing the different eye-tracking systems in Section 2, we present in Section 3 general guidelines to utilize eye-tracking technologies. In Section 4 we demonstrate the importance of eye-tracking technologies in pension communication. In Section 5 we discuss the application in three phases of pension communication. Finally, Section 6 contains conclusions and provides recommendations for further development.

1 Level-k theory assumes that players in strategic games base their decisions on their predictions about the likely actions of other players.

2. How does eye-tracking work?

2.1 A brief history of eye trackers

There are several ways to track eye movements. Most modern eye trackers rely on corneal reflection to detect and monitor eye activities. An eye tracker uses a light source to illuminate the eyes and a high-resolution and high-frequency camera to detect the reflection. The images captured are then used to record the reflection of light on the cornea and the pupil. Image processing algorithms, designed in line with the respective eye tracker, are then used to interpret eye activities such as eye fixations, saccades, and pupil dilations (Bergstrom & Schall, 2014).

Before delving into the more detailed characteristics of eye-tracking, we briefly discuss the historical development of eye-tracking. Technology advances in the past half century have significantly lowered the barrier to applying eye-tracking technologies in research (Wedel, 2013). The technological advancements allow us to use eye-tracking devices with much lower costs, more natural use, and better data quality (Ashby, Johnson, Krajbich, & Wedel, 2016). These have led to the increased use of eye-tracking in social sciences such as cognitive psychology, organizational science, marketing, and accounting research and, more recently, in behavioral economics and finance.

Eye-tracking was first employed for research purposes in the late nineteenth century by using invasive techniques that require contact lenses. Measurements based on physical contact with eyeballs generally became very sensitive (Duchowski, 2017). These early studies tried to understand the most basic hypotheses of how the visual system and brain activities are linked together. They were usually very expensive, obstructive, and complicated for commercial use (Bergstrom & Schall, 2014).

Starting in the 1940s, researchers applied video-based eye-tracking devices to study eye movements. In 1947, Paul Fitts and his colleagues studied pilots' eye movements when using cockpit controls and instruments to land an airplane. Their study was one of the earliest eye-tracking studies (Jacob & Karn, 2003).

The evolution of video-based (corneal reflection) eye-tracking in the 1960s and 1970s established the foundations of modern eye-tracking devices and opened up possibilities for further applications of eye-tracking techniques. However, these primitive eye trackers were still highly intrusive; for example, they required a head restraint and bite bar. These made it hard to stimulate a comfortable and realistic environment for testing the behavior of participants. Modern eye-tracking devices were introduced in the late 1990s. New technological advancements in hardware and software design allowed the eye tracker to leave the academic arena and to

Figure 1: A participant using a computer equipped with an eye tracker together with electroencephalographic (EEG) equipment. (Courtesy of Tobii Technology.)

Figure 2: A participant using a pair of eye-tracking glasses. (Courtesy of Tobii Technology.)

be incorporated in industrial applications (see Figures 1 and 2) (Bergstrom & Schall, 2014). Nowadays, there are several eye-tracking technology companies that offer eye-tracking devices for both academic and commercial applications. Tobii Technology AB (Swedish), SensoMotoric Instruments (German-based and owned by Apple Inc.), LC Technologies (American), and SR Research (Canadian) are significant players in this field.

2.2 Characteristics of modern eye-tracking

Modern video-based eye-tracking hardware is designed for quick and easy data acquisition. Most video-based eye-tracking devices require a calibration process to adjust the tracking system to a specific participant in an experiment. These devices usually require a participant to follow a standardized sequence of stimuli to test the eye activities. Advancements in eye-tracking technology lead to large increase of speed in this calibration process. Nowadays, the calibration process is typically completed within seconds. A complete application procedure in eye-tracking today also requires minimal training that is easy to learn for a beginner.

Figure 3: Heat map generated by eye-tracking software. (Courtesy of iMotion.)

Eye-tracking technology has over the years become participant-friendly and is no longer physically connected to a desktop-based system and no longer involves a limited obstruction for a mobile system (see also Figure 2). Therefore, modern eye trackers can make participants feel almost unconstructive, and experiments can be run that approximate real-world settings.

