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Visual Representation and
Financial Decision Making

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Abstract

This Thesis explores connections between visual representation and financial decision making. Visual representations have several facets. The interplay between these factors, how they are presented and/or manipulated by the proposers, and the way by which consumers and more generally individuals perceive, analyze, and make financial decisions, has important consequences on such decisions. The several ways visual representations can be mixed and offered may indeed result in triggering positive, negative, successful or misleading outcomes. This is a relatively new and unexplored area of research that, however, is expected to grow very rapidly, particularly due to the growing importance of visual stimuli that we are constantly absorbing from our fast-pace society and the need of making quick, winning financial decisions.

The experimental research here described has been divided into three main topics, which correspond to different aims and experiments. Each of them will be dealt with separately in corresponding chapters. The summaries of such studies are provided below and also pasted in the Introduction section at the beginning of each chapter, to make the reader quickly focus on the specific cut of the topic addressed, the results obtained, and the main conclusions reached.

Chapter 1: *Interplay of Visual Representation, Financial Literacy, and Investment Experience on Financial Decision Making*

Ordinary consumers and casual investors often engage in suboptimal financial behaviors, such as poor investment choices, that reinforce the conditions of economic insecurity and lack of trust in financial institutions. Some explanations for these behaviors focus on heuristics and cognitive biases. Others emphasize the importance of subjective factors such as financial knowledge, financial literacy, and capability to manage own finances. We instead consider how certain financial behaviors stem simply from having too much variation in financial information communication. Financial advertising, for instance, acts as an important source of information that shapes consumers' preference for and choice of financial products and services. Insights from both controlled laboratory and field experiments in consumer behavior suggest that by employing frames and cues to affect choices non-informative advertising may, apparently, also play a large role in decision making. We hypothesize that visual representation of financial information may directly impede comprehension and decision making processes and outcomes. Specifically, we suggest that the choice of visual representation and content changes how people allocate attention, and how they process, perceive, and act upon presented information. Biased representations may lead to engage more deeply in some attributes while neglecting others, and this affects decision processes and outcomes. To test these hypotheses we conducted two online experiments. In the first experiment, we manipulated

visual proportions of investor graphs and found that this decreases decision accuracy not only among ordinary participants but also among those with prior investing experience. In the second experiment, we investigated how controlled variations of the visual content (accomplished by accompanying text-base information with graphs and/or face photographs) could shape investments' perception and subsequent willingness to invest. Across two experiments, we show that the choice of visual representation leads to shifts in attention, comprehension, and evaluation of the information provided. These results help to explain behaviors such irrational and frequently suboptimal financial decision making. In addition, we find that people's performance is reduced when they are presented with inaccurate graphs despite the accuracy of text-based information. It appears that financial literacy moderates the visual representation effects by reducing susceptibility to graph manipulation and advertising content effects. We discuss how this mechanism might also explain other puzzles of inferior decision making among consumers. These data provide a previously underexplored perspective and help to explain a spectrum of behaviors among casual investors and ordinary consumers of retail financial products. We discuss some implications for consumer protection policy and provide insights into other stakeholders interested in optimizing the quality of financial decision making.

Chapter 2: *Experts' and Novices' Judgment in Retail Finance*

Financial service and product promoters often act as financial advisers and provide expert judgment to aid naïve consumers facing important financial decisions. Such advisers often acquire their status as experts via education or direct experience in the financial domain, and the accuracy and the objectivity of their assessments and predictions are rarely questioned by their clients. The expert advisers, however, may be prone to bias and cognitive illusion, impairing their ability to perceive and judge impartially. This might further reinforce the conditions of wide-spread suboptimal financial decision making. The literature on expert decision making explores divergent arguments concerning this issue. We hypothesize that financial advisers are able to predict their customers' preferences even though they are not able to overcome their own biases. We suggest that advertisement content can alter on which attributes people focus the most and how they evaluate the provided information. Across both parts of the experiment, we show that variations in presentation leads to attentional and attitudinal shifts that can help to explain irrational behaviors, such as overrating potential benefits of the offer or willingness to recommend it to the client. First, we experimentally test how advisers perceive their client preferences and find that advisers are quite skilled in predicting consumers' attitudes toward advertised products. Second, we examine both financial professionals' and ordinary consumers' comprehension of disclosed information in financial communications and assess their preferences for advertised products. We find that advertising content significantly affects both expert and novice decision makers. We also find that experts show

systematic biases, sometimes of larger magnitude than those of novices. These unintended deviations from rational norms by advisers cannot be explained by existing theory of fallible experts alone. Instead, in this case, it appears that expertise does not correspond to the traditional definition of it. We suggest that financial advisers may develop expertise in relational aspects of their profession while lacking important skills for sound financial decision making. These data provide a previously under-explored viewpoint of decision making and perspective taking by finance professionals which could provide some further explanation of misguided and suboptimal financial choices among households. We discuss how this mechanism might also explain other paradoxes related to increased distrust in financial institutions, choice confusion, and financial decision avoidance among people. We also address some implications for policy concerning the adviser - consumer relationship and other aspects of retail finance in a more general sense.

Chapter 3: *Effects of Salient Cues and Changing Environments on Performance in Multi-attribute Visual Inference Tasks*

Human learning is complex and multi-faceted, especially when it takes place in a dynamic environment. The ability to learn from multiple cues, adapt to changes, and develop new strategies is what differentiates between success and failure, survival and extinction. We investigate the effects of salient cues and environmental changes on learning. Across six treatments groups (N = 182), we experimentally manipulate the initial weights assigned to visual cues (features of Chernoff Faces that correspond to multivariate data) that participants need to learn to categorize by developing a decision strategy. In other words, the learning is in the form of a search for appropriate weights as well as for unexpected changes of these weights. We hypothesize that lack of meaningful cues not only hampers the learning speed, but also affects how people allocate attention to changes and develop new strategies to cope with such changes. We hypothesize, that "abrupt" transformations in an environment are more harmful than "smooth" ones. We find that initially meaningful cues are instrumental for adaptation, suggesting that prior learning can inhibit subsequent learning. Moreover, response-time measures indicate that non-salient cues lead to more costly learning and less confident decision making. The participants in "shock" condition are also less likely to recover from significant confidence drops. These results provide a previously unexamined perspective and lead to possible explanations for variability in learning. We discuss how this mechanism might also explain other puzzles concerned with learning constraints and point out some implications for education policy.

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CHAPTER 1

Interplay of Visual Representation, Financial Literacy, and Investment Experience on Financial Decision Making

Contents

1. Introduction

Financial advertising provides an important source of information that shapes individual investors' preference for and choice of financial offers. Most communications contain visual persuasion elements meant to capture and guide consumers' attention toward selected attributes, for the promoted product to be perceived as superior within an increasing spectrum of available alternatives. In the evermore important retail finance sector, misleading ads might, in fact, drive suboptimal choices and lead to detrimental consequences on consumers' economic outcomes. Recent years have shown signs of some progress in restricting financial communication format aimed at individual investors (Greene and Kanach, 2013, 2012). Nonetheless, laws do not directly regulate the inclusion of visuals in promotional and informational materials. Prior research provides evidence that non-verbal advertising content, such as face stimuli and illustrative graphs, may affect demand. For instance, Bertrand, Karlan, Mullainathan, Shafir, and Zinman (2010) show that incorporating an attractive female photograph into direct mail advertisements results in increased loan demand by about as much as 25% reduction in the interest rate.

However, we still know little as to how much specific facial dimensions influence consumers' perception and evaluation of financial offers. Much accounting literature reports that graphs are highly influential in shaping readers' perceptions of financial information, as well as in guiding investment decision. However, there is little consumer finance research aimed at studying how including graphical representations of textual information can alter investment decisions. It is, therefore, crucial to explore the possibility for graph- or image-based communications in order to reduce the gap in and improve the capability of understanding and using economic information among consumers with different levels of financial literacy and investing experience (Karrh, 2004).

Here, we use Qualtrics and AMT platforms to conduct a cross-cultural experiment on 741 subjects (358 female), mean age = 31. While keeping the textual content constant, we investigate how controlled variations of visual format affect investment advertisements content evaluation and subsequent decisions about the offered product. The hypothetical ads in the experiment represent closely real-market offers in terms of risk-return structure and communication style. Ads are designed to include a text-based description of investment offers, and some of them additionally include graphs or close-up face photographs, or both types of the visual stimuli. Because recent evidence suggests that automatic and rapid inferences from faces impact the decisions that people make in a variety of important domains, including finance, in our study we employ carefully preselected portraits of ordinary people, professionally shot in a controlled environment. The faces are chosen to convey trustworthiness, honesty and confidence. By using close-up face portraits with direct eye gaze, we rely on the fact that a reduced physical distance conveyed by such photos positively correlates with a reduced psychological distance.

The models closely resemble the prototypes of major demographic categories of participants,

representing two genders and four major racial groups. We also check for effects within demographic and socioeconomic groups and, using Lusardi's scale, assess the level of respondents' financial literacy. By exploring its role in investment information perception and evaluation, we aim to broaden the existing knowledge about financial literacy in the domain of consumer finance. We examine whether there is any evidence that more financially literate individuals are less susceptible to visual framing and priming efforts. We additionally explore whether gender, age, financial education, and cultural background are relevant factors in explaining the variance in the perception of investment risk and responsiveness to visual stimuli.

Our data reveal that the inclusion of visuals into a financial communication significantly enhances the perceived understanding of information and can even boost willingness to invest. The results show that fluent processing of text-based information can be facilitated by means of illustrative graphics, reinforcing the propensity to keep, show, and recommend the investment offer. We also obtain evidence that the trustworthiness of a financial advisor promoting the offer augments when the investment ad contains both a graph and a photo. This effect is very pronounced for participants with little investing experience. The male participants perceive as more trustworthy the advisor who promotes advertisements containing photos of females, as opposed to photos of males. We also show that the perceived understanding of financial investments improves when race and/or gender of participants and models in the advertising material match. At the same time, the willingness to accept, show, and recommend the financial offers increases when participants view advertisements containing faces of females as opposed to those of males. The two last effects are highly significant for male participants. Our results suggest that graphs influence consumers independently of their financial literacy level, but to a different extent. Whereas, more financially literate subjects report to rely primarily on the numerical information provided in the text, less financially literate respondents place more focus on quantities depicted in graphs. Still, the high susceptibility of financially literate individuals to graphic representations is quite surprising and worth investigating in deeper detail. The individuals with higher financial literacy perceive the financial advisers as less trustworthy, but at the same time they are more confident on their own skills and thus more willing to take risks associated with the advertised structured investment product.

The outcome of this study establishes useful grounds to inform financial regulation policy-makers, scholars, and other stakeholders interested in optimizing the quality of individual financial decision making (Tufano, 2009). A future extension of this study would require a systematic field experimentation inquiring how visual format relates to real-world financial choices. The exploration of framing and priming effects obtained by use of graphs and photographs in investment prospectuses is not completely absent from financial research. To our knowledge, however, none of the prior studies considered the use of both photographs and graphs from the viewpoint of their interconnection, no study has analyzed the relationship between financial literacy and responsiveness

in the framework of financial choice, and no similar study has employed a cross-cultural subject pool. In a fast-pace world, future decision making will depend more on visuals and thus visual communication will become more and more prevailing within financial markets. We believe that future research in this area will be of particular value to help consumers make sound financial decisions.

Paper structure

The remainder of the paper is structured as follows. In Section Literature Review we give a general overview of related work in the context of consumer finance and effects of visual representation on decision making. In addition, we briefly discuss relevant research in the areas of financial literacy and financial knowledge, with special focus on the moderating effects. In Section Implementation of Experiments, we define the problem addressed and the terminology used in the paper. We also describe the hypotheses guiding this study. In the subsequent Sections Experiment 1: *Graphic Represenation* and Experiment 2: *Advertising Content*, the methodology of two experiments is presented. A general discussion of the results obtained from the two experiments is discussed in Section General Discussion. Finally, we summarize our conclusions and considerations, and outline future work.

2. Literature Review

2.1. Consumer financial decision-making

Numeracy and document literacy

Both numeracy (aka. quantitative literacy) and document literacy are subsumed under the broad construct of literacy and act as grounding blocks for financial literacy. In its broadest sense, the concept of numeracy refers to the ability to access, process, interpret, communicate, and act on numeric, quantitative, and probabilistic information; it is especially critical for effective financial decisions (see different definitions in Table 1). Document literacy, on the other hand, involves the skills required to search for and effectively analyze text-based and graphically represented numeric information contained within documents, such as drawing meaning from tables and graphs (Nelson, Ph, Reyna, Fagerlin, Lipkus, and Peters, 2007). For some decades, numeracy and document literacy have been a challenge for cognitive, behavioral, and decision scientists trying to understand how numbers could be made transparent and comprehensible so that people could make intelligent, rational decisions. In 2001, Lipkus et al. added eight questions to the three-item numeracy scale developed by Schwartz, Woloshin, Black, and Welch in 1997. In their study, Lipkus et al. demonstrated that numeracy is not correlated with education parameters but plays a role in lowering susceptibility to framing effects and improving accuracy in judgment (Peters, Vastfjall, Slovic, Mertz, Mazzocco, and Dickert, 2006). Numeracy measures can be broadly classified as either objective (ability to perform calculations or make numeric judgments) or subjective (the level of

Table 1. *Definitions:* of Numeracy, Financial Literacy, Financial Knowledge, and Consumer Knowledge

| TERM	DEFINITION	SOURCE
Numeracy	Numeracy, in the sense of knowledge and mastery of systems for quantification, measurement and calculation, is a practice-driven competence rather than abstract academic knowledge of "mathematics." Proficiency in numeracy varies with people's backgrounds and experience.	Adelswärd and Sachs, 1996
Numeracy	The knowledge and skills required to effectively manage and respond to the mathematical demands of diverse situations. These tasks cover a wide range of mathematical skills and include applying number sense, estimation skills, measurement and statistical literacy to real-life tasks.	Tamassia, Lennon, Yamamoto, and Kirsch, 2007
Financial literacy	The ability to read, analyze, manage and communicate about the personal financial conditions that affect material wellbeing.	Courchane, Gailey, and Zorn, 2008; Kim, 2008; Nicolini, Cude, and Chatterjee, 2013
Financial literacy	Financial literacy refers to a person's ability to understand and make use of financial concepts.	Kaestner and Servon, 2008
Financial literacy	The ability to interpret, communicate, compute, develop independent judgment, and take actions resulting from those processes in order to thrive in our complex financial world	Danes and Haberman, 2007
Financial literacy	Mathematical ability and understanding of financial terms.	Worthington, 2006
Financial knowledge	Financial knowledge is defined as understanding key financial terms and concepts needed to function daily in American society	Bowen, 2002
Consumer literacy	Consumer literacy, defined as self-assessed financial knowledge or objective knowledge.	Courchane et al., 2008
Financial literacy	Financial literacy is a measure of the degree to which one understands key financial concepts and possesses the ability and confidence to manage personal finances through appropriate short-term decision-making and sound, long-range financial planning, while mindful of life events and changing economic conditions.	Remund, 2010
Financial literacy	Financial literacy is a measure of the degree to which one understands key financial concepts and possesses the ability and confidence to manage personal finances through appropriate short- term decision-making and sound, long-range financial planning, while mindful of life events and changing economic conditions.	INFE, 2011; OECD, 2012

confidence in one's numeric abilities). Objective measures assess a number of skills related to, e. g., arithmetical operations, metric conversion, probability estimation, and inference of quantitative data. Subjective measures were adopted as an alternative, less demanding way to measure level of numeracy by surveying individuals' perceptions of their numerical competence (Fagerlin, Zikmund-Fisher, Ubel, Jankovic, Derry, and Smith, 2007). From the viewpoint of financial perspective, numerical competence is needed to understand and weight the risks and potential gains of different options, while document literacy is required to find and interpret the decision-relevant information. For instance, whether it is an advertising proclaiming that the card offers the 29.99% APR, a mutual fund prospectus reporting a growth of 2%, or a news outlet reporting 4.73% daily surge in the The Dow Jones Industrial Average index, consumers cannot avoid dealing with numbers and their representations in order to make informed financial choices. To examine the skills of numeracy and document literacy, consumer finance researchers have defined a new construct called financial literacy, which has attracted substantial attention in the last decade.

Financial literacy and financial knowledge

Both financial literacy and financial knowledge are often used interchangeably, as they both refer to human capital. However, recent work in financial literacy emphasizes the conceptual differences between the two definitions. Financial literacy, frequently defined as the ability of people to make financial decisions in their own best short- and long-term interests, reaches beyond individual quantitative skills and knowledge of financial skills. In fact, it actually has two dimensions, which refer to understanding (i) personal finance concepts and (ii) their application, as illustrated in Figure 1 (Huston, 2010). In the last decade financial literacy has received a lot of atteniton from academic researchers and policy makers world wide(Nicolini et al., 2013). Most researchers agree that financial literacy mirrors one's capability to search for and comprehend relevant information in financial communications. Despite that, there is a lot of disagreement between scholars and policy makers about the possible ways to address the issue of low financial literacy and its consequences. There is an ongoing debate whether mandatory financial education is a viable solution, particularly, since it has been shown to have diminished benefits in the long run. As an alternative to the latter solution, other researchers suggest stricter regulation of financial products and services available to retail consumers. In this context, we aim at tackling a small subset of this grand issue: effects of financial communication in print. Earlier research on financial advertising have placed much interest in investors' impression management and general effectiveness of advertising strategies (Laskey, Seaton, and Nicholls, 1992). Some have examined the content of such adds (Eliaz and Spiegler, 2011; Lawson, Borgman, and Brotherton, 2007), focusing on disclosure effects (White, 2013). Literature exploring discourse of communicative-cognitive dimension of financial advertising is, on the other hand, has seen limited attention.

Figure 1. Concepts of Financial Literacy and Financial Knowledge (Huston, 2010)
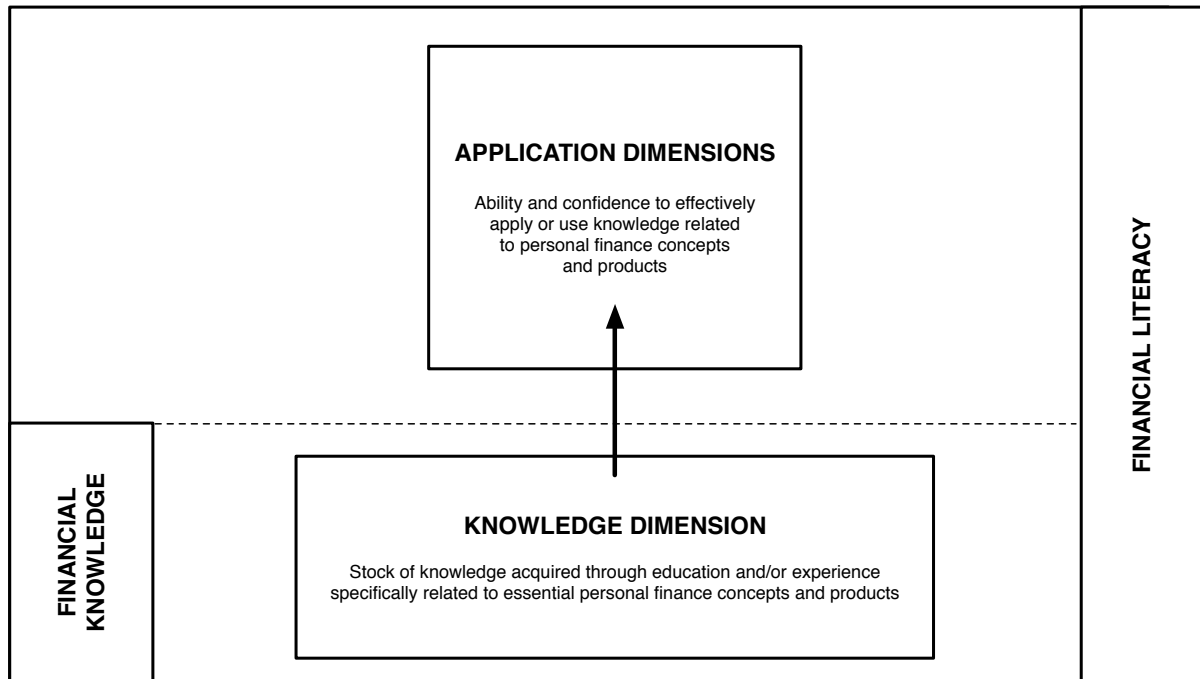
2.2. Advertising content and cognitive biases

It is known that people often see themselves as "active and purposeful decision makers", while studies in managerial cognition argue that in most cases they may be prone toward using relatively effortless information processing (Kuvaas and Selart, 2004). In his review, Grantier (2007) states that "reflection requires an exertion of energy. Like the use of a muscle, it is actually tiring." The brain is hardwired to favor "short-term gratification" which leads to "quick and easy" decisions: thus, humans are subject to biases. For instance, cognitive psychology research suggests that people judge fluent stimuli more favorably than nearly equivalent information that is harder to process. Green and Jame (2013) report that closed-end funds with short, easy to pronounce names were trading at smaller discounts and fluently named mutual funds profited from greater fund flows. Montier (2005) discusses "seven sins" of money management, some of which can easily be applied to ordinary investors as well. For instance, a couple of Montier's sins will be explored in our study, namely, the facts that (i) investors prefer more information, which in most cases does not "lead to better decisions, just overconfidence," and (ii) they are often influenced by wishful thinking, enhancing stories "to suit their own biases, while ignoring the boring facts". The present study explores these biases by means of visual framing.

Although most studies employ identical prospects, framed in terms of gains and losses, one of the conditions of this study focuses only on effects of gain framing by use of graphical representations. The concept of "framing" dates back to the works of Tversky and Kahneman (1981), which define decision frame as "decision-maker's conception of the acts, outcomes, and contingencies"

corresponding to a particular choice. The present study takes advantage of the framing aspect that can be controlled by the formulation of the problem, since the other side of framing is highly influenced by the norms, habits, and personal characteristics of the decision-maker. According to Tversky and Kahneman (1981), the alternative frames for a decision problem are analogous to alternative perspectives on a visual scene. In our experiment, for instance, we apply alternative visual formulations of investment communication materials. Similarly, according to Entman (1993, 2004), framing is the process of selecting "a few elements of perceived reality" and putting together "a narrative" that underlines connections among them to advocate a particular evaluation and acts to shape target audience's impressions, interpretations and preferences through priming. In other words, the salience or apparent importance of certain features can be made more salient by frames, activating schemas of target individuals that are assisted to think, feel, and decide in a particular manner. We strive to explore to which extent, by including various visual aids, promotional materials of financial products can appear more appealing and convincing to the readers.

The present research also relies on the theory of accessibility, proposed by Higgins (1996), which is based on the availability heuristic (Kahneman, Slovic, and Tversky, 1982; Tversky and Kahneman, 1973). The basic idea of this theory is that distinctive, unique, and vivid concepts influence human judgment disproportionately. An application of these ideas can be shown through use of vivid pictures in investment communication materials, as it is common practice among financial service providers and marketers. In view of the work of Schneider and Shiffrin (1977) this phenomenon is explained through the way by which the information is processed in the brain, distinguishing between involuntary and voluntary attention. In the context of psychology of choice connecting the above concepts and framing we also refer to Tversky and Kahneman (1981): "Individuals who face a decision problem and have a definite preference (i) might have a different preference in a different framing of the same problem, (ii) are normally unaware of alternative frames and of their potential effects on the relative attractiveness of options, (iii) would wish their preferences to be independent of frame, but (iv) are often uncertain how to resolve detected inconsistencies."

In the same line of thought, while designing the stimuli for our study we drew on the work of Abraham and Appiah (2006) and the concept of implicit visual propositioning, stating "that both linguistic and visual resources" are of use for sense making in "multimodal messages." It means that text can be enhanced by the use of visual aids. A similar idea is at the basis of Gibson and Zillman's (2000) study on news and media framing and priming: "it might be expected that impressions from text and images merge" changing the perception on the main message conveyed by the news. Interpretation and judgment of issues can be profoundly affected by reactions to featured photographs that tend to suggest an alternative or even contradicting meaning to the primarily text-based information and, thus, lead to altered perceptions (Gibson and Zillman, 2000).

Research has shown that the opposite can also be true: textual descriptions may transform the memory of accompanying images (Gentner and Loftus, 1979). The concept of implicit visual propositioning of Abraham and Appiah (2006) relies on "cognitive theories on how verbal and visual resources are cognitively processed in multiple modalities of presentation". Two competing theories provide insights into memory processes in multimodal presentations: "the dual-code theory" and "the single-code theory." The dual-code theory presumes differentiated encoding of visual and verbal cues and proposes that images are memorized in a qualitatively different and separate way from verbal materials. This theory suggests that "visual and verbal information are cognitively represented in different subsystems". In spite of that, there is a close connection between the two subsystems so that information can be transferred and integrated easily to attain their cognitive effect. To explain the picture superiority effect, the authors rely on the "cue summation", which refers to when textual information is displayed along with visuals, and where the visuals serve as supplementary "learning cues", particularly at the moments of retrieving from the memory. (In depth discussion of the subject is covered by Paivio (1971) and Severin (1967).) Concerning the single-code theory, it implies an undifferentiated encoding of the two modalities. Basically it means that "semantically related information, which is presented partially in the pictorial modality and partially in the verbal modality, should be integrated in memory" (Pezdek, 1977). Actually, Grimes (1990) and Pezdek (1977) show that textual information (words) and pictorials (images) eventually merge into a single memory. Thus, in the present study, a synergy effect is obtained by combining textual and visual information in prospectuses, because, as Abraham and Appiah (2006) showed, it may supplement cognitive processing of the presented information and may lead to "potential merger or interaction between the two channels to create meanings that go beyond information provided by each individual channel." For this reason, in our experiment the textual information presented is kept unchanged but visual cues and presentation format are altered for each of the four treatment groups across conditions. By considering the above mentioned notions, we explore the power of visual representation, both text-based and pictorial. In the next sections we introduce our general research questions guiding this study and provide an overview of the experimental implementation.

3. Implementation of Experiments

3.1. Predictions and hypotheses

We propose a framework derived from a set of testable propositions suggested by earlier research on visual representations and their implications for decision making (Nicholas and Mason, 2007). Figure 2 drafts this framework by suggesting that visual elements of advertising or other financial communications, including graphs and photographs, integrate to shape the decision-making frame, which, in turn, has consequential effects for financial decision-making processes and outcomes.

Having the research questions in mind, Figure 2 provides a simplified index of these processes and outcomes. User characteristics, such as expertise and prior knowledge in financial domain (economic education, financial literacy, and investment experience) as well as demographic variables are expected to moderate the impact of the decision-making frame on processes and outcomes.

Figure 2. Features of visual content in financial communications and potential implications for decision making
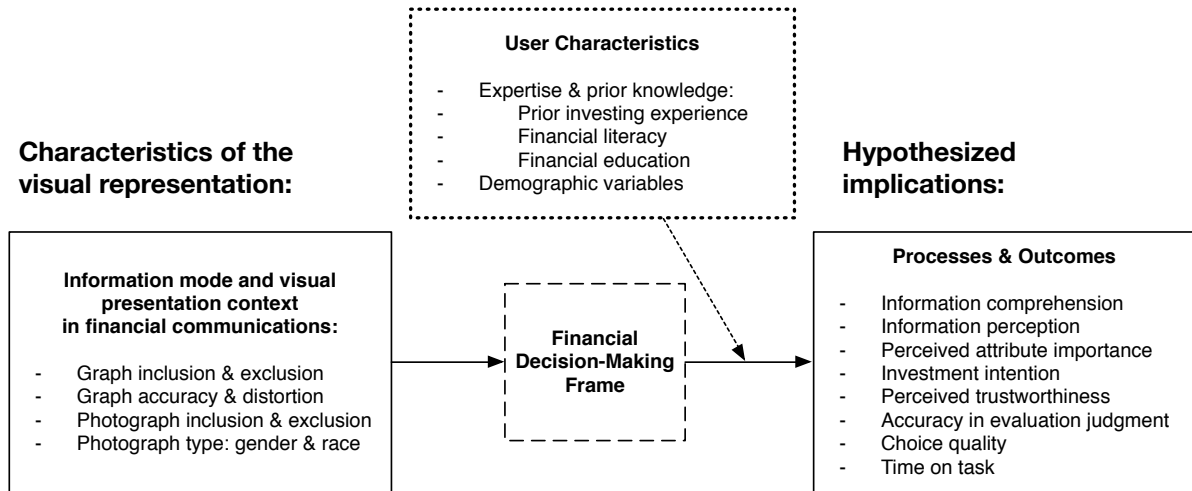
3.1.1. Experiment 1

The first experiment is aimed at examining to which extent visual representations of numeric data that include graphs as well as text-based information can change information perception and choices in response to modifications in attribute values that are depicted graphically. We expect participants to assign greater weight on the graphic information representation than on the text-based numeric information.

Primary hypotheses

H1: In a comparison task, scale distortion of comparable graphs will lead to lower accuracy in judgment.

H2: In a conceptual categorization task, graphs with a larger slope (due to alterations to the y-axis scale) will be categorized as showing a more significant data increase even if the text-based numeric data is kept constant.

The first two hypotheses, $H1$ and $H2$, test whether graphical representation of numeric information has any impact on the performance trend perception and the evaluation. If $H1$ or $H2$ are verified, we can confirm results obtained by Beattie and Jones (2002a) in traditional laboratory environment.

Potential moderators

The above hypotheses are formed to explore how decision makers use graphic and text-based information, together, in financial domain. This allows us to explore if graphically represented information can result in overlooking some important text-based information on which the graph is actually based. We anticipate that the above effects are likely to be contingent on factors such as expertise in financial domain (see Figure 2). Subjects' financial literacy or experience in investing are expected to moderate the effects of visual representation on financial information perception, evaluation, and subsequent choice. Participation in the stock market or similar investing experience is likely to act as a moderator for several reason. We hypothesize that the magnitude of the effect depends on users' financial knowledge of which visual elements are important in similar decision making tasks. It is plausible to expect that financially literate subjects are less subject to such visual framing effects and, therefore, more accurate in judgment and choice. Less literate subjects, on the other hand, may be unwilling to engage in the cognitive effort needed to process the numeric data, and thus use the graphic data to faster identify the trends, leading to less accurate assessments of differences. Therefore, the following two hypotheses, $H3$ and $H4$, are formed to test whether susceptibility to graph manipulation and framing effects depends on the participant's financial literacy level and/or the participation in the stock market. If $H3$ is supported by results, we can conclude that there is a positive relationship between an individual's financial literacy and the ability to identify which visual representation elements are important and, thus, use these elements to make effective evaluations. If $H4$ is supported, we can induce that the participants of the stock market are also less prone to biases that could be induced by visualization tools.

Secondary hypotheses

> **H3:** Financially literate subjects will be less likely affected by graph distortion and be more accurate in the selection task.

> **H4:** Subjects with investing experience will be less likely affected by graph distortion and make more accurate assessments of differences between values.

These hypotheses are tested with a single experiment composed of four parts: (i) comparison and selection task of manipulated graphs, (ii) evaluation and categorization task of manipulated graphs, (iii) assessment of financial literacy using Lusardi's scale (Van Rooij, Lusardi, and Alessie, 2007), and (iv) assessment of the individual participation in the stock market. The first and the second parts of the experiment assess the predictions made in $H1$ and $H2$ regarding framing influence on perception and evaluation of graphically presented quantitative information. Both the first and second parts of experiment are used to test the predictions of the last two hypotheses, $H3$ and $H4$, regarding the interactions between financial literacy, stock market participation and responsiveness to visual representations.

3.1.2. Experiment 2

The second experiment takes a further step to investigate whether adding an illustrative graph or a neutral face image or both to the text-based information may impact perception and evaluation of an advertised financial product. Use of well controlled close-up photographs of subjects representing both genders and four major racial groups as visual primes is expected to reduce physiological distance as well as convey trustworthiness, an essential ingredient in financial communication. Finally, we investigate whether financial literacy is likely to act as a moderator in defining individual responsiveness to visual content effects. The four primary hypothesis of the second experiment are listed below.

Primary hypotheses

H1: Decision makers who are presented an advertisement that includes graphic as well as text-based information will report significantly different comprehension, perception, and evaluation of the investment offer than those to whom only text-based presentations of the same information are shown.

H2: Inclusion of a face photograph into an investment ad will act as a salient cue and have a significant effect on perception and/or evaluation of the advertised investment. In other words, decision makers presented with the advertisement that contains a face photo are likely to place weight on this non-informative cue and to change their choices in response to changes in gender, race, and emotion of the face.

The first two hypotheses, $H1$ and $H2$, test whether primes and frames have any impact on risk perception and evaluation. If $H1$ or $H2$ are confirmed by data, there is evidence of the framing and possibly priming effect. Therefore, the following two hypotheses, $H3$ and $H4$, are formed to test whether susceptibility to visual representation effect is contingent on the level of financial literacy of a participant.

Secondary hypotheses

H3: Across the four treatment groups, decision makers with below average financial literacy score will place more weight on the most salient visual representations, and are more likely to report different comprehension and change their evaluations of the investment information in response to changes in attribute values that are highlighted by the visually salient features.

H4: Across the four treatment groups decision makers with no investment experience will place more weight on the most salient visual representations and are more likely to change their evaluations of the investment information in response to changes in attribute values that are highlighted by the visually salient features.

These hypotheses are tested with a single experiment composed of two parts: the tasks testing for visual content effects and the assessment of financial literacy of participants using Lusardi's scale (Van Rooij, Lusardi, and Alessie, 2007), which is used to measure basic and advanced financial skills of respondents. The first part of the experiment assesses the predictions made in $H1$ and $H2$ regarding visual representation influence on perception and evaluation of financial information. Both the first and the second parts of experiment are used to test the predictions of the last two hypotheses regarding the interactions between financial literacy, investment knowledge, and ability to objectively evaluate financial information despite of variations in the visual content.

3.2. Overview of sample frame characteristics

In the following sections, implementation of both experiments is discussed in detail. The concise methodology of *Experiment 1* is presented first, whereas *Experiment 2* is discussed next; the latter is more complex and covers most of the issues relevant to both experiments.

We employ Amazon Mechanical Turk (AMT) platform to recruit online subjects to participate in both experiments. We resort to "crowdsourcing", a relatively new phenomenon, in which online workers get paid upon completion of relatively small tasks (Fort, Adda, and Cohen, 2011; Khasraghi and Mohammadi, 2012; Mason and Suri, 2012; Yu, Willis, Sun, and Wang, 2013). Growing popularity of this tool among behavioral researchers can be attributed to its scalability, speed, and low-cost means of carrying out user studies across the globe (Crump, McDonnell, and Gureckis, 2013; Ipeirotis, 2010). In addition, both of our experiments benefit from a greatly increased and diversified subject pool as compared to prior studies that entirely focused on university student populations (Johnson and Borden, 2012; Saunders, Bex, and Woods, 2013; Sprouse, 2011). In this context we note that a recent survey of the psychology and behavioral economics literature finds that American students are "outliers, quite atypical of the world population"; therefore, general "conclusions based on such a narrow and non-representative sample of the population" could be questionable (Henrich, Heine, and Norenzayan, 2010). Additionally, prior successful replication of the framing principle on AMT (Paolacci, Chandler, and Ipeirotis, 2010) has demonstrated that the principle of priming can be studied with AMT platform (Heer and Bostock, 2010; Horton, Rand, and Zeckhauser, 2010), supporting our choice of using AMT as a mean for subject recruitment. In addition to what mentioned above, Paolacci, Chandler, and Ipeirotis (2010) point out that AMT, as an online experimental tool, offers other practical advantages such as (i) supportive infrastructure with an easy payment process, (ii) participant anonymity, (iii) participant identifiability preventing subject pool contamination and allowing prescreening (pre-qualification) prior to completing a HIT (Human Intelligence Task), (iv) the design, language and content of each HIT posting can be exclusively "tailored" to the specific subject population. Furthermore, individual's lack of knowledge about participating in an experiment is expected to eliminate "experimenter effects" in which the

participants try "to produce the effect they believe the experimenters expect" (Horton, Rand, and Zeckhauser, 2010).

Most importantly, we expect our study to benefit from AMT by its culturally diverse user base allowing for comparisons between culturally diverse samples of both high- and low-financial literacy individuals from different parts of the world. The hypothesis concerning moderating effects of investing experience is also made possible due to the fact that online investors are well represented among AMT workers.

3.3. Overview of experimental apparatus

For both experiments we employ an online research tool, Qualtrics.com[1], which allows us to create a visually interesting, interactive, and realistically looking user interface. In each case, we follow analogical procedure for developing our experiment into an online survey using Qualtrics.com research suite. The suite provides advanced capabilities and logics appropriate for our experimental design and allows us to present specific treatments to the respondent as well as to measure the effects. Qualtrics software enables us to structure the question flow, experimental logics, and randomization. We also set the sample size quotas required for appropriate analyses. The integrated panel management functionality of this tool allows us to track, profile, and monitor responses (and the time associated with them) while they are collected. To achieve the desired level of randomization, we create several *question blocks* (a cohesive group of questions that receive similar treatment) and *branch logic* (a set of filters based on specific information) corresponding to the flow of the experimental design. We use partial randomization to keep the order of some blocks and questions fixed (e.g. demographic questionnaire, etc.), while randomizing the order of other questions and blocks (the kind of visual stimuli presented to the respondent).

4. Experiment 1: *Graphic Represenation*

4.1. Method

4.1.1. Participants

By using the AMT platform, we recruited 200 online subjects to participate in the experiment (the mean age was 31; 104 females and 96 males; 37.5% indians, 43% US residents, 11% European, 8.5% residents of other countries; 41.5% of the respondents had previous investing experience). For detailed summary, please refer to Table 2.

4.1.2. Design

Responses were collected using Qualtrics software and careful screened for timing and proper replies to the control questions. Each AMT worker was paid 0.10 US \$ for a successfully completed

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[1]Qualtrics, a highly sophisticated survey technology provider; see http://www.qualtrics.com/.