With the help of modern software suites, which are usually bundled with the eye-tracking devices, eye-tracking systems can produce a visualization of data aside from the data used most often such as scan paths (the sequence of fixation of the eyes), duration (the time spell that the eyes fixate), and pupil dilation. Heat map and gaze plot are two of the most commonly used visualizations.

A heat map is a graphical representation of data that uses different colors to show the number of fixations or duration of fixations that participants make. An example is shown in Figure 3. The colors typically range from red to green, where red is used to indicate a relatively high number or long duration of fixations and green the lowest number or duration. For example, Gödker and Lukas (2019) use heat maps to show that fixation durations are higher for recent periods and shorter for past periods. The heat maps provide the first indication for a subject's great attention to the period directly prior to the current period, independent of the specific decision task. An area without color on a heat map shows that it may not attract a participant's attention. This area does not necessarily mean that the participant did not see anything – he or she may have looked there for a short period or may have only registered peripherally. Alternatively, it may not have been detectable by the eye tracker. Most research papers in economics and finance use heat maps for a first indication to focus their research questions on (Chen et al., 2016; Devetag, Di Guida, & Polonio, 2016; Duclos, 2015).

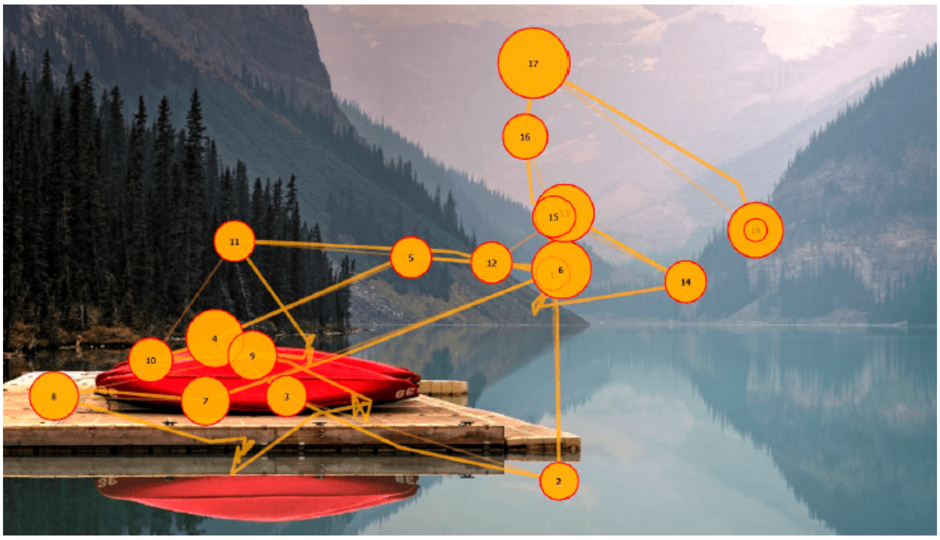

Figure 4: Gaze plots generated by eye-tracking software. (Courtesy of iMotion.)

Gaze plots are a graphical representation of the number of fixations or the duration of fixations that participants make, together with saccades, for a particular time spell. Usually, dots represent fixations, the number or duration of fixations are represented by the size of dots, and saccades are lines connecting the dots. Additionally, fixations are typically numbered to show their sequence (Figure 4).

Researchers often use areas of interest (AOI) to analyze different visual presentation components such as parts of a table, chart, or paragraph (see Figure 5 for an example of defined AOIs). For example, Duclos (2015) used AOIs to capture stock performance paths on a run chart, linking the stock prices of different periods to each other. He found that households pay more attention to the most recent stock performance and anchor their investment decision on the latest trend. Similar to Chen et al. (2016), we can use AOIs to analyze visual information of pension fund websites and products instead of performance measures of a balanced scorecard. It will be worthwhile to use eye-tracking technology for research on the communication between pension funds (or insurance companies) and households.

Researchers can divide the visual presentation into different geometric regions that correspond to different elements of the information. For instance, in the content phase of pension communication, researchers can create AOIs for graphical and textual components of a pension fund fact sheet, to see how the information processing differs between graphical presentation and textual presentation. Aggregation of the data from AOIs across participants can be used to understand the sequence in which particular areas were viewed and the frequency and duration of the views. These analytical tools make it relatively easy to analyze the results of an eye-tracking study.

Figure 5: Areas of interest (AOIs) by eye-tracking software*. (Courtesy of iMotion.)

* In Figure 5, TTFF (Time to First Fixation) indicates the average amount of time that it takes participants to look at a specific AOI; Time Spent quantifies the amount of time an average participant looks at a specific AOI; the Ratio is the total number of participants who looked at a specific AOI divided by total number of participants; the Revisitors row shows the ratio of the total number of revisitors divided by the total number of participants who ever looked at a specific AOI; the Revisits row shows how many times an average participant returned to a specific AOI; finally, Fixations show the number of eye fixations in a specific AOI.

A trained researcher can adjust the settings for this attention information to understand what the user saw at a specific moment in the context of what the user was doing (i.e., a particular task) (Bergstrom & Schall, 2014). In addition, an AOI can be used as a "button" for participants to interact with the system. In this case, distracting eye movements such as eye movements for locating a keyboard or a mouse for a desktop-based eye-tracking system can be avoided. For example, the participants can simply activate a pre-defined program by looking at an AOI for a few seconds without the interference of a mouse or keyboard.

3. Experiment design and guidelines

3.1 Experiment design

Eye-tracking studies are not very different from most experimental studies. Therefore, researchers usually start with economic theories of individual decision-making or strategic decision-making. For a study of dynamic choice models, eye trackers can be used to distinguish competing search models, such as the optimal search model with zero cost, a satisfying search model with a reservation utility, and a hybrid search model (see, for example, Reutskaja, Nagel, Camerer & Rangel, 2011).

Researchers need to be explicit about their research questions and corresponding testable hypotheses. The research questions and hypotheses define which variables need to be constant and which variables need to change systematically (in a controlled environment like a lab). Reutskaja et al. (2011) combine the choice results with duration and number of fixations observed by eye trackers to reveal participants' search patterns and to test the above three theories. Since we focus on more specific guidelines for eye-tracking studies, we do not go into detail about experimental economics in general. Excellent overviews of more detailed instructions on the interaction between economic theory and experiment design and data are provided by Friedman, Cassar, and Selten (2004) and Croson and Gächter (2010). The following subsections discuss guidelines that apply more specifically to eye-tracking.

3.2 What type of eye-tracker should be used?

As briefly discussed in Section 2, three main types of eye-tracking systems are used: desktop-based (remote or stationary), small wearable systems, and webcam-based systems.

Desktop-based eye-tracking works by placing camera in front of the subject's eyes to capture eye gaze and corneal reflection of infrared sensors and to record eye movements ranging between 60 and 1200 Hz (i.e., 60–1200 captures per second). For a desktop-based system, either remote or stationary systems can be used. The remote system is usually a head-mounted system that is useful in applications that require participants to view their environment; these are prevalent in marketing research. For instance, Gödker and Lukas (2019) use remote binocular Tobii Pro X2-60 eye-trackers to study investors' attention to extreme stock returns. The stationary system can be applied to any circumstance that allows participants to stay in front of a desktop. For example, Lahey and Oxley (2018) use a stationary desk-mounted system from Applied Science Laboratories (ASL). They use the eye-tracking system to capture how long and where the participants look.

Wearable eye-tracking systems are useful when the participant needs to travel around in a lab or the field (either virtually with virtual reality or physically). For instance, Wästlund, Otterbring, Gustafsson, and Shams (2015) investigate the effects of decision heuristics on visual attention in a real store (e.g., a gas station or a grocery store). Additionally, eye-tracking technologies can be combined with virtual reality (VR) to investigate a subject's information- gathering process in a simulated environment, which may be hard to find in a real setting. Moreover, there is also a new trend in behavioral economics and neuroeconomics to use neural data to test theories of investor behavior (Frydman, Barberis, Camerer, Bossaerts, & Rangel, 2014). In this case, eye-tracking is usually combined with neuroeconomic measurements such as functional magnetic resonance imaging (fMRI) and electroencephalogram (EEG) to measure neural activities and eye movements to know more details about how information is gathered and processed by a subject.