Table 2. *Experiment 1:* Sample summary

SAMPLE RESPONDENTS	TOTAL COUNT	PROPORTION *(in %)*	COMMENTS & NOTES
Observations	200		*Number reflects the properly completed surveys.**
Female:	104	52 %	
Male:	96	48 %	
Education			
High school	26	13 %	
Some college	52	26 %	
4-year degree	78	39 %	
Masters degree	38	19 %	
Ph.D. degree	4	2 %	
Professional degree	2	1 %	
Age (mean = 31)			*Minimum 16 years, maximum 70 years.*
16-25 years	62	31 %	
25-34 years	86	43 %	
35-70 years	52	26 %	
Residence			
India	75	37.5 %	
United States	86	43 %	
Europe Union	22	11 %	
Canada	2	1 %	
Africa	2	1 %	
Other	11	5.5 %	
Employment			
Full time	68	34 %	
Part time	35	17.5 %	
Unemployed	41	20.5 %	
Students	32	16 %	
Homemakers	15	7.5 %	
Retired	5	2.5 %	
Disabled	4	2 %	
Investing experience			
Investors (all)	83	41.5 %	
Female investors	35	17.5 %	
Male investors	48	24.0 %	
Non-investors	117	58.5 %	

Population: *Amazon Mechanical Turk workers. Data were collected within 36 hours, on April 17-18, 2010.*

*Sample: *We filtered out the responses by participants who failed to answer correctly to the control questions.*

survey. The data were collected within 36 hours.

4.1.3. Materials

4.1.3.1. Experimental stimuli (graph design)

The experimental stimuli were designed to reflect those commonly found in corporate reports: they consisted of dark-grey colored five-year time series column graphs. Each graph had a numeric value printed in bold and attached to the column. Graphs did not have the *y*-axis. We constructed a set of 11 situations containing time series graphs to reflect a change in independent variables (*scale parameter* and *overall data increase*). The sample of stimuli used in the experiment are shown in Appendix A: *Experiment 1:* materials and methods extended, page 45.

4.1.3.2. Procedure

At the beginning of the experiment, subjects are informed that the purpose of the experiment is to examine how people perceive financial information. The experiment consists of two parts. Both parts of the experiment are conducted simultaneously. The order of questions and the choices are sophistically randomized to remove order effects and to allow for an in-between subject study.

The first part of the experiment consists of two types of tasks. The first set of tasks refers to *comparison* and *selection* of the company based on past-performance indicators. To answer the question *"Which company performed better over the last 5 years?*, participants are asked to make their choice. The second set of tasks requires participants to observe the past performance of one company and categorize according to the following options: *"Net profits (i) sharply increased, (ii) increased, (iii) slightly increased, (iv) did not increase.* The second part of the experiment is meant to assess the financial literacy scale of participants. Each of the respondents are asked to respond to five basic and eight advanced questions from Lusardi's financial literacy scale questionnaire (please see Appendix A-3: Basic financial literacy scale on page 46). The proportion of correct answers reflects the financial literacy level of an individual.

4.1.4. Empirical Strategy

In this study, we used parametric statistics. A set of measures collected for the analysis are based on semantic differential ratings scales. Such data can be considered as interval-level data or merely as ordered-categorical (Norman, 2010). Choice of one method over the other could be the subject of debate, particularly, since in our experimental design we use semantic words of response levels to indicate a symmetry of response levels. Additionally, by use of a visual analog scale to indicate equal spacing of response levels (provided by Qualtrics research suite) we further supports our choice of treating this data as interval-level. In this way we preserve some important information that would be otherwise lost in case of nonparametrics methods. Full application of nonparametric statistics, which should improve the analysis further (Göb, McCollin, and Ramalhoto, 2007; Norman, 2010;

Reips and Funke, 2008), however, will have to be included in future phases and developments of our investigation and associated analyses. In this connection, however, it is worth mentioning that we already tested, on a preliminary basis, the possible effects of nonparametric analysis and found that although this procedure leads, not unexpectedly, to some differences, the main conclusions of our study are not affected. Full comparison between the two statistical approaches is expected to provide hints on the particularly salient outcomes of our study.

4.2. Results and discussion

    Task #1: *Comparison and selection*

Our findings support hypothesis $H1$ that visual data presentation may overpower text-based quantitative data and that distortion of comparable graphs can lead to lower accuracy in judgment. In the comparison and selection task, 4.17% of participants made at least one mistake when graphs were presented accurately, whereas 10.83% of participants confused which of the two past-performance trends were better when graphs scales were manipulated (the maximum of y value was different) (See Table 3). 68.50% of all participants were able to distinguish between accurate and manipulated data trends presented in pairs of graphs in all 8 situations, while 31.50% made at least one mistake in judgment.

Table 3. *Experiment 1:* distribution of accurate assessments based on firms' past-performance trends

N = 200	PERCENTAGE OF CORRECTLY EVALUATED PAIRS	
GRAPH PAIR	ACCURATE REPRESENTATION	DISTORTED REPRESENTATION
Pair 1	97.22 %	86.67 %
Pair 2	96.11 %	87.22 %
Pair 3	96.67 %	93.33 %
Pair 4	93.33 %	89.44 %
Average proportion correct	95.83 %	89.17 %
Average proportion incorrect	4.17 %	10.83 %

Please see Appendix A: Experiment 1: materials and methods extended on page 46 for illustration of a sample pair of graphs.

4.2.0.1. Effects of financial literacy and investment experience on accuracy

The secondary hypotheses $H3$ and $H4$ propose that experience in looking at financial data may moderate the graphical representation effects and lead to increased accuracy. Findings support hypothesis $H3$: subjects who scored 100% in basic financial literacy test, identified graphs correctly in 81.36% of cases, whereas, on average, people were able to identify graphs correctly only in 68.50% of cases. Surprisingly, our results disconfirm hypothesis $H4$: subjects who declared themselves as investors identified all the graphs correctly only in 69.88% of cases, which is slightly but insignificantly more than an average person (68.50%). These results suggest that individual investors participating

in the stock market and searching for prominent and immediate data can be easily harmed by improper visual representations of financial information.

Task #2: *Categorization*

Our results support hypothesis $H2$ that people have a tendency to perceive and evaluate the magnitude of the data increase depending on the slope inclination of the graph rather then text-based numbers accompanying the graphical representation. In a conceptual categorization task, graphs with larger slope (stretched vertically) were categorized as showing a more significant data increase by the majority of participants, even though the text-based numerical data was kept constant for both cases, as illustrated in Table 4. (For illustration of a sample pair of graphs used as stimuli, please see: Appendix A: *Experiment 1:* materials and methods extended).

Table 4. *Experiment 1:* distribution of responses in the past-performance trend categorization task

Categorization N=200	Small slope (E)	Medium slope (F)	Sharp slope (G)
Sharply increased	33.5 %	37.0 %	66.5 %
Moderately Increased	41.5 %	52.0 %	30.0 %
Slightly increased	23.0 %	10.5 %	2.0 %
Did not increased	2.0 %	0.5 %	1.5 %

See Apendix "C" for illustration of E, F, and G types of graphs.

Results of both parts of the experiment show that using improper graphical representations together with accurate text-base information can lead to lower accuracy in judgment. Results indicate that decision makers are prone to overweight the graphic representation and underweighting the text-based numeric representation of data. Managers have many incentives to use visuals to increase evaluability of particular data trends: however, as we have shown in this experiment, inaccurate graphic representations may shift investors' focus on attributes that are easier to compare rather than those that lead to more accurate evaluations. We note that our design did not include other possible mechanisms of visual representation, such as color choice, orientation of shapes, and selection of markers, which can be relevant factors influencing decision making processes and outcomes.

5. Experiment 2: *Advertising Content*

5.1. Method

In *Experiment 2*, we aim to identify key aspects of visual representations used in advertising financial products that are likely to influence the visual decoding process and shape financial choices. In particular, we focus on (i) the visual content salience, which concerns with the presence or absence of facial cues or graphic representations, and (ii) the information presentation format, which examines the effects of graphic vs. text-based presentation of quantitative data. These

two dimensions are not intended to be comprehensive but rather accentuate elements that are common to financial communication, and possibly to stimulate further research on this topic. To test our hypotheses, we employ randomly assigned variation in the advertisement's graphic content, which is then presented to the experimental subjects for evaluation. The ads used as stimuli in the experiment contained randomly assigned variations of two visual representation elements, such as presence or absence of photographs and graphs. The description of the visual elements and their characteristics is presented in Table 6. (For further details see Appendix B: *Experiment 2: materials and methods extended*, page 48).

5.1.1. Participants

We recruit 897 online subjects to participate in the experiment (404 females and 493 males), as shown in Table 5. We use only 741 observations out of the total sample, i.e., those that passed minimum qualification requirement (358 females and 383 males). Overall, the participants ranged in age from 18 to 71, with a mean age of 31.2 and a standard deviation of 10.27. All participants were recruited using Amazon Mechanical Turk platform. Participants were allocated to conditions randomly.

Table 5. Experiment 2: *Sample summary*

	Total	GENDER		TREATMENTS			
	Total	*Male*	*Female*	*T1*	*T2*	*T3*	*T4*
Observations							
Before screening	897	493	404	225	220	215	237
After screening	741	383	358	193	179	176	193
Average age	31.11	29.76	32.56	32.16	30.39	30.6	31.21
Standard deviation	(10.27)	(9.05)	(11.27)	(11.14)	(9.8)	(9.92)	(10.09)
Gender							
Male	383	383	0	101	83	97	102
Female	358	0	358	92	96	79	91
Ethnic background							
African Descent / Black	26	10	16	8	7	2	9
S. Asian & Indian	239	156	83	64	49	59	67
Asian (Other)	107	58	49	26	29	23	29
Caucasian / White	330	139	191	89	81	84	76
Hispanic / Latin American	19	11	8	3	7	4	5
Middle Eastern	4	2	2	0	1	0	3
Native American	4	2	2	1	1	0	2
Pacific Islander	2	0	2	0	0	1	1
Mixed ethnicity	5	3	2	2	2	1	0

Population: *Amazon Mechanical Turk workers. Data was collected on Qualtrics.com.*

5.1.2. Design

We use factorial design because it permits to combine two completely randomized designs into a single experiment. This type of design enables us to study possible interactions among the variables of interest: *non-informative visual content* (at three levels - no photograph, female model, male model) and *visual representation of information* (at two levels -text-based information

without a graph and text-based information with a graph). The scheme of the design is shown in Appendix B: *Experiment 2*: materials and methods extended. We randomize the presentation of each combination and the order among the various respondents (each receiving four ads). The factorial experiment allows us to test for all main effects (i.e., non-informative visual content, visual representation of information), and for the interaction of the variables as well. There are 8 (4×2) treatment groups consisting of approximately 90 subjects each. In the first round the participants are distributed randomly and assigned to one of the four treatment groups that start the survey with the initial evaluation of a specific ad design: (i) plain text; (ii) text and a graph; (iii) text and a photograph; (iv) text and both a graph and a photograph. Table 6 summarizes the distribution of the different conditions.

Table 6. Experimental Summary (*Experiment 2*)

VISUAL FRAMING FEATURE	TREATMENT DESCRIPTION	FRE-QUENCY	HYPOTHESIZED EFFECTS
Feature 1: Photo			
	No photo	0.50	
	Photo	0.50	Close-ups altering subjective perceptions of physical proximity may reduce perception of psychological distance. Presence of facial features might engage decision makers in more compensatory processing than in cases where faces are not present.
	Gender		Matching gender increases due to affinity, similarity.
	Female photo	0.25	Female increases evaluations due to affective response.
	Male photo	0.25	Male increases perceived trustworthiness due to stereotyping.
	Ethnicity (race):		Matching race increases due to affinity, similarity.
	Asian photo	0.125	
	Black photo	0.125	
	Indian photo	0.125	
	White photo	0.125	
Feature 2: Graph			
	No graph	0.50	
	Graph	0.50	Graph increases evaluation, as it facilitates information processing or it may also increase salience of an investment option.
	Graph only	0.25	
	Graph with photo	0.25	Combination of graph and photograph can increase an individual's willingness to make riskier investments.

5.1.3. Materials

5.1.3.1. Experimental stimuli (ad design)

Visual stimuli were presented as examples of investment information that people are confronted with daily. Subjects were shown a stereotypical investment brochure-like communication on their computer screen and asked to make their judgments about it. Visual representation manipulations were introduced through inclusion of one or more visual elements, such as a graph or a photograph or both, to accompany the text-based information of the investment product. (For variations of

an advertising design, used as a stimulus, please see Appendix B: *Experiment 2*: materials and methods extended).

All four treatment groups are supplied with an identical text-based information formatted using the same font and color, whereas the other visual elements such as graphs and photographs are different for each treatment group. The uniform use of text-based information is important because information framing or presentational format may "subtly but dramatically" alter investor's perspective shaping "their preference for one object over another that may be objectively equivalent" (Olazábal and Marmorstein, 2010). We use simple terms to reduce unwanted textual framing effects, which are well documented in behavioral studies.

As it is known from the channel factors theory in psychology, putting information into simpler terms and more accessible format increases people's willingness to accept the offer. For instance, a simplified communication of structured products attracts more "first-time buyers than in the case of traditional communication" (Dubeli and Vanini, 2010). Or preference for simplified text accounts also for gender differences, because in investing behavior gender differences vanish when structured products are explained in an easy-to-understand language (Schubert, Brown, Gysler, and Brachinger, 1999). Research on investors' decision making has also shown that advertisements with emphasis on certain goals can affect preferences for riskier investments. For instance, including numerical examples that illustrate possible investment returns can be highly deceptive. Therefore, in the present study, we only focus on visual content and visual representation of information.

Use of faces as visual stimuli

As mentioned previously, the choice of using visual elements for the experiment is based on the evidence that visual information elicits priority processing in the brain. Other research shows that emotional stimuli, such as facial expressions, can also elicit priority cognitive processing (Steffen, Rockstroh, and Jansma, 2009). Neuropsychological and cognitive research has shown that faces serve as a unique kind of stimulus for perception (Calvo, Nummenmaa, and Avero, 2008; Dekowska, Kuniecki, and Jaśkowski, 2008; Todorov, Gobbini, Evans, and Haxby, 2007). Indeed, a face is the most salient source for emotional processing, since the information from people's emotional facial expressions is evaluated instantaneously (Dotsch and Todorov, 2011a,b; Eastwood, Smilek, and Merikle, 2003; Gallese, Keysers, and Rizzolatti, 2004). The information conveyed through faces, especially through emotional expressions, serves an important adaptive purpose for social interaction (Bonnefon, Hopfensitz, and De Neys, 2013; Jackson, Wu, Linden, and Raymond, 2009; Stins, Roelofs, Villan, Kooijman, Hagenaars, and Beek, 2011). Even if not watched directly, the gaze direction and emotion of the presented faces is encoded by the visual system of the observers (e.g., Adams, Gray, Garner, and Graf, 2010; Bayliss, Frischen, Fenske, and Tipper, 2007; Doi, Tagawa, and Shinohara, 2010; Kouider, Berthet, and Faivre, 2011; Slessor, Phillips, and Bull, 2010). Such coding occurs very rapidly as all facial features are simultaneously analyzed to identify

the emotion, form impressions (N., 2010), and recognize familiar faces (Peterson, Abbey, and Eckstein, 2009). For instance, Haberman and Whitney (2009) showed that instead of remembering separate attributes of high-level objects like faces, the visual system favors a summary statistical representation, the so-called "ensemble coding." From expressional signals on a face, observers can uncover "the motivational state and intentions" of the face owner, and, therefore, adjust their own behavior (Neta and Whalen, 2010). Moreover, emotional expressions, not being fully under control by an individual, "make emotional states transparent in the way that thoughts and beliefs can never be" (Etcoff and Magee, 1992). Earlier experimental research suggests that feature resemblance can elicit the transference effect (Kraus and Chen, 2010), bias toward outgroup categorization (Miller, Maner, and Becker, 2010), and that perception of faces varies with gender (Palermo and Coltheart, 2004) and age (e.g., Isaacowitz, Löckenhoff, Lane, Wright, Sechrest, Riedel, and Costa, 2007; Keightley, Winocur, Burianova, Hongwanishkul, and Grady, 2006; Mienaltowski, Corballis, Blanchard-Fields, Parks, and Hilimire, 2011; Mill, Allik, Realo, and Valk, 2009; Murray, Halberstadt, and Ruffman, 2010; Phillips and Allen, 2004; Werheid, Gruno, Kathmann, Fischer, Almkvist, and Winblad, 2010). Additionally, emotional stimuli can highly influence a variety of cognitive processes, such as risk perception or investment-related decision making (e.g., Bradley, Mogg, and Millar, 2000; Fox, Lester, Russo, Bowles, Pichler, and Dutton, 2000). In some cases fast, unreflective facial trait inferences can influence decisions, such as voting, which require serious rational and deliberate consideration (Horiuchi, Komatsu, and Nakaya, 2012; Todorov, Mandisodza, Goren, and Hall, 2005).

Considering post-recessional sentiments and suppressed enthusiasm of investors and resorting to marketing research, we restrain from including happy faces in our experiment. Puccinelli (2006) argues that the preconception that smiling sales personnel can increase customers' satisfaction is simply "an oversimplification". The author presents evidence that in some cases customers "in a bad mood" do not appreciate salespersons conveying positive feelings (Puccinelli, 2006). It is also known that individual's decisions to buy a product are often influenced by their reaction to the person who sells or promotes it (Grimsley, 1998). We selected faces conveying trust, honesty, and confidence. In marketing research, trust is defined as "confidence that advertising is a reliable source of product/service information" and intention "to act on the basis of information conveyed by advertising" (Soh, Reid, and King, 2009). The authors list seven factors of trust that have been most frequently identified by scholars: integrity, reliability, benevolence, competence, confidence, likeability, and willingness to rely on. For this reason, we choose to include photographs of attractive models conveying self-confidence, compassion, and trustworthiness. Some scholars argue that in almost all circumstances attractive people obtain more favorable results than unattractive people and that "person attributes that are important for specific decisions are inferred from facial appearance" (Willis and Todorov, 2006). Finally, as we have already mentioned, face perception does not depend

on the level of expertise in processing faces, as this ability is quite similar across observers (Smith, Gosselin, and Schyns, 2004). This validates use of faces in the experiment involving such a diverse subject pool.

Across the experiment design, portrayed faces are chosen to vary in terms of race and gender to eliminate related biases (DeBruine, Jones, Smith, and Little, 2010; Seidel, Habel, Kirschner, Gur, and Derntl, 2010). We use close-ups of sixteen different models specifically chosen and photographed for this experiment to represent four selected racial groups: white, asian, indian, and black, and both genders. Also, as mentioned earlier, the faces are chosen to resemble the prototypes of the demographical categories of major groups of participants since "that categorical perception occurs in identification of familiar faces" (Kikutani, Roberson, and Hanley, 2010).

5.1.3.2. Procedure

The experiment is carried out according to the following steps: (i) recruit AMT adult users (also called "m-turkers"); (ii) using Qualtrics survey software randomly distribute participants into four treatment groups; (iii) familiarize them with conditions and general purpose of the survey; (iv) administer a set of questions related to a hypothetic advertisement of a financial product presented to respondents; (v) survey demographics; (vi) survey stock market participation, risk aversion, basic and advanced financial literacy, self assessed economic knowledge; (vii) upon completion of survey, assign a unique identification code to each participant and process agreed payment ($ US 0.30).

In the introduction of the experiment questionnaire, the AMT qualified participants are informed that they will be presented four simple investment opportunities and asked to express their opinion about them based on the information provided (For instructions, please see 53, for complete design of the questionnaire, see Appendix B-4: Questionnaire). Afterwards, subjects are also asked to answer a few questions indicating their level of risk-aversion, financial literacy, economic knowledge, and stock participation (For Lusardi's financial literacy scale questions please see Appendix B-5: Basic financial literacy scale and Appendix B-6: Advanced financial literacy scale). Upon submission of the complete set of answers, subjects are thanked for participation, and provided a brief summary of a purpose of this survey.

5.1.4. Measures

There are three treatment groups and one control group (note, that in the text we refer to them as four treatment groups, interchangeably). The three treatment groups are given information that is accompanied by *a graph*, *a photograph* or *both*, and a control group is provided only with *text-based* information; therefore, the treatment is just a visual variation in advertisement content (see Table 6). Dependent variables measure respondents' comprehension and evaluation of the information and range on a scale from 1 to 7 (Likert scale). We expect that the set of perception items varies systematically with visual content. Due to the ordinal nature of the data, differences

in respondents' perception and evaluation of information are analyzed using nonparametric tests.

5.1.4.1. Financial literacy scale

Lusardi's *Financial literacy scale* is used to assess both basic and advanced financial literacy of participants (Van Rooij, Lusardi, and Alessie, 2007). Table 7 presents summary statistics of financial literacy scores and investment experience of respondents.

Table 7. Experiment 2: *Measuring financial literacy and economic knowledge of participants*

	Total	GENDER		TREATMENTS			
		Male	Female	T1	T2	T3	T4
Number of Observations	741	383	358	193	179	176	193
AVERAGE FINANCIAL LITERACY scores (proportion correct answers)							
Basic Financial Literacy							
Mean score	67.37%	68.98%	65.64%	68.91%	65.81%	65.91%	68.6%
Standard Deviation	(27.59%)	(28.92%)	(26.03%)	(26.6%)	(29.33%)	(27.9%)	(26.67%)
Advanced Financial Literacy							
Mean score	57.15%	59.27%	54.89%	57.51%	58.38%	56.04%	56.67%
Standard Deviation	(28.35%)	(28.63%)	(27.91%)	(28.27%)	(28.96%)	(26.69%)	(29.45%)
Total Financial Literacy							
Mean score	61.08%	63%	59.02%	61.9%	61.24%	59.83%	61.26%
Standard deviation	(24.66%)	(25.4%)	(23.71%)	(23.75%)	(25.57%)	(24.05%)	(25.38%)
INVESTING EXPERIENCE							
Investors	323	184	139	84	86	70	83
Account owners	226	151	75	58	61	50	57
EDUCATION & ECONOMIC KNOWLEDGE (self-reported measures)							
Education (at least 4-year degree)	557	303	254	142	140	136	139
Economic Education							
Mean score	44.15%	46.48%	41.66%	44.49%	44.13%	43.43%	44.49%
Standard deviation	(15.8%)	(15.13%)	(16.14%)	(15.75%)	(16.95%)	(15.15%)	(15.41%)
Economic Knowledge							
Mean score	47.87%	49.31%	46.33%	46.85%	49.16%	47.48%	48.04%
Standard deviation	(11.42%)	(11.62%)	(11%)	(11.8%)	(11.44%)	(11.04%)	(11.32%)

Financial literacy score is a proportion of correct answers to the scale items (questions).
Economic knowledge was measured on the 7-point scale, then transformed into percentages.

5.1.5. Empirical strategy

First, we test the predictions made in $H1$ and $H2$ regarding visual content effects on perception and evaluation of an investment opportunity. Financial literacy and investment knowledge assessment is used to build groups of financially literate and non-literate participants (for a summary, see Table 7) and test the predictions of $H3$ and $H4$ regarding interactions between financial literacy, participation in stock market, risk perception, and responsiveness to visual representations. Secondary hypotheses are designed to test the significance of moderating demographic variables such as cultural background, gender, ethnicity, and age.

5.1.5.1. Treatment differences

We analyze and present the results of our study from two perspectives. First, we analyze subjects' perceptions under different treatment conditions. Then, we test if financial literacy or investment experience moderate the effects of advertisement content. The pairwise Wilcoxon tests show how each of the perception dimensions (medians values) vary with visual content of investment information, providing further insights into how financial information is perceived by respondents of different demographic groups, as well as with different levels of financial literacy. The presentation and discussion of the initial results closely follow the four primary hypothesis discussed in Section 3.1.

5.2. Results and discussion

The results of *Experiment 2* are summarized in *Tables 8-15*. Our data support $H1$ suggesting that the inclusion of graphs has a statistically significant effect on financial information comprehension and perception. Specifically, in the evaluation task the advertisement containing a graph was categorized more favorably as compared to the same advertisement counting no graphical representation (*Tables 8-15*). Thus, we can infer that the graphic representation combined with the text-based numeric information can have a positive significant impact on perception and evaluation, especially when graphic representation is designed to draw attention to the potential gains.

In addition, the evidence from *Experiment 2* suggests that literate processing of text-based information can be facilitated by means of graphs, which further increases favorable impressions and consequently the willingness to accept an investment offer. In such cases, participants are more likely to keep the advertisement material and even engage in the "viral marketing". These results are not quite surprising, because it is known from consumer theory that increased information accessibility may lead to increased decision confidence (Nicholas and Mason, 2007). Creating graphic representation of text-based information can be a win-win situation for both consumers and financial service providers. On the other hand, one should keep in mind that even though graphical representation may enable information to be processed quicker than a text-based presentation, distorted representations can increase biases in decision making, as evidenced in *Experiment 1*.

Overall, our data do not support hypothesis $H2$. That is, on average, in the evaluation task the investment information accompanied with an evocative portrait were evaluated equally favorably, which indicates no effect on perception and/or evaluation of an investment information (*Tables 8-15*). Although experimental results show that photographs of gazing male subjects have little influence over perceivers, they still act as powerful artefacts in attracting viewers attention (*Table 15*) and conveying trust (*Table 14*). For instance, photographs of a male subject used together with a graph in information leaflet, significantly increases perceived *advisors' trustworthiness* (*Table 14*). Moreover, by testing sub-samples we find some important exceptions that take place when a photograph is

included in a visual content of an investment advertisement design. Photographs appear to increase vividness of an advertisement and can be used to capture attention, especially when the model in a photograph is an attractive woman (*Table 15*). Portraits, when used in combination with a graph, may increase willingness to keep an advertisement, show it, and recommend it to others (*Table 11*, *Table 12* and *Table 13*).

The first two hypotheses, $H1$ and $H2$, indicate that visual framing, especially inclusion of graphs, is relevant for information understanding, investment evaluation, and intention to invest. Without doubt, we can argue that graphs play a relevant role in forming investors' opinions, while use of photographs is less universal and, in fact, may even result in reduced evaluation of the ad if used inappropriately.

Table 8. Experiment Treatment Combinations: Differences of Mean Responses: *Q1 Information understanding*

CONTROL FRAME	VISUAL STIMULI	MEAN Evaluation	EFFECT Difference	SIGNIF. P-value	HYPOTHESIZED EFFECTS
Dependent Variable #1: Perceived information understanding
Text	None	5.21	-	-	-
	Graph	5.54	-0.33	0.00000	*Significant at 1%.* Adding an illustrative graph increases participants' perception of information understanding.
	Photo	5.26	-0.05	0.44543	*Not significant.* Adding a photograph does not affect (on average) participants' perception of information understanding.
	Photo (M)	5.2	-0.03	0.74482	*Not significant.* Adding a male photograph does not affect (on average) participants' perception of information understanding.
	Photo (F)	5.32	-0.07	0.43749	*Not significant.* Adding a female photograph does not affect (on average) participants' perception of information understanding.
	Graph+Photo	5.51	-0.3	0.00000	*Significant at 1%.* Adding an illustrative graph and a photograph increases participants' perception of information understanding.
	Graph+Photo (M)	5.49	-0.32	0.00067	*Significant at 1%.* Adding an illustrative graph and a male photograph increases participants' perception of information understanding.
	Graph+Photo (F)	5.53	-0.28	0.00185	*Significant at 1%.* Adding an illustrative graph and a female photograph increases participants' perception of information understanding.
Text+Graph	None	5.54	-	-	-
	Photo	5.51	0.03	0.68192	*Not significant.* Adding a photograph to a prospectus design already containing an illustrative graph does not affect (on average) participants' perception of information understanding.
	Photo (M)	5.49	0.07	0.44412	*Not significant.* Adding a male photograph to a prospectus design already containing an illustrative graph does not affect (on average) participants' perception of information understanding.
	Photo (F)	5.53	-0.02	0.82464	*Not significant.* Adding a female photograph to a prospectus design already containing an illustrative graph does not affect (on average) participants' perception of information understanding.
Text+Photo	None	5.26	-	-	-
	Graph	5.51	-0.25	0.0001	*Significant at 1%.* Adding an illustrative graph to a prospectus design already containing a photo increases participants' perception of information understanding.
Text+Photo	None (M)	5.2	-	-	-
	Graph	5.49	-0.29	0.00183	*Significant at 1%.* Adding an illustrative graph to a prospectus design already containing a male photo increases participants' perception of information understanding.
Text+Photo	None (F)	5.32	-	-	-
	Graph	5.53	-0.21	0.01804	*Significant at 5%.* Adding an illustrative graph to a prospectus design already containing a female photo increases participants' perception of information understanding.

Tests of hypotheses: we reject the null hypothesis that the true mean difference is zero

Table 9. Experiment Treatment Combinations: Differences of Mean Responses: *Q2 Willingness to Accept*

CONTROL FRAME	VISUAL STIMULI	MEAN Evaluation	EFFECT Difference	SIGNIF. P-value	HYPOTHESIZED EFFECTS
Dependent Variable #2: Perceived willingness to accept
Text	None	4.02	-	-	-
	Graph	4.34	-0.32	0.00004	*Significant at 1%.*
	Photo	4.07	-0.06	0.4875	*Not significant.*
	Photo (M)	4.01	0.00000	0.98176	*Not significant.*
	Photo (F)	4.14	-0.11	0.31391	*Not significant.*
	Graph+Photo	4.31	-0.29	0.00031	*Significant at 1%.*
	Graph+Photo (M)	4.29	-0.28	0.01504	*Significant at 5%.*
	Graph+Photo (F)	4.33	-0.3	0.0075	*Significant at 1%.*
Text+Graph	None	4.34	-	-	-
	Photo	4.31	0.03	0.70768	*Not significant.*
	Photo (M)	4.29	0.11	0.34251	*Not significant.*
	Photo (F)	4.33	-0.05	0.63271	*Not significant.*
Text+Photo	None	4.07	-	-	-
	Graph	4.31	-0.24	0.00335	*Significant at 1%.*
Text+Photo	None (M)	4.01	-	-	-
	Graph	4.29	-0.28	0.0162	*Significant at 5%.*
Text+Photo	None (F)	4.14	-	-	-
	Graph	4.33	-0.19	0.08631	*Significant at 10%.*

Tests of hypotheses: we reject the null hypothesis that the true mean difference is zero

Table 10. Experiment Differences of Mean Responses: *Q3 Investment's attractiveness*

CONTROL FRAME	VISUAL STIMULI	MEAN Evaluation	EFFECT Difference	SIGNIF. P-value	HYPOTHESIZED EFFECTS
Dependent Variable #3: Perceived investment's attractiveness
Text	None	4.28	-	-	-
	Graph	4.46	-0.18	0.02852	*Significant at 5%.*
	Photo	4.28	0.00000	0.96065	*Not significant.*
	Photo (M)	4.33	-0.05	0.66517	*Not significant.*
	Photo (F)	4.23	0.06	0.6015	*Not significant.*
	Graph+Photo	4.49	-0.21	0.00939	*Significant at 1%.*
	Graph+Photo (M)	4.56	-0.28	0.01417	*Significant at 5%.*
	Graph+Photo (F)	4.43	-0.14	0.23264	*Not significant.*
Text+Graph	None	4.46	-	-	-
	Photo	4.49	-0.04	0.66101	*Not significant.*
	Photo (M)	4.56	-0.07	0.54625	*Not significant.*
	Photo (F)	4.43	0	1	*Not significant.*
Text+Photo	None	4.28	-	-	-
	Graph	4.49	-0.22	0.00808	*Significant at 1%.*
Text+Photo	None (M)	4.33	-	-	-
	Graph	4.56	-0.23	0.04708	*Significant at 5%.*
Text+Photo	None (F)	4.23	-	-	-
	Graph	4.43	-0.2	0.0795	*Significant at 10%.*

Tests of hypotheses: we reject the null hypothesis that the true mean difference is zero

Table 11. Experiment Treatment Combinations: Differences of Mean Responses: *Q5 Likeliness to keep it*

CONTROL FRAME	VISUAL STIMULI	MEAN Evaluation	EFFECT Difference	SIGNIF. P-value	HYPOTHESIZED EFFECTS
Dependent Variable #5: Likeliness to keep it or take it home					
Text	None	4.08	-	-	-
	Graph	4.52	-0.43	0.00000	*Significant at 1%.*
	Photo	4.22	-0.14	0.11902	*Not significant.*
	Photo (M)	4.14	-0.12	0.34348	*Not significant.*
	Photo (F)	4.32	-0.16	0.20764	*Not significant.*
	Graph+Photo	4.41	-0.33	0.00025	*Significant at 1%.*
	Graph+Photo (M)	4.37	-0.36	0.00429	*Significant at 1%.*
	Graph+Photo (F)	4.46	-0.3	0.0204	*Significant at 5%.*
Text+Graph	None	4.52	-	-	-
	Photo	4.41	0.1	0.22994	*Not significant.*
	Photo (M)	4.37	0.11	0.36654	*Not significant.*
	Photo (F)	4.46	0.1	0.4286	*Not significant.*
Text+Photo	None	4.22	-	-	-
	Graph	4.41	-0.19	0.03318	*Significant at 5%.*
Text+Photo	None (M)	4.14	-	-	-
	Graph	4.37	-0.24	0.05795	*Significant at 10%.*
Text+Photo	None (F)	4.32	-	-	-
	Graph	4.46	-0.14	0.27289	*Not significant.*

Tests of hypotheses: we reject the null hypothesis that the true mean difference is zero

Table 12. Experiment Treatment Combinations: Differences of Mean Responses: *Q6 Likeliness to show it*

CONTROL FRAME	VISUAL STIMULI	MEAN Evaluation	EFFECT Difference	SIGNIF. P-value	HYPOTHESIZED EFFECTS
Dependent Variable #6: Perceived likeliness to show it					
Text	None	3.93	-	-	-
	Graph	4.27	-0.34	0.0002	*Significant at 1%.*
	Photo	4.03	-0.1	0.29328	*Not significant.*
	Photo (M)	4	-0.13	0.30773	*Not significant.*
	Photo (F)	4.06	-0.06	0.64608	*Not significant.*
	Graph+Photo	4.23	-0.3	0.00102	*Significant at 1%.*
	Graph+Photo (M)	4.18	-0.31	0.01533	*Significant at 5%.*
	Graph+Photo (F)	4.29	-0.3	0.02665	*Significant at 5%.*
Text+Graph	None	4.27	-	-	-
	Photo	4.23	0.03	0.70716	*Not significant.*
	Photo (M)	4.18	0.07	0.58625	*Not significant.*
	Photo (F)	4.29	0	0.9828	*Not significant.*
Text+Photo	None	4.03	-	-	-
	Graph	4.23	-0.21	0.02327	*Significant at 5%.*
Text+Photo	None (M)	4	-	-	-
	Graph	4.18	-0.18	0.15703	*Not significant.*
Text+Photo	None (F)	4.06	-	-	-
	Graph	4.29	-0.24	0.07211	*Significant at 10%.*

Tests of hypotheses: we reject the null hypothesis that the true mean difference is zero

Table 13. Experiment Treatment Combinations: Differences of Mean Responses: *Q7 Likeliness to recommend it*

CONTROL FRAME	VISUAL STIMULI	MEAN Evaluation	EFFECT Difference	SIGNIF. P-value	HYPOTHESIZED EFFECTS
Dependent Variable #7: Perceived likeliness to recommend it					
Text	None	3.68	-	-	-
	Graph	3.93	-0.25	0.00465	*Significant at 1%.*
	Photo	3.76	-0.08	0.37736	*Not significant.*
	Photo (M)	3.8	-0.11	0.37647	*Not significant.*
	Photo (F)	3.71	-0.04	0.72754	*Not significant.*
	Graph+Photo	3.96	-0.28	0.00197	*Significant at 1%.*
	Graph+Photo (M)	4.02	-0.33	0.01166	*Significant at 5%.*
	Graph+Photo (F)	3.9	-0.23	0.06735	*Significant at 10%.*
Text+Graph	None	3.93	-	-	-
	Photo	3.96	-0.03	0.73919	*Not significant.*
	Photo (M)	4.02	-0.05	0.69684	*Not significant.*
	Photo (F)	3.9	-0.01	0.94641	*Not significant.*
Text+Photo	None	3.76	-	-	-
	Graph	3.96	-0.2	0.02512	*Significant at 5%.*
Text+Photo	None (M)	3.8	-	-	-
	Graph	4.02	-0.21	0.09479	*Significant at 10%.*
Text+Photo	None (F)	3.71	-	-	-
	Graph	3.9	-0.19	0.13602	*Not significant.*

Tests of hypotheses: we reject the null hypothesis that the true mean difference is zero

Table 14. Experiment Treatment Combinations: Differences of Mean Responses: *Q8 Advisors' Trustworthiness*

CONTROL FRAME	VISUAL STIMULI	MEAN Evaluation	EFFECT Difference	SIGNIF. P-value	HYPOTHESIZED EFFECTS
Dependent Variable #8: Perceived advisors' trustworthiness					
Text	None	4.19	-	-	-
	Graph	4.3	-0.1	0.1232	*Not significant.*
	Photo	4.25	-0.06	0.38125	*Not significant.*
	Photo (M)	4.24	-0.12	0.22815	*Not significant.*
	Photo (F)	4.27	0	0.97629	*Not significant.*
	Graph+Photo	4.33	-0.13	0.05112	*Significant at 10%.*
	Graph+Photo (M)	4.31	-0.19	0.05539	*Significant at 10%.*
	Graph+Photo (F)	4.34	-0.07	0.43579	*Not significant.*
Text+Graph	None	4.3	-	-	-
	Photo	4.33	-0.03	0.65242	*Not significant.*
	Photo (M)	4.31	-0.07	0.47756	*Not significant.*
	Photo (F)	4.34	0.01	0.90165	*Not significant.*
Text+Photo	None	4.25	-	-	-
	Graph	4.33	-0.07	0.27845	*Not significant.*
Text+Photo	None (M)	4.24	-	-	-
	Graph	4.31	-0.07	0.46892	*Not significant.*
Text+Photo	None (F)	4.27	-	-	-
	Graph	4.34	-0.08	0.41487	*Not significant.*

Tests of hypotheses: we reject the null hypothesis that the true mean difference is zero

Table 15. Experiment Treatment Combinations: Differences of Mean Responses: *Q12 Eye-catching design*

CONTROL FRAME	VISUAL STIMULI	MEAN Evaluation	EFFECT Difference	SIGNIF. P-value	HYPOTHESIZED EFFECTS
Dependent Variable #12: Perceived eye-catchiness					
Text	None	3.14	-	-	-
	Graph	4.16	-1.01	0.00000	*Significant at 1%.*
	Photo	4.43	-1.29	0.00000	*Significant at 1%.*
	Photo (M)	4.38	-1.04	0.00000	*Significant at 1%.*
	Photo (F)	4.5	-1.56	0.00000	*Significant at 1%.*
	Graph+Photo	4.65	-1.51	0.00000	*Significant at 1%.*
	Graph+Photo (M)	4.72	-1.38	0.00000	*Significant at 1%.*
	Graph+Photo (F)	4.59	-1.65	0.00000	*Significant at 1%.*
Text+Graph	None	4.16	-	-	-
	Photo	4.65	-0.5	0.00000	*Significant at 1%.*
	Photo (M)	4.72	-0.41	0.00009	*Significant at 1%.*
	Photo (F)	4.59	-0.59	0.00000	*Significant at 1%.*
Text+Photo	None	4.43	-	-	-
	Graph	4.65	-0.22	0.0051	*Significant at 1%.*
Text+Photo	None (M)	4.38	-	-	-
	Graph	4.72	-0.34	0.00183	*Significant at 1%.*
Text+Photo	None (F)	4.5	-	-	-
	Graph	4.59	-0.09	0.42496	*Not significant.*

Tests of hypotheses: we reject the null hypothesis that the true mean difference is zero

Next, we will analyze $H3$ and $H4$, which are devised to test whether susceptibility to advertising content effects depends on participants' level of financial literacy or investment experience.