Since recently, webcam-based eye-tracking has become more accessible. Even though a webcam-based eye-tracking system is not nearly as accurate as a video-based system, there are extra benefits for using it. For example, it allows extending the participant pool to users of general personal computers (e.g., laptops) and mobile devices (smartphones and tablets). Webcam-based eye trackers involve little significant work since these precision devices are still inferior to video-based eye trackers. However, webcam-based eye-tracking is still attractive due to its capacity to support field experiments among everyday users of a laptop or tablet. Papoutsaki et al. (2016) apply webcam-based eye-tracking to study web user interactions and confirm that the accuracy of WebGazer (a webcam-based eye-tracking system) is sufficient for approximating a user's eye movements. Król and Król (2019) use webcam-based eye-tracking in finance and find that a simple eye movement measurement, such as the eye transition between different pieces of information, relates to the quality of investment decisions. This result is based, for example, on existing research that shows that novices are more likely than experts to become distracted by task-irrelevant information (Wolff, Jarodzka, van den Bogert, & Boshuizen, 2016). In summary, all three kinds of eye-tracking systems have both benefits and drawbacks. Thus, based on the research questions and experimental design, the researcher should carefully choose a particular system.

In pension communication, the desktop-based and web-based eye-tracking systems are the best fits since most pension communication is conducted on the internet, without personal interaction (Dinkova et al., 2018). For example, researchers can conduct lab experiments involving a desktop-based eye-tracking system or field experiments involving a webcam-based eye-tracking system to better understand whether participants experience difficulties understanding certain information, by observing corresponding pupil dilations and fixations duration. Such experiments can help pension providers to improve the selection and structure of content and to personalize pension communication.

In addition to eye-tracking hardware, software is needed to run experiments and to process the collected data. While most eye-tracking providers bundle the hardware and software, additional software might be needed to facilitate analysis. For example, in the Lahey and Oxley (2018) study, the ASL software is not flexible enough to also perform an implicit association test (IAT), so they use Inquisit software to run all of the IATs without changing the software in-between. However, there is typically no need to use additional software to collect or process eye-movement-related data. Duchowski (2017) provides detailed instructions on software for different eye-tracking systems and data analysis in case of a more demanding supporting software need and introduces system software development tools for more advanced users. There are also consulting firms such as iMotion that can help customers to choose the most suitable hardware and software combination.

3.3 Experiment participants

In general, there are few restrictions regarding the selection of participants for eye-tracking experiments. In pension communication, it is essential to attend to the segmentation of target groups on financial literacy or knowledge, financial wealth, education, age, and gender, so that researchers can come up with better and more comprehensible pension information (Elling & Lentz, 2019). Financial literacy or knowledge can be measured by, for example, the financial numeracy index developed by Van Rooij, Lusardi, and Alessie (2011), which is vital for informed financial decision-making as widely used in the finance and pension literature. Financial wealth is also a key factor for investment decision-making since financially wealthy individuals tend to have better investment outcomes than their counterparts. This is because wealthier persons are more likely to seek financial advice (often by paid specialists) and to diversify their portfolios (Von Gaudecker, 2015). It is also essential to control for education level, industry, and occupation if possible. Education significantly affects how people perceive pension information, and it signals cognitive abilities (even beyond financial literacy, which is considered a much weaker explanatory factor). Cognitive functioning declines with age, but age can positively affect investor performance through experience (Agarwal, Gabaix, Driscoll, & Laibson, 2009; Korniotis & Kumar, 2011). As to gender, it is well documented in the literature that women are on average more risk-averse than men (R. Croson & Gneezy, 2009). Because several pension funds have multiple sectors as clients, it is also relevant to control for industries. Moreover, occupational information may relate to how people perceive their retirement plans.

There are also some technical issues when it comes to selecting participants. It is better to exclude participants with reading or learning disabilities and native English speakers since they may have different eye-tracking patterns than the average person (Duchowski, 2017). The time for calibration may vary by participant due to differences in eye size, but this is typically not a concern when using optical instruments such as glasses and contact lenses. However, the experimenter should be careful with the frame of glasses, as this can block light reflections and make eye-tracking problematic. In terms of specific groups of participants such as top managers or CEOs, it may be hard to apply lab-based systems such as desktops due to time restrictions and geographical limits. But in most cases, a webcam-based eye-tracking system can be used to make it easier for studying these participants.

3.4 Experimental environment

For a lab experiment, it is essential that the environment is controlled as strictly as possible. For example, distractions must be avoided during eye-tracking experiments. Researchers should ensure that the participant can focus on the AOIs instead of looking elsewhere. Although good lighting is usually enough to enhance eye-tracking experiments, perfect lighting is often necessary for video-based systems since they detect near-infrared spectrum lights (Lahey & Oxley, 2018). For a controlled field experiment, the key points do not differ much from a lab experiment. It is still necessary to guide participants carefully away from unwanted distractions in the field. For example, it is crucial to control the noise and number of people in a room when studying the interactions between a participant and a pension fund representative. Finally, for a field experiment involving webcam-based eye-tracking systems, proper instructions should be given to participants to control their situation. However, in a field experiment it is harder to control the environment compared to a lab experiment.

Meanwhile, researchers should also consider that the corresponding experiment environment may not be as ideal as expected and that the data may thus be interpreted with a conservative attitude. There is as yet no significant study involving a field experiment that uses webcam-based eye-tracking systems. However, this will be an exciting avenue for further research, given the popularity of more advanced mobile devices with eye-tracking functions such as the modern iOS and Android phones and tablets. Moreover, even though webcam-based eye-tracking systems are not as good as desktop-based eye-tracking systems, the tracking errors can be compensated by a much larger sample size since most smartphones, tablets, and laptops allow for conducting eye-tracking experiments. Again, for general instructions on experimental environments, we can follow the design applied in experimental economics to control experimental conditions.

3.5 Types of observables

Eye-tracking technology offers an exciting dimension to behavioral data for business research. In an experimental design, eye-tracking allows researchers to observe the movements of a participant's eyes during an experiment's instructed actions. Therefore, researchers can obtain more insight into the cognitive processes under a wealth of economic behaviors. For instance, Bertrand and Mullainathan (2004) and Lahey (2008) studied the effects of age, gender, and race discrimination in the hiring process. Eye-tracking can tell the researcher whether resumé screeners look at resumés, how long they look at it, which parts of resumés they look at, and in what sequence they look at them. It allows them to answer whether they ignore the resumé when seeing the gender or a name. These observed cognitive processes can thus further contribute to distinguishing different theories. For example, do participants look longer at resumés by women for items that provide information about quality (as with level-based statistical discrimination), or do they spend less time on them (as with variance-based statistical discrimination) (Lahey & Oxley, 2016)? Given this example, researchers can easily choose, instead of resumés, for pension communication materials such as e-mails, website texts, and videos that can be accessed on any screen such as a PC screen or tablet. In this case, researchers can test a pension document's effectiveness and eventually implement the practices learned in real-life settings.

Based on the assumption that there is a direct link between eye fixations and cognitive thinking processes, eye movements can be used as an indicator of attention to stimuli. Researchers can obtain the data on eye-tracking observables such as pupil fixations, saccades, pupil dilations, gaze plots, and heat maps. Based on the assumption that the information acquisition procedures and thinking processes of a participant can be interpreted from eye movements, the participant's emotional behavior and working load can be explained in terms of output such as pupil dilation (expansion in width and area) and blinking frequency (more advanced eye-tracking outputs that are not standard for most eye trackers). As mentioned earlier, pupils dilate under pain, arousal, stress, and cognitive difficulties (Reutskaja et al., 2011; Wang et al., 2010). Moreover, all those measures can be combined with more diverse neuroscientific measures, including fMRI graphs, EEGs, and galvanic skin response (GSR). In addition to visual attention, fMRI graphs and EEGs enable measurement of the brain's instantaneous cognitive efforts. At the same time, GSR measures an experiment participant's excitement, exertion, and stress. Therefore, the combined neuroscientific techniques provide a better picture of human cognitive and physiological activities and offer more detailed insights into an individual's decision-making processes (Sickmann & Le, 2016).

4. Academic eye-tracking literature[2]

4.1 Eye-tracking studies in experimental economics and finance

Research in experimental economics and finance using eye-tracking technology is a recent phenomenon, even though related literature is often found in marketing, organizational science, and accounting. Like other disciplines, most eye-tracking studies in experimental economics and finance focus on individual decision-making processes. As in pension communication, individual decision-making processes are the most relevant since most of such communication is conducted online without human interactions (Dinkova et al., 2018). Therefore, this survey will focus on the literature on individual decision-making processes rather than on strategic decision-making processes.