5.2.0.2. Potential moderators: financial literacy

In this experiment, we investigate how the use of graph- or image-based communications can influence economic decision making among respondents with varying levels of financial literacy. To examine the moderating role of financial literacy, the subjects of the experiment are subdivided into financial literate (above average) participants and non-literate (bellow average) participants (later, also into investors and non-investors). This accounts for the knowledge structures present in the former, as "the presence or absence of knowledge structures of various sorts should affect the types of information processed and the processing heuristics used by consumers" (Bettman and Park, 1980). For instance, inexperienced investors may require more time to evaluate levels of attributes before selecting criteria for choice than those who are more knowledgeable and experienced in financial domain. In addition, at different stages of decision making respondents participating in the stock market may decide to exert not only different type of knowledge and information, but also different heuristics.

Our data analyses reveal that the respondents' level of financial literacy (mean score 61%) affects their perception of investment offers. Table 16 provides a detailed summary of mean evaluations and differences between evaluations reported by financially literate and less-literate respondents to advertisement stimuli. Compared to the financially literate respondents, the less literate participants

Table 16. Responses mean differences between groups of financially literate and non-literate respondents

Treatment Visual Stimuli	Group 1 Financialy Literate	Group 2 Financialy Non- Literate	Effect Difference in Means	P-value Significance	Hypothesized effects
Q1: Perceived easiness to understand an investment offer					
Text	5.30	5.14	0.16	0.1025	*Not significant.*
Graph	5.76	5.37	0.39	0.0000	*Significant at 1%.*
Photo	5.37	5.18	0.19	0.0394	*Significant at 5%.*
Graph+Photo	5.70	5.37	0.33	0.0002	*Significant at 1%.*
Q2: Perceived willingness to accept an offer					
Text	3.67	4.28	-0.61	0.0000	*Significant at 1%.*
Graph	4.15	4.48	-0.33	0.0026	*Significant at 1%.*
Photo	3.75	4.32	-0.56	0.0000	*Significant at 1%.*
Graph+Photo	4.05	4.51	-0.46	0.0001	*Significant at 1%.*
Q3: Perceived investment's attractiveness					
Text	4.10	4.42	-0.32	0.0074	*Significant at 1%.*
Graph	4.33	4.56	-0.23	0.0426	*Significant at 5%.*
Photo	4.13	4.39	-0.26	0.0292	*Significant at 5%.*
Graph+Photo	4.34	4.61	-0.27	0.0209	*Significant at 5%.*
Q5: Perceived likeliness to keep or take the leaflet home					
Text	3.71	4.37	-0.65	0.0000	*Significant at 1%.*
Graph	4.31	4.67	-0.36	0.0032	*Significant at 1%.*
Photo	3.87	4.50	-0.63	0.0000	*Significant at 1%.*
Graph+Photo	4.09	4.66	-0.58	0.0000	*Significant at 1%.*
Q6: Perceived likeliness to show the investment advertisement to family and/or friends					
Text	3.40	4.34	-0.94	0.0000	*Significant at 1%.*
Graph	3.93	4.53	-0.59	0.0000	*Significant at 1%.*
Photo	3.55	4.39	-0.84	0.0000	*Significant at 1%.*
Graph+Photo	3.76	4.6	-0.84	0.0000	*Significant at 1%.*
Q7: Perceived likeliness to recommend an investment offer to family and/or friends					
Text	3.05	4.16	-1.11	0.0000	*Significant at 1%.*
Graph	3.55	4.22	-0.66	0.0000	*Significant at 1%.*
Photo	3.18	4.2	-1.02	0.000	*Significant at 1%.*
Graph+Photo	3.47	4.34	-0.87	0.000	*Significant at 1%.*
Q8: Perceived advisor's trustworthiness who strongly recommends this investment					
Text	3.93	4.39	-0.46	0.0000	*Significant at 1%.*
Graph	4.15	4.41	-0.25	0.0063	*Significant at 1%.*
Photo	4.03	4.43	-0.40	0.0000	*Significant at 1%.*
Graph+Photo	4.10	4.50	-0.41	0.0000	*Significant at 1%.*
Q9: Perceived risk associated with an investment (in terms of interest)					
Text	4.15	4.14	0.01	0.9444	*Not significant.*
Graph	3.99	4.13	-0.13	0.2557	*Not significant.*
Photo	4.00	4.17	-0.18	0.1389	*Not significant.*
Graph+Photo	4.1	4.04	0.06	0.6100	*Not significant.*
Q10: Perceived gains associated with an investment in the best-case scenario					
Text	3.63	4.14	-0.51	0.0001	*Significant at 1%.*
Graph	3.59	4.17	-0.59	0.0000	*Significant at 1%.*
Photo	3.52	4.26	-0.73	0.0000	*Significant at 1%.*
Graph+Photo	3.6	4.16	-0.56	0.0000	*Significant at 1%.*
Q11: Perceived losses associated with an investment in the worst-case scenario					
Text	5.27	5.10	0.17	0.0888	*Significant at 10%.*
Graph	5.37	5.05	0.32	0.0011	*Significant at 1%.*
Photo	5.28	5.11	0.17	0.0821	*Significant at 10%.*
Graph+Photo	5.26	5.14	0.12	0.2153	*Not significant.*
Q12: Evaluation of eye-catchiness of an investment's advertisement design					
Text	2.69	3.50	-0.81	0.0000	*Significant at 1%.*
Graph	3.98	4.29	-0.31	0.0056	*Significant at 1%.*
Photo	4.20	4.61	-0.41	0.0020	*Significant at 1%.*
Graph+Photo	4.52	4.75	-0.23	0.0343	*Significant at 5%.*

report that their understanding of ads is lower (*Question 1*), but still they are more willing to accept the offer and invest (*Questions 2*). The participants with lower financial literacy scores tend to trust the financial advisers more than their counterparts with higher financial literacy scores (*Question 8*). Compared to the financially literate respondents, the less literate participants perceive both the potential gains (*Question 10*) and potential losses (*Question 11*) in divergent scenarios as being significantly larger. Furthermore, less financially literate reported higher willingness to keep the advertisement, to show it, and to recommend it to others (*Question 8*). These results provide an important evidence that less financially-savvy individuals might be searching for prominent and immediate data in visual representations and are the ones to be affected the most by inaccurate or manipulative visual representations.

6. General Discussion

Theories of visual communication, in particularly in finance field, and prior research on visual perception, risky decision making, graphical representation, impression management, framing, and priming suggest that the use of visuals can have a significant effect on investors' behavior. However, there are notable gaps in literature on how much and what type of visual frames may affect individual perception, and, ultimately, the final investment choice. The two ways to fill these gaps and improve understanding of the relationship between visual attributes and perception are: (i) draw on theoretical and empirical findings in relevant areas and; (ii) carry out controlled experiments to examine the effects and test specific hypotheses. We choose the second path through analysis of experimental data to further highlight some of the behavioral biases related to visual representation effects often present in financial communication materials. We also aim to show that the graphic context in which an investment opportunity is presented can elicit affective responses that investors often misinterpret as their judgments of the investment itself. In the first experiment, we investigate of how graphic distortion of visual representations in financial communications may affect information comprehension and lead to consequential mistakes. In the second experiment, we continue the theme of psychological influences on financial decision making and explore how non-informative cues can affect this kind of behavior.

To assess investors' perceptions and to measure visual framing effects on their decision making, we conduct two questionnaire-based experiments recruiting participants world-wide via the Amazon Mechanical Turk (AMT) platform. As mentioned previously, we fulfilled our main objective to show that (i) visual representations can serve as a powerful tool of persuasion in investment communication, (ii) there are some gender and cultural differences in the investment behavior, (iii) the degree of financial literacy and prior investment knowledge are significant factors in moderating susceptibility to visual content effects.

Our results point to the importance of contributing to an ongoing effort aimed to characterize the

framing and priming effects on perceivers' ability to infer the contents of presented data for sound investment decisions. Our study also calls attention to the main weaknesses of this experiment: substantially reduced sample impacts the statistical power needed to test some specific hypotheses of interest (for instance, perception of differences between financially literate non-american female investors and financially literate american female investors). Future experiments should strive for larger sample sizes and/or settings with higher specific target population ratios, allowing for additional flexibility to design tests with different treatment combinations, including interactions between race, gender, and financial literacy.

We take a further step with the second experiment when we investigate whether simultaneously and independently randomizing visual content, such as adding an illustrative graph or an evocative face close-up or both to the text of investment disclosure, has an impact on perception and evaluation of a risky opportunity. We find that inclusion of certain visuals has statistically significant effects on different perception dimensions. We also test whether portraits (representing both genders and four major racial groups) used as visual primes can reduce physiological distance and/or transmit trustworthiness, impacting the perception and willingness to accept the investment. We find that gender and race have statistically significant effects on investment opportunity evaluation.

In the further step of our analysis, we investigate whether financial literacy play a moderating role not only in risk assessment, but also in defining individual responsiveness to visual representation. We find that financially literacy has a statistically significant effect in both dimensions, risk assessment and responsiveness to advertisement content. Financially literate people exhibit more conservative attitude toward investment and are less likely to be affected by visual content. Furthermore, the evidence from the second experiment suggests that fluent processing of text-based content can be facilitated by means of graphs, which further increases favorable impressions, affective reactions, and, consequently, the willingness to accept an investment offer. When presented information can be fluently processed, participants are more likely to keep the advertisement material and even engage in its viral marketing. Although experiment results show that photographs of gazing male subjects have little influence over perceivers, they still act as powerful artefacts in attracting viewers' attention and improving perceived understanding of the information provided. On the other hand, female faces have a statistically significant effect on eliciting more favorable affective response and thus altering perception.

6.1. Limitations and future research

These concluding remarks highlight the fact that the design and results of both experiments have some limitations and leave questions unanswered, which suggests interesting directions for future research. The present study can be limited by the reduced control over the persuasion knowledge factor, as respondents may obtain "persuasion knowledge" whenever they try to unravel "what is going on as they observe advertisements, sales presentations, or the behaviors of service providers"

([Friestad and Wright](), 1994). Also, the Persuasion Knowledge Model (PKM) suggests that observers may develop understanding about persuasion which can later be applied to deal with persuasion attempts ([Campbell and Kirmani](), 2000). Moreover, persuasion knowledge makes references not only to consumers' persuasion theories but also "includes beliefs about marketers' motives, strategies, and tactics" and "ways of coping with persuasion attempts" ([Campbell and Kirmani](), 2000). The present study partially overcomes this limit by asking a few opened ended questions at the end of the survey, meant to understand what persuasion knowledge the subjects used to make their assessments. A key next step would require a systematic field experimentation. One avenue would involve conducting additional empirical field research to promote the understanding of advertising contents. Such future field experiments could try to address the issue how perception of visually presented information relates to the real-world choices.

Another unresolved question is what moderating variables are truly relevant for investment choice. Our design scope does not encompass all variables and thus unravel all mechanisms underlying the visual representation effects on investing behavior. In this context, it would be helpful to conduct studies including financial decision makers who vary on key individual difference attributes, such as level of financial literacy, education, cultural upbringing, investment expertise, etc. This would be another avenue for research, liable to gather new insights in the implications of visual dimension for individual decision making.

It would also be useful to analyze visual intelligence and investing behavior in conjunction with the strategies of the financial institutions that create and frame choice sets. Providers of financial services, as well as many other financial data reporting companies, often use self serving visual aids to psychologically target and shape behavior of ordinary consumers and private investors searching for prominent and immediate data in visual presentations. Various corporate strategies can be reflected in visual communication, which is often designed to enhance selected attributes through visuals in order to influence readers' opinion of presented information and shift their preferences for the investment. Research focusing on the link between investor behavior and strategic impression management has still a lot of room for further development. Furthermore, we see possible gains for connecting research fields such as, economics of advertisement, visual perception, and consumer choice.

7. Conclusion

Consumer welfare depends on how wisely individuals allocate their financial resources. Providers of financial services and products offer a wide spectrum of instruments to enable people to manage their finances and enhance their economic outcomes. On the other hand, few people are sufficiently sophisticated to understand the mechanisms and the true risks underlying these instruments ([Lynch JR.](), 2011). Often poorly informed, consumers highly rely on financial institutions and policy

makers to provide necessary guidelines for informed decision making. Respondents of our study confirm that financial advertising has become a major source of consumer financial knowledge. The purpose of financial advertising, however, is often geared on nudging and persuading individuals rather then providing them with objective information and complete disclosure. The recent increase of regulations in marketing have been evidenced globally across different financial sub-industries. Nevertheless, these laws have little control over the creative use of graphics allowing advertising to entwine decision-relevant information into persuasive representations.

The creative use of visualization, as we show in our experiments, may mislead decision makers and result in serious choice errors leading to significant personal and societal consequences. Our experiments show that people facing financial decisions use their cognitive abilities to process and evaluate the provided information, often in the format of a visual representation. We show that people's evaluations of such information vary systematically depending on a diverse set of individual traits and skills (financial literacy, investing experience) and contextual factors (e.g., visual representation, presence of salient non-informative cues, etc.). In such a fast-pace world, there is no doubt left that future decision making will depend more on visual and that visual communication will become more and more prevailing in financial sector. The results described in this chapter could stimulate further curiosity about carrying out research on how use of visuals affects consumers cognitively and what is the relevance of visuals in communication, perception and decision making.

To conclude, we expect that this kind of research will contribute to the growing body of knowledge in this field, but, more importantly, it is likely to alert the immediate victims of sometimes self-serving, unregulated financial adversing and corporate reporting. As discussed earlier, the people to be affected the most are ordinary consumers and casual investors searching for prominent and immediate information in financial communications. Thus, we strongly support the idea of further implementing research on the correspondence between visual representation and sound financial decision making.

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8. Appendices

Appendix A: *Experiment 1:* materials and methods extended

In appendix "A" we explain the experimental design and stimuli presented to the respondents in *Experiment 1*.

Appendix A-1: *Experiment 1:* experimental design and stimuli

Appendix A-1.1: Stimuli Task 1:

Type 1a questions showed accurately drawn graphs and asked to indicate the company that was doing better based on past performance. On the other hand, **Type 1b** questions presented manipulated graphs where maximum y value was not the same for both graphs: this was meant to potentially "trick" a decision maker. Note that accurate and visible numbers were attached to each bar of the graphs, allowing decision makers to draw sound conclusions. There were no ambiguous situations.
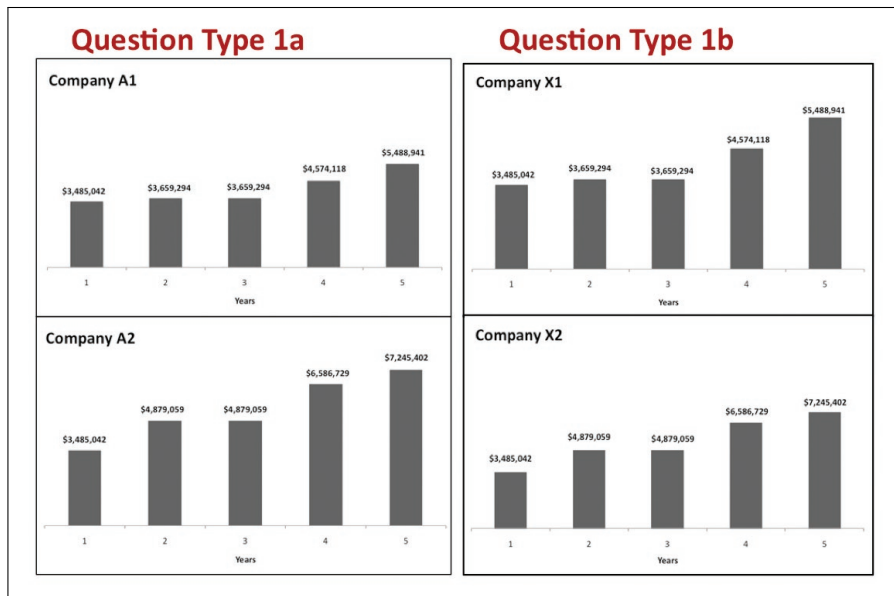
Appendix A-1.2: Stimuli Task 2:

Type 2 question had one of the three graphs. Participants were shown a graph and were asked their opinion regarding the net income change over the last five consecutive years; consumers had to choose between four options: *sharply increased, increased, slightly increased, did not increase.* All of the three graphs represent the same increase, both in nominal and relative terms, and have numbers displayed above each bar of a chart; apart from that, the y-value is different for E (the first) and F (the second) graphs, whereas graph G (the third) has a different y origin value (it does not start at zero). The two sets of responses are later compared analyzing differences between performance inferred from graphs E and F, and differences between performance inferred from graphs F and G.

Appendix A-3: Basic financial literacy scale

Q#B1: Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

☐ Less than $102   ☐ More than $102   ☐ Exactly $102   ☐ Do not know

Q#B2: 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 today   ☐ Exactly the same   ☐ Less than today   ☐ Do not know

Q#B3: Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

☐ More than today   ☐ Exactly the same   ☐ Less than today   ☐ Do not know

Q#B4: Assume a friend inherits $10,000 today and his brother inherits $10,000 five years from now.

Who is richer because of the inheritance?

☐ My friend   ☐ They are equally rich   ☐ His brother   ☐ Do not know

Q#B5: Suppose that in the year 2012, your income has doubled and prices of all goods have doubled too. In 2012, how much will you be able to buy with your income?

☐ More than today   ☐ Less than today   ☐ The same   ☐ Do not know

Appendix A-4: Advanced financial literacy scale

Advanced Financial literacy Questions

Q#A1: Which of the following statements describes the main function of the stock market?

☐ The stock market results in an increase in the price of stocks
☐ The stock market helps to predict stock earnings
☐ The stock market brings people who want to buy stocks together with those who want to sell stocks
☐ None of the above
☐ Do not know

Q#A2: Which of the following statements is correct?

☐ Mutual funds can invest in several assets, for example invest in both stocks and bonds
☐ Once one invests in a mutual fund, one cannot withdraw the money in the first year
☐ Mutual funds pay a guaranteed rate of return which depends on their past performance
☐ None of the above
☐ Do not know

Q#A3: If the interest rate falls, what should happen to bond prices?
☐ Fall   ☐ Stay the same   ☐ Rise   ☐ None of the above   ☐ Do not know

Q#A4: Which statement is TRUE?

☐ Buying a company stock usually provides a safer return than a stock mutual fund.
☐ Buying a stock mutual fund usually provides a safer return than a company stock.
☐ Do not know

Q#A5: Which statement is TRUE?

☐ Bonds are normally riskier than stocks.
☐ Stocks are normally riskier than bonds.
☐ Do not know

Q#A6: Considering a long time period (for example 20 years), which asset normally gives the highest return?
☐ Stocks   ☐ Bonds   ☐ Savings accounts   ☐ Do not know

Q#A7: Normally, which asset displays the highest fluctuations over time?
☐ Savings accounts   ☐ Bonds   ☐ Stocks   ☐ Do not know

Q#A8: When an investor spreads his money among different assets, does the risk of losing money:
☐ Decrease   ☐ Increase   ☐ Stay the same   ☐ Do not know

Appendix B: *Experiment 2*: materials and methods extended

In appendix "B" we list the set of questions presented to the subjects of *Experiment 2*. The schematic plan for the first part of *Experiment 2* is presented below. Note that there are more variations of models presented in the actual leaflets than shown in this scheme.

Appendix B-1: Experiment design
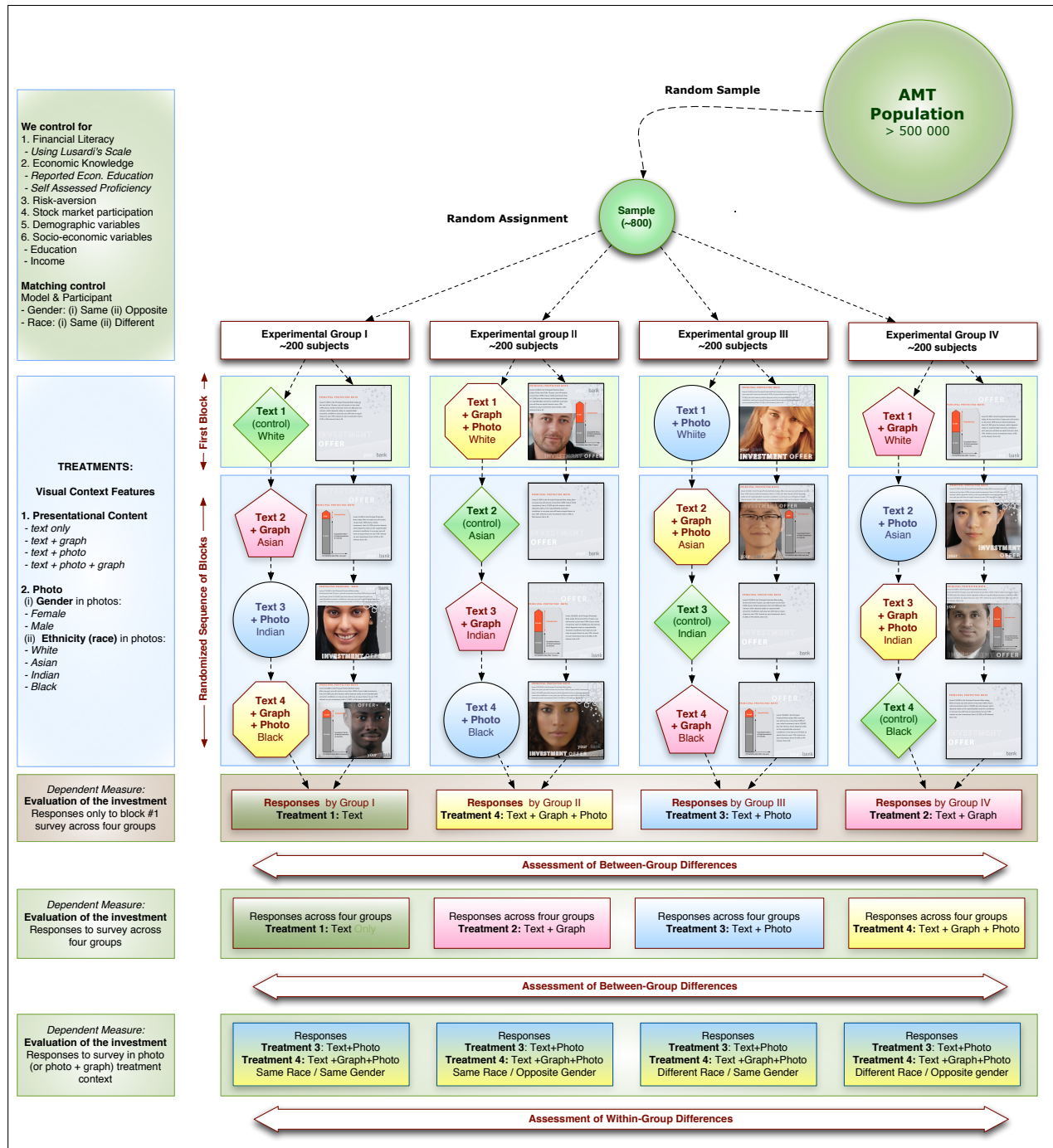
Appendix B-2: Stimuli examples

Samples of visual stimuli presented to the four treatment groups of the experiment.

Stimuli: Investment #1

Version 1: Text

Version 2: Text and a graph

Version 3 (male): Text and a photo

Version 4 (female): Text, a graph and a photo

Stimuli: Investment #2

Version 1: Text

Version 2: Text and a graph

Version 3: Text and a photo (female)

Version 4: Text, a graph, and a photo (male)

Stimuli: Investment #3

Version 1: Text

PRINCIPAL PROTECTED NOTE

Invest $10,000 in the Principal Protected Note today. After one year you will receive no less than 100% of your initial investment, that is $10,000, plus the interest, which depends solely on the unpredictable economic conditions: in one year you will have an equal chance to earn 10% interest on your investment, that is $1,000, or 0% interest, that is $0.

INVESTMENT
OFFER
your bank

Version 2: Text and a graph

INVESTMENT
OFFER

PRINCIPAL PROTECTED NOTE

$1,000 — Potential Gain

$10,000 — Guaranteed return of initial investment at maturity

On maturity date (After one year)

Invest $10,000 in the Principal Protected Note today. After one year you will receive no less than 100% of your initial investment, that is $10,000, plus the interest, which depends solely on the unpredictable economic conditions: in one year you will have an equal chance to earn 10% interest on your investment, that is $1,000, or 0% interest, that is $0.

your bank

Version 3: Text and a photo (female)

PRINCIPAL PROTECTED NOTE
Invest $10,000 in the Principal Protected Note today.
After one year you will receive no less than 100% of your initial investment, that is $10,000, plus the interest, which depends solely on the unpredictable economic conditions: in one year you will have an equal chance to earn 10% interest on your investment, that is $1,000, or 0% interest, that is $0.

your bank
INVESTMENT OFFER

Version 4: Text, a graph and a photo (male)

PRINCIPAL PROTECTED NOTE
Invest $10,000 in the Principal Protected Note today.
After one year you will receive no less than 100% of your initial investment, that is $10,000, plus the interest, which depends solely on the unpredictable economic conditions: in one year you will have an equal chance to earn 10% interest on your investment, that is $1,000, or 0% interest, that is $0.

INVESTMENT OFFER

$1,000 — Potential Gain

$10,000 — Guaranteed return of initial investment at maturity

On maturity date (After one year)

your bank

Stimuli: Investment #4

Version 1: Text

PRINCIPAL PROTECTED NOTE

Invest $1,000 in the Principal Protected Note today. After one year you will receive no less than 100% of your initial investment, that is $1,000, plus the interest, which depends solely on the unpredictable economic conditions: in one year you will have an equal chance to earn 10% interest on your investment, that is $100, or 0% interest, that is $0.

INVESTMENT

OFFER

your bank

Version 2: Text and a graph

INVESTMENT

OFFER

PRINCIPAL PROTECTED NOTE

$100   Potential Gain

$1,000   Guaranteed return of initial investment at maturity

On maturity date (After one year)

Invest $1,000 in the Principal Protected Note today. After one year you will receive no less than 100% of your initial investment, that is $1,000, plus the interest, which depends solely on the unpredictable economic conditions: in one year you will have an equal chance to earn 10% interest on your investment, that is $100, or 0% interest, that is $0.

your bank

Version 3: Text and a photo (male)

PRINCIPAL PROTECTED NOTE

Invest $1,000 in the Principal Protected Note today. After one year you will receive no less than 100% of your initial investment, that is $1,000, plus the interest, which depends solely on the unpredictable economic conditions: in one year you will have an equal chance to earn 10% interest on your investment, that is $100, or 0% interest, that is $0.
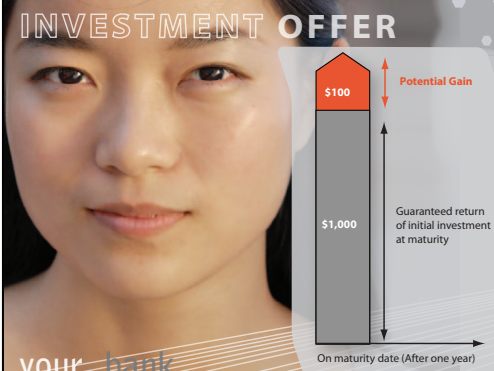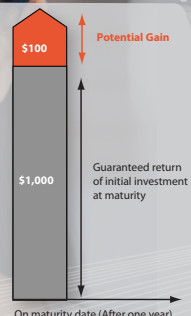
INVESTMENT

OFFER

your bank

Version 4: Text, a graph and a photo (female)

PRINCIPAL PROTECTED NOTE

Invest $1,000 in the Principal Protected Note today. After one year you will receive no less than 100% of your initial investment, that is $1,000, plus the interest, which depends solely on the unpredictable economic conditions: in one year you will have an equal chance to earn 10% interest on your investment, that is $100, or 0% interest, that is $0.

INVESTMENT OFFER

$100   Potential Gain

$1,000   Guaranteed return of initial investment at maturity

On maturity date (After one year)

your bank

Appendix B-3: Survey instructions

| Page #1 Initial Page |

Welcome to "Investments" survey!

Please do *not* answer this survey if you have done it before!

Q#G1: How did you learn about this survey?

☐ Amazon M-Turk   ☐ Other [   ]

Please input your *Amazon WorkerID* number. If you are not *Mturker* then please create your UserName. It can be anything you like and can remeber, but it must be *at least* 5 characters long.?

[   ]

Page #2 Conditions of Study

About "Investments" survey: We invite you to participate in a reasearch about peoples' investment decisions. This survey is being conducted by academic researchers, thus we ask you to read each question carefully, answer it honestly and to the best of your ability.

We invite you to participate in an survey about how people basic investment decisions.

CONDITIONS OF STUDY:

Purpose of the study: To understand how people evaluate investment opportunities.

What you will do: You will be presented 4 different simple investment opportunities and asked to express your opinion about them based on information provided to you, also you will answer a few questions related to your basic understanding of economics and finance as well as some questions about yourself.

Time required: The survey will take about 15 minutes.

Benefits: Participation in this study may be an intersting learning experiance providing insights into various tools marketers use to shape peoples' investment decsions. In the long run we hope that the results of this experiment will eventually benefit financial decision makers by proving a better understanding of visual framing effects on investme.

Risks/Discomforts: There are no anticipated risks associated with participating in this study, and your participation will remain anonymous.

Compensation (for Mechanical Turkers only): You will receive an agreed amount for completing the survey. We screen all responses very carefully and compensation is adjusted based on quality of your responses: if you try to cheat and fail to answer basic contol questions, your participation is considered to be fraudulent and no compensation is granted. This survey is part of our research, so it is essential that we adopt stringent guidelines for participation.

Important: Conditions of HIT Acceptance:

· We will not accept mulitple submissions from the same IP address. We will block any Worker who submits from an IP address for which there are multiple submissions.

· We will only pay those Workers who pass contol questions demonstrating that they read and understood the instructions. We will block any worker who responds randomly to the quiz questions.

·We will only pay Workers who submit the required information: valid and unique ResponseID that is given at the end of the survey and the UserName (which one will have to create), along with their HIT.

·We apologize for the need to have these conditions, but we must try to safeguard the integrity of our data by doing our best to filter out cheaters (of which there are a very high number, unfortunately).

Confidentiality: All data you provide will be strictly confidential and will not be connected to your email, IP address, or other personal information.

Voluntary nature of participation and withdrawal: By participating in this survey you provide consent that the information can be used in this research project. Your participation in this study is completely voluntary. Should you decide to withdraw by exiting the questionnaire, your submitted answers up to the point may not be used for the study purposes. Participation in this study does not oblige you to participate in any further experiments, however, as stated above we would like to stay in contact with you and invite you to other research studies. Please note that there is no back button and, therefore, there is no possibility to correct submitted answers.

Contact: If you have any questions or concerns about this research please contact us by sending an e-mail to visualperceptionlab@gmail.com.

Keywords: psychology, graph, visual, photograph, survey, decision, decision making, questionnaire, choice, experiment, financial, perception, risk, investment, finance, economics, stock market, note, fund, bank, advertisement, ad, face.

Q#G2: *Agreement with Conditions of Study.*

Please check the box bellow if you understand the purpose and nature of this research and you agree to participate in this study and provide honest answers to the questions. M-turkers: this agreement also implies that you understand that you will need to submit both the ResponseID (which will be displayed when you finish the survey) and also your UserName (which you just created) when you submit your hit.

☐ YES, I understand and agree to participate in the survey.   ☐ No, I don't agree to participate.

Appendix B-4: Questionnaire

Q#G3: Below is your *lucky* number. Memorize it, then check the box. At the end of the survey you may be asked to recall it.
☐ Your lucky number is: 1   ☐ Your lucky number is: 2   ☐ Your lucky number is: 3
☐ Your lucky number is: 4

Q#G4: Below is your *lucky* letter. Memorize it, then check the box. At the end of the survey you may be asked to recall it.
☐ Your lucky number is: Your lucky letter is "M"   ☐ Your lucky number is: Your lucky letter is "F"

Q#G5: You will be presented 4 investment brochures. All of them are *DIFFERENT*, so please read them *carefully*.

> **Page #3 Stimuli Condition #1: Text**

Please consider the following situation:
You have the choice of investing some extra money. Your financial advisor, after being asked for his opinion, points out to you an informational leaflet that explains "Principal protected note", an investment offered by the bank. Please take a look at the brochure presented below and evaluate the offered investment.

PRINCIPAL PROTECTED NOTE

Invest $10,000 in the Principal Protected Note today. At the end of the 10 years you will receive no less than 100% of your initial investment, that is $10,000, plus the interest, which depends solely on unpredictable economic conditions: each year you will have an equal chance to earn 10% interest on your investment, that is $1,000, or 0% interest, that is $0.

INVESTMENT OFFER

your bank

Q#M1: How easy is it to *understand* the information provided in the informational leaflet?
☐ Very Difficult   ☐ Difficult   ☐ Somewhat Difficult   ☐ Neutral   ☐ Somewhat Easy   ☐ Easy   ☐ Very Easy

Q#M2: How great is your *willingness* to accept this investment offer?
☐ Very Unwilling   ☐ Unwilling   ☐ Somewhat Unwilling   ☐ Neutral   ☐ Somewhat Willing   ☐ Willing   ☐ Very Willing

Q#M3: Please assume that alternatively you could also keep your money in a secure savings account paying 2% of interest per year. Now, how *attractive* is the investment offered in the

---

Q#M4: This question is to see if you have understood the information provided in the advertisement above.
Consider the advertisement above, what is the *maximum* and *minimum* amount of interest you could *gain* if you chose to accept the offer (consider all the investment period)? Please, enter the *max* and *minimum* amounts in the US dollars ($) and the time till maturity (number of years), as explained in the advertisement. eg.:
Max=$..., Min=$..., Time until maturity= ... years

Q#M5: How *likely* is it for you to *keep* this informational leaflet or *take* it home?
☐ Very Unlikely   ☐ Unlikely   ☐ Somewhat Unlikely   ☐ Neutral   ☐ Somewhat Likely   ☐ Likely   ☐ Very Likely

Q#M6: How *likely* is it for you to *show* this informational leaflet to your family / friends?
☐ Very Unlikely   ☐ Unlikely   ☐ Somewhat Unlikely   ☐ Neutral   ☐ Somewhat Likely   ☐ Likely   ☐ Very Likely

Q#M7: How *likely* is it for you to *recommend* this investment to your family / friends?
☐ Very Unlikely   ☐ Unlikely   ☐ Somewhat Unlikely   ☐ Neutral   ☐ Somewhat Likely   ☐ Likely   ☐ Very Likely

Q#M8: How *trustworthy* is the financial advisor who sells or strongly promotes such investment??
☐ Not trustworthy at all   ☐ Not trustworthy   ☐ Somewhat not trustworthy   ☐ Neutral   ☐ Somewhat trustworthy   ☐ Trustworthy   ☐ Totally trustworthy

Q#M9: How much *risk* is there in terms of the *interest* paid for this investment?
☐ No risk   ☐ Low risk   ☐ Somewhat low risk   ☐ Undecided   ☐ Somewhat high risk   ☐ High risk   ☐ Very high risk

Q#M10: In the *worst case* scenario, are the *losses* significant to you?
☐ Very Insignificant   ☐ Insignificant   ☐ Somewhat Insignificant   ☐ Neutral   ☐ Somewhat Significant   ☐ Significant   ☐ Very Significant

Q#M11: In the *best case* scenario, are the *gains* significant to you?
☐ Very Insignificant   ☐ Insignificant   ☐ Somewhat Insignificant   ☐ Neutral   ☐ Somewhat Significant   ☐ Significant   ☐ Very Significant

Q#M12: How much *eye-catching* is the booklet design?
☐ Not at all eye-catching   ☐ Not eye-catching   ☐ Somewhat not eye-catching   ☐ Undecided   ☐ Somewhat eye-catching   ☐ Eye-catching   ☐ Very eye-catching

Please consider the following situation:

You have the choice of investing some extra money. Your financial advisor, after being asked for his opinion, points out to you an informational leaflet that explains "Principal protected note", an investment offered by the bank. Please take a look at the brochure presented below and evaluate the offered investment.

Q#M1: How easy is it to *understand* the information provided in the informational leaflet?

☐ Very Difficult   ☐ Difficult   ☐ Somewhat Difficult   ☐ Neutral   ☐ Somewhat Easy   ☐ Easy   ☐ Very Easy

Q#M2: How great is your *willingness* to accept this investment offer?

☐ Very Unwilling   ☐ Unwilling   ☐ Somewhat Unwilling   ☐ Neutral   ☐ Somewhat Willing   ☐ Willing   ☐ Very Willing

Q#M3: Please assume that alternatively you could also keep your money in a secure savings account paying 2% of interest per year. Now, how *attractive* is the investment offered in the informational leaflet?

☐ Very Unattractive   ☐ Unattractive   ☐ Somewhat Unattractive   ☐ Neutral   ☐ Somewhat Attractive   ☐ Attractive   ☐ Very Attractive

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Page #4 cont. Stimuli condition #2: Graph

Q#M4: This question is to see if you have understood the information provided in the advertisement above.

Consider the advertisement above, what is the *maximum* and *minimum* amount of interest you could *gain* if you chose to accept the offer (consider all the investment period)? Please, enter the *max* and*minimum* amounts in the US dollars ($) and the time till maturity (number of years), as explained in the advertisement. eg.:

Max=$..., Min=$..., Time until maturity= ... years

Q#M5: How *likely* is it for you to *keep* this informational leaflet or *take* it home?
□ Very Unlikely   □ Unlikely   □ Somewhat Unlikely   □ Neutral   □ Somewhat Likely   □ Likely   □ Very Likely

Q#M6: How *likely* is it for you to *show* this informational leaflet to your family / friends?
□ Very Unlikely   □ Unlikely   □ Somewhat Unlikely   □ Neutral   □ Somewhat Likely   □ Likely   □ Very Likely

Q#M7: How *likely* is it for you to *recommend* this investment to your family / friends?
□ Very Unlikely   □ Unlikely   □ Somewhat Unlikely   □ Neutral   □ Somewhat Likely   □ Likely   □ Very Likely

Q#M8: How *trustworthy* is the financial advisor who sells or strongly promotes such investment??
□ Not trustworthy at all   □ Not trustworthy   □ Somewhat not trustworthy   □ Neutral   □ Somewhat trustworthy   □ Trustworthy   □ Totally trustworthy

Q#M9: How much *risk* is there in terms of the *interest* paid for this investment?
□ No risk   □ Low risk   □ Somewhat low risk   □ Undecided   □ Somewhat high risk   □ High risk   □ Very high risk

Q#M10: In the *worst case* scenario, are the *losses* significant to you?
□ Very Insignificant   □ Insignificant   □ Somewhat Insignificant   □ Neutral   □ Somewhat Significant   □ Significant   □ Very Significant

Q#M11: In the *best case* scenario, are the *gains* significant to you?
□ Very Insignificant   □ Insignificant   □ Somewhat Insignificant   □ Neutral   □ Somewhat Significant   □ Significant   □ Very Significant

Q#M12: How much *eye-catching* is the booklet design?
□ Not at all eye-catching   □ Not eye-catching   □ Somewhat not eye-catching   □ Undecided   □ Somewhat eye-catching   □ Eye-catching   □ Very eye-catching

Q#M13: How *helpful* was *the graph* in understanding the information of the investment offered?
□ Not helpful at all   □ Not helpful   □ Somewhat not helpful   □ Undecided   □ Somewhat helpful   □ Helpful   □ Very helpful

Page #5 Stimuli condition #3: Photo

Please consider the following situation:
You have the choice of investing some extra money. Your financial advisor, after being asked for his opinion, points out to you an informational leaflet that explains "Principal protected note", an investment offered by the bank. Please take a look at the brochure presented below and evaluate the offered investment.

PRINCIPAL PROTECTED NOTE

Invest $10,000 in the Principal Protected Note today.
After one year you will receive no less than 100% of your initial investment,
that is $10,000, plus the interest, which depends solely on the unpredictable
economic conditions: in one year you will have an equal chance to earn 10%
interest on your investment, that is $1,000, or 0% interest, that is $0.

INVESTMENT OFFER

your bank

Q#M1: How easy is it to *understand* the information provided in the informational leaflet?
☐ Very Difficult   ☐ Difficult   ☐ Somewhat Difficult   ☐ Neutral   ☐ Somewhat Easy   ☐ Easy   ☐ Very Easy

Q#M2: How great is your *willingness* to accept this investment offer?
☐ Very Unwilling   ☐ Unwilling   ☐ Somewhat Unwilling   ☐ Neutral   ☐ Somewhat Willing   ☐ Willing   ☐ Very Willing

Q#M3: Please assume that alternatively you could also keep your money in a secure savings account paying 2% of interest per year. Now, how *attractive* is the investment offered in the informational leaflet?
☐ Very Unattractive   ☐ Unattractive   ☐ Somewhat Unattractive   ☐ Neutral   ☐ Somewhat Attractive   ☐ Attractive
☐ Very Attractive

Q#M4: This question is to see if you have understood the information provided in the advertisement above.

Consider the advertisement above, what is the *maximum* and *minimum* amount of interest you could *gain* if you chose to accept the offer (consider all the investment period)? Please, enter the *max* and *minimum* amounts in the US dollars ($) and the time till maturity (number of years), as explained in the advertisement. eg.:

Max=$..., Min=$..., Time until maturity= ... years [   ]

Q#M5: How *likely* is it for you to *keep* this informational leaflet or *take* it home?

☐ Very Unlikely   ☐ Unlikely   ☐ Somewhat Unlikely   ☐ Neutral   ☐ Somewhat Likely   ☐ Likely   ☐ Very Likely

Q#M6: How *likely* is it for you to *show* this informational leaflet to your family / friends?
☐ Very Unlikely   ☐ Unlikely   ☐ Somewhat Unlikely   ☐ Neutral   ☐ Somewhat Likely   ☐ Likely   ☐ Very Likely

Q#M7: How *likely* is it for you to *recommend* this investment to your family / friends?
☐ Very Unlikely   ☐ Unlikely   ☐ Somewhat Unlikely   ☐ Neutral   ☐ Somewhat Likely   ☐ Likely   ☐ Very Likely

Q#M8: How *trustworthy* is the financial advisor who sells or strongly promotes such investment??
☐ Not trustworthy at all   ☐ Not trustworthy   ☐ Somewhat not trustworthy   ☐ Neutral   ☐ Somewhat trustworthy   ☐ Trustworthy   ☐ Totally trustworthy

Q#M9: How much *risk* is there in terms of the *interest* paid for this investment?
☐ No risk   ☐ Low risk   ☐ Somewhat low risk   ☐ Undecided   ☐ Somewhat high risk   ☐ High risk   ☐ Very high risk

Q#M10: In the *worst case* scenario, are the *losses* significant to you?
☐ Very Insignificant   ☐ Insignificant   ☐ Somewhat Insignificant   ☐ Neutral   ☐ Somewhat Significant   ☐ Significant   ☐ Very Significant

Q#M11: In the *best case* scenario, are the *gains* significant to you?
☐ Very Insignificant   ☐ Insignificant   ☐ Somewhat Insignificant   ☐ Neutral   ☐ Somewhat Significant   ☐ Significant   ☐ Very Significant

Q#M12: How much *eye-catching* is the booklet design?
☐ Not at all eye-catching   ☐ Not eye-catching   ☐ Somewhat not eye-catching   ☐ Undecided   ☐ Somewhat eye-catching   ☐ Eye-catching   ☐ Very eye-catching

Q#M13: How *attractive* is the face in the leaflet in your opinion?
☐ Very unattractive   ☐ Unattractive   ☐ Somewhat unattractive   ☐ Undecided   ☐ Somewhat attractive   ☐ Attractive   ☐ Very attractive

Q#M14: Which *facial feature* attracted most of your attention?
☐ Eyes/gaze   ☐ Lips/mouth/smile   ☐ Hairstyle   ☐ Overall expression   ☐ Emotion conveyed
☐ Other [   ]

Q#M15: *You* and the *model* in the advertisement are...
☐ Same gender   ☐ Opposite gender

Q#M16: *You* and the *model* in the advertisement are...
☐ Close in age   ☐ Different in age

Q#M17: *You* and the *model* in the advertisement are...
☐ Same race   ☐ Different race

Page #6 Stimuli condition #4: Graph & Photo

Please consider the following situation:
You have the choice of investing some extra money. Your financial advisor, after being asked for his opinion, points out to you an informational leaflet that explains "Principal protected note", an investment offered by the bank. Please take a look at the brochure presented below and evaluate the offered investment.

Q#M1: How easy is it to *understand* the information provided in the informational leaflet?
☐ Very Difficult   ☐ Difficult   ☐ Somewhat Difficult   ☐ Neutral   ☐ Somewhat Easy   ☐ Easy   ☐ Very Easy

Q#M2: How great is your *willingness* to accept this investment offer?
☐ Very Unwilling   ☐ Unwilling   ☐ Somewhat Unwilling   ☐ Neutral   ☐ Somewhat Willing   ☐ Willing   ☐ Very Willing

Q#M3: Please assume that alternatively you could also keep your money in a secure savings account paying 2% of interest per year. Now, how *attractive* is the investment offered in the informational leaflet?
☐ Very Unattractive   ☐ Unattractive   ☐ Somewhat Unattractive   ☐ Neutral   ☐ Somewhat Attractive   ☐ Attractive
☐ Very Attractive

Q#M4: This question is to see if you have understood the information provided in the advertisement above.
Consider the advertisement above, what is the *maximum* and *minimum* amount of interest you could *gain* if you chose to accept the offer (consider all the investment period)? Please, enter the *max* and *minimum* amounts in the US dollars ($) and the time till maturity (number of years), as explained in the advertisement. eg.:
Max=$..., Min=$..., Time until maturity= ... years

☐ Very Unlikely   ☐ Unlikely   ☐ Somewhat Unlikely   ☐ Neutral   ☐ Somewhat Likely   ☐ Likely   ☐ Very Likely

Q#M5: How *likely* is it for you to *keep* this informational leaflet or *take* it home?
☐ Very Unlikely   ☐ Unlikely   ☐ Somewhat Unlikely   ☐ Neutral   ☐ Somewhat Likely   ☐ Likely   ☐ Very Likely

Q#M6: How *likely* is it for you to *show* this informational leaflet to your family / friends?
☐ Very Unlikely   ☐ Unlikely   ☐ Somewhat Unlikely   ☐ Neutral   ☐ Somewhat Likely   ☐ Likely   ☐ Very Likely

Q#M7: How *likely* is it for you to *recommend* this investment to your family / friends?
☐ Very Unlikely   ☐ Unlikely   ☐ Somewhat Unlikely   ☐ Neutral   ☐ Somewhat Likely   ☐ Likely   ☐ Very Likely

Q#M8: How *trustworthy* is the financial advisor who sells or strongly promotes such investment??
☐ Not trustworthy at all   ☐ Not trustworthy   ☐ Somewhat not trustworthy   ☐ Neutral   ☐ Somewhat trustworthy   ☐ Trustworthy   ☐ Totally trustworthy

Q#M9: How much *risk* is there in terms of the *interest* paid for this investment?
☐ No risk   ☐ Low risk   ☐ Somewhat low risk   ☐ Undecided   ☐ Somewhat high risk   ☐ High risk   ☐ Very high risk

Q#M10: In the *worst case* scenario, are the *losses* significant to you?
☐ Very Insignificant   ☐ Insignificant   ☐ Somewhat Insignificant   ☐ Neutral   ☐ Somewhat Significant   ☐ Significant   ☐ Very Significant

Q#M11: In the *best case* scenario, are the *gains* significant to you?
☐ Very Insignificant   ☐ Insignificant   ☐ Somewhat Insignificant   ☐ Neutral   ☐ Somewhat Significant   ☐ Significant   ☐ Very Significant

Q#M12: How much *eye-catching* is the booklet design?
☐ Not at all eye-catching   ☐ Not eye-catching   ☐ Somewhat not eye-catching   ☐ Undecided   ☐ Somewhat eye-catching   ☐ Eye-catching   ☐ Very eye-catching

Q#M13: How *attractive* is the face in the leaflet in your opinion?
☐ Very unattractive   ☐ Unattractive   ☐ Somewhat unattractive   ☐ Undecided   ☐ Somewhat attractive   ☐ Attractive   ☐ Very attractive

Q#M14: Which *facial feature* attracted most of your attention?
☐ Eyes/gaze   ☐ Lips/mouth/smile   ☐ Hairstyle   ☐ Overall expression   ☐ Emotion conveyed
☐ Other

Q#M15: *You* and the *model* in the advertisement are...
☐ Same gender   ☐ Opposite gender

Page #6 cont. Stimuli Condition #4: Graph & Photo

Q#M16: *You* and the *model* in the advertisement are...

☐ Close in age   ☐ Different in age

Q#M17: *You* and the *model* in the advertisement are...

☐ Same race   ☐ Different race

Q#M18: Is the model's facial expression (gender, race, age, attractiveness) chosen appropriately for the given advertisement?

	Very inappropriate	Inappropriate	Somewhat inappropriate	Undecided	Somewhat appropriate	Appropriate	Very appropriate
Facial expression	☐	☐	☐	☐	☐	☐	☐
Gender	☐	☐	☐	☐	☐	☐	☐
Race	☐	☐	☐	☐	☐	☐	☐
Age	☐	☐	☐	☐	☐	☐	☐
Attractiveness	☐	☐	☐	☐	☐	☐	☐

Q#M19: How *helpful* was *the graph* in understanding the information of the investment offered?

☐ Not helpful at all   ☐ Not very helpful   ☐ Somewhat not helpful   ☐ Undecided   ☐ Somewhat helpful   ☐ Helpful   ☐ Very helpful

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Page #7 Demographics

Tell us about yourself:

Q#D1: In which *country* were you *born*? Drop-down LIST ▽

Q#D2: In which *country* do you *live*? Drop-down LIST ▽

Q#D3: What was your age? Drop-down LIST ▽

Q#D4: What is your gender?

☐ Female   ☐ Male

Q#D5: What is the highest level of *education* you have completed?

☐ Elementary   ☐ 2-year College Degree   ☐ Ph.D. / Postdoctoral Degree
☐ High School   ☐ 4-yearCollege/ Bachelors Degree   ☐ Other [   ]
☐ Some College   ☐ Masters College Degree

Q#D6: What is your current *martial* status?

☐ Single   ☐ Married   ☐ Living with partner   ☐ Divorced/Separated   ☐ Other [   ]

Q#D7: What is your *race*?

☐ African Descent/ Black   ☐ Caucasian/ White   ☐ Pacific Islander   ☐   Mixed   ethnicity
☐ Asian (Indian)   ☐ Middle Eastern   ☐ Latin American / His-   [   ]
☐ Asian (Other)   ☐ Native American   panic   ☐ Other [   ]

Q#D8: *Employment:* You are currently...

☐ Employed Full Time   ☐ Unemployed   ☐ Student   ☐ Disabled
☐ Employed Part Time   ☐ Homemaker   ☐ Retired   ☐ Other [   ]

Q#D9: Please indicate your current annual household *income* in U.S. dollars (after tax).

My current net income per year in the U.S. dollars ($) is: $ [   ] .

Q#D10: What is your *mother tongue* (native language)?

If you are completely multi-lingual, please list the relevant languages: [   ] .

Page #8 Riskaversion

Q#R1: Do you smoke?
☐ No   ☐ Occasionally   ☐ Socially   ☐ Regularly   ☐ Trying to quit

Q#R2: Do you play lottery?
☐ No   ☐ Occasionally   ☐ Regularly

Q#R3: Do you gamble?
☐ No   ☐ Occasionally   ☐ Regularly

Page #9 (1) Economic Knowledge

Q#E1: How would you assess your understanding of economics?
☐ Very poor   ☐ Poor   ☐ Average   ☐ Good   ☐ Very Good

Q#E2: How much of your education was devoted to economics?
☐ None   ☐ Hardly at all   ☐ Little   ☐ Some   ☐ A lot

Page #9 (2) Prior knowledge of concepts related to study

Q#E3: What is your most important source of advice when you have to make important financial decisions for the household?

☐ Financial magazines, guides, books
☐ Brochures from my bank or mortgage adviser
☐ Parents, friends or acquaintances
☐ Information from the newspapers
☐ Financial computer programs
☐ Advertisements on TV, in papers or other media
☐ Financial information on the Internet
☐ Professional financial advisers
☐ Other (explain)

Q#E4: Do you own stocks or mutual funds?
☐ Yes   ☐ No

Q#E5: Do you have a trading account online?
☐ Yes   ☐ No

Page #9 (3) Emitted questions

Q#E6: How much do you know about persuasion techniques, such as priming and framing?
(No knowlege)   ☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5   ☐ 6   ☐ 7   (Expert knowledge)

Q#E7: How familiar are you with the advertising industry?
(Very unfamiliar)   ☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5   ☐ 6   ☐ 7   (Very familiar)

Q#E8: How familiar are you with the financial services industry?
(Very unfamiliar)   ☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5   ☐ 6   ☐ 7   (Very familiar)

Appendix B-5: Basic financial literacy scale

Q#B1: Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?
□ Less than $102 □ More than $102 □ Exactly $102 □ Do not know

Q#B2: 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 today □ Exactly the same □ Less than today □ Do not know

Q#B3: Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?
□ More than today □ Exactly the same □ Less than today □ Do not know

Q#B4: Assume a friend inherits $10,000 today and his brother inherits $10,000 five years from now.
Who is richer because of the inheritance?
□ My friend □ They are equally rich □ His brother □ Do not know

Q#B5: Suppose that in the year 2012, your income has doubled and prices of all goods have doubled too. In 2012, how much will you be able to buy with your income?
□ More than today □ Less than today □ The same □ Do not know

Appendix B-6: Advanced financial literacy scale

Page #11 **Advanced financial literacy questions**

Q#A1: Which of the following statements describes the main function of the stock market?

☐ The stock market results in an increase in the price of stocks
☐ The stock market helps to predict stock earnings
☐ The stock market brings people who want to buy stocks together with those who want to sell stocks
☐ None of the above
☐ Do not know

Q#A2: Which of the following statements is correct?

☐ Mutual funds can invest in several assets, for example invest in both stocks and bonds
☐ Once one invests in a mutual fund, one cannot withdraw the money in the first year
☐ Mutual funds pay a guaranteed rate of return which depends on their past performance
☐ None of the above
☐ Do not know

Q#A3: If the interest rate falls, what should happen to bond prices?
☐ Fall   ☐ Stay the same   ☐ Rise   ☐ None of the above   ☐ Do not know

Q#A4: Which statement is TRUE?

☐ Buying a company stock usually provides a safer return than a stock mutual fund.
☐ Buying a stock mutual fund usually provides a safer return than a company stock.
☐ Do not know

Q#A5: Which statement is TRUE?

☐ Bonds are normally riskier than stocks.
☐ Stocks are normally riskier than bonds.
☐ Do not know

Q#A6: Considering a long time period (for example 20 years), which asset normally gives the highest return?
☐ Stocks   ☐ Bonds   ☐ Savings accounts   ☐ Do not know

Q#A7: Normally, which asset displays the highest fluctuations over time?
☐ Savings accounts   ☐ Bonds   ☐ Stocks   ☐ Do not know

Q#A8: When an investor spreads his money among different assets, does the risk of losing money:
☐ Decrease   ☐ Increase   ☐ Stay the same   ☐ Do not know

Page #12 **Some Control Questions:**

CONGRATULATIONS! You are very close to the finish line!

Q#G2: In your opinion, what was the underlying purpose of this study?
Please, explain in your own words.

Q#G3:   Finally, in order to facilitate our research, we are interested in knowing whether you actually take the time to read the directions; if not, then the data we collect based on your responses will be invalid for our research. So, in order to demonstrate that you have read the instructions, simply write "I read the instructions" in the box labeled "Any comments or questions?" Then, feel free to add additional comments. You do not need to skip any questions.

Q#G4:   Here, please input your *Amazon WorkerID* or *UserName* the same that you created at the beginning of the survey:

Q#G5: Any comments or questions?

Q#G6: Please, provide your email if you would like to participate in our future experimental studies. Your email will be kept confidential and used only to invite you to participate in the academic research conducted by University of Venice Ca'Foscari (possibly providing higher compensation as well).

Feel free to contact us regarding questions, concerns and our research by sending us an email at *visualperception-lab@gmail.com.*

□ No, thanks □ Yes, I would like to participate in your future studies. Enter your e-mail:

CHAPTER 2

Experts' and Novices' Judgment in Retail Finance

Contents

1. Introduction

Consumers are increasingly responsible for managing their personal finances (Benartzi and Thaler, 2013). For people, however, understanding and choosing among the ever-expanding variety of complex financial products is not a trivial task (Lynch JR., 2011). Less financially savvy individuals often seek financial advice and rely heavily on professional guidance for making non-speculative and unbiased economic decisions (Collins, 2012; Hackethal, Haliassos, and Jappelli, 2012). Behavioral finance as well as cognitive psychology researchers have documented a large spectrum of heuristic decision-making processes that might lead to cognitive illusions, such as representativeness, neglect of base rates, illusory correlation, hindsight bias, anchoring (Dokko, 2012), overconfidence (Chu, Im, and Jang, 2012; Fellner and Krügel, 2012; Kaustia and Perttula, 2008), mental accounting (R., 1985; Zhou and Pham, 2004), loss aversion (Kamenica, 2012; Weber and Johnson, 2009), regret aversion, the availability heuristic, confirmation bias and gambler's fallacy (Singh, 2012). These have all been documented in behavioral finance during the last two decades (e.g. Almenberg and Gerdes, 2012; Kahneman, Slovic, and Tversky, 1982). Some research suggests that heuristic-driven bias and framing effects that lead to suboptimal financial decisions can be reduced or even eliminated if some conditions are met. Some literature argued that experience and extensive knowledge could serve as a remedy to overcome some of the cognitive illusions and biases. Nonetheless, research on expert performance in decision making tasks has contradictory findings (Weiss and Shanteau, 2003), whereas most decision-making literature suggests that, due to heuristics, experts exhibit systematic biases and they are not "immune to the cognitive illusions that affect other people" (Kahneman, 1991).

Financial service and product promoters often act as financial advisers and provide expert judgment to aid naïve consumers facing important financial decisions (Bhattacharya, Hackethal, Kaesler, Loos, and Meyer, 2012; Collins, 2012; Hackethal et al., 2012). Such advisers often acquire their status as experts via education or direct experience in financial domain, but the accuracy and the objectivity of their assessments and predictions are rarely questioned by their clients (Schwartz, Luce, and Ariely, 2011). In other terms, an expert adviser might be more similar to a novice consumer than is generally believed. This fact, if true, can further reinforce the conditions of wide-spread suboptimal financial decision making. The literature on expert decision making proposes divergent arguments concerning this issue. Some suboptimal behaviors by experts can be explained by the narrow scope of knowledge and the limited range of applications. Given a novel task to deal with, an expert may not know how to solve it (Shanteau, 1992) but at the same time he might not be keen to admit that the task exceeds his expertise (Weiss and Shanteau, 2012). Other researchers emphasize cognitive aspects such as information overload, time pressure, and over-cofindence (Andrade, 2011) to impair expert decision making. We, instead, consider how financial experts' comprehension can be influenced by variations visual cues and their salience, and to which

extent they lead people to engage more deeply in processing these elements while neglecting more relevant ones. We hypothesize that financial advisers have developed ability of taking perspective and predict their customers' preferences quite accurately. On the other hand, experts show to be prone to biases affecting their expert judgment skills. We suggest that information presentation format can influence on what features and attributes people focus the most and how they perceive and evaluate the provided information.

Across two parts of experiment, we show that variations in presentation leads to attentional and attitudinal shifts that can help to explain irrational behaviors, such as overrating potential benefits of the offer and willingness to recommend it to the client. First, we experimentally test how advisers perceive their client preferences and find that advisers are quite skilled in predicting consumers' attitudes toward advertised products. Second, we examine both financial professionals' and ordinary consumers' comprehension of disclosed information in variety of financial communications and assess their preferences for advertised products and services. We find that the financial services and products promoters show systematic biases, in some cases even stronger than those of novices. These kind of departures from optimal evaluation process by advisers cannot be explained by existing theory of expertise that assumes experts to be on average better decision makers, at least in their field of knowledge. Instead, it appears that in this case expertise might not correspond to the traditional definition. We suggest that this is because expertise might be a privileged one, leaving advisers to be experts in consumer perspective taking or in financial service marketing and not necessarily in financial decision making. These data provide a previously under-explored viewpoint of decision making and perspective taking by finance professionals, which could provide some important insights into understanding misguided financial choices among households. We discuss how this mechanism may also explain other paradoxes related to increased distrust in financial institutions (Martenson, 2008), choice confusion, and financial decision avoidance among people. We also address some implications for policy concerning the adviser - consumer relationship and other aspects of retail finance in a more general sense.

Prior research provides evidence that non-verbal advertising content, such as face stimuli and illustrative graphs, may affect demand for a financial product (Bertrand, Karlan, Mullainathan, Shafir, and Zinman, 2010; Macgregor, Slovic, Dreman, and Berry, 2010; Olivola and Todorov, 2010; Steffen, Rockstroh, and Jansma, 2009). The complex financial instruments have become inseparable elements in defining innovation in the world of financial engineering (Gaurav, Cole, and Tobacman, 2011; Olazábal and Marmorstein, 2010). This trend is reflected in a growing number of offerings available not only to institutional investors but also to individual consumers (Dubeli and Vanini, 2010; Fisher, 2006; Laise, 2006). Enormous losses suffered by naïve investors during the recent financial meltdown can partially be attributed to inadequately regulated marketing of such engineered products to economically unsophisticated people (Olazábal and Marmorstein, 2010).

Even though recent years have shown some significant progress in restricting sales of complex financial instruments to retail investors and implementing further guidelines for financial communication format (Barr, Mullainathan, and Shafir, 2012), the general regulation of advertising content leaves plenty of room for variability in visual presentation style and content. Most financial-service advertising regulations do not directly forbid use of visuals, such as explanatory graphs or photographs in promotional and informational materials (Garrison, Hastak, Hogarth, Kleimann, and LEevy, 2012). For instance, a recent consumer credit marketing field experiment in South Africa has provided evidence that advertising content does affect demand: specifically, incorporating a photograph of an attractive female results in increased loan demand by as much as 25% reduction in the interest rate (Bertrand, Karlan, Mullainathan, Shafir, and Zinman, 2010). Unsurprisingly, for the last three decades scholars of behavioral finance and consumer research have occasionally argued that neither visual perception or decision making should be seen as isolated phenomena (i.e. Mandel and Johnson, 2002). Moreover, some psychology of consumer choice, neuroscience, perception, decision and cognitive science research articles invite us to fill "a blind spot" with regard to the role of visual aids in both perception of risk and financial choice (e.g. Diacon and Hasseldine, 2007). More broadly, visualization encapsulates the information of risk bearing financial products in the form of charts, graphs, diagrams, tree-maps, and tables, which in turn continue to provide common language for coordination between various financial actors, such as investment engineers, financial service promoters, and consumers. For instance, accurately designed investment graphs most often facilitate investors to visualize and process complex interrelationships between risk and return (Raghubir and Das, 2010). While a broad spectrum of visual artifacts act as a bridge between the world of financial service providers and consumers, some of them are used to draw viewers attention to factors that might lead to skewed perception of factual information. More often, the visual evolves as "the play of real and appearance" (Gane, 1991). Barry (1997) argues that impact of visuals on the quality of individual lives is enormous, and that it is necessary to understand the associated implications and to educate people. The advertisers have long understood the value of "creative" content in consumer persuasion (Barry, 1997; Mullainathan, Schwartzstein, and Shleifer, 2008). "The visual dominates, the verbal augments" and "it will be more so in the future", as was promised by Dondis four decades ago (Dondis, 1973). A handful of laboratory experiments in psychology and marketing and decision sciences have documented the effects of non-informative content on consumer perceptions of advertised products. Likewise, in consumer finance and in marketing of financial service research (Piercy, Campbell, and Heinrich, 2011) there is still a gap (Pitt, 2012) in defining links between expertise and advertising content effects. In this paper, we argue that it is very important assessing the potential impact of visuals on financial information comprehension and evaluation: we reach this conclusion by focusing on a rarely studied sample, namely, the industry experts. We explore whether and to which extent the specific non-informative

visual cues matter in this context.

To test our hypothesis, we use a large-scale experiment recruiting both financial experts and novices in order to study the effects of advertising content on perceptions and evaluations of financial disclosures in ads. Recent evidence shows that automatic inferences from faces alter decisions that people make in a variety of important domains, including finance (Steffen et al., 2009; Verosky and Todorov, 2013). In addition, the inclusion of portraits can signal trustworthiness, shaping consumers' preference for and choice of financial products (Olivola and Todorov, 2010). It is, therefore, important to examine how visual content influence expert subjects (Wang and Dowding, 2010) when evaluating financial products. By focusing on experts, we explore how visual advertisement content elements, such as forecast performance graphs and evocative portraits, when used creatively in conjunction with written language, can serve as persuasion tools (Malkewitz, Wright, and Friestad, 2003) in altering people's perception of a particular financial offer. To gain a deeper insight into this not yet fully explored dimension of financial expertise, we particularly focus on circulation of visuals in advertising of popular financial offers that hypothetically could be available to retail consumers. We aim to reach a better understanding of the role of advertising and marketing on the important financial choices made by expert and novice decision makers. The experiment is conducted using *Qualtrics* online survey service and Amazon's Mechanical Turk (AMT), a viable platform for conducting visual and graphical perception experiments as well as recruiting participants globally (Heer and Bostock, 2010). The study randomly divides both experts and globally sampled novices into five treatment groups, which are then asked to evaluate four different financial offers. Each group receives exactly the same information while only the visual cues differ. Following the experiment, we measure financial knowledge and experience of each participant. To assess the basic and advanced financial knowledge of naïve participants we use the widely accepted Lusardi's financial literacy scale (Van Rooij, Lusardi, and Alessie, 2007). Consistent with prior research, our data suggest that the attitude toward advertised product may be influenced by prior knowledge or expertise in the financial domain.

The exploration of advertisement content effects by use of graphs and photographs in the financial communications is not completely absent from financial research (Gottlieb, Weiss, and Chapman, 2007; Olazábal and Marmorstein, 2010; Wang and Dowding, 2010; Zhou and Pham, 2004). However, to the best of our current knowledge, none of the earlier studies has analyzed the relationship between financial expertise and responsiveness to information mode and presentation format in the context of risk. A few closely related studies are discussed in further detail in the Literature review section, with focus on shared similarities and differences.

The main objectives guiding this research are:

- Better understand decision-making processes of finance professionals, and collect experimental evidence regarding the most influential visual elements that could bias their judgment and

subsequent advice;

- Examine to which extent the visually represented data overpowers the numerical one, and analyze the causal relationship between expertise and the ability to evaluate disclosures despite of information mode;

- Investigate whether perception of competence of finance professionals can be manipulated by use of creative advertising content;

- Explore whether presence of an evocative portrait can alter attitudes and beliefs of the readers, as well as investigate whether images of professional fund managers can act as socially relevant stimuli enhancing trust perception and whether this perception varies with gender and emotion of the portrayed face;

- Examine whether there is consistent evidence that advisers are able to take their clients' perspective and predict their behavior;

- Understand whether gender, age, financial education, and cultural background are relevant factors in perception of investment risk and responsiveness to visual stimuli.

The remainder of the chapter is structured as follows. In Section 2 we give a general overview of related work in the context of expert and novice financial decision making. In addition, we briefly discuss relevant research in the areas of persuasion and impression management in retail finance, with a special focus on effects of type of disclosure in financial advertising and communication. Related studies are summarized last. In Section 3, we state the problem addressed and the terminology used along the chapter. We also present the hypotheses guiding this study. In Section 4, the methodology is presented. The results obtained from the experiment are discussed in Section 5. Finally, we draw some conclusions and considerations, and describe future work in Section 7.

2. Related Work

2.1. Experts and Novices

'No lesson seems to be so deeply inculcated by the experience of life as that you never should trust experts" (Lord Salisbury, 1877 cited in Shanteau (1992))

It is challenging to define expertise or try to list its characteristics, as some authors have attempted to do (for example, Shanteau (1992)). Expertise literature is rather vast and spans a number of different scientific domains. The general agreement is that expertise corresponds to skills that are nothing but the accumulation of domain specific knowledge and methods during many years of training and practice (Alba and Hutchinson, 1987; Brucks, 1985; Markus, Smith, and Moreland, 1985). Cognitive psychology studies have introduced a variant view of expert-novice

differences in number of dimensions of cognitive functioning, from memory and learning to problem solving and reasoning (Anderson, 1980; Ross and Anderson, 1981). Expertise is domain specific: often experts are not able to take advantage of their skills outside of their area of expertise, as their cognitive processes are suited to tackle unique characteristics of a specific problem area. Generally, financial expertise is defined in terms of "what people perceive they know about a product or product class" (Brucks, 1985). Despite numerous claims in cognitive psychology that any individual can achieve expert performance with practice, there is still considerable evidence that people differ significantly in general ability or domain specific abilities. Even if novices have general ability to process information, they may lack skills and motivation to process information that is complex and demands for domain specific knowledge to make a reasonable inference.

Research on expert superior performance has contradictory findings (Lambert, Bessière, and N'Goala, 2012; Weiss and Shanteau, 2003), whereas most decision-making literature suggests that due to heuristics experts exhibit systematic biases and they are not "immune to the cognitive illusions that affect other people" (Kahneman, 1991). In facts, prior studies have shown that experts suffer from overconfidence and often overestimate the accuracy and depth of their knowledge (Koriat, Lichtenstein, and Fischhoff, 1980; Lichtenstein, Fischhoff, and Phillips, 1981). Shefrin (2001) found evidence that portfolio managers and financial analysts often overestimate stock returns, and attributes these results to the representativeness heuristic. Kaustia and Perttula (2008) research showed that financial advisers are not only prone to overconfidence but also to anchoring effects in respect to return expectations. Furthermore, (Kaustia, Laukkanen, and Puttonen, 2009) focused on inconsistency in preferences and evaluation of 741 professional financial advisers. The authors show that that visual framing and use of graphs can alter perception of expected investments' risk and return. Interestingly, another bias of professional traders is documented by Haigh and List (2005): the authors find professionals to be affected by myopic loss aversion at a greater magnitude compared to students. Some other research, on the other hand, focuses on possible solutions that could be useful in reducing forecast optimism among analysts (e.g., Kadous, Krische, and Sedor, 2006) and other financial industry professionals. Gilad and Kliger (2008) findings show that, compared to students, financial advisers' risks attitude and investment decision can be affected to a grater degree. Similar to Gilad and Kliger's study, other studies have questioned the implications of mutual funds advertising and communication strategies. The authors' concern is to understand how the past performance representations can affect investors of varying knowledge levels (Barber, Odean, and Zheng, 2005). Capon, Fitzsimons, and Alan Prince (1996) report that most investors appear to be naïve, having little knowledge of the investment strategies. Husser and Wirth (2013) examine what cognitive processes are associated in consumer investors' information processing of mutual fund characteristics. In their study, Husser and Wirth (2013) manipulate processing abilities of investors by varying the duration of information exposure time to a mutual fund advertisement, leading

to conclusions that consumer investors with lower knowledge of mutual fund characteristics are significantly influenced by prior fund performance. Interestingly, their data suggest that disclaimers warning that past performance does not guarantee future results had no effect on participants with lower processing abilities and attention. Another study, conducted by Kozup and Howlett (2008), examined whether variations in supplemental information disclosure impacted consumers' evaluations of the fund and subsequent investment intentions. Kozup and Howlett argue that investors focus too much on prior performance, and the supplemental information, particularly in a graphical format, can shift perceptions and evaluations of mutual funds.

In line with these studies, we consider the other contextual factors that may be relevant and influential for financial expert behaviors. Prior research provides evidence that non-verbal advertising content, such as face stimuli and illustrative graphs, may affect demand for a financial product (Bertrand et al., 2010; Olivola and Todorov, 2010). Recent evidence shows that automatic inferences from faces alter decisions that people make in a variety of important domains, including finance (Olivola and Todorov, 2010). In addition, the inclusion of portraits can signal trustworthiness, shaping consumers' preference for and choice of financial products (Olivola and Todorov, 2010). It is, thus, important to examine how visual content influences expert subjects (Wang and Dowding, 2010) when evaluating financial products.

Understanding the nature of visual perception may provide useful insights into how perception of disclosure may vary depending on information mode and presentation form. Introducing additional visual cues to an informational content may create conditions under which accurate perception becomes rather challenging and prone to distortion. The present study focuses on the effects of salient visual cues on evaluation of the advertised offers. In the following paragraphs we summarize a broad spectrum of behavioral sciences literature concerning the use of selected visual artifacts to manage impressions and emotions, or even trigger specific perceptual biases in risk-related decision making.

2.1.1.   *Visual perception & persuasion*

> *…the image is felt to be weak with respect of meaning: there are those who think that the image is an extremely rudimentary system in comparison with language and those who think that signification cannot exhaust the image's ineffable richness. […] How does meaning get into the image? Where does it end? And if it ends, what is there beyond? (Barthes, 1977)*

Warren (2005) reminds of the widely-used phrase "seeing is believing" and demonstrates how intuitively we embrace the visual as being the most important way to describe some phenomena. Noteworthy, a strong visual connotation of the word *graphic* originates from the latin *graphicus*, whose etymological meaning is "to write" (Warren, 2005). Numerous studies in neuroscience and neuropsychology have shown that visual information stimuli most often elicit priority processing in human brain (Carretie, Hinojosa, Lopez-Martin, and Tapia, 2007; Rubenstein and Thompson,

2012; Vuilleumier, Armony, Driver, and Dolan, 2003; Winston, Vuilleumier, and Dolan, 2003). This may suggest the reason why today's advertisement, including various financial communications, is increasingly saturated with various forms of visual representations (Barry, 1997; Mitchell, 2005; Nicholas and Mason, 2007). Even text can take different visual forms in terms of various text features, such as font, size, color, and thus influences consumers' behavior (Doyle and Bottomley, 2006). "[In] act of *viewing* we are not just *seeing*" - writes Warren (2005), underlining that "reading" images requires skills, ability to filter viewing experience with acquired cultural, social and psychological knowledge, which is often subjective. Pieters and Wedel (2007) resort to vision science as a way to gain insight into how we build the representations of the world surrounding us with the help of complex mechanisms occurring in the eye and the brain. The authors argue that the role of visuals, both pictorial and textual, can be better understood by interlinking three disciplines: visual science, cognitive psychology, and social psychology. For instance, a recent study in social psychology research has shown that ambiguous visuals are more likely to be perceived as desirable objects than undesirable ones (Balcetis and Dunning, 2006). Persuasion research has found that people appear to have an ability to readily detect and interpret coaxing attempts in advertisement context; nevertheless, it is still difficult to measure the expertise in such visual persuasion (Malkewitz et al., 2003). Financial institutions believe in the effectiveness of visual persuasion and spend large portions of their revenue to shape the content of their messages (Bertrand et al., 2010; Huhmann and Bhattacharyya, 2005; Husser and Wirth, 2013; Lee, Yun, and Haley, 2012). What truly constitutes persuasive advertisement content remains a puzzle (Mullainathan et al., 2008). Knowing the "nature" of finance is very likely that most of the researchers consider, as a starting point, that images, graphs, charts, tables and other visuals are data in themselves (Macgregor et al., 2010; Wang, 2011). Thus, the analyzed visual material "magically" transforms into another source of information, i.e., the "text" about the investments, economic conditions, financial places, or about people who are producers, sellers or buyers of those financial products and services. Clearly, as we will continue stressing throughout this literature survey, it is unwise to consider visual representation as factual or truthful representation, or as an inactive and innocent decoration; rather one should remember that visuals have unbounded power in conveying different perspective or reality, and this can play a crucial role in risk-related decision making. In sum, the above concepts underpin the role and influence of visual stimuli often present in the design of financial communication materials.