Experimental economics on individual choices became popular after the prosperous line of new theories in the 1960s. Game theory, industrial organization, general equilibrium, social choice, search theory, voting theory, etc. offered competing ways to understand microeconomic data, especially on individual decision-making. Experimental economics took off in the 1980s. Financial markets, auctions, asymmetric information models, institutional engineering, voting, and dozens of other new applications opened to the new methodology. Mainstream economic and finance journals began to publish experimental papers on a regular basis (Friedman et al., 2004). The recent 2019 Nobel Prize in economics was awarded to experimental economists who investigated poverty. Therefore, economic and business researchers were encouraged to make more use of experimental technologies for their studies.

Eye-tracking is a relatively cheap and easy-to-use method for experimental research in information perception and processing. There is abundant evidence on the impact of the provision, reception, and processing of information on decision-making from experimental economics and finance. Eye-tracking helps generate complementary data to standard observations of choice variables and became popular among behavioral economists and finance researchers. Generally speaking, eye-tracking technologies can be potentially integrated into three directions of experimental literature: experiments designed to test theories of individual decision-making, experiments conducted to test and develop hypotheses of strategic decision making

2 Table 1 contains an overview of the academic literature investigated in this survey, including Original Topics, Implications in Pension Communication, Research Questions, Key Eye-tracking (ET) Based Finding, ET System & Environment, Types of Eye-trackers, Sample Size and ET Measures Used. We also derived some paper summaries from two similar tables in Sickmann and Le (2016) and Meissner and Oll (2019).

(game theory), and market experiments with a focus on industrial organization (Davis & Holt, 1993; Roth & Kagel, 1995).

4.2 Individual decision making

Individual decision-making, especially regarding financial decisions (e.g., consumption and savings, mortgages, retirement plans, asset allocation, insurance, etc.), usually involves choosing between options that involve limited available time and/or resources such as information and cognitive abilities. The eye-tracking research on individual decision-making has covered different economic theories and applications in behavioral economics and finance and in accounting and organizational economics.

4.2.1 Attention and inattention (static choice)

Even though it is clear that attention is limited, traditional rational economics assumes that individual agents process all available information. Modifying this classical assumption based on empirical evidence and theoretical prediction is essential for economic modeling, understanding market efficiency, and designing better policies (Gabaix, 2019). Decision theories suggest how individuals allocate attention to their economic choices (Bordalo, Gennaioli, & Shleifer, 2012; Schwartzstein, 2014). It has indeed been shown that attention to salient features is an essential factor in explaining risky choice (Frydman & Mormann, 2018). Therefore, it is crucial that pension organizations, when designing pension communication materials, ensure that these help pension participants to allocate their attention to the most relevant information. Attention navigation is relevant in all three pension communication phases since pension organizations know better than the average pension participant what is most relevant in terms of information, so as to avoid information overload for pension participants.

Most attention research in finance makes use of natural experiments or settings, involving information events that vary only in terms of media coverage. More recent studies establish a causal relationship between attention-catching events and investment behavior. They show the causal effect of media coverage on local trading, of being positioned on the front page of the Bloomberg terminal news screen on the security's market dynamics, such as trading volume, and of being mentioned in a prominent ranking list on flows into mutual funds (Engelberg & Parsons, 2011; Fedyk, 2018; Kaniel & Parham, 2017). Still, compared to eye-tracking research, these studies use events that attract attention in a large crowd, which makes conclusions about the nature and underlying mechanisms of individual attention-driven investment behavior difficult.

Using eye trackers in an incentivized laboratory experiment, Gödker and Lukas (2019) investigated whether attention-grabbing characteristics of stock returns, such as extreme positive/negative returns, guide retail investors' attention and thus lead to their subsequent investment choice. They applied a direct measure of visual attention, i.e., fixation duration at the individual level, by recording the eye movements of subjects during their investment tasks using eye-tracking devices. Contrary to stock market data, their experimental design allowed them to observe individual attention and separate rational trading on investor preferences and beliefs from attention-driven purchase behavior. They found that attention-driven purchase behavior can lead to wealth reductions for stock market investors. This result was linked to the observation that the demand for stocks with attention-grabbing returns increases at the expense of the demand for stocks without attention-grabbing returns, leaving the investor's total stock investment unchanged.