2.2. Visual cues in financial communication

Financial services and product advertising are almost universally used as the means of communicating a range of offers and their features (Wang, 2011). It also appears that financial institutions tend to employ various visual tools in designing communications in an attempt to manage readers' impressions. Often, the informational leaflets are purposely fashioned to shape a more favorable

opinion or even to persuade the target audience. The proportion of academic literature focusing on the use of *the visual* in the context of persuasion within behavioral finance is still limited, but growing. Early steps of this direction could be attributed to cognitive psychology studies emphasizing attentional and perceptual processes using abstracted stimuli (Pieters and Wedel, 2007). However, the rapidly changing interest in the topic can be accredited to behavioral and neuroscience research devoting increasing attention on visual perception and framing effects (Beattie and Jones, 2008b; Diacon and Hasseldine, 2007; Dubeli and Vanini, 2010; Husser and Wirth, 2013; Wang, 2011; Wang and Dowding, 2010). Nowadays, visual tools are used excessively by financial service providers as facilitators in representing and communicating investment opportunities to their customers. Recent research of the visual is predominantly in the investigation of "the use and abuse" of graphs in corporate reports, published accounts, web reports, and technical fund performance analyses (Beattie and Jones, 1996, 2000b, 2008b, 1992b). Some other studies have shown that color too can be seen as an important signifier in financial communications (Courtis, 2004; So and Smith, 2002), together with other text features and design elements (Doyle and Bottomley, 2006; Kozup and Howlett, 2008). Lawson, Borgman, and Brotherton (2007) investigated how firms, through the use of the visual, are able to successfully convey the intended corporate message and create different types of "human subjectivities and realities." Graves, Flesher, and Jordan (1996) concluded that, at least in the United States, all-pervasiveness of televisual media have "restructured the American mind that for any discourse to be perceived as valid it must be presented in a television format", that is "kaleidoscopic, glamorous, and entertaining". This statement can be interpreted that in order to persuade investor audiences designer should imitate the way television communicates, which is primarily by entertaining through images: emphasizing not only decorative, glossy and novel parts of visual design, but also its social and rhetorical significance (Graves et al., 1996).

One of the aspects of the present study is specifically designed to investigate the influence of graphs' on the information comprehension and attitude formation. Thus, in the next paragraphs we review the major findings in graph research.

2.3. Graphs and impression management

Graphs have been created by William Playfair over two centuries ago and have been commonly used since. They are symbolic displays which can be interpreted using certain conventions (Kosslyn, 1989). As bridges between the numerate and visual domains, graphs possess a strong communicative power, grounded in visual cognition and spatial intelligence (Anderson, 1980). Pinker (1990) makes a remarkable observation about human cognition: the truth is that "we like to process information in graphic form." Use of financial graphs, in practice, can be attributed to two main purposes: first, to explore and analyze data, and second, to present and communicate information to a target audience. Beattie and Jones (2008b) list six reasons why graphs are used in communication of financial

information: (i) they allow for flexibility often being outside the regulatory remit of standards; (ii) they are eye-catching (especially with use of color) (iii) graphs are excellent in summarizing and distilling financial information (trends, patterns, highlighting anomalies); (iv) graphs tap into a highly developed human cognitive skill - spatial intelligence; (v) they are memorable; (vi) they are egalitarian. The underlying purpose determines what kind of graphs needs to be used. Even if highly regulated, financial advertising often contains graphs that present and communicate past or forecasted financial performance (Husser and Wirth, 2013; Lawson et al., 2007; Lee et al., 2012). These forms of visual elements are usually employed to make their readers quickly grasp trends and relationships, and to boost the return expectations (Husser and Wirth, 2013). Recent research in graph theory has indicated that graphs can make a difficult decision easier and faster only if they are properly designed (Lee et al., 2012). On the other hand, improperly designed or purposely distorted graphs can potentially mislead the readers (Bertin, 1983; Henry, 1995; Kosslyn, 1989, 1994; Tuffte, 1983, 1990, 1997). Experimental study conducted by Tractinsky and Meyer (1999) showed that graph design and content of information varies with presentation purposes, i.e., whether the graphs are designed to persuade or to help the reader in decision making. There is also well-documented literature on how graph design can alter readers' perceptions of the presented information (Beattie and Jones, 2002a,b; Burgess, 2003) and even alter viewer's choices for an investment (Arunachalam and Steinbart, 2002; Barber et al., 2005; Huhmann and Bhattacharyya, 2005; Husser and Wirth, 2013; Lee et al., 2012; Mullainathan et al., 2008; Wilcox, 2003). Both Beattie and Jones (2002b) and Arunachalam and Steinbart (2002) find that decision makers' choices are actually influenced by improperly designed graphs, despite the fact that such graphs are presented with precise, accurate numeric data.

Clearly, the use of visual representation and other techniques of persuasion in advertising guides and directs readers' attention to specific attributes of the offer. Similarly to graphs, photographs can also be included to manage viewers' impressions, as later we will show with our experiment. The significance of photography goes beyond its manifest elements (Warren, 2005) and it "can be used to create critical representations that express ideas in ways written words cannot" (Pink, 2001). Mainly for this reason we choose to use photographical communicative power of portraits made by professionals to represent the mutual fund. Thus, in the next paragraph we present the relevant research discussing photography phenomenon in a broader context as well as the use of evocative portraiture in financial advertising.

2.4. Photographs in financial advertising

> . . . *[in] a succession of metonymies and metaphors which transpose the scene of the*
> *photograph to the spaces of the "other scene" of the unconscious, and also, most importantly, the*

scene of the popular preconscious: the scene of discourse, of language.   (Burgin, 1986)

The above citation poetically describes photography's potential to go beyond its manifest elements (Warren, 2005). Photographic images enable us to see what is happening outside our own spatial and temporal boundaries; however, this benefit does not come without a cost. Taking the post-modern perspective, some authors point out that we tend to immerse into an imaginary world by simply relating to images as if they were the "true real thing" (Baudrillard, 1998; Featherstone, 1991; Welsch, 1997). However, Warren (2005) claims that photographs can no longer be taken as faithful reproductions of reality, *the truth*. Since manipulative use of graphs has been shown to distort the viewer's perceptions of *factual reality* (Beattie and Jones, 2002b, 1992b), e.g., altered expectations of future performance of investment funds (Husser and Wirth, 2013,?), one may wonder if misuse of photographs could be equally or even more powerful in altering the viewers' perception. According to Wells, Burnett, and Moriarty (1995) the use of strong photography has a greater capacity to attract attention than the text in general, and this capacity is proportional to the size of the image. Thus, "the initial attention is more likely to turn to interest with a strong visual" (Wells et al., 1995). The underlying meaning of the picture is not only the subject, but also how the picture is shot and how it is integrated keeping in mind what the message creator intends to communicate both directly and indirectly. However, photographs, more than other visual forms, often convey different messages to different people according to their cultural context, level of knowledge or familiarity with the subjects photographed, and visual culture in general. The subjective perception of photographs is well framed by Loizos (2000) who writes that "the information may be *in* the photograph, but not everyone is equipped to recover it in full". Knowing the main limitation of photographs in general, we now turn back to the philosophical aspect of photographic power to convey complex and subtle meanings. In contrast to *text*, images offer a unique form of communication that are not bounded by strict rules of reading and may convey a *realistic* sense of "what it was like to be there" (Scherer, 1992).

Taking a step away from the strict marketing discipline, behavioral finance literature counts sparse studies examining direct connections between photographic images and investments related decision making. For instance, a particularly interesting study about use of photographs in direct loan marketing was carried out by Bertrand, Karlan, Mullainathan, Shafir, and Zinman (2010) in South Africa. The marketing field experiment, implemented by the consumer lender, provided strong evidence that the photograph of a women favorably affects demand for the loan (Bertrand et al., 2010). Similarly, our study explores the power of the photographic phenomenon in providing non-textual cues for assessment. We expect photographs to stimulate readers' minds by offering them, as Parker (2009) writes, "a greater opportunity to actively engage in the sense-making exercise." Furthermore, our choice to include close-up photographs as experimental stimuli is based on the fact that reducing the perceived physical distance can reduce perception of the psychological

distance (Balcetis and Dunning, 2010). Images that can easily convey a sense of closeness to the referent objects are commonly used in the perceptual analysis, whereas text is less effective in conveying proximity: thus, words are "preferably used to represent distal objects in space, time, and social perspective" (Amit, Algom, and Trope, 2009). Financial institutions sell intangible products and thus the use of photographs can play an essential role in conveying socially relevant information, such as trustworthiness and competence.

2.5. Emotion and financial decision making: the role of faces

It is widely accepted that a broad spectrum of factors influences investors' risk perception and decision making. Each factor's attributed significance varies depending on the discipline and focus of the study itself. In this study, we rather draw our attention to the *emotion* that can be evoked by the presence of a visual, i.e., an evocative face image. Rational models of decision making rarely consider an emotional state as a relevant variable, but it may well be one (Steffen et al., 2009). Nevertheless, today there is a large body of empirical research in neuroscience, psychology and behavioral economics arguing that emotions do play a role in decision making (e.g., Camerer, Loewenstein, and Prelec, 2004; Knutson, Rick, Wimmer, Prelec, and Loewenstein, 2007; Tversky and Kahneman, 1973). "Emotions and risk perceptions are sensitive to context and framing," states Huang (2008) in response to Kahan's article *Two Conceptions of Emotion in Risk Regulation*. Explaining the roles that emotions play in risk perception is not a trivial task because they are *not* "fixed and stable" characteristics of an individual; rather, they are time and situation dependent. Therefore, these roles should not be ignored. Huang (2008) argues that emotions are more than mere biases or "expressive" perceptions, and that risk perception requires "not only negative emotions, such as anger, anxiety, and fear, but also positive emotions, such as contentment, hope, and serenity". Huang compares risk perception to preferences that are "not so much revealed as they are constructed, formed, or learned". Most emotions are easily perceived from facial expressions because emotions are universally recognized. It is widely believed that humans are biologically prepared for recognition of these facial expressions (Öhman, 1993). Additionally, emotional stimuli can highly influence a variety of cognitive processes, such as risk perception or investment-related decision making (e.g. Bradley, Mogg, and Millar, 2000; Fox, Lester, Russo, Bowles, Pichler, and Dutton, 2000).

In the present case, to elicit selected emotions we employ some priming techniques. For instance, in the experimental materials of this study we attempt to include faces that appear to convey trust to potential customers. Behaviorally, the act of trust corresponds to an expectation that the act will pay off in terms of the investor's goals. Additionally, when considering trust behavior, the crucial role is played by an individual's perceptions of others' "trustworthiness" and his or her "willingness" to undertake the risks associated with trusting acts (Fehr, 2009). Moreover, emotional expressions,

not being fully under control by an individual, "make emotional states transparent in the way that thoughts and beliefs can never be" (Etcoff and Magee, 1992). For instance, the experiment of DeBruine (2002), in which morphed faces were used to represent partners in a trust game, showed that experiment participants "trusted opponents who resembled themselves significantly more than they trusted other opponents" and it was concluded that "facial resemblance is a candidate cue for human visual phenotype matching" (DeBruine, 2002). Thus, inspired by the conclusions of Fehr (2009), we analyze the potential trust gap across genders. Since there is no generally agreed measure of trust except for a few frequently used survey questions that have been used to measure national and cross-cultural differences in trust (Fehr, 2009), here we employ seven item rating scale, similar to one developed by Likert (Likert, 1932), to asses participants perception of the financial adviser's trustworthiness and competence. In this way, we explore the emotion, gender, and image effects on perception of disclosure as well as the perceived trustworthiness and the competence of the fund managers. By considering the already mentioned differences and similarities, it is worth comparing our results with those of the above studies. This comparison will be addressed in later sections, where the experimental results are discussed.

3. Research Questions and Hypotheses

The last section of literature review suggests, that in the recent years, finance research community has evidenced a growing interest in the advertising content effects. Still, there is enough room for contributions analyzing and documenting the use of both graphic and photographic images as relevant dimensions of perception and judgment of risky opportunities in the context of expertise and prior knowledge. Because there are no conclusive results that specifically compare comprehension and perception of financial information of expert and novice decision makers when types of visual mode and visual presentation format of disclosure vary, our research asks the following research questions:

Research Question 1 : What are the effects of the information mode and the presentation format on shifting experts' comprehension and perception of the financial services and/or products disclosures in advertisement material?

Research Question 2 : Are financial experts able to predict their clients' perceptions and comprehension disclosure of the advertised financial product or service?

3.1. Experiment

The experiment is aimed at examining to which extent the visually framed data leads to different impressions as opposed to when the numeric data are presented. Specifically, we analyze the causal relationship between financial expertise, literacy, and ability to evaluate financial information despite

its presentation format or presence of non-informative visual cues (e.g., face photographs). We investigate whether adding an illustrative graph or an evocative face close-up or a set of photographs representing the professional team to the text of financial instrument disclosures could have an impact on perception, evaluation, and investment intentions. Use of pre-rated and well controlled close-up photographs of professionally dressed people is expected to reduce physiological distance as well as convey social factors, such as competence and trustworthiness, the essential ingredients in financial transactions. Finally, we investigate whether expertise is a relevant factor for overcoming advertisement persuasion attempts. Lastly, we investigate the expertise of financial advisedviserrs to predict their consumers' ability to comprehend and willingness to invest in the advertised financial offer. The hypotheses guiding this research address the following targets:

- Are financial experts perceiving their customers as different from themselves?

- Are professionals biased? To what degree are their choices influenced by behavioral biases?

- And if they are, are they biased in the direction showed by naïve consumers?

- Is there a correlation between response time and evaluation? If yes, can it be explained within the context of the dual-system theory?

4. Methodology

4.1. Experimental design

A two-part experimental design was used in this study. For convenience, we refer to the first part as *Experiment I* and the second as *Experiment II*. Both parts of the experiment were conducted simultaneously. *Experiment I* and *Experiment II* are equivalent but with the difference that the first one was designed to gauge attitudes of Italian-speaking financial advisers (expert sample), and the second was designed to survey English-speaking consumers (novice sample). In particular, five conditions were created to represent different treatment conditions (see Appendix A: materials and methods).

Table 1. Experimental Summary (*Experiment Conditions*)

Visual framing feature	Treatment description	Frequency	Hypothesized effects
Fund 1: Graphs			
	Table only No graph	0.25	Numeric data require more cognitive effort to process.
	Graph only	0.50	Graphs may alter perception of prior or forecasted performance.
	Vertical graph	0.25	
	Horizontal graph	0.25	
	Graph+Table	0.25	
Fund 2: Photos			
	No photos	0.25	
	Photos	0.75	
	Female neutral	0.25	
	Male smiling	0.55	
	Male seutral	0.55	
Fund 3: visual cue			
	No photo	0.50	
	Photo	0.50	Close-ups altering subjective perceptions of physical proximity may reduce perception of psychological distance.
	Text only	0.25	
	Text&Graph	0.25	
	Text&Photo	0.25	
	Photo&Graph	0.25	
Loan 4: graphs			
	No graph	0.25	
	Graph	0.75	
	Total interest	0.25	
	Total pay	0.25	
	Monthly pay 3	0.25	

4.1.1. Method and Sample

4.1.1.1. Participants

A recent survey of psychology and behavioral economics literature finds that American students are "outliers, quite atypical of the world population," and therefore, general "conclusions based on such a narrow and non-representative sample of the population" could be questionable (Henrich, Heine, and Norenzayan, 2010; Nature, 2010). This was one of the motivations for not recruiting an easily available research subject source, such as students. Instead, we focused on unique samples that could provide further insights into expert and novice decision making in financial context. For the expert sample, we recruited 621 (99 female) responding staff members of a financial institution in Italy. Financial experts were recruited to a survey posted on the website through which the entire study

was conducted. Responses were collected using *Qualtrics* software (See *http://www.qualtrics.com*) and careful screened for timing and proper replies to the control questions. Out of the expert participants the average age was 34, and the average professional experience financial industry was over 5 years. Participants in the expert condition were placed into a fictional version of their professional roles with the purpose of evaluating financial offers, deciding whether recommending them to their clients, and trying to predict their clients' initial evaluations. For the novice sample, we used AMT platform to recruit 600 online subjects to participate in the experiment (the mean age is 31.2; 304 females and 296 males). We used 573 observations out of the total sample, i.e., we used only those who passed the minimum qualification requirement. Upon completion of the study, non-expert participants (AMT workers) received a cash compensation, 0.50 US dollars per completed survey.

4.1.1.2. Procedure

All participants were administered a survey on financial advertisement perception, evaluation and decision making. In the introduction of the experiment, participants are informed that they will be presented four simple financial advertisements and asked to express their opinion about them based on the information provided in each ad. Later they are also asked to answer a few questions related to their basic understanding of concepts directly related to the study, such as financial knowledge. After participants read the instructions they are presented one advertisement at at time containing relevant and irrelevant information about a financial product or service (for stimuli examples, please refer to Appendix C: Stimuli). Participants are asked to complete a questionnaire evaluating the prospects and providing their judgments. For each offer, the information presented varies in the presentation content across the groups. For instance, to emphasize the mutual funds' quality, the prior performance graphs are included. The participants are distributed randomly across the five conditions of investment prospect design. The order of questions and the choices are sophistically randomized to remove order effects and to allow for an in-between subject study.

The offers are presented with randomly assigned variations of visual cues, such as presence or absence of photographs, and variations in information mode, such as prior performance graphs. The names of the advertised fictional products and the names of the people pictured in the advertisement are also chosen randomly. Furthermore, financial advertisements are presented to each participant in a randomly determined order. Participants made from three to seven judgments depending on the condition concerning each advertisement (See 8). After participants finish the experimental portion of the study, they reply a small number of questions assessing their financial expertise (for the expert sample) or financial literacy (for the novice sample) (for sample questions, please see Appendix B-1: basic financial literacy scale and Appendix B-2: advanced financial literacy scale). The subjects are then also asked to answer a few questions to self-report their level of

risk-aversion, financial literacy, economic knowledge and stock participation. They also provide their ages, genders, general education, and ethnical backgrounds. Upon submission of the complete set of answers, subjects are thanked for participation, and a brief summary of the detailed underlying purpose of this survey is provided.

4.1.2. Measures

This study measured several dependent variables.

4.1.2.1. Information comprehension

Comprehension of disclosure information was measured by asking the participants how understandable is the information in the advertising, using a semantic differential scale ranging from 1 (very difficult to understand) to 7 (very easy to understand).

4.1.2.2. Attitude toward financial offer

Recommendation intuitions, consideration intentions, and investment intentions were measured by asking the participants to what extent they were willing to invest, recommend or keep the advertisement, using a semantic differential scale ranging from 1 (unlikely) to 7 (very likely).

4.1.2.3. Trustworthiness and competence

Perceived trustworthiness of the adviser and perceived competence of the professional team of the mutual fund advertised were measured in a similar manner.

4.1.2.4. Financial literacy

The financial literacy score was measured by administering a quiz including thirteen questions about basic financial concepts: each of the naïve respondents was asked to respond to five basic and eight advanced questions from financial literacy questionnaire (see Appendix B-1: basic financial literacy scale and Appendix B-2: advanced financial literacy scale). The proportion of correct answers reflected the financial literacy level of the respondent.

4.1.2.5. Sociodemographic variables

Research has documented that socioeconomic characteristics of respondents may affect financial behaviors. Thus, we measured several demographic and socioeconomic variables for both samples.

4.1.3. Empirical strategy

A set of variables is measured using semantic differential ratings scales. The latter are sometimes considered as interval-level data and sometimes merely as ordered-categorical (Göb, McCollin, and Ramalhoto, 2007; Norman, 2010; Reips and Funke, 2008) . Choice of one over the other could thus be the subject of disagreement. In particular, by using only seven levels we cannot automatically

assume that respondents perceive all pairs of adjacent levels as equidistant. On the other hand, we use semantic words of response levels to clearly indicate symmetry of response levels about a middle category. Because our data fall between ordinal- and interval-level measurements, by analyzing the data as simply ordinal we would probably loose some valuable information. In addition, our questionnaire scale items were designed to indicate clearly visible equal spacing of response levels by means of a visual analog scale provided by the Qualtrics suite, which further supports our choices of treating the data from two perspectives: (i) as if they were categorical (or ordinal) and (ii) as if they were interval. We analyze the data in both ways: using parametric and nonparametric tests. Then, we compare the two sets of results.

We began by analyzing our data with descriptive statistics. To understand if there are significant differences between two independent groups, we used the Kruskal-Wallis and independent 2-group Mann-Whitney U Tests. Furthermore, we used nonparametric tests for statistical dependence between two ordinal variables, such as the Kendall Tau rank correlation and the Spearman's tests. We prefer the Kendall Tau because it can handle ties. In the cases of parametric statistics, we convert responses into numeric values and report basic descriptive statistics comparisons.

5. Results

As it will be detailed below, the results obtained from both parts of the experiment show that graphical representations of numerical data may lead decision makers to incorrect evaluations by considering only a visual portion of the data and ignoring the numbers.

5.1. Perspective taking: how do professionals perceive their customers?

Aim

Experts are asked to take customers' perspective and evaluate either the Growth Fund past performance report (Condition 1, Table 2), or Mutual Fund prospectus (Condition 2, Table 3), or Loan offer (Condition 3, Table 4), or Structured Investment Product ad (Condition 4, Table 5). Ratings provided by experts and naïve subjects are then compared.

Results

Experts perceive that depending on the actual information format their customers may have significantly (see Tables 2, 3, 4, 5)

i) higher (or lower) willingness to invest in the product or the fund;

ii) more (or less) propensity to recommend the product or the fund to others;

iii) higher (or lower) willingness to invest in the risky option over a safe one;

iv) higher or lower trustworthiness rating of an adviser promoting such investment options.

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Discussion

Experts perceive their customers significantly different from themselves. After comparing predicted by experts and actual customers' ratings, experts show superior ability to estimate the direction and the magnitude of their customers' perception of and preference for financial products, as show in Tables 2, 3, 4, and 5.

Table 2. Differences in responses Condition 1: Johnson Growth Fund
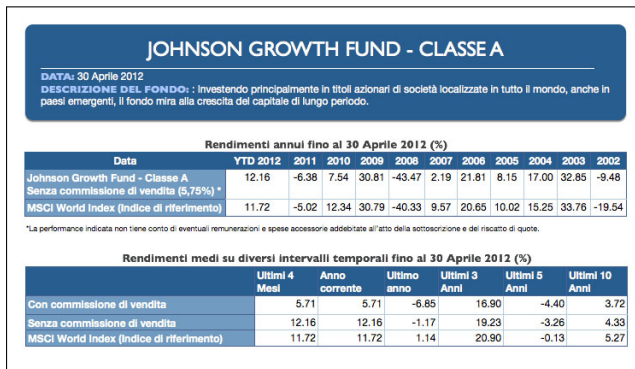
Condition 1 (Stimulus)   Responses by expert and naïve subjects
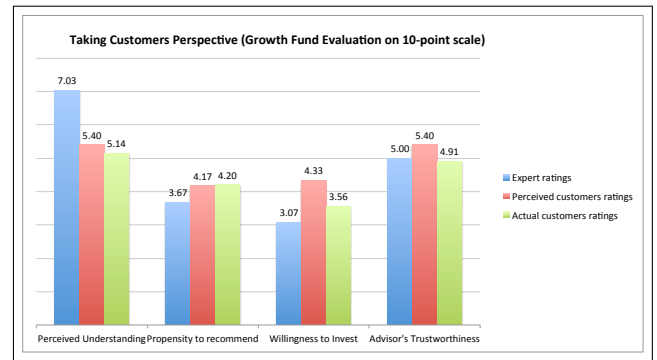
Table 3. Differences in responses Condition 2: Robinson Mutual Fund
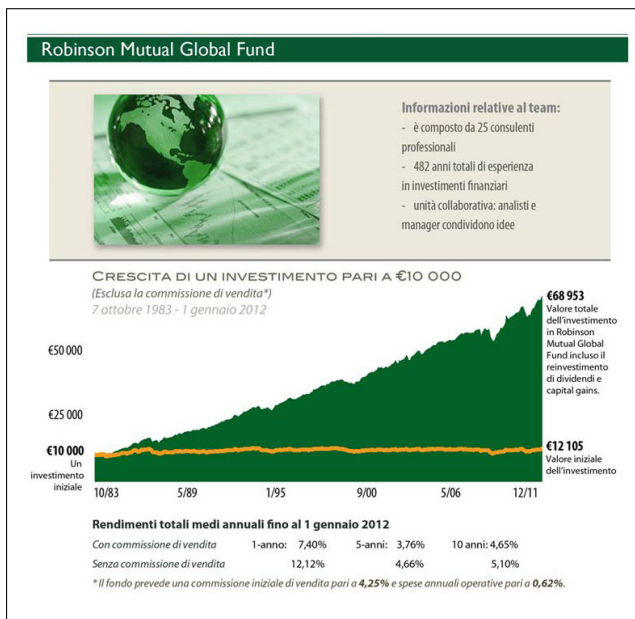
Condition 2 (Stimulus)   Responses by expert and naïve subjects
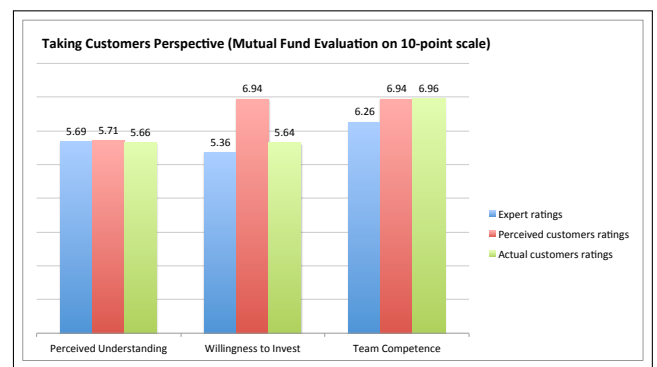
Table 4. Differences in responses Condition 3: Loan offer

Condition 3 (Stimulus)

Responses by expert and naïve subjects

Table 5. Differences in responses Condition 4: Principal Protected Note (Structured Investment Product)

Condition 4 (Stimulus)

Responses by expert and naïve subjects

5.2. Graphs

Task

Participants were asked to evaluate financial offers that were shown to them on the computer screen. Two out of four experimental conditions manipulated graphs, namely, in communications of Mutual Fund (Condition 1) or Structured Investment Product (Condition 2):

Results

Adding graphical representations of financial data (past or forecasted performance) significantly (see Tables 6 and 7):

i) reduces perceived understanding;

  ii) increases propensity to recommend the advertised investment or the fund;

  iii) increases willingness to invest in the advertised fund.

Discussion

In selected cases, inclusion of graphs has biased professional subjects more than naïve ones. Adding graphs to illustrate past or forecasted financial performance appears to interfere with fluent information processing and significantly reduce perceived understanding.

5.3. Photographs

Task

Evaluate an opportunity to invest in the Mutual Fund (Treatment Appendix C: Stimuli: Robinson Growth Fund (Condition #2)). In addition to financial information, some prospectuses contained images of professional teams of investors. In some cases, gender and emotion were manipulated.

Results

Including the portraits of a professional team into financial communication significantly (see Table 10):

  i) increases perceived understanding;

  ii) increases propensity to recommend the mutual fund;

  ii) increases perceived trustworthiness of adviser promoting such fund;

  ii) increases perceived competence of the professional team.

Discussion

Including the photo of a professional team appears to be a source of bias for both expert and non-expert subjects; however, such images have a stronger effect on professional respondents as compared to naïve ones. Our results suggest that experts are influenced by the presence of both female and male images, while emotions conveyed have little effect. On the contrary, the naïve subjects rate the advisers promoting such funds as significantly more trustworthy if the investment-fund team is represented by a group of serious men.

5.4. Graph perception

5.4.1. Johnson Growth Fund: Tables vs Tables & Graphs

Table 6. Differences in responses Johnson Growth Fund: Tables vs Tables & Graphs
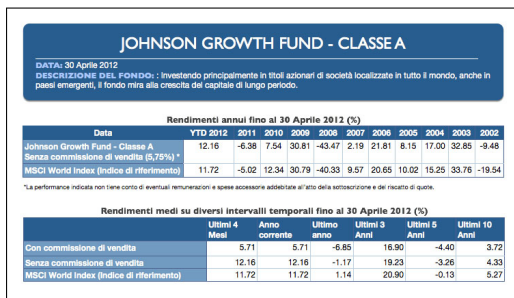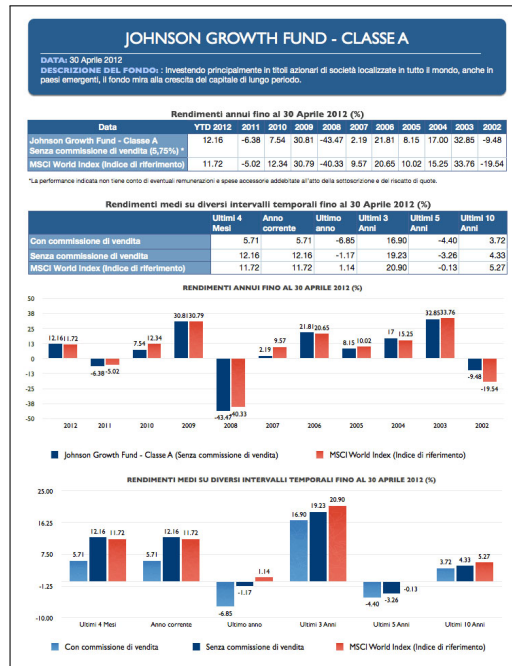
Treatment Group 1 (table only)   Treatment Group 2 (table & graphs)

Table 7. Differences in Gender Responses : *1.1 Tables vs Tables & Graphs*

DIMENSIONS/ QUESTIONS	EFFECT *All*	EFFECT *Male*	EFFECT *Female*	COMMENTS / HYPOTHESES
Understanding	0.6*	0.61*	0.44	*Both men & women experts find "table only" more understandable.*
Advice	-0.61*	-0.67*	-0.33	*Both are more likely to recommend an investment in "Graph+Text" frame.*
Invest	-0.68*	0.78*	-0.11	
vs ETF	0.03	-0.11	-0.88***	*Women tend to prefer investment more over ETF, in "table" only frame.*
Trustworthiness	-0.22	-0.33**	0.37	*Male experts would trust adviser more if he recommends investment in "graph & text" frame.*

Population: *Experts*; Significance: $*** < 1\%, ** < 5\%, * < 10\%$

5.4.2. Treatment group 3 and treatment group 4: vertical graphs vs. horizontal graphs

Table 8. Treatment group 3 and treatment group 4: vertical graphs vs. horizontal graphs
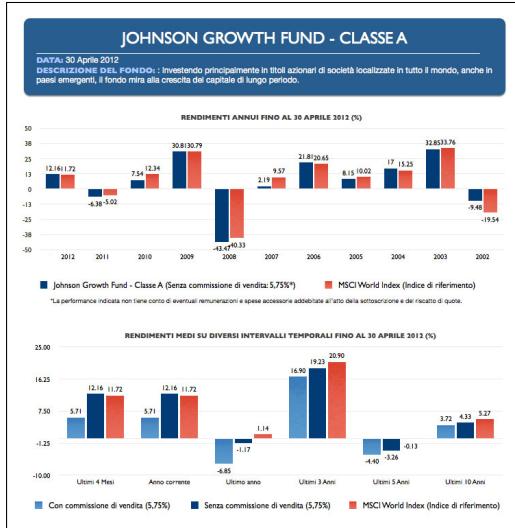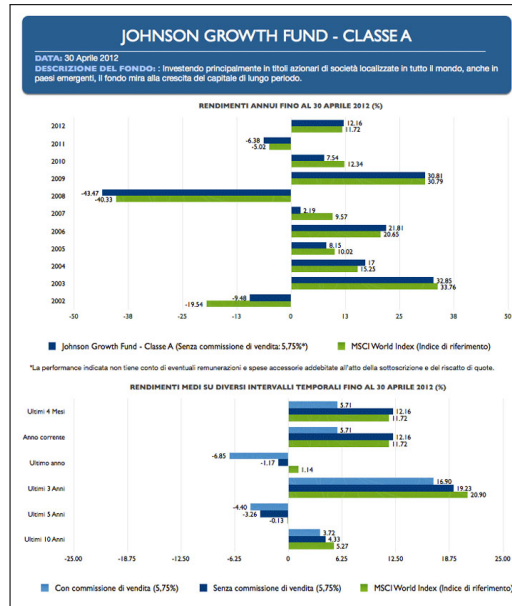
Treatment Group 3 (Vertical Graphs)   Treatment Group 4 (Horizontal Graphs)

Table 9. Differences in gender responses : *vertical graphs vs. horizontal graphs*

Dimensions/ Questions	Effect *All*	Effect *Male*	Effect *Female*	Comments / Hypotheses
Understanding		0.18	0.89	*Women report greater understanding in "vertical graph" frame.*
Advice		-0.45**	0.75	*Women would recommend more in "vertical graph" frame, men would recommend more in "horizontal graph" frame.*
Invest		-0.45**	0.24	*Men would in vest more likely in "horizontal graph" frame*
Trust		-0.31 ***	0.29	*Men trust adviser more when he/she sells "horizontal graph" investment.*

Population: *Experts*; *Significance:* $*** < 1\%$, $** < 5\%$, $* < 10\%$

5.5. Response time and photographs in advertisement

5.5.1. Expert sample, treatment 3: Spearman's rank and Kendall's Tau correlation coefficients

Table 10. Correlation coefficients: *Principal Protected Note:* treatment 3 (expert sample)

Variable 1 Vector	Variable 2 Vector	Kendall Tau	p-value	Spearman's Rho	p-value	Significance
Understand	Advice	0.1729	0.01465	0.2013	0.02328	Sign. at 5
Understand	Invest	0.1813	0.0119	0.2177	0.01395	Sign. at 5
Understand	Attractive	0.1129	0.1092	0.1392	0.1186	—
Understand	Trust	0.1753	0.01486	0.2039	0.02148	Sign. at 5
Advice	Invest	0.6795	0	0.7399	0	Sign. at 1
Advice	Attractive	0.4012	0	0.4706	0	Sign. at 1
Advice	Trust	0.5289	0	0.61	0	Sign. at 1
Invest	Attractive	0.3466	0.000001	0.3877	0.000007	Sign. at 1
Attractive	Trust	0.3342	0.000003	0.3961	0.000004	Sign. at 1
Res. Time	Understand	-0.08773	0.1777	-0.1164	0.1923	—
Res. Time	Advice	0.09673	0.139	0.1298	0.1457	—
Res. Time	Invest	0.1356	0.04151	0.1838	0.03861	Sign. at 5
Res. Time	Attractive	-0.04593	0.4806	-0.06715	0.4532	—
Res. Time	Trust	0.1034	0.1194	0.1375	0.1231	—
Experience	Understand	0.04689	0.482	0.06315	0.4806	—
Experience	Advice	-0.0498	0.4572	-0.06081	0.497	—
Experience	Invest	-0.03799	0.5779	-0.04616	0.6063	—
Experience	Attractive	-0.05373	0.4198	-0.0706	0.4302	—
Experience	Trust	0.0317	0.6421	0.04018	0.6538	—
Age	Understand	0.04313	0.5161	0.05755	0.5204	—
Age	Advice	0.004842	0.9437	0.008182	0.9273	—
Age	Invest	0.05715	0.3998	0.07431	0.4064	—
Age	Attractive	-0.0304	0.6474	-0.035	0.696	—
Age	Trust	-0.05547	0.4131	-0.06528	0.4659	—
Gender	Understand	0.0346	0.6651	0.03892	0.664	—
Gender	Advice	0.1001	0.2096	0.1121	0.2095	—

Population: *experts*

5.5.2. Naïve sample, treatment 3: Spearman's rank and Kendall's Tau correlation coefficients

Table 11. *Non-experts:* Correlation coefficients: *Principal Protected Note:* treatment 3 (non-expert sample)

Variable 1 Vector	Variable 2 Vector	Kendall Tau	p-value	Spearman's Rho	p-value	Significance
Understand	Advice	0.4729	0	0.5687	0	Sign. at 1%
Understand	Invest	0.4118	0	0.5048	0	Sign. at 1%
Understand	Attractive	0.1634	0.0235	0.1992	0.02782	Sign. at 5%
Understand	Trust	0.3596	0.000001	0.4501	0	Sign. at 1%
Advice	Invest	0.8403	0	0.9111	0	Sign. at 1%
Advice	Attractive	0.2862	0.000055	0.3327	0.000181	Sign. at 1%
Advice	Trust	0.559	0	0.6499	0	Sign. at 1%
Invest	Attractive	0.2537	0.00035	0.3034	0.000681	Sign. at 1%
Attractive	Trust	0.3923	0	0.4569	0	Sign. at 1%
Res. Time	Understand	-0.1816	0.006702	-0.2463	0.006456	Sign. at 1%
Res. Time	Advice	-0.06368	0.3348	-0.09115	0.3201	—
Res. Time	Invest	-0.02219	0.7379	-0.02816	0.7591	—
Res. Time	Attractive	-0.04386	0.5105	-0.0431	0.6388	—
Res. Time	Trust	-0.01844	0.7869	-0.02408	0.7932	—
Experience	Understand	-0.1575	0.03277	-0.1926	0.03359	Sign. at 5
Experience	Advice	-0.1424	0.04987	-0.1767	0.05149	Sign. at 10
Experience	Invest	-0.1429	0.04911	-0.1791	0.04842	Sign. at 5
Experience	Attractive	-0.06573	0.3704	-0.08028	0.3794	—
Experience	Trust	-0.09489	0.2034	-0.115	0.2073	—
Age	Understand	0.05982	0.3787	0.08037	0.3789	—
Age	Advice	0.04605	0.4912	0.07384	0.4189	—
Age	Invest	0.005406	0.9372	0.0153	0.8671	—
Age	Attractive	0.07439	0.27	0.0966	0.2899	—
Age	Trust	0.0317	0.645	0.04627	0.6128	—

Population: *novices*

5.5.2.1. Result summary

To assess experts' perceptions and to measure advertisement content effects on comprehension and evaluation of advertised offers, we conduct a questionnaire-based experiments recruiting over 600 professional advisers from one large financial institution based in Italy and 600 naïve consumers, globally, through the Amazon Mechanical Turk platform. This large-scale survey shows that even well-informed and numerate people, such as finance professionals, exhibit systematic biases when facing financial decisions. Visual context can shift experts' attitudes regarding the advertised financial service products. Experts taking consumers' perspective reported significantly lower understanding and higher willingness to invest. Our experiment confirms results of prior studies that use of graphs alter readers' perception of data trends and impairs sound decision making. Interestingly, we find that in some cases novice subjects are less likely to be affected by the visual cues and presentation format, whereas professional advisers may fall prey to visual manipulations.

In the further step of our analysis, we investigate whether expertise is a relevant factor for sound judgment in financial domain. We also explore the ability of professional advisers to take their clients perspective and try to predict their preferences. We find that financial experts are excellent in predicting the naïve consumer behavior. When compared to naïve subjects, financial experts show better comprehension of the advertised investment products, but at the same time they exhibit more conservative attitudes toward these investments. Furthermore, the evidence from conditions suggest that expertise does not eliminate biases induced by visual cues in financial ads. Although experiment results show that large scale close up photographs have little influence over novice perceivers, they still act as powerful artifacts in guiding the attention and improving the perceived understanding of the provided information.

Contrary to what expected, we find experts to be influenced by a close up image of a female face: this effect is correlated with time spent to evaluate the proposal: it elicits more favorable affective response from experts toward the advertising. Non-parametric tests reveal that experts believe their customers to have significantly higher willingness to invest in the product or the fund, higher propensity to recommend the product or the fund to others, higher willingness to invest in the risky option over the safe one, higher trustworthiness rating of the adviser promoting such investment options. Experts show superior ability to estimate and predict the actual preference ratings reported by the naïve subjects. Furthermore, in most treatments, inclusion of visuals has biased expert evaluations more than naïve ones. Hence, managers may have incentives to use visuals to increase the availability of particular attributes, and thus graphical representations may lead investors to focus on attributes that are easier to compare rather than those that are most accurate. Finally, color choice, orientation of shapes, and selection of markers can be relevant factors influencing investor's perceptions and decisions. For these reasons, individual investors should be careful when relying on figures as valid sources of data representation.

On the contrary, the naïve respondents tend to rate the adviser promoting such fund as significantly more trustworthy when a photo of a group of serious men accompanies textual information. In addition, there is a significant correlation between an individual's willingness to invest in a fund and the perceived competence and honesty of an adviser. This correlation suggests that selective use of interpersonal-cues may induce trust-related biases and shift experts' judgment. The present research thus provides valuable insights and sound starting point for future in-depth research on how contextual factors, often non-informative, can influence financial advisers' judgments.

6. General Discussion

Very recently, a few articles, in many aspects comparable to ours, have been published. In the article "Effects of Visual Priming on Improving Web Disclosure to Investors", Wang and Dowding (2010) employ online experiments to investigate how various types of visual priming may affect "less knowledgeable and knowledgeable online investors' processing and understanding of disclosure information". However, even though Wang and Dowding categorize the investors in two distinct groups, the study differs significantly from ours in many respects: (i) they focus their research on one specific product; (ii) the authors analyze disclosure information present on web sites but not the print advertisements; (iii) although the authors heavily rely on knowledge categorization, just as in the present study, they focus on awareness, while we look deeper into eliciting preferences; (iv) whereas the authors run a laboratory study, we recruit and carry out the experiment online; (v) whereas the authors do not apply any specific measure of knowledge, we take into account both financial expertise and financial literacy, and, most importantly, our subject pool contains experts from the real world.

Another closely related article is "Framing effects and risk perception: The effect of prior performance presentation format on investment fund choice" by Diacon and Hasseldine (2007). These authors argue that fund managers can easily persuade potential investors to invest in their funds by simply pointing at successful past performance. The hypothesis of Diacon and Hasseldine's work is somewhat similar to ours: they hypothesize that participants have different perceptions of investment risk and will choose different instruments based on the performance information format shown to them. Considering that and resorting to visual framing and impression management, Diacon and Hasseldine's work differs from our study in a few aspects: (i) the authors employ a two-by-two "repeated measures experiment where the factors are (1) presentation format which is varied within-subjects and (2) time horizon that is varied between-subjects", while we employ variation in graphs and photographs as visual cues and control for expertise, financial literacy and economic literacy of both subject pools; (ii) whereas the authors resort to a mail field experiment, our study tests the hypotheses online; (iii) Diacon and Hasseldine, just like the present study, use a

seven point rating scale for the attitude questions, but we employ a larger set of questions adapted to our specific purposes and to our dependent variables; (iv) whereas the authors use real market data, we provide hypothetical designs of financial instruments, allowing for more general conclusions; (v) the authors limited themselves to the UK subjects, our study recruits experts subjects from Italy and the novices from a multinational pool.

The article that shares common themes (e.g., face induced effects) is "What's Advertising Content Worth? Evidence from a Consumer Credit Marketing Field Experiment" by Bertrand, Karlan, Mullainathan, Shafir, and Zinman (2010). Both the suggested underlying dependent variables influencing decision making and the techniques of randomized presentations used to asses consumers' perceptions are comparable to those of our study. Nevertheless, there are numerous differences between the two studies: (i) Bertrand et al. analyze results of a direct mailer field experiment initiated by local loan creditor whereas we examine an independent online experiment world-wide; (ii) the experiment of Bertrand et al. is limited to South African subjects, whereas our study recruits subjects from Italy and the northern hemisphere pool; (iii) they use eight different variables to enhance visual content, whereas we focus on narrower determinants: use of illustrative graphs and close-up portraits of professional managers; (iv) the pictures used by Bertrand et al. differ in format and occupy only a small fraction of the communication space, whereas photographs used in our experiment take up nearly two-thirds of the advertisement space.

A third article to consider for similarity is "Stated and revealed investment decisions concerning retail structured products" by Dubeli and Vanini (2010). The study's objective is to test whether a retail structured product promoted in a clear and simple form is more attractive to the investor than structured products presented in a rather technical style. This study also builds on a channel factors theory, stating that to be effective concepts must be put into simpler terms and that even minor presentation and description nuances may have substantial impact on investors' behavior "as decision alternatives arise or disappear", concluding that "this communication style has an impact on women and first-time buyers of structured products." Despite the mentioned similarities and the use of "an eye-catching illustrated brochure", there are some major differences between the two studies: (i) Dubeli and Vanini's limit their subject pool to Swiss bank employees; (ii) differently from our study, Dubeli and Vanini's subjects are offered an opportunity to diversify their investment portfolio.

The last article that shares some parallel concepts is "The Interplay between Advertising Disclosures and Financial Knowledge in Mutual Fund Investment" by Lee, Yun, and Haley (2012). The authors explore experimentally the relationship between financial disclosures and investors' financial knowledge within the context of advertising. The authors suggest that mutual fund ads with financial disclosures are more prone to induce positive thoughts regarding advertised information for the fund, more favorable attitudes toward the mutual fund, and greater investment

intention. This study poses instructing arguments and invites to explore further the impact of advertising content and disclosure on financial behavior, as the authors suggest that this can be moderated by the level of an individual's financial knowledge. Lee, Yun, and Haley conclude that advertising disclosures has no significant effect on attribute-related thinking among participants with high financial knowledge (Lee et al., 2012). We attempt to verify this hypothesis by comparing expert and novice decision makers' responses.

7. Conclusion

7.1. Limitations and future research

Our analysis has to be appreciated within the limits of this experiment. First, substantially homogeneous sample of experts limits the generalizability of the conclusions, even though the results are highly significant. Future experiments should strive for exploring different expert subsamples in order to see if results are similar. Second, despite the fact that the experts are true professionals in the financial field, the study used hypothetical decision mechanism, which may have limited validity as a model of fully consequential and incentivized decision making.

Future research could benefit from a more qualitative research approach to investigate how financial decisions are made by people in real world situations. A key next step would require a systematic field experimentation. One strategy could involve conducting empirical field research to advance our understanding of the discussed effects of graphics for effective financial communication and thus improved individual decision making. These field experiments could try to answer how perception of visually presented information relates to the real-world choices.

These concluding remarks highlight the fact that our design and results of the experiment leave some questions unanswered, which, in turn, suggests interesting directions for future research. One of the unresolved question is what moderating variables are truly relevant for financial decision making, both from advisers' and form clients' perspectives. We stress that our design scope is not sufficient to encompass all variables and thus to point out clearly the mechanisms underlying the moderating effects of expertise on financial behavior. It would be helpful to conduct further studies including financial decision makers who vary on key individual difference attributes, such as different types of financial expertise, different cultural backgrounds, etc. This would be another avenue for research that could conceivably gather new insights into the implications of visual dimensions for experts and novices decision making.

7.2. Conclusions and policy implications

Financial service and product promoters often act as financial advisers and provide expert judgment to aid naïve consumers. Our study provides evidence that experts as much as novices may be susceptible to visual bias impairing their ability to perceive objectively and make sound

financial decisions. A comparison between two samples, experts and novices, shows that in both cases variations in presentation leads to attentional and attitudinal shifts. The experts, in fact, exhibit systematic biases, sometimes of a larger magnitude than those of novices. The effects of the advertising content may be different depending on the level of financial capability and the area of financial expertise. Our findings also suggest that the presence of face photographs in communications can distort expert evaluations. If ignored, such biases can perpetuate the conditions of common suboptimal financial decision making among households. Therefore, it is very important to investigate further how visual representation of information can be best designed to meet the needs, preferences, and biases not only of consumers but also of financial advisers. On the other hand, we find that advisers are quite skilled in predicting consumers' preferences and attitudes toward advertised products. This suggests that financial advisers develop exceptional expertise in perspective taking while undermining the skills necessary for optimizing financial advice and decision making. These data provide a previously underexplored viewpoint of decision making and perspective taking by finance professionals, which could provide some further explanation of misguided and suboptimal financial choices among households. This mechanism could also explain other paradoxes, such as the lack of trust in financial institutions, choice overload, and financial decision avoidance among consumers. The outcome of this study is considered to be particularly relevant in developing remedies to overcome experts' overconfidence and other financial decision-making related biases.

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Appendices:

Appendix A: materials and methods

Appendix **A** lists the collection of questions presented to the experiment's subjects. The schematic plan for the first part of the *Experiment* is presented below. Note the second part of the *Experiment* is equivalent in structure except that wording is adjusted to novice respondents. By combining both parts of the *Experiment*, we collected nearly one thousand and two hundred distinct observations. To match the expert sample, six hundred participants (mean age = 31; 342 females, 261 males) were recruited from Amazon.com's Mechanical Turk service (MTurk) and were paid 0.50 US dollars for successful completion of the survey.

Appendix A: Experimental design
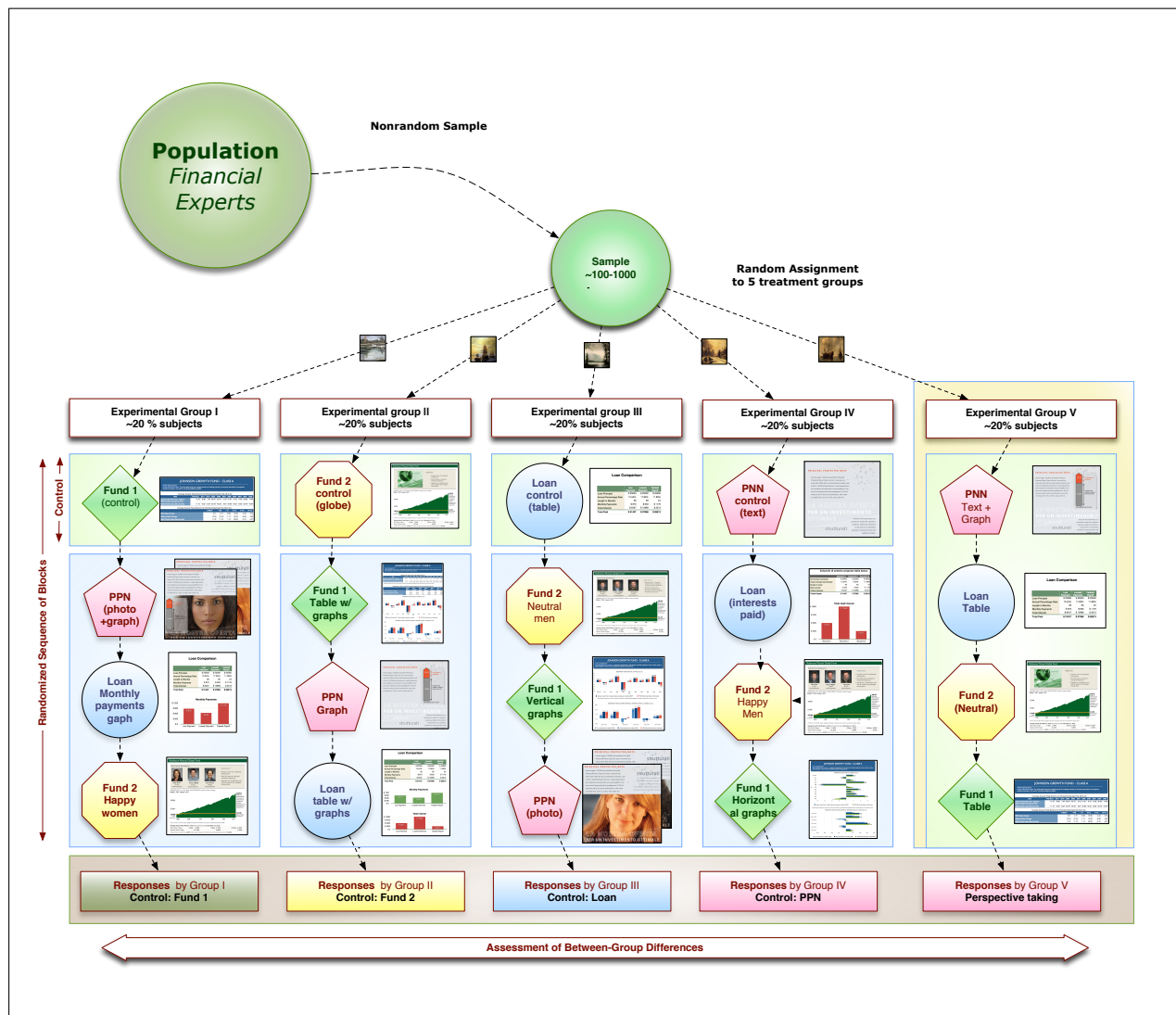
Appendix B-1: basic financial literacy scale

> **Page #1 Basic Financial literacy Questions**

Q#B1: Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

☐ Less than $102   ☐ More than $102   ☐ Exactly $102   ☐ Do not know

Q#B2: 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 today   ☐ Exactly the same   ☐ Less than today   ☐ Do not know

Q#B3: Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

☐ More than today   ☐ Exactly the same   ☐ Less than today   ☐ Do not know

Q#B4: Assume a friend inherits $10,000 today and his brother inherits $10,000 five years from now.
Who is richer because of the inheritance?

☐ My friend   ☐ They are equally rich   ☐ His brother   ☐ Do not know

Q#B5: Suppose that in the year 2012, your income has doubled and prices of all goods have doubled too. In 2012, how much will you be able to buy with your income?

☐ More than today   ☐ Less than today   ☐ The same   ☐ Do not know

Appendix B-2: advanced financial literacy scale

Page #2 Advanced financial literacy questions

Q#A1: Which of the following statements describes the main function of the stock market?

☐ The stock market results in an increase in the price of stocks
☐ The stock market helps to predict stock earnings
☐ The stock market brings people who want to buy stocks together with those who want to sell stocks
☐ None of the above
☐ Do not know

Q#A2: Which of the following statements is correct?

☐ Mutual funds can invest in several assets, for example invest in both stocks and bonds
☐ Once one invests in a mutual fund, one cannot withdraw the money in the first year
☐ Mutual funds pay a guaranteed rate of return which depends on their past performance
☐ None of the above
☐ Do not know

Q#A3: If the interest rate falls, what should happen to bond prices?
☐ Fall ☐ Stay the same ☐ Rise ☐ None of the above ☐ Do not know

Q#A4: Which statement is TRUE?

☐ Buying a company stock usually provides a safer return than a stock mutual fund.
☐ Buying a stock mutual fund usually provides a safer return than a company stock.
☐ Do not know

Q#A5: Which statement is TRUE?

☐ Bonds are normally riskier than stocks.
☐ Stocks are normally riskier than bonds.
☐ Do not know

Q#A6: Considering a long time period (for example 20 years), which asset normally gives the highest return?
☐ Stocks ☐ Bonds ☐ Savings accounts ☐ Do not know

Q#A7: Normally, which asset displays the highest fluctuations over time?
☐ Savings accounts ☐ Bonds ☐ Stocks ☐ Do not know

Q#A8: When an investor spreads his money among different assets, does the risk of losing money:
☐ Decrease ☐ Increase ☐ Stay the same ☐ Do not know

Appendix C: Stimuli

Appendix C: Stimuli PPT (Condition #4

Treatment group 1 (Graph & Photo)

Treatment group 2 (Text & Graph)

Treatment Group 3 (Text & photo)

Treatment group 4 (Text only)

Appendix C: Stimuli: Johnson Growth Fund (Condition #1)
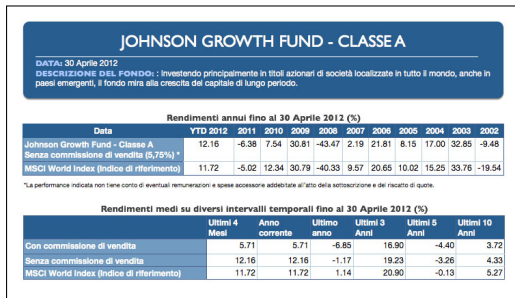
Treatment Group 1 (Table only)
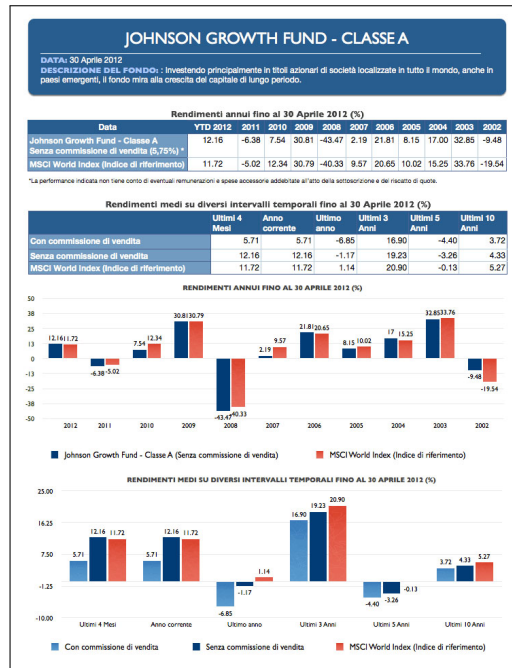
Treatment Group 2 (Table & graphs)
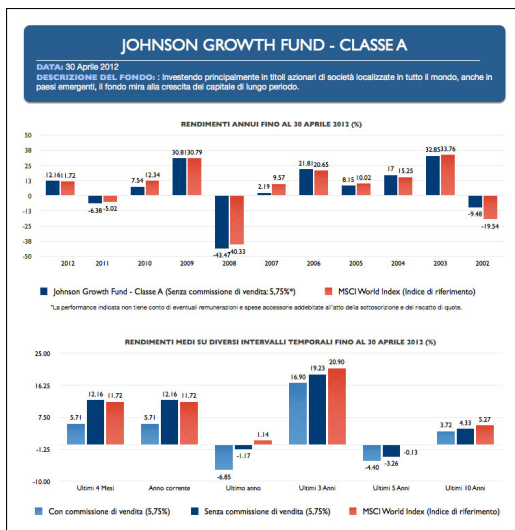
Treatment Group 3 (Vertical graphs)
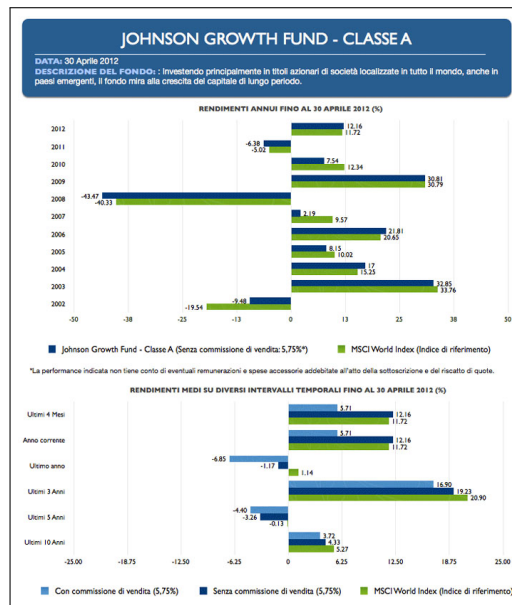
Treatment Group 4 (Horizontal graphs)

Appendix C: Stimuli: Robinson Growth Fund (Condition #2)
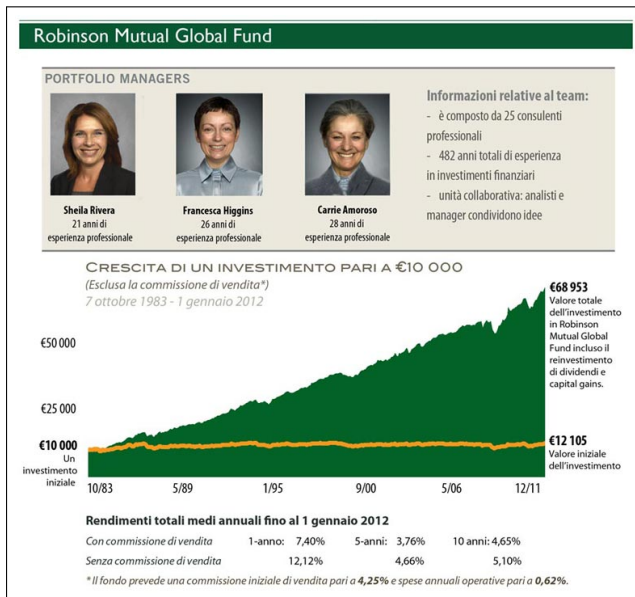
Treatment Group 1 (Female happy)
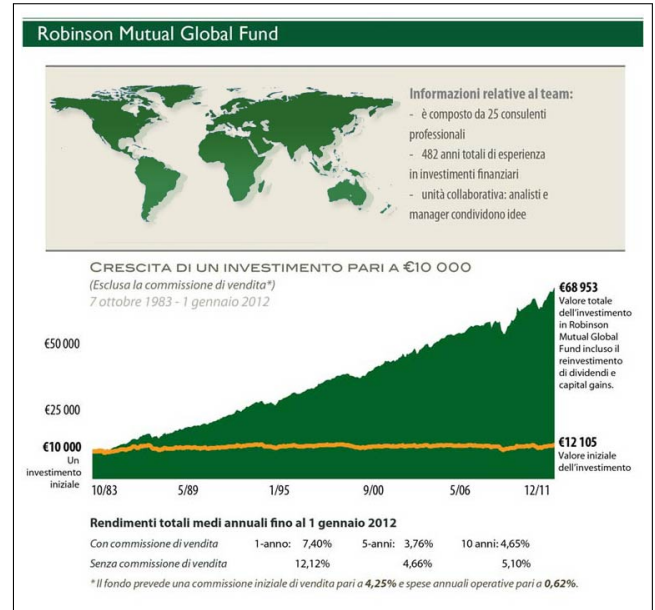
Treatment group 2 (No photo)
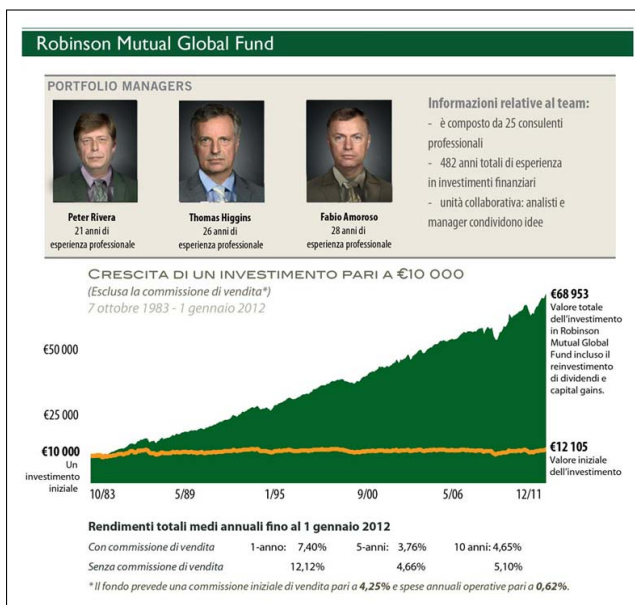
Treatment group 3 (Males neutral)
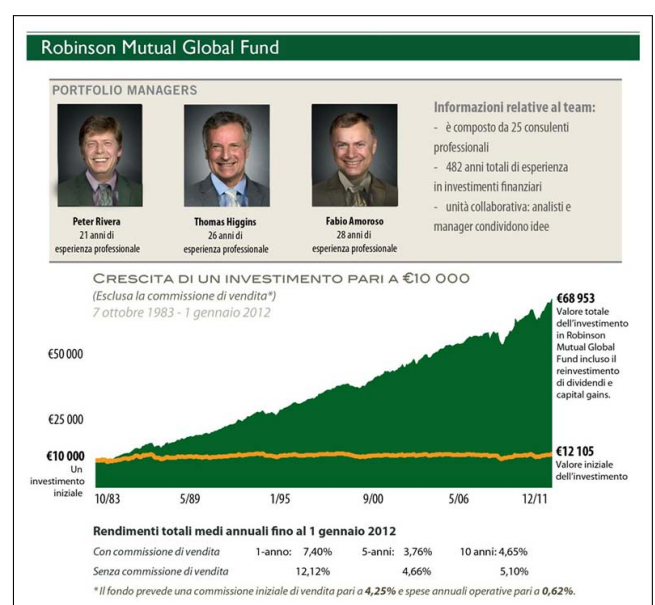
Treatment group 4 (Males happy)

Appendix C: Stimuli: Loan (Condition #3)
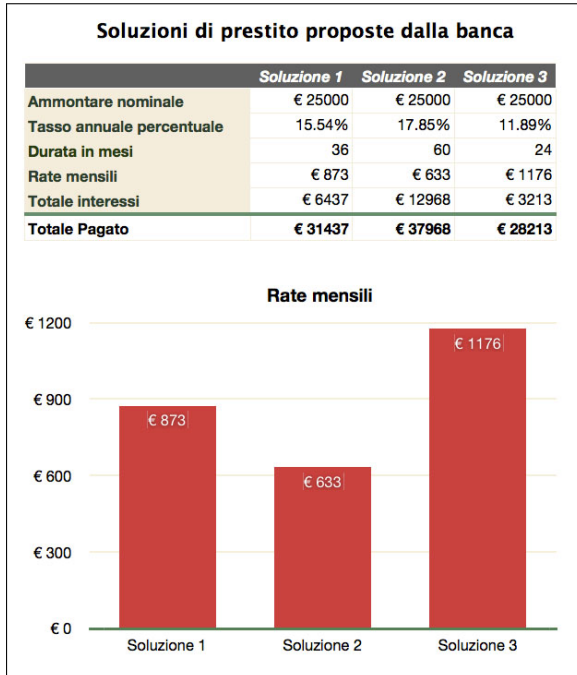
Treatment group 1 (Monthly payment)
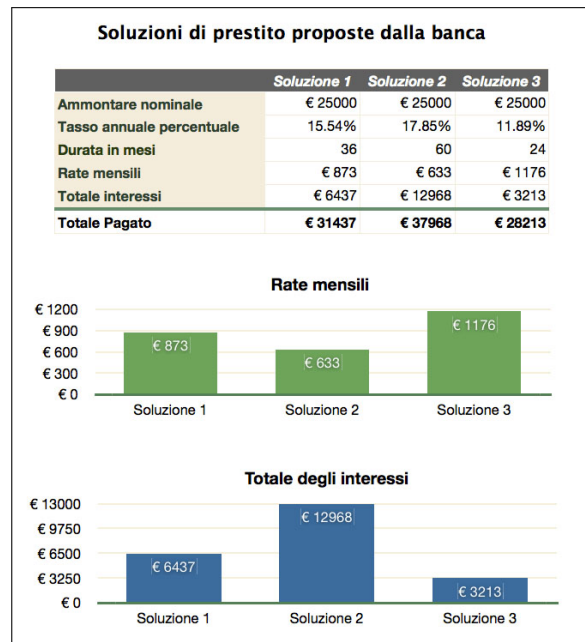
Treatment group 2 (Interest & monthly payment)

Treatment group 3 (Table, no graph)
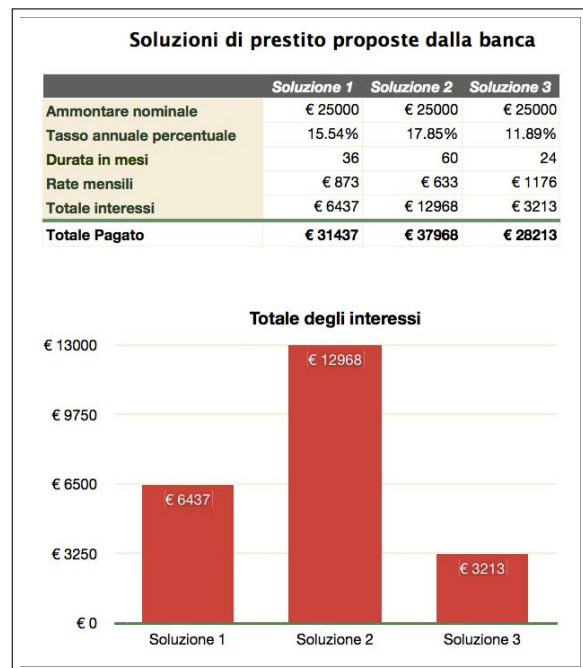
Treatment group 4 (Total interest graph)

CHAPTER 3

Effects of Salient Cues and Changing Environments on Performance in Multi-attribute Visual Inference Tasks

Contents

1. Introduction

Human learning is complex and multi-faceted, especially when it takes place in a dynamic environment. The ability to learn from multiple cues, adapt to changes, and develop new strategies is what differentiates between success and failure, survival and extinction. Today's consumers face richer information environments than ever before.

Here, we investigate the effects of salient cues and environmental changes on learning. Across six treatments groups (N = 182), we experimentally manipulate the initial weights assigned to visual cues (features of Chernoff Faces (Chernoff, 1973) that correspond to multivariate data) that participants need to learn to categorize by developing a decision strategy. Learning is thus in the form of a search for appropriate weights as well as for unexpected changes of these weights. We hypothesize that lack of meaningful cues not only hampers learning speed, but also affects how people allocate attention to changes and develop new strategies to cope with such changes. Here we hypothesize that "abrupt" transformations in an environment are more harmful than "smooth" ones. We find that initially meaningful cues are instrumental for adaptation, suggesting that prior learning can inhibit subsequent learning. Response-time measures indicate that non-salient cues lead to more costly learning and less confident decision making. The participants in "shock" condition are also less likely to recover from significant confidence drops. These results provide a previously unexamined perspective and lead to possible explanations for variability in learning. We discuss how this mechanism might also explain other puzzles concerned with learning constraints and point out some implications for education policy.

To summarize, earlier research on human learning from multiple-cues in changing environments suggests that when the environment changes people are reluctant to modify those strategies they rely on for making their choices. The general challenge is thus to understand the mechanisms underlying adaptation in dynamic environments. In this chapter, we consider one limited but important aspect of this general issue: we focus on characteristics that define the environment, namely on the salience and familiarity of the cues. We also examine how well people are able to adapt to changes in the environment when these changes occur either progressively or instantly.

2. Literature Review

2.1. Learning in dynamic environment

Human environments are dynamically changing: whether because of external or internal, tangible or intangible factors. Climate changes, species mutate, science provides new discoveries, knowledge gets updated, faces become familiar, memories fade away. People are continuously challenged to evolve and adapt new decision making strategies in order to cope with newly formed situations. Developing strategies that work well is already a challenging task in stationary conditions, and

becomes an even more complicated task in continuously changing environments. There is a large body of research on human behavior in dynamic environments. Much experimental research has been carried out aiming to measure how people detect changes and how they monitor environments to understand the learning and adaptation processes underlying decision making (e.g., Brown and Steyvers, 2005; Gallistel, Fairhurst, and Balsam, 2004; Nassar, Rumsey, Wilson, Parikh, Heasly, and Gold, 2012; Otto, Markman, Gureckis, and Love, 2010; Speekenbrink and Shanks, 2010).

2.1.1. Continuous learning by adapting strategies to changing environments

Some recent research on adaptation to changes in the statistical structure of decision environments has raised interesting questions regarding situations in which people have less resistance to rapidly adapt their strategies to changes.

Bröder and Schiffer (2006) explored experimentally in which environments choice of a compensatory strategy or a non-compensatory strategy was optimal in relation to the expected payoffs. In this context, a compensatory strategy refers to weighting and integrating all cue information, and a non-compensatory strategy refers to considering only a subset of the cue information. In the initial trials of Bröder and Schiffer's experiment, participants were able to develop the appropriate strategy despite the type of environment they were placed in. However, when the environment changed (at trial 80 out of 200 trials) the majority of participants retained the same strategy despite its reduced optimality in the new environment. Bröder and Schiffer interpreted these results in terms of the application of maladaptive routines. In the initial stage, participants used a "top-down" deliberative mode of reasoning to develop the appropriate strategy. However, when the selected strategy appeared to work successfully, participants switched to a "bottom-up" routine mode of thinking and, therefore, failed to recognize the need for developing a new strategy when the environment changed.

Similarly to Bröder and Schiffer, Rieskamp and Otto (2006) experimentally tested strategy adaptation patterns in dynamic environments and found that the strategy *take-the-best* (TTB; Gigerenzer and Goldstein, 1996) appeared to be more or less adaptive, in terms of expected monetary pay-off, than a *weighted additive strategy* (WADD; Payne, Bettman, and Johnson, 1989): in particular, whereas in non-compensatory environment TTB strategy led to more correct predictions (83%) compared to WADD's (60%), in the compensatory environment the prediction performance was reversed. Participants who started with non-compensatory environment and transitioned to the compensatory one exhibited a significant inertia, failing to adopt a strategy more appropriate for the new environment. Experimental subjects transitioning from compensatory to non-compensatory environments were more prone to a change in strategy. The Strategy Selection Learning (SSL) developed by Rieskamp and Otto (2006) predicted and explained the inertia effect. The model explains that adaptation results to be time-consuming because a strategy that is initially successful it is so due to prior substantial reinforcement, and this reinforcement will

only progressively subside in the new environment provided a participant takes risks by testing the potential of the rival strategy.

2.1.1.1. Environment change dynamics: shocks, cyclic, and gradual drifts

Earlier research on human learning from multiple cues has commonly focused on decision making in stationary environments. However, some recent studies have incorporated dynamic environments in their designs and explored environments involving a gradual drift (e.g., Otto, Markman, Gureckis, and Love, 2010; Rakow and Miller, 2009; Yi, Steyvers, and Lee, 2009), patterns consistent with cyclical change (e.g., Yi, Steyvers, and Lee, 2009), step-change jumps (e.g., Brown and Steyvers, 2005), and combinations of all of these types of dynamics (e.g., Speekenbrink and Shanks, 2010). For instance, Yi, Steyvers, and Lee (2009) used the restless bandit tasks in two dynamic environments: (i) changes occur at discrete, but hidden, time points, and (ii) changes occur gradually across time. The authors found that the changing environment encourages the decision-maker to cycle between states of exploration and exploitation (Yi et al., 2009). Otto et al. (2010), on the other hand, investigated situations where the payoffs from each decision depended on a participant's recent choice history. In three experiments, Speekenbrink and Shanks (2010) explored learning in changing environments. Participants of all three experiments were responsive to both types of changes: abrupt and gradual. Surprisingly, however, the results did not provide evidence of people adapting to those different types of changes in qualitatively different ways. Brown and Steyvers (2005) investigate context effects of dynamic environment, and found that participants' decision criteria lag behind stimulus changes, and the length of this lag is considerable. In the particular setup, it took about 14 trials for participants to adjust their decision criteria to new decision environments.

2.2. Performance measures of learning

The three most often-used performance measures in cognitive and decision sciences are choice, response or decision time, and confidence (Lurie, 2004).

2.2.1. Judgment accuracy

Observable judgment accuracy often determines whether a selected decision strategy works well in a given environment. Changes in accuracy may indicate changes in either environment or strategy itself, indicating some undergoing processes such as learning, adaptation, or even forgetting. Judgment accuracy is often used to measure performance of human decision makers in sequential sampling experiments. Some research suggests that externally observable accuracy together with immediate reward and payoff lead people to reevaluate strategies they employ to make decisions (Busemeyer and Rapoport, 1988); however, these are not the only factors stimulating adaptation (Kheifets and Gallistel, 2012). Rieskamp and Otto (2006) suggest that in addition to observed

accuracy and reward, people are very much interested in minimizing effort and time spent in making choices. In the case in which the environment changes slowly, the accuracy should change at a similar rate and, therefore, it may be difficult for a human observer to catch the undergoing changes until some threshold is reached.