Similarly, when conducting eye-tracking experiments, Rubaltelli, Dickert, and Slovic (2012) also found, based on their study of eye movements, that individuals pay more attention to losses and/or uncertain outcomes than on gains and/or sure outcomes. Results showed that pupil dilations, fixation duration, and the number of fixations increased when individuals evaluated the gambles involved in a pricing task with increased adverse outcomes and when the outcomes were uncertain (rather than sure). Fixations were also predictive of the subjects' final evaluation of the gambles. The experimental results also indicate that individuals tend to use more cognitive efforts on pricing tasks than rating tasks. Thus, the outcomes of pricing tasks are weighted by subjects more heavily than the respective probabilities when dealing with pricing tasks than rating tasks. In terms of the three phases of pension communication, pension organizations can guide pension participants through the quantitative evaluation of their pension choices to thoroughly understand the pension choices in the navigation phase.

Although an investment's past performance is not a perfect predictor for its future results (Brown & Goetzmann, 1995; Carhart, 1997), the behavioral bias of overweighting of the most recent information can be adjusted by using the past performance (De Bondt & Thaler, 1985; De Bondt & Thaler, 1987). In turn, this behavioral bias may impair asset valuation and investment decisions as it leads to biased forecasting of future performances (e.g., mutual fund future returns). In finance research, Duclos (2015) further conjectured that this end-anchoring bias is more likely to occur when quantitative information is reviewed graphically (very often used by modern technologies, including financial services providers such as Bloomberg and Refinitiv). Using eye trackers, he observed that investors spend the most extended fixation duration on the latest stock performances than earlier ones and therefore biased their expectations on future stock performance. He also found that this bias is more substantial when displayed on a graph instead of a table. This literature suggests a compromise on presenting quantitative information with a graph instead of a table for pension organizations. It will be helpful to raise the awareness of this bias when communicating graphs of investment's past performance with pension participants.

In accounting research, Chen et al. (2016) investigated the role of visual attention in managerial judgments during balanced-scorecard performance evaluations. They found that managers who look more at strategically linked performance measures are more likely to make decisions that are consistent with the achievement of their subordinates' strategic objectives. When aware of the strategy, managers focused more on strategically linked performance measures than on non-linked measures. They use fixation duration on the visual information captured by eye trackers to measure the attention on balanced-scorecard performance measures.

Additionally, in the context of the dual-process theory (Kahneman, 2003a, 2003b; Kahneman, Lovallo, & Sibony, 2011), some studies address information communication formats. The literature finds that graphical risk formats encourage further elaboration for individuals with lower numeracy abilities on numeric risk information and suggest some implications for the design of risk communication formats (Hess, Visschers, & Siegrist, 2011; Hess, Visschers, Siegrist, & Keller, 2011; Keller, Kreuzmair, Leins-Hess, & Siegrist, 2014; Siegrist, Leins-Hess, & Keller, 2015). Even though these studies are mainly aimed at risk understanding and decision-making in medical contexts, they are good starting points for pension communication research. The closely related literature on infographics and financial decisions is also relevant for the design of pension communication materials. For example, Cox, de Goeij, and Van Campenhout (2018) show that the visualization of key information of mutual funds helps investors to reduce the amount of preventable fees. However, the effectiveness of visualization in terms of financial literacy and education differs by segmentation group. As to graphical presentation of crucial information, pension funds can guide pension participants through quantitative evaluation of their pension choices instead of just offering a variety of pension options. However, pension communication designers need to avoid a one-size-fits-all approach for different segmentation groups.

4.2.2 Dynamic search

Eye-tracking techniques are also used in dynamic search models in economics pioneered in Jovanovic's seminal work and by McCall (1970). For instance, Reutskaja et al. (2011) proposed and compared three competing models of the computational processes that are used to make consumer goods decisions involving time restraints. The three search models mainly differ on the stopping rule of searching. The first model assumes optimal search with zero search costs, which means that subjects stop searching after a complete search of all possible options. The second model assumes satisfaction, which implies that subjects stop searching when they find a sufficiently good option or run out of time. The third model is a hybrid form in which subjects search for a random amount of time, depending on the value of the options encountered. Aside from supporting evidence on the hybrid model, they also find display effects based on eye-tracking observations. They found that the probability that a specific option is selected depends on its display location. Subjects exhibit a bias to look first and more often to items placed in certain display regions, which they also choose more often. More recently, Wästlund et al. (2015) applied eye-tracking technology in field experiments to investigate the relationship between heuristics decision-making and cognitive limitations. They tested this relationship by observing visual attention during searching behavior in real stores, i.e., a gas station, a sports store, and a grocery store. The results from their field experiments confirmed that a sophisticated heuristic (take-the-best heuristics) decision makes greater use of cognitive resources, which results in less visual attention during subsequent choices. These results support the resource depletion theory.

5. Conclusion: three phases of pension communication

The power of eye-tracking technology lies in the possibility to capture the visual attention of individuals for different types of economic behavior, whether asset allocation for retirement purposes or grocery shopping in a supermarket. This visual attention information is useful for pension funds in their design and presentation of pension communication contents and structure, intended to enable pension participants to understand pension products better and to make better pension decisions. The eye-tracking system and the acquired visual attention can thus be applied in all three phases of pension communication: the trigger phase, the navigation phase, and the content phase.

In the trigger phase, the pension plan provider can offer structured information by means of graphs about the different tools and websites available, via email or regular mail, to enable a pension participant to acquire more information about his or her pension situation. Alternative triggers include brochures, short videos, postcards, and even instant messages or posts on social media.

According to Dinkova et al. (2018), the navigation phase pertains to the structural design and presentation of pension choices. As reviewed by Prast and Van Soest (2016), the choice architecture is crucial towards improving the decision-making process of pension participants. Using eye-tracking experiments, researchers can find better ways to prioritize a particular theme, by changing the sequence and pension information ranking. Also, eye-tracking devices can be used to better understand the choice behavior of individuals, such as searching and screening. This leads to better pension-related decisions, as the information is more individually tailored as pension participants make choices in the navigation phase.

As to the content phase, little empirical research has been done due to the lack of methodologies to distinguish between good and bad for different contents. In this case, eye-tracking experiments can be helpful. Researchers can use graphical representations, such as gaze plots and heat maps. Pupil dilation and fixation duration generated by eye-tracking software also serve to analyze individual information acquisition behavior. The pension communication designer can thus understand the visual hierarchy of an interface or certain content and can make informed decisions about how to optimize the organization of visual information.

Finally, the structural data, such as pupil dilation and fixation duration, can help both academics and non-academics to understand the relationship between visual attention and everyday decision-making. Here, eye-tracking is often used to reinforce the theoretical and empirical findings in the existing literature. Moreover, previous research and experimental designs can further help practitioners to increase the efficiency of pension communication efficiency, by conducting tailored experiments concerning the various pension communication phases. Pension providers can then implement the practices learned from experiments, to increase the accuracy and efficiency of the communication by pension providers to pension participants.

6. Further research

As to further research, eye-tracking can be extremely helpful, both for academics to study and for policymakers to make decisions on information interventions that involve financial decisions. Financial education and informational interventions are useful tools when it comes to improving the economic outcomes of individuals (Benartzi et al., 2017; Benartzi & Thaler, 2007; Beshears, Choi, Laibson, & Madrian, 2018; Beshears, Choi, Laibson, Madrian, & Milkman, 2015; Willis, 2011). Eye-tracking can be helpful for both of these tools. Moreover, recent Netspar research focused on several areas in this regard. For example, Elling and Lentz (2019) argue that tailoring pension communication can lead to greater motivation on the part of pension participants to delve into their personal pension situation and to better and more comprehensible pension information. Linde (2019) suggests introducing a pension choice architecture that contains a module involving a set of nudges to encourage pension saving and that considers the behavioral differences between self-employed persons and employees. Lately, eye-tracking research has become more prevalent in experimental economics and individual decision-making research. This survey therefore focused on these, as examples on how to conduct research using eye-tracking equipment. Many of these applications are relevant to research in the pension communication and choice field.

To summarize, eye-tracking technology enables us to observe the information acquisition process better and to understand the cognitive process of individuals, as detailed data are increasingly available for individual economic decisions. As other neuro-economic methodologies such as fMRI and EEG are increasingly used and observational data become available, the current generation of research on individuals transforms our understanding of individual behavior and the associated consequences for individual decisions. Therefore, further research in behavioral economics and finance will be more exciting with the availability of eye-tracking technologies and other advancements in the area. For example, eye-tracking technology can lead to better information for pension boards. A separate research paper in this area would be worthwhile.

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