2.2.2. Confidence

> "Despite its practical importance and pervasiveness, the variable of confidence seems
> to have played a Cinderella role in cognitive psychology-relied on for its usefulness, but
> overlooked as an interesting variable in its own right" - *(Vickers, 2001, p 148)*

Confidence is considered to be a unique measure of cognitive performance that mirrors "inner workings of the mind" (Pleskac and Busemeyer, 2010). Different theories of memory have been tested using confidence ratings about recognition (e.g., Squire, Wixted, and Clark, 2007; Yonelinas, 1994). In cognitive and decision sciences research confidence has been used as to chart a relationship between reality and people's internal beliefs about events occurring, for example redacting the outcomes of games (Yates, Curley, and P., 1985). Most people rely on confidence judgments when making decisions. Hence, cognitive and decision sciences have a significant interest in understanding how actual choices, decision speed, and ratings of confidence interact with watch other and whether they tap to the same latent process. Confidence corresponds to the observed outcomes but whether it is a good proxy for subjective probabilities (Tversky and Kahneman, 1974) is still an ongoing debate. Prior studies showed that accuracy and confidence are positively correlated (e.g., Mickes, Wixted, , and Wais, 2007). Prior research on accuracy of subjective probabilities (Koehler, Brenner, L., Griffin, and Gilovich, 2002) has not revealed as to how and why the accuracy of subjective probability assessments fluctuates with time, time pressure, and how decision makers balance time and accuracy when making a choice. This dynamic understanding of confidence, can be studied experimentally in a standard detection task where decision makers are presented with a stimulus and are asked to make a choice between the two options (e.g., to invest in a stock or not, to hire an applicant or not, to accept a proposal or not, and so on). After making a decision, participants were asked to express their level of confidence in their judgement. In our experimental setup, participants provide confidence rating immediately after having made a forced decision. Some theories argue, including random walk/diffusion theory that the confidence ratings can actually change from the moment the choice was made to the moment the confidence rating was expressed. This is because decision makers can observe some new evidence useful for their decision: this refers to as "drift". In our experiment the time is almost negligible, but we still control for the time spent in reporting the confidence level. We use the following procedure to measure the confidence: after participants make a choice, we ask them to provide their confidence that their decision was correct. As a matter of fact, this this type of measurement has been widely used in psychology and decision sciences. In

this chapter, we focus on the confidence with binary choice task. This focus allows us to measure and examine how choice accuracy and decision time are related to judgment of confidence.

2.2.3. Response Time

Important questions are: What is the effect of time on the confidence ratings and its predictive nature (a choice being correct)? What is the effect of time on the rate of learning (or accuracy)? The experiments where decision makers are presented a stimulus and have to make a choice can vary on one important element: the end of evidence collection and information processing. In *optional stopping* choice task, the participants control their own sampling by choosing the moment in time when they feel they have enough information and are ready to provide their judgment. An alternative task type is known as *interrogation choice task*, and it refers to conditions when an external event or person interrupts the evidence collection and request to make a choice (Ratcliff and Smith, 2004; Ratcliff and Starns, 2009). In this study, we use the optional stopping choice task where participants can decided themselves when they are ready to make a choice.

2.2.4. Questions regarding relations between learning performance measures

In this context, there are many issues and questions that need to be considered and accounted for. We will now lists the most salient aspects. *Speed-accuracy trade-off.* Decision time and error rate are negatively correlated such that the decision maker can trade accuracy for speed. *Relationship between confidence and stimulus discriminability.* Confidence increases monotonically as stimulus discriminability increases. *Resolutions of confidence: constant or changing?* Choice accuracy and confidence are positively related even after controlling for the difficulty of the stimuli. On the other hand, under time pressure there is an increase in the resolution of confidence judgments. *Relationship between confidence and decision time: negative or positive?* During optional stopping tasks there is a monotonically decreasing relationship between decision time and confidence where judges are more confident in fast decisions. There is a monotonically increasing relationship between confidence and decision time where participants are on average more confident in conditions when they take more time to make a choice. This relationship is seen when comparing confidence across different conditions manipulating decision time. *Errors: fast or slow?* For difficult conditions, particularly when accuracy is emphasized, mean decision times for incorrect choices are slower than mean decision times for correct choices. However, for easy conditions, particularly when speed is emphasized, mean decision times for incorrect choices are faster than mean decision times for correct choices.

2.3. Signal Detection Theory: its extensions and applications

Signal detection theory is silent in terms of decision time. As a result, random walk/diffusion theory was introduced as an explanation of both choices and decision times Thus, random walk/dif-

fusion theory can in fact be interpreted as a logical extension of signal detection theory. A great limitation of random walk/ diffusion theory, however, is its inability to account for confidence ratings Dynamic signal detection theories, on the other hand, combine the strengths of a signal detection model of confidence with the power of random walk/diffusion theory to model choice and decision time.

2.4. Perception of visual representation of information

Human information processing is widely recognized as resource limited yet individuals are often asked to perform safety critical tasks using displays that communicate large amounts of data (e.g., air traffic control). Graphical data visualizations allow for the consolidation of large amounts of information into symbolic visual representations so that most important patterns in the data may be revealed (**??**). This also implies comprehension of graphical displays. Visual presentation encourages global pattern perception. Users can get a global impression of the average statistics of a display, including the average size and location of multiple elements, as well as the relative number of those elements. When glyphs are used in data analysis, perceived patterns in the arrays can reflect statistically significant relationships in the data.

2.4.0.1. Insights from visual associative learning

The visual environment is full of information about the relationships between objects and events, distributed over space and time. As Henderson and Hollingworth (1999) write, the visual scene is "a semantically coherent view of a real-world environment comprising background elements and multiple discrete objects arranged in a spatially licensed manner". Across repeated experiences with objects and their context, the associations are formed and the statistical relationships of these objects are encoded into the brain. These associations can bias and facilitate future visual processing, helping to anticipate and predict information (where and when to look, what to expect, etc.). Spatial and object contextual cuing, often studied separately, refers to the formation of one specific type of knowledge without influence from the other. Other studies show that spatial statistical learning can lead to object associations (Turk-Browne and Scholl, 2009). Similarly to spatial statistical learning, visual processing is continuous in time: the focus of attention moves from one object to another as the visual scene changes. The temporal learning can be studied in two main ways, but for the scope of this chapter we refer to that concerning the reliable and ordered sequences of visual input (Zacks and Tversky, 2001). Understanding of visual associative learning mechanisms helps us to characterize better the nature and relationship between human learning and visual representations.

2.4.0.2. Visual salience & Information Selectivity

Whitman and Garner (1963) suggest that information structure has important simplifications for information search, acquisition, processing, and subsequent choice quality (Lurie, 2004). By linking the literature on information overload (Jacoby, Speller, and Kohn, 1974; Keller and Staelin, 1987; Malhotra, 1982) and research on decision processes (Bettman, Johnson, and Payne, 1990; Creyer, Bettman, and Payne, 1989; Johnson and Payne, 1985; Payne, Bettman, and Johnson, 1988), one understands that the information structure affects the amount of effort required for acquiring information, developing decision strategies, and making a choice. Decision makers have evolved to adapt their strategies and decision making processes to the decision environment (Payne et al., 1988). To trace such processes and measure information acquisition, studies have employed various methods such as Mouselab, eye tracking, or verbal protocols (Jarvenpaa, 1989). There are multiple alternative methods to trace and measure processing effort by participants; in this study, we focus on one of these measures: the time spent making a decsion (Payne et al., 1988). In general, humans (and animals) learn to allocate attention across potentially informative cues. Importantly, when cues compete, the cue that is allocated more attention will dominate learning. Attention is also affected by the relative validity of cues. A cue with the greater validity has a greater probability of attracting attention, at the expense of attention to other cues. This seems accurate, however, only if all cues are of equal salience (e.g., Denton and Kruschke, 2006). Even the addition of irrelevant cues has a degrading effect on the use of relevant information and when additional cues are relevant, the initial cues will become even less used. The highly salient cues also have more power to attract attention from the other cues. Attending to salient cues could be deemed irrational, because all that should matter, ultimately, is the actual validity of the cue, not the salience. (The conflict between attending to valid cues versus salient cues has important implications on learning theories.)

2.4.1. Visualizing multivariate data

When solving decision problems where multiple conflicting criteria are to be considered simultaneously, decision makers must compare several different alternatives and select the most preferred one. The task of comparing multidimensional vectors is indeed very demanding for the decision maker without any support. Cognitive science research on multi-attributable visual processing, has shown that people can accurately categorize multivariate data based on appropriate visual cues. Different graphical visualization tools can be used to support and help the decision maker in understanding similarities and differences between the alternatives, and graphical illustration is a very important part of decision support systems that are used in solving multiple criteria decision making problems. Visualization techniques for multivariate data can be broken down into four distinct groups: geometric projection, pixel-oriented techniques, hierarchical display, and iconography Within the domain of data visualization, iconography refers to the use of glyphs. A

glyph is a visually distinct graphical entity that represents values on more than one data dimension via physical attributes such as shape, size, or color. Glyphs are one popular approach to data visualization for large, complex, multidimensional data sets.

2.4.1.1. Chernoff Faces

"We perceive the face as a gestalt and our built-in computer is quick to pick out the relevant information and to filter out the noise when looking at a limited number of faces" (Chernoff, 1973). The unique type of glyph design is used to represent data by means of Chernoff Faces (Chernoff, 1973), which takes advantage of peoples ability to perceive faces. The human face (or a simpler representation of it) is one of the most effective graphical icons for visually clustering multivariate data, particularly for long-term memory processing. Some researchers argue that Chernoff Faces, if mapped appropriately to underlying variables, can help to detect patterns, clusters, outliers, and temporal trends very quickly. During the last four decades the use of Chernoff-type faces (a technique of representing points in k-dimensional space graphically) has been increasing for discovering clusters and outliers present in a set of multivariate observations. Each element of the face (e.g., smile, face shape, nose width) is used to represent a different variable and each facial feature's size, shape, and relative separation reflects particular data points and relationships. Even though some researchers identified this as "doubtful" way to visualize data *(Wolfe & Horowitz, 2004)*, Chernoff faces have been widely used in a variety of applications.

2.5. Chapter structure

The chapter is organized as follows. In the next section, The Experiment, we describe the experiment that measures how people learn from multiple visual cues in changing environments. The experiment uses the same binary categorization task over a sequence of rounds, but it manipulates the magnitude, direction, and rate of change in underlying weights associated with the multiple visual cues. We report empirical results for this experiment in terms of performance measures. Accuracy, response time, and confidence measure are compared across different treatments to understand how change in environment as well as visual cue salience predicts performance. Finally, we discuss the implications of our experimental findings for future empirical and theoretical developments.

3. The Experiment

3.1. Research questions:

Performance accuracy is negatively correlated with the time spent in making a decision, reflecting on post-decision, reporting judgment confidence, as well as analyzing feedback. Note that these hypotheses question the results obtained by Speekenbrink and Shanks (2010) showing no evidence of people adapting to different types of changes.

Question 1: Type of change in environment, abrupt or gradual, will lead to differences in adaptation affecting:

   a) performance accuracy;

   b) level of judgment confidence;

   c) average speed (decision, feedback, and confidence).

Question 2: Observed increase (decrease) in performance accuracy will lead participants to reduce (increase):

   a) the amount of time spent to make a decision;

   b) the average amount of time spent to report the level of confidence;

   c) the average amount of time spent to absorb feedback.

In other words, to maintain the speed-accuracy tradeoff ratio constant, we expect observed performance accuracy to be negatively correlated with the time spent in making a choice, reflecting on post-decision, reporting judgment confidence, as well as studying post-decision feedback.

3.2. Experimental implementation

The experimental task was designed to meet three leading principles. First, we wanted to manipulate the initial cue salience structure across treatments, so that in half of the treatments people would start with more salient cues and in another half with less salient cues. Second, we included two types of changes: sudden and continuous. Third, we wanted to be able to measure three-stage response time of each trial in order to quantify how long it took to participants to evaluate information and make decision, report confidence, and process feedback information. To achieve these targets, we created a game-like task in which participants saw a series of 200 visual stimuli, Chernoff faces (Chernoff, 1973), and had to make a binary forced choice, accepting or rejecting a given face. The task involved deciding whether a face was "good" or "bad" based on a particular criterion. To asses the quality of a face and make a decision, participants had not to rely on intuitive response, but to evaluate the size, slant and position of geometrical shapes that a face was composed of. Participants were told that these geometrical shapes and lines corresponded to quantitative information, which was used by computer to determine whether the case was above or below the acceptance criterium. The weights assigned to each geometrical element (one feature of the face) were not known to participants. Learning was measured by participants' ability to estimate the weights and make appropriate decisions. There were three dependent measures of interest: decision accuracy, judgment confidence, and response time. The response time was measured in three stages of each round.

3.2.1. Participants

We used the Amazon Mechanical Turk (AMT) platform to recruit our participants. The online experiments conducted on AMT present equal validity to other types of experiments and are oftentimes more suitable to obtain data from subjects that possess desired qualities and characteristics (Horton, Rand, and Zeckhauser, 2010; Paolacci, Chandler, and Ipeirotis, 2010). To participate in the experiment we recruited 182 US residents via AMT over the internet (the mean age was 32.94; 85 females and 97 males). Please see Figure 2 for distribution of participants across different treatment groups. The data were collected over a two-week period, starting from October 25, 2013.

3.3. Procedure

A schematic presentation of the experimental task is shown in Figure 2. The experiment was designed to look like a game, in which participants had to read the instructions of the game and then make decisions for 200 rounds. In the instructions part of the experiment, participants saw at least two sample stimuli, but after that they were free to generate as many face variants as they wished before starting the game by clicking "*Show me new faces!*" button. At the end of the instructions, they had to answer eight multiple choice questions before starting the game. This procedure was designed to make the instructions as clear as possible to participants. Each round of the game required the participant to make a decision whether to accept or reject a face based on the estimated value. Following each decision (accept or reject), respondent had to indicate the level of confidence using a slider. After that, feedback was provided to the participant. At the end of each round, the feedback contained the following information: the success of assessment decision (correct or incorrect), the quality of a face (good or bad), the record of total correct and incorrect decisions made so far, and the rounds remaining.

3.3.0.1. Experimental Design

Phases of experiment

The experiment had a total of 200 trials that were subdivided into three phase blocks of 90, 20, and 90 trials respectively. Two stationary environments with different underlying structure were created: State 1 (salient cue condition) and State 2 (non-salient cue condition). The changes were taking place either instantaneously or gradually evolving from one to another. The participants were instructed about the possibility of change, but were not explicitly told about the exact subdivisions. The participants played this game continuously from round 1 to 200 without interruptions. The subdivisions, however, corresponded to the change points in the cue-salience structure of the underlying decision rule. The schematic drawing of the experiment design is shown in Figure 2. (To see screenshots of the experimental stimuli please refer to Appendix 7).

Table 1. *Experiment 1:* Sample summary

	TOTAL	PROPORTION	COMMENTS & NOTES
Total participants	182	100%	*Mean age 41.86, from 18 to 64 years old.*
Female:	85	46.7%	*Mean age 32.94 (St. Dev. = 10.26)*
Male:	97	53.3%	*Mean age 30.91 (St. Dev. = 9.8)*
Treatments			**States of the world:** *1-90, 91-110, 111-200 rounds*
T1_SSS	31	17.03%	*Salient, Salient, Salient*
T2_SNN	29	15.93%	*Salient, Non-salient, Non-salient*
T4_SCN	30	16.48%	*Salient, Gradually Changing, Non-salient*
T5_NNN	31	17.03%	*Non-salient, Non-salient, Non-salient*
T6_NSS	32	17.58%	*Non-salient, Salient, Salient*
T7_NCS	29	15.93%	*Non-salient, Gradually Changing, Salient*

Population: Amazon Mechanical Turk workers, US residents.

Data collection: Data was collected over two week period, starting October 25, 2013

Sample: Participants who did not complete all 200 experimental trails were excluded from the analysis.

Figure 1. Experimental Design: a flowchart of experimental procedure
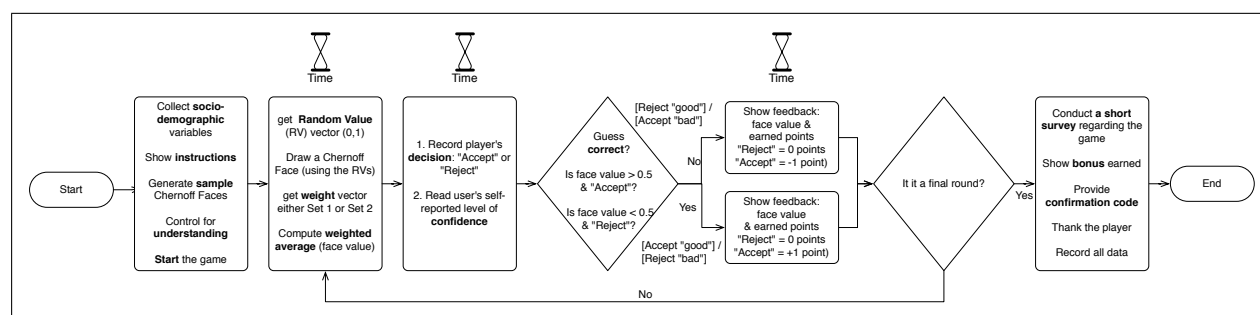
Treatments

There were six treatment groups. The first three treatment groups (T1, T2, T4) began the game with an initial set of weights, of which one substantial weight of 0.5 corresponded to the underlying value of a highly salient cue (a smile curve), creating conditions for faster learning. The next three treatment groups (T5, T6, T7) started the game with an initial set of weights of which one substantial weight of 0.5 corresponded to non-salient cue (width of eyes). In the first block of 90 trials, participants learned in an environment in which the most salient cue was informative (Treatments 1, 2, and 4) or non-informative (Treatments 5, 6, and 7). Treatments 1 and 2 have experienced the game with no changes in the environment until the end. Treatments 2 and 6 experienced a sudden change in underlying structure at round 91, and no further change until the end. Treatments 4 and 7 played a 20 rounds, from round 91 to 110, in which environment was gradually changing from one state into another. From round 91 to 110, the relative importance of a salient cue (smile feature) was either increasing or decreasing at marginal increments. In the third block from trials 111 to 200, as for the initial phase, the first environment remained stationary for 90 rounds. The subdivision of treatment groups is shown schematically in Figure 2 and described

in Table 1.

Figure 2. Experimental Design: treatment groups and conditions
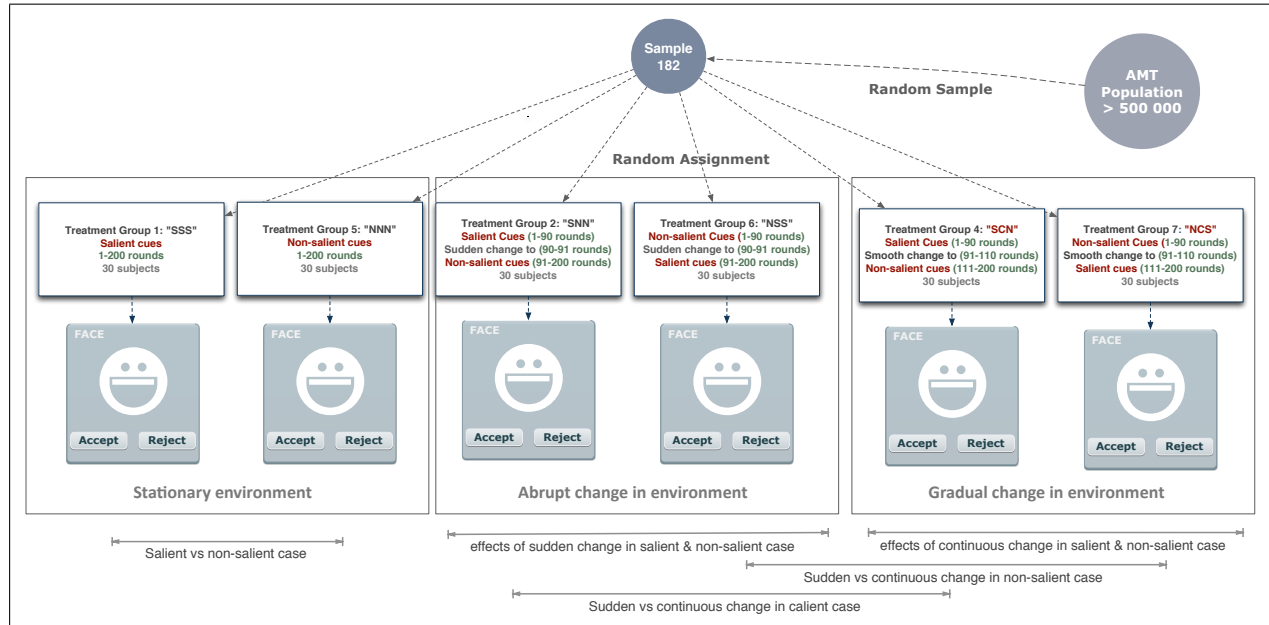
The same 200-trial task with randomly generated Chernoff faces was used in six separate treatments. In Treatments 1 and 5 considered a stationary environment with no changes.

Throughout all 200 trials, participants played for points that could be converted to US dollars at the end of the game (100 points = US$1). Participants started off with zero points and could earn 1 point on each trial for each correct "accept" response and −1 points for each incorrect "accept" response. Despite the correctness of their decision, participants earned no points each time they were choosing to "reject" a face. This reward structure was designed to motivate participants to put some effort in learning to discriminate between "good" and "bad" cases. At the end of the experiment, a confirmation code, a final score, and bonus earnings were displayed on the screen; participants were thanked and debriefed. Upon successful submission of confirmation code through AMT platform, they were paid a cash reward based on a HIT (Human Intelligence Task) fee (US$ 0.50) and their score bonus (Points*US$ 0.01). Since the experiment required to pass a qualification test, no HITs were rejected for this experiment.

Table 2. *Summary:* Aggregate measures of performance in different phases of the experiment

MEASURE	PERIODS I, II, & III			TOTAL
	Rounds *1-90*	Rounds *91-110*	Rounds *111-200*	
Proportion Difference between				
Decisions Accept and Reject				
Mean	**6.545**%	**6.758**%	**5.714**%	**6.20**%
Proportion of Correct				
Mean (St. Dev.)	**0.64817** (*0.4776*)	**0.59780** (*0.4904*)	**0.61154** (*0.4874*)	**0.63** (*0.48*)
St. Error	*0.003731*	*0.008128*	*0.003808*	*0.00*
Proportion of Correct Accept				
Mean (St. Dev.)	**0.33956** (*0.4736*)	**0.31731** (*0.4655*)	**0.31966** (*0.4664*)	**0.325** (*0.466*)
St. Error	*0.003700*	*0.007715*	*0.003644*	*0.00*
Proportion of Correct Reject				
Mean (St. Dev.)	**0.30861** (*0.4619*)	**0.28049** (*0.4493*)	**0.29188** (*0.4546*)	**0.294** (*0.450*)
St. Error	*0.003609*	*0.007447*	*0.003552*	*0.00*
Level of Confidence				
Mean (St. Dev.)	**60.27** (*27.99*)	**57.79** (*28.47*)	**56.44** (*28.71*)	**58.31** (*28.43*)
St. Error	*0.218715*	*0.471998*	*0.224361*	*0.15*
Decision Response Time (ms)				
Mean (St. Dev.)	**2056** *18685*)	**1634** (*3552*)	**1415** (*6102*)	**1518** (*1247*)
St. Error	*145.9985*	*58.8775*	*47.6837*	*69.38*
Confidence Response Time (ms)				
Mean (St. Dev.)	**1717** (*1402.74*)	**1418** (*778.61*)	**1340** (*1133.29*)	**1725** (*13237*)
St. Error	*10.9602*	*12.9053*	*8.8549*	*6.54*
Feedback Response Time (ms)				
Mean (St. Dev.)	**1748** (*3323*)	**1271** (*4847*)	**1158** (*10352*)	**1435** (*7458*)
St. Error	*25.9705*	*80.3410*	*80.8864*	*39.09*
Total Time Spent (seconds)				
Mean (St. Dev.)				**1157** (*471*)
St. Error				*3.6865*

4. Empirical Results

All participants who successfully completed 200 rounds were included in the analysis. Table 2 shows us a general overview of the results. The performance accuracy across participants was 63% when aggregating across all conditions and six treatment groups. In general, people had a tendency to accept slightly more, 53%, than reject , 47%. The distribution of accuracy, confidence, and response time varied significantly across the treatment groups and conditions: the results are summarized in Tables 5, 7, 9, 6, 8, and 10. For instance, considering stationary environment, the accuracy in Treatment 1 (Tables 5) (78%) was significantly higher than the accuracy in Treatment

5 (Table 6), (52%), , suggesting that having highly discriminant visual cues leads to faster learning and more accurate responses.

There are a few major results discussed in detail below. First, we briefly examine the general results related to all treatment groups. Second, we present results concerning the effects of salient and discriminative cues in stationary environments. Third, we look into the dynamic environment where the change occurs abruptly. Fourth, we take a step into the gradually chaining environment. Fifth, we analyze the relationship between confidence and other cognitive performance measures. Finally, we look at the three-element response time and highlight behavioral patterns associated with each treatment condition.

4.0.1. Effects of salient cues and change in environment on judgment accuracy

Figure 3. The distributional characteristics of average total correct choices for comparative treatment groups
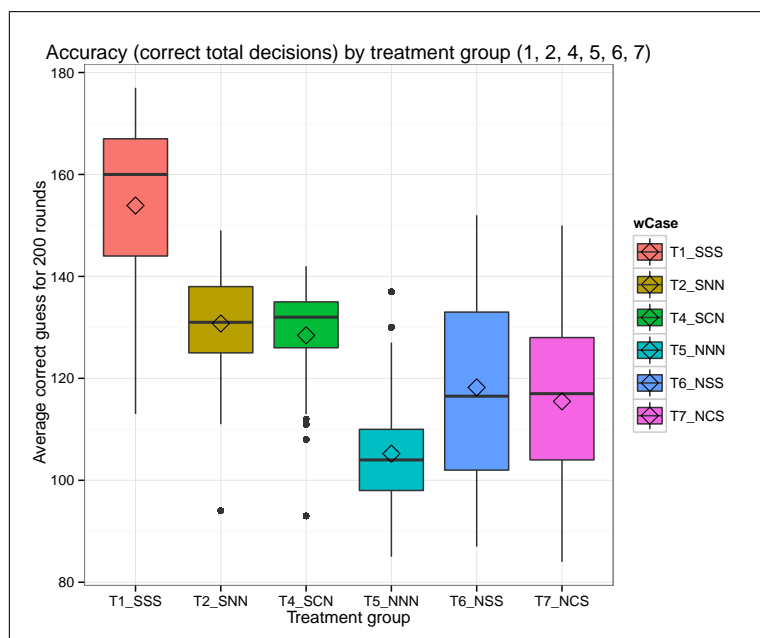
Figure 3 provides a summary of the experimental data across six treatment groups. We compare the performance accuracy of Treatments 1 and Treatment 5 and clearly see the substantial differences between the two. Half of the participants in Treatment 1 scored above 140 (mean = 153.90, SD = 17.07, Table 5), which is quite above chance, whereas half of Treatment 5 participants scored slightly above 100 (mean = 105.22, SD = 11.54, Table 6), which is what one could get if playing randomly. It is important to note that both groups have not been exposed to any variation in environment. Hence, the difference between the two treatment groups reflects the salience effect on learning. These results clearly indicate that presence of familiar cues can enable people to learn quickly and develop successful strategies for decision making. On the other hand, the absence of familiar or salient cues hinders learning and can lead to random or nearly random behavior and inferior outcomes.

Table 3. Probability of correct "accept" decision in Treatment 1 (SSS) and Treatment 5 (NNN)

Treatment 1: $P_{correct\ accept}$

Treatment 5: $P_{correct\ accept}$
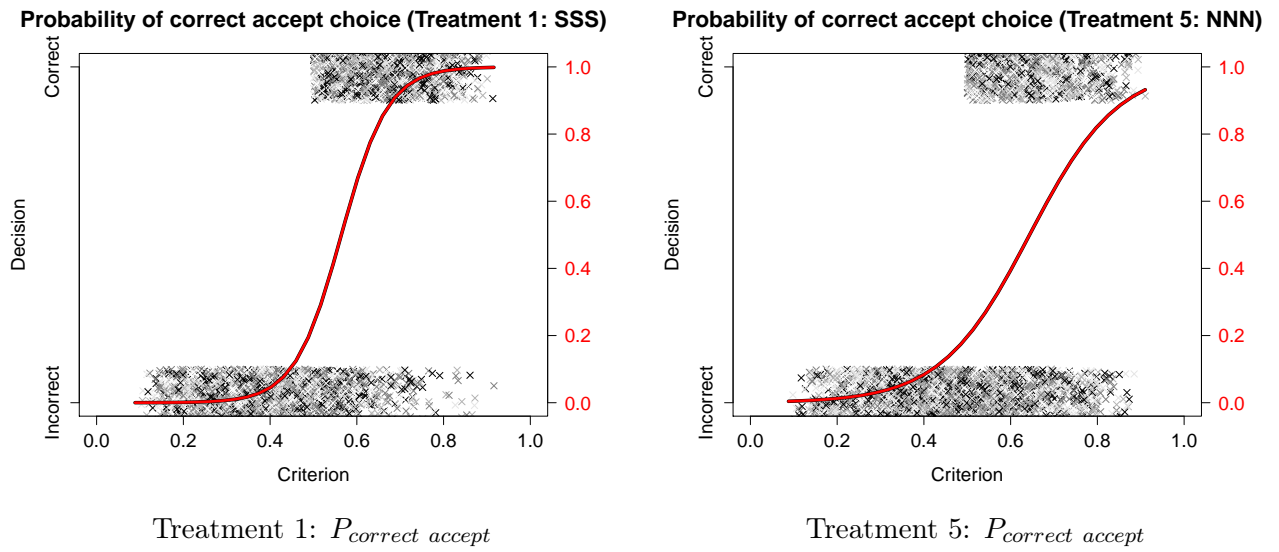
Table 4. Probability of correct guess in Treatment 5 (SSS) Johnson Growth Fund: Tables vs Tables & Graphs

Treatment 1: $P_{correct\ reject}$

Treatment 5: $P_{correct\ reject}$
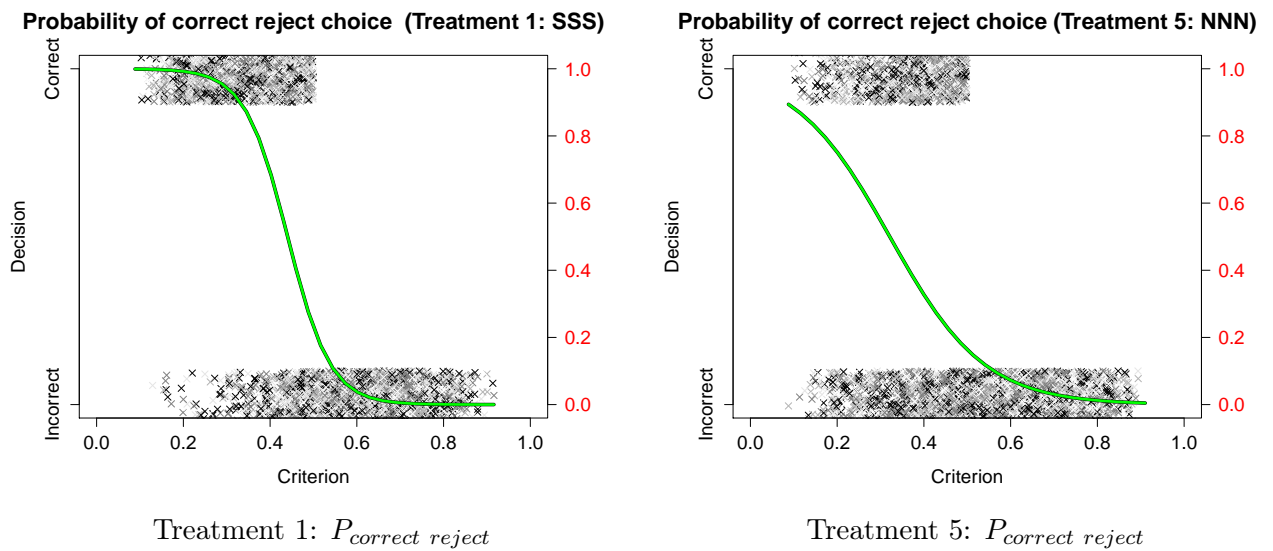
4.0.2. Effects of salient cues on learning in stationary environment

Table 5. *Treatment 1:* Salient cues and stationary environment

TREATMENT 1 (SSS)	PERIOD 1 *Salient cues* *Rounds 1-90*		PERIOD 2 *Salient cues* *Rounds 91-110*		PERIOD 3 *Salient cues* *Rounds111-200*	
	Mean	St. Dev	Mean	St. Dev.	Mean	St.Dev
Decision tendency	0.00072	1.00018	−0.04839	0.99964	−0.02151	0.99995
Accuracy (total)	0.74767	0.43443	0.79516	0.40391	0.78566	0.41044
Hit (correct accept)	0.36918	0.48267	0.38065	0.48594	0.39319	0.48855
Correct reject	0.37849	0.48510	0.41452	0.49304	0.39247	0.48839
False positive	0.13118	0.33766	0.09516	0.29367	0.09606	0.29472
Miss	0.12115	0.32636	0.10968	0.31274	0.11828	0.32300
Confidence	71.05663	24.38732	69.55484	26.28074	68.10000	27.13537
Decision RT	2554.11971	43353.33868	1479.96452	2693.27362	1646.87670	13976.04548
Confidence RT	1632.01111	1079.93950	1398.10806	728.40732	1346.16129	672.69443
Feedback RT	1467.48244	2279.63026	935.44516	851.61848	1178.42867	6669.69482
Criterion	0.49566	0.17043	0.50050	0.17472	0.50316	0.17079

Group average of total correct: Mean = 153.90, St. Dev. = 17.07. Mean total time = 1170 (s), St. Dev = 681 (s).
RT = response time; it was measured in milliseconds.

Table 6. *Treatment 5:* Stationary environment with non-salient cues (no change)

TREATMENT 5 (NNN)	PERIOD 1 *Non-salient cues* *Rounds 1-90*		PERIOD 2 *Non-salient cues* *Rounds 91-110*		PERIOD 3 *Non-salient cues* *Rounds111-200*	
	Mean	St. Dev	Mean	St. Dev.	Mean	St.Dev
Decision tendency	0.07527	0.99734	0.10968	0.99477	0.07384	0.99745
Accuracy (total)	0.52724	0.49935	0.55323	0.49756	0.51900	0.49973
Hit (correct accept)	0.27957	0.44887	0.30161	0.45933	0.27097	0.44454
Correct rejection	0.24767	0.43174	0.25161	0.43429	0.24803	0.43195
False Positive	0.25806	0.43765	0.25323	0.43521	0.26595	0.44192
Miss	0.21470	0.41068	0.19355	0.39540	0.21505	0.41093
Confidence	53.29032	31.45085	50.27581	32.68343	49.23047	32.64680
Decision RT	2164.72330	2218.39882	1828.60968	6218.87523	1282.91254	1499.94766
Confidence RT	1850.51039	1162.52198	1485.98871	696.84609	1381.54014	1733.01240
Feedback RT	1904.63943	2619.44384	1706.30000	11269.65496	1350.25986	22794.57294
Criterion	0.49773	0.16698	0.49848	0.16911	0.49536	0.17164

Group average of total correct: Mean = 105.22, St. Dev. = 11.54. Mean total time = 1171 (s), St. Dev = 395 (s).
RT = response time, measured in milliseconds.

4.0.3. Abrupt change in dynamic environment

Table 7. *Treatment 2:* Dynamic environment with salient cues: abrupt change to non-salient cues

TREATMENT 2 (SNN)	PERIOD 1 Salient cues Rounds 1-90		PERIOD 2 Abrupt change to non-salient Rounds 91-110		PERIOD 3 Non-salient cues Rounds 111-200	
	Mean	St. Dev	Mean	St. Dev.	Mean	St.Dev
Decision tendency	−0.02069	0.99998	0.01379	1.00077	0.02605	0.99985
Accuracy (total)	0.80153	0.39892	0.52759	0.49967	0.53410	0.49893
Hit (correct accept)	0.39732	0.48944	0.28448	0.45156	0.28123	0.44968
Correct rejection	0.40421	0.49083	0.24310	0.42933	0.25287	0.43474
False Positive	0.09234	0.28956	0.22241	0.41623	0.23180	0.42206
Miss	0.10613	0.30806	0.25000	0.43339	0.23410	0.42352
Confidence	68.43065	24.63931	62.15172	28.20921	55.61648	28.12335
Decision RT	1960.38161	12561.75249	1514.81207	1383.71082	1341.21648	1122.75491
Confidence RT	1506.88812	977.44804	1183.72414	518.83191	1070.04100	456.03594
Feedback RT	1503.40881	2201.33844	1283.47586	1397.44694	1082.56054	3329.22572
Criterion	0.50054	0.16864	0.50345	0.17005	0.50406	0.17075

Group average of total correct: Mean = 130.75, St. Dev. = 11.85. Mean total time = 1124 (s), St. Dev = 475 (s).
RT = response time, measured in milliseconds.

Table 8. *Treatment 6:* Dynamic environment with non-salient cues: abrupt change to salient cues

TREATMENT 6 (NSS)	PERIOD 1 Non-salient cues Rounds 1-90		PERIOD 2 Abrupt change, Salient cues Rounds 91-110		PERIOD 3 Salient cues Rounds 111-200	
	Mean	St. Dev	Mean	St. Dev.	Mean	St.Dev
Decision tendency	0.19097	0.98177	0.19375	0.98182	0.09514	0.99564
Accuracy (total)	0.54340	0.49820	0.56875	0.49564	0.64375	0.47897
Hit (correct accept)	0.32431	0.46820	0.33281	0.47159	0.33437	0.47185
Correct rejection	0.21910	0.41371	0.23594	0.42492	0.30938	0.46232
False Positive	0.27118	0.44465	0.26406	0.44118	0.21319	0.40964
Miss	0.18542	0.38870	0.16719	0.37344	0.14306	0.35019
Confidence	49.88368	25.08280	47.34219	25.19172	50.73160	26.27328
Decision RT	2022.37535	1966.44962	1584.60625	1585.51888	1474.29549	2270.06663
Confidence RT	1767.35243	1162.70290	1598.65625	994.74413	1520.23681	1527.45716
Feedback RT	1988.17292	3184.76922	1215.46875	1122.06256	1121.62743	3493.65932
Criterion	0.50136	0.16762	0.50017	0.16595	0.49126	0.16733

Group average of total correct: Mean = 118.21, St. Dev. = 17.32. Mean total time = 1198 (s), St. Dev = 441 (s).
RT = response time, measured in milliseconds.

4.0.4. Gradual change in dynamic environment

Table 9. *Treatment 4:* Dynamic environment with salient cues: gradual change to non-salient cues

TREATMENT 4 (SCN)	PERIOD 1 *Salient* *Rounds 1-90*		PERIOD 2 *Gradual change* *Rounds 91-110*		PERIOD 3 *Non-salient* *Rounds 111-200*	
	Mean	St. Dev	Mean	St. Dev.	Mean	St.Dev
Decision tendency	0.01111	1.00012	−0.01667	1.00070	0.01037	1.00013
Accuracy (total)	0.77185	0.41972	0.59000	0.49224	0.52407	0.49951
Hit (correct accept)	0.38778	0.48733	0.28167	0.45019	0.26593	0.44191
Correct rejection	0.38407	0.48647	0.30833	0.46219	0.25815	0.43770
False Positive	0.11778	0.32240	0.21000	0.40765	0.23926	0.42671
Miss	0.11037	0.31341	0.20000	0.40033	0.23667	0.42511
Confidence	69.95667	23.34375	70.36667	20.72603	62.88222	25.00712
Decision RT	1607.20481	1351.50232	1465.74833	1385.56182	1402.95444	1588.78985
Confidence RT	1699.05111	1121.90742	1422.31333	951.95337	1340.35222	1037.23970
Feedback RT	1409.46037	1683.90503	1058.54667	1173.79397	1052.55667	3840.74375
Criterion	0.49780	0.16670	0.49895	0.15147	0.50152	0.17197

Group average of total correct: Mean = 128.43, St. Dev. = 11.05. Mean total time = 1040 (s), St. Dev = 325 (s).
RT = response time, measured in milliseconds.

Table 10. *Treatment 7:* Dynamic environment with non-salient cues: gradual change to salient cues

TREATMENT 7 (NCS)	PERIOD 1 *Non-salient cues* *Rounds 1-90*		PERIOD 2 *Gradual change* *Rounds 91-110*		PERIOD 3 *Salient cues* *Rounds 111-200*	
	Mean	St. Dev	Mean	St. Dev.	Mean	St.Dev
Decision tendency	0.12797	0.99197	0.14828	0.98980	0.16092	0.98716
Accuracy (total)	0.50536	0.50007	0.54483	0.49842	0.65670	0.47490
Hit (correct accept)	0.28123	0.44968	0.31897	0.46648	0.37088	0.48313
Correct rejection	0.22414	0.41709	0.22586	0.41851	0.28582	0.45189
False Positive	0.28276	0.45043	0.25517	0.43633	0.20958	0.40709
Miss	0.21188	0.40872	0.20000	0.40035	0.13372	0.34041
Confidence	49.51149	28.03055	47.41552	25.60437	52.20038	27.41752
Decision RT	2009.17663	3608.53183	1938.96897	4829.49674	1330.04100	3598.68906
Confidence RT	1844.18084	2412.86060	1400.32586	572.96175	1363.50575	601.67124
Feedback RT	2215.93295	6076.47825	1436.32241	2437.66012	1157.86552	5470.20563
Criterion	0.49667	0.17215	0.50308	0.14637	0.50277	0.16823

Group average of total correct: Mean = 115.48, St. Dev. = 16.49. Mean total time = 1236 (s), St. Dev = 399 (s).
RT = response time, measured in milliseconds.

4.0.5. Effects of salient cues and environments changes on confidence judgment

Figure 4. Confidence patterns for comparative treatment groups over time (200 rounds)
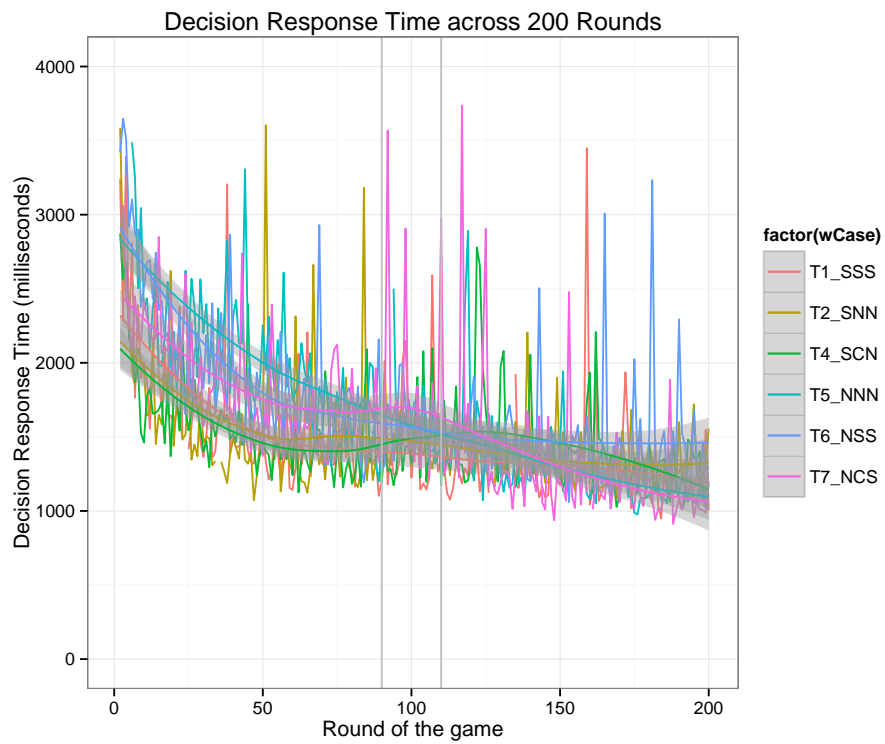
Figure 5. Confidence patterns for comparative treatment groups over time (200 rounds)
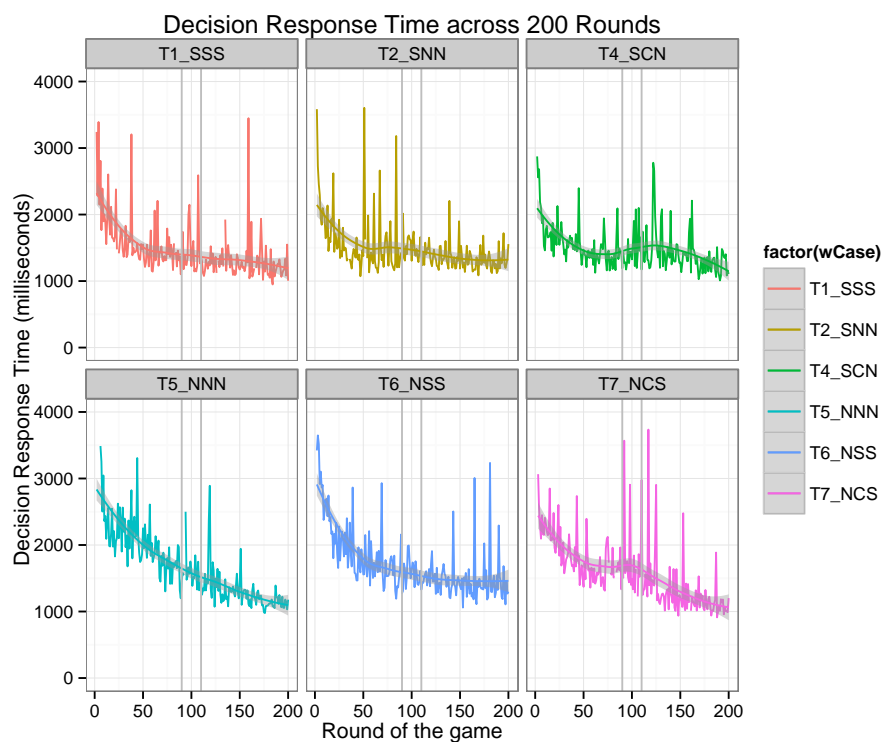
4.0.6. Effects of salient cues and environments changes on response time

Figure 6. Decision response time patterns for comparative treatment groups over time (200 rounds)
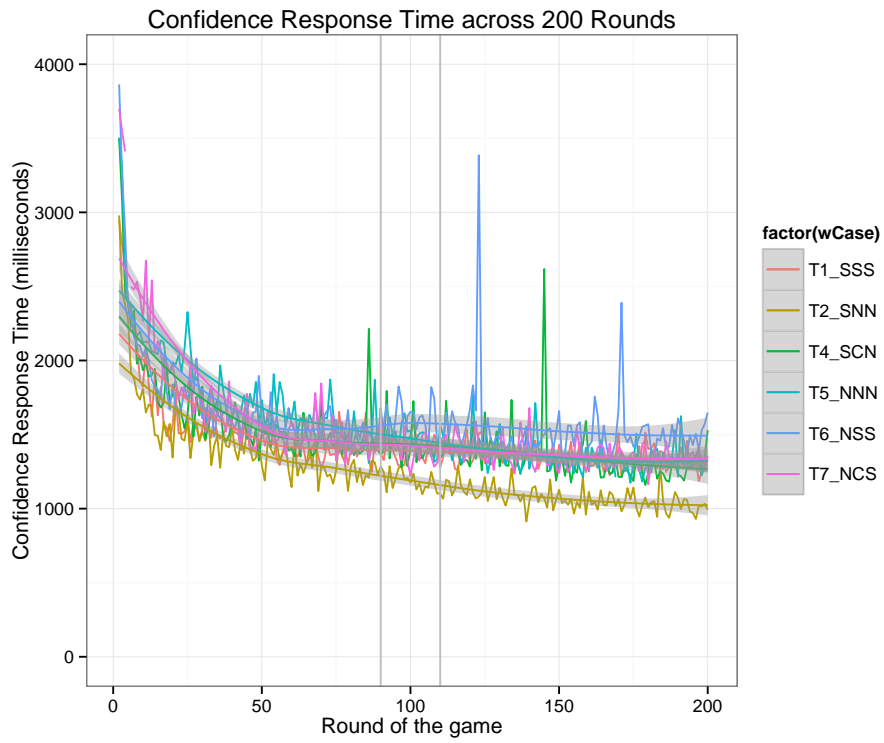
Figure 7. Decision response time patterns for comparative treatment groups over time (200 rounds)
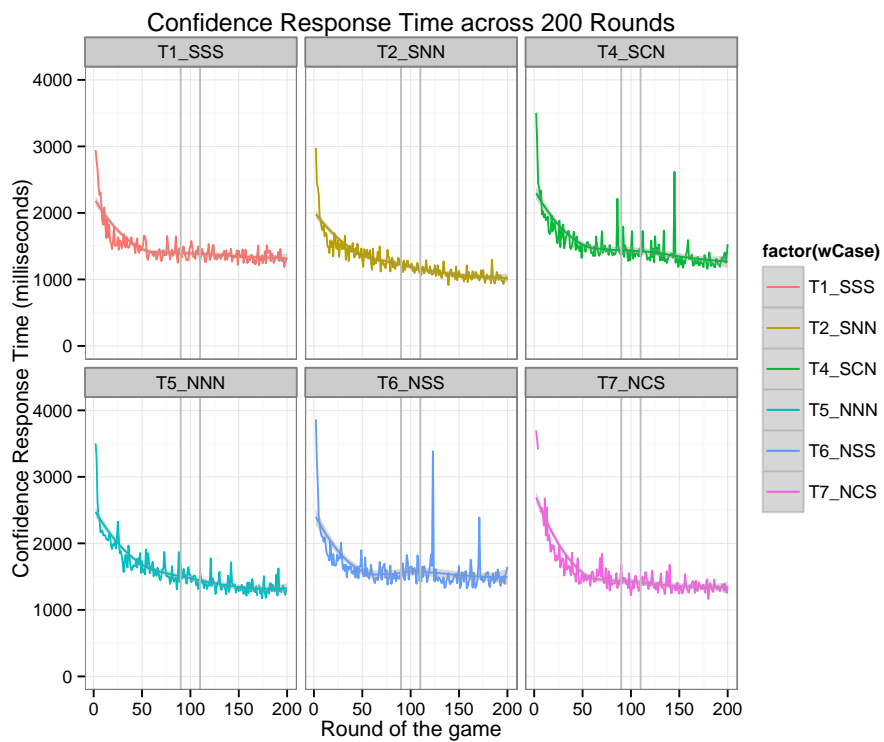
Figure 8. Feedback response time patterns for comparative treatment groups over time (200 rounds)
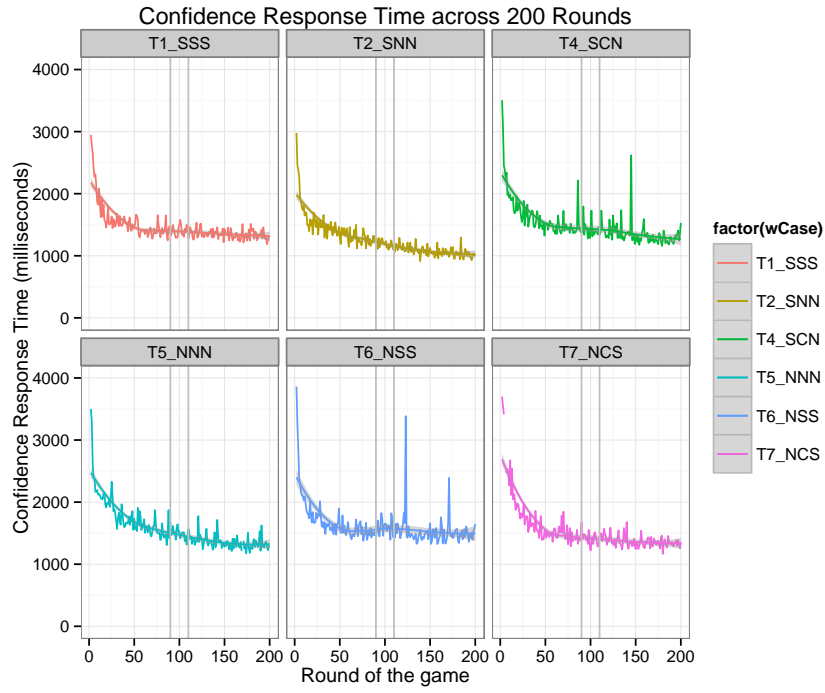
Figure 9. Confidence response time patterns for comparative treatment groups over time (200 rounds)
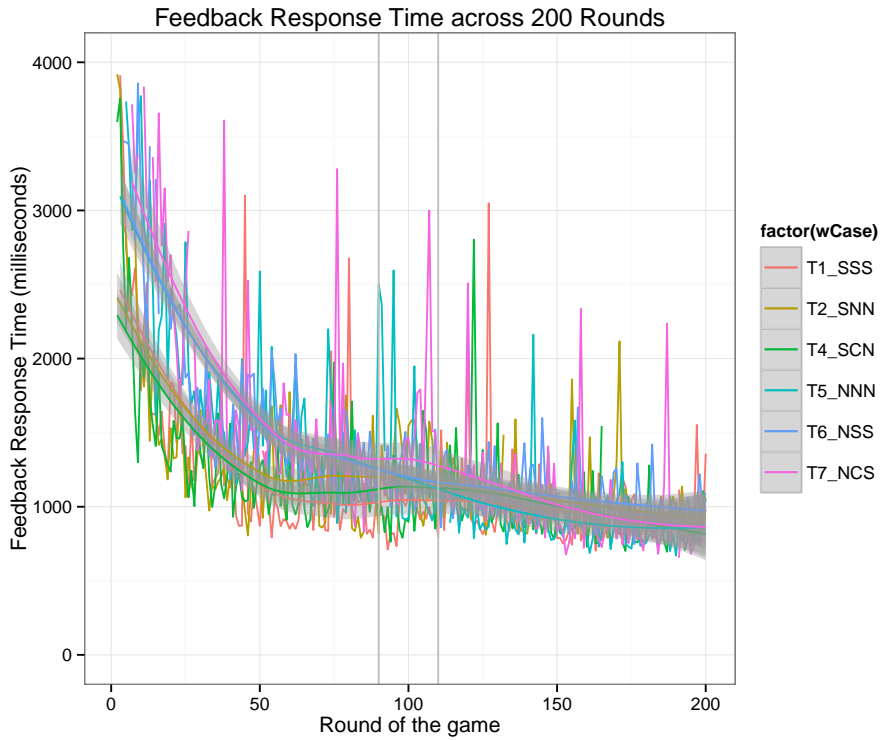
Figure 10. Confidence response time patterns for comparative treatment groups over time (200 rounds)
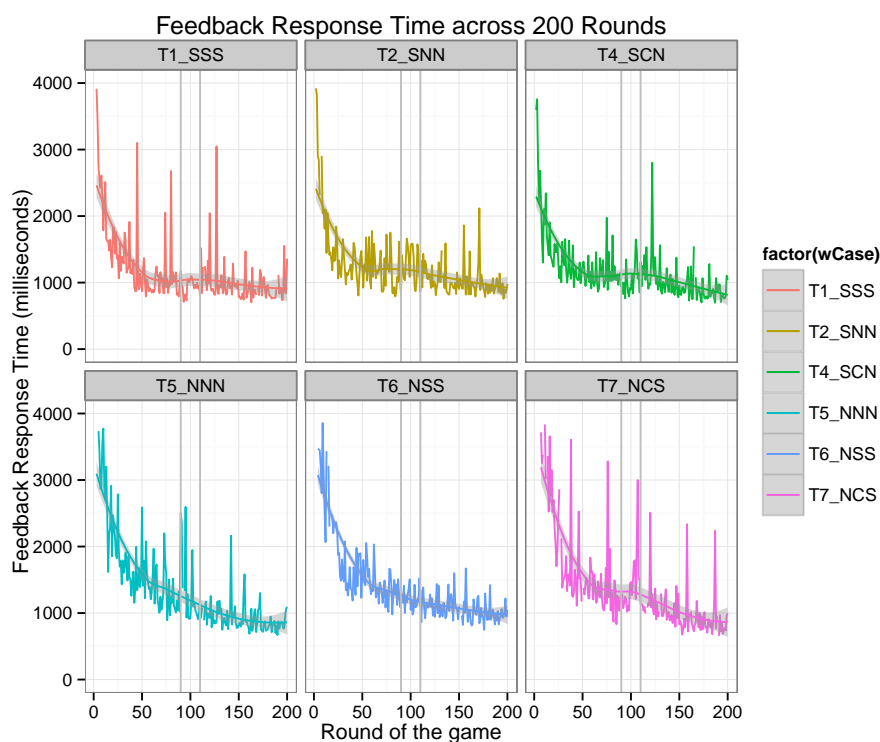
5. General Discussion

Learning is the fundamental cognitive ability that allows people to adapt to a changing environment by developing new strategies for decision making. If people are not able to learn from experience and adapt to changes in the environment, the long-term performance and outcomes may be at risk. Many empirical studies suggest that people regulate their learning and adaptation behavior continuously based on external and internal signals such as availability of corrective feedback, expected payoff, or sense of confidence (Kheifets and Gallistel, 2012). Our results suggest, that people reduce effort spent on learning once they reach a satisfactory level of accuracy or when the opportunity costs of learning exceed those of expected payoff. Our data show that people's level of confidence mirrors an internal psychological mechanism which in turn guides peoples behavior. Our response time data has rich information as it provides an effective way to study to what extent the adaptation lags behind environmental change, and whether this lag is smaller or greater when environments change either abruptly or gradually.

This chapter links interdisciplinary but related streams of research on learning in dynamic and information-rich environments. In addition, we provide novel insights that can inform researchers who are particularly interested in modeling decision processes and decision outcomes. For example, most of the existing models do not incorporate all decision-relevant dimensions of decisions making such as confidence measures of change patterns (Pleskac and Busemeyer, 2011). As a matter of

fact, most models subdivide time measures into two main categories: decision and non-decision time intervals. This might be an overgeneralization of processes that take place after and before decision making. A further breakdown would be wise to consider for future models. Time elements might be playing an important role, but the importance of other variables is also relevant. Our data suggest that learning in an environment with salient and discriminant cues leads decision makers to develop strategies different from those who learn in environments containing less salient and less discriminative cues, thereby affecting decision outcomes or processes. This research provides compelling evidence that visual stimuli used to study signal detection, human learning, and adaptation should be considered as special types of stimuli, as they activate different cognitive processes not yet fully understood. For those who are interested in studying decision accuracy, this research provides interesting insights regarding its relation to levels of confidence, initial environment cues, and subsequent changes, all interacting in deterring long-term decision making outcomes.

6. Conclusion

We discuss in detail the three most relevant measures of cognitive performance in the cognitive and decision sciences: choice accuracy, decision time, and judgment confidence. We experimentally explore diverse ingredients of decision making some of which have not been considered by researchers and modellers before. We place a particular focus on the environment that is dynamic and information rich. The experimental evidence we have presented makes an intelligible case for the importance of cue salience as a means of adapting to changes, for the sensitivity of people's recognition of changes, for the potential role of confidence as a unifying regulatory variable. There are many more environments, task conditions, decisions variables to consider and that could help understanding of what actually accelerates initial and facilitates subsequent learning of humans in information-rich environment. We have demonstrated that environment change patterns, together with visual information structure, influence how people perform in the short run and in the long run. A logical next step is to incorporate a theoretical account of why decision makers behave in the way our data show. One possible avenue would require a model that considers not only the discussed variables, but possibly addresses visual information search patterns and other other aspects of face perception. Another challenge to take into account for the future is learning in an information-rich but not easy to discriminate environment. Our results show that people appear to give up when they can not figure out the underlying rule of the decision criterium. If people strop trying, when do they stop trying to learn? If they are playing randomly, but the environment is such that learning can be easy, what motivates them to start learning over again? How and when people decide to abandon old strategies for new ones? Clearly, there are still many questions to be answered.

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7. Appendices

Appendix A: *Experiment:* materials and methods extended

Figure 11. Experimental design: treatment groups

wCase	Name	1-90 rounds P1	91-110 rounds P2	111-200 rounds P3
T1	SSS	Salient	Salient	Salient
T2	SNN	Salient	Non-Salient	Non-Salient
T4	SCN	Salient	Changing	NonSalient
T5	NNN	Non-salient	Non-salient	Non-salient
T6	NSS	Non-salient	Salient	Salient
T7	NCS	Non-salient	Changing	Salient

Figure 12. Experimental design: a payoff diagram
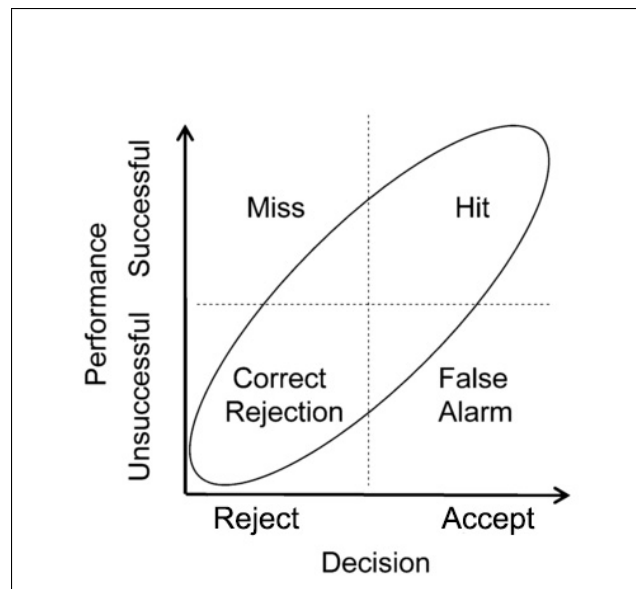
Appendix A-1: Experimental design

Figure 13. Experimental design: a flowchart
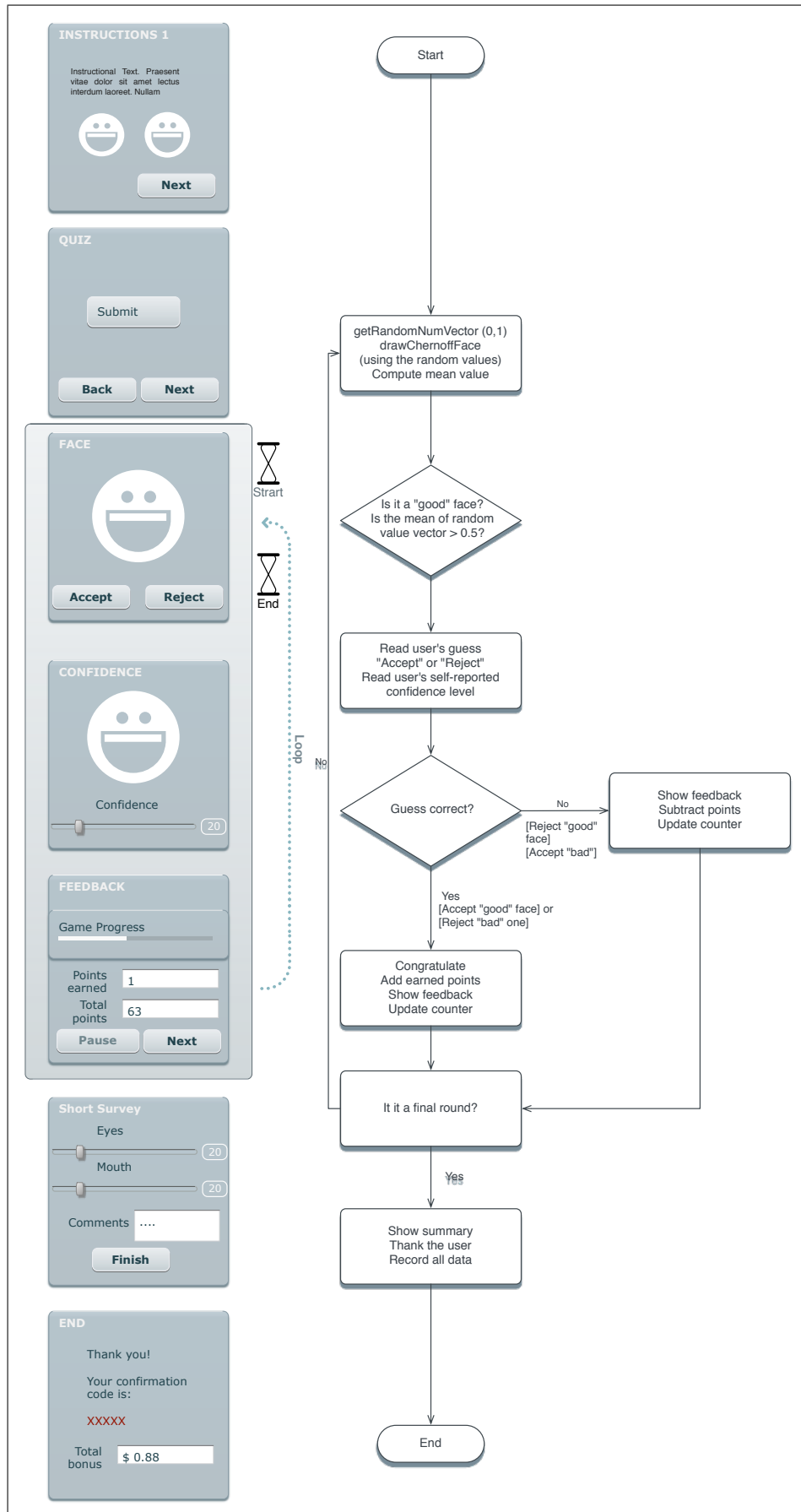
Appendix A-4: Experiment Instructions

Figure 14. Experimental design: Instructions page 1

Figure 15. Experimental design: Instructions page 2

Figure 16. Experimental design: Instructions page 3

Appendix A-5: Qualifying questionnaire

Figure 17. Experimental design: Quiz

Appendix A-6: Example of stimuli

Figure 18. Experimental design: Game screen
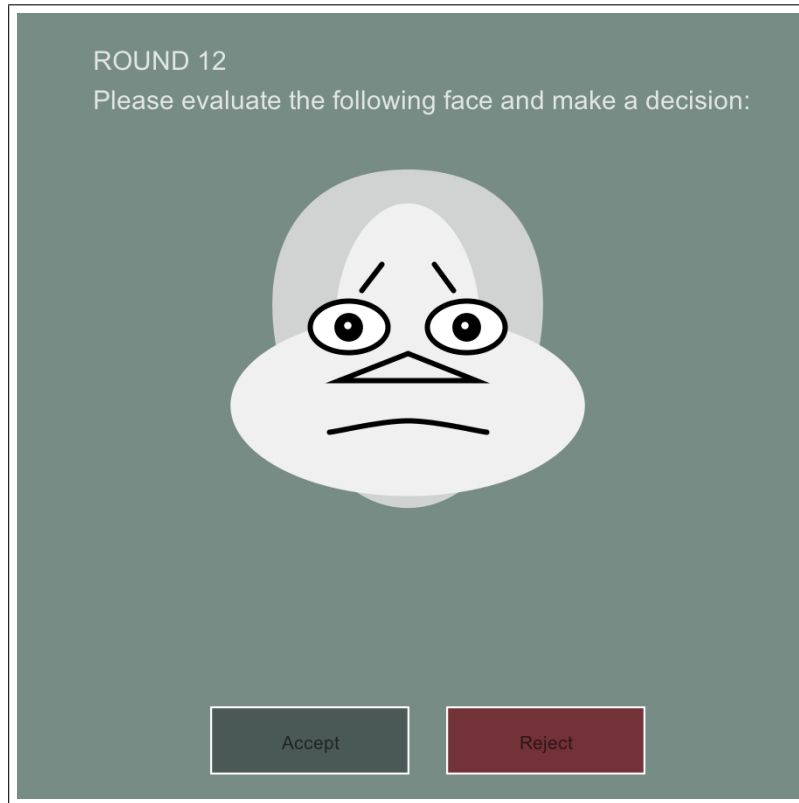
Figure 19. Experimental design: Confidence screen
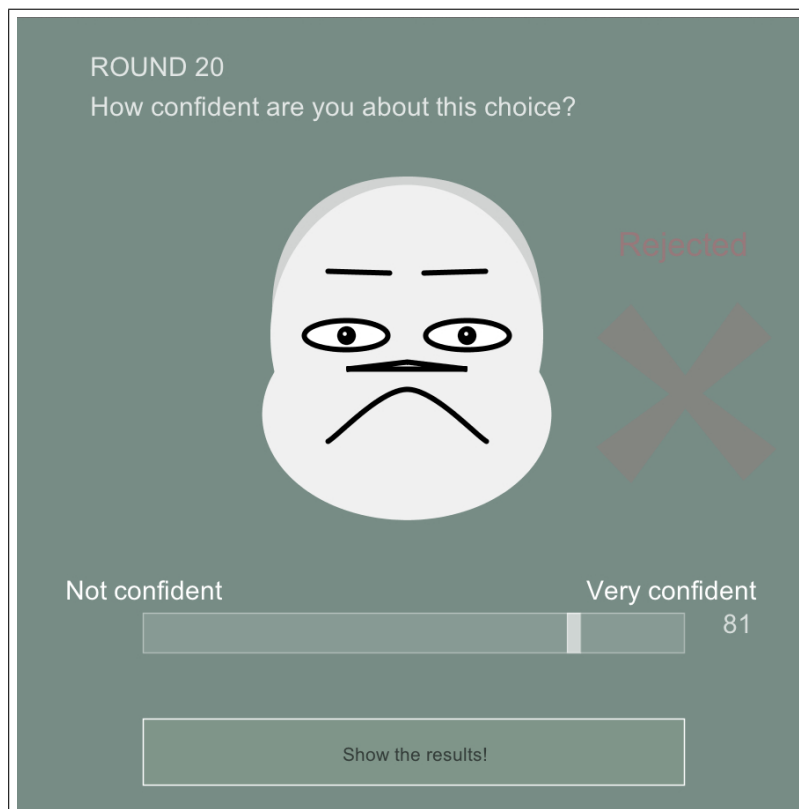
Figure 20. Experimental design: Feedback screen
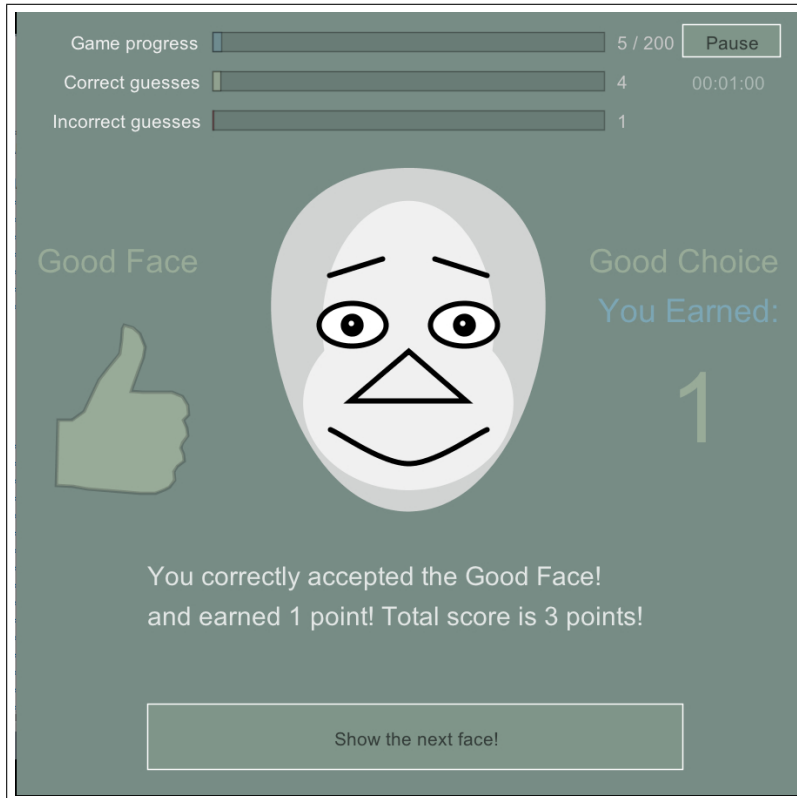
Appendix A-7: Post-experiment survey

Figure 21. Experimental design: post-experiment survey
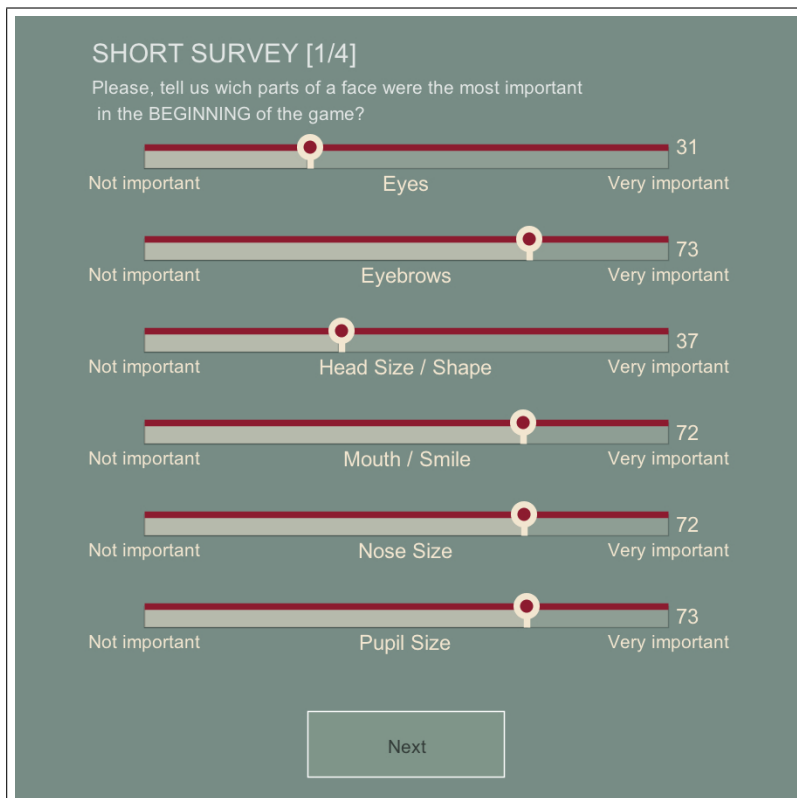
Figure 22. Experimental design: Post-experiment survey

Figure 23. Experimental design: Post-experiment survey

Estratto per riassunto della tesi di dottorato

Studente: Inga Jonaityte   matricola: 955707

Dottorato: Economia Aziendale

Ciclo: XXV

Titolo della tesi : Visual Representation and Financial Decision Making (Rappresentazione Visiva e Decisioni Finanziarie)

Abstract:

This thesis addresses experimentally three topics concerning the effects of visual representations on financial decision making. First, we hypothesize that visual representation of financial information affects comprehension and decision-making processes and outcomes. To test our hypothesis, we conducted online experiments demonstrating that the choice of visual representation leads to shifts in attention, comprehension, and evaluation of the information. The second study focuses on the ability of financial advisers to provide expert judgment to aid naïve consumers facing financial decisions. We found that advertising content significantly affects both experts and novices. Our results provide a previously underexplored viewpoint of decision making by finance professionals. The third topic concerns our ability to learn from multiple cues, adapt to changes, and develop new strategies. We investigated the effects of salient cues and environmental changes on learning, and found, among other things, that "abrupt" transformations in an environment are more harmful than "smooth" ones.

Questa tesi affronta sperimentalmente gli effetti delle rappresentazioni visive sulle decisioni finanziarie. Ipotizziamo che le rappresentazioni visive dell'informazione finanziaria possano influenzare le decisioni. Per testare tali ipotesi, abbiamo condotto esperimenti online e mostrato che la scelta della rappresentazione visiva conduce a cambiamenti nell'attenzione, comprensione, e valutazione dell'informazione. Il secondo studio riguarda l'abilità dei consulenti finanziari di offrire giudizio esperto per aiutare consumatori inesperti nelle decisioni finanziarie. Abbiamo trovato che il contenuto della pubblicità influenza significativamente tanto l'esperto quanto l'inesperto, il che offre una nuova prospettiva sulle decisioni dei consulenti finanziari. Il terzo tema riguarda l'apprendimento da informazioni multidimensionali, l'adattamento al cambiamento e lo sviluppo di nuove strategie. Abbiamo investigato gli effetti dell'importanza delle "cues" e di cambiamenti dell'ambiente decisionale sull'apprendimento. Trasformazioni improvvise nell'ambiente decisionale sono più dannose di trasformazioni graduali.

Firma dello studente

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