Information Foraging - In a Decision Making Environment under Conditions of Uncertainty

- The case of Saxo Bank's Tradingfloor.com

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PREFACE

This master's thesis is written by Nicolaj Bohn and Nicolai Frederiksen as completion of the IT Management and Business Economics program Cand.merc.(it.). The topic of research is information foraging in financial decision making when analyzed using Eye-Tracking technology. This thesis contributes as a new tread to the existing Information Foraging Theory. It will include studying, analyzing, and interpreting the information foraging behavior and how it is affected by different representations of information. Ultimately, the results from this thesis will answer the question of which representation that is most suitable for traders forage information before making decisions.

The topic is selected in cooperation with our supervisor Jonas Hedman (Associate Professor), Saxo Bank employees Jeffrey Todd Lins (Head of Research and Innovation) and Christian Villumsen (Head of Portfolio Office). The ambition with this thesis has been to provide valuable contributions to the information foraging literature as well as Saxo Bank.

The advanced and expensive Eye-Tracking equipment used in this thesis has required external support from Department of IT Management and Saxo Bank. In this regard, we would like to thank our supervisor Jonas Hedman for his constructive guidance throughout this thesis and his ability to cut to the point. A Special thanks to Jeffrey Todd Lins for his guidance and help in the development of the research scope, the experiment and for his great domain knowledge of finance and behavioral science. Tremendous thank you to scientific assistant, Kjeld Hansen for his support in the eye-tracking studies and analysis. We would also like to thank Professor Ravi Vatrapu for his guidance and assistance with the Eye-Tracking equipment and the statistics.

EXECUTIVE SUMMARY

This thesis studies a financial trader's information foraging behavior in financial decision making context using Eye-Tracking technology. The decision making will include uncertainty because it simulates the reality. Various representations of information are used to inform traders before they make a decision, but which representation is the most suitable? Representations like graphs, texts, pictures, and videos are all used by Saxo Bank's Tradingfloor.com and new knowledge within this area will strengthen Saxo Bank's ability to compose websites and information systems which represent the information in ways that maximize rational decision making.

In order to study the information foraging behavior, it was necessary to develop a website and use it as an experiment where the participating subjects would make several financial decisions. In this experiment, the subject's ability to allocate their attention efficiently between the representations and estimate the expected value returned from the information foraged, is an important parameter to determine the quality of their decisions. The information foraging behavior was measured with the following parameters: first fixation as a parameter of their visual preferences, first click to illustrate the selection of information, and choices to indicate how rational the decisions are. The experiment was conducted in a laboratory with ten subjects all with a financial education from Copenhagen Business School.

The results indicate that the representations most suitable for traders foraging information are the graphs and texts. While the video representation also creates a high level of visual attention, the level decreased through the rest of the experiment. In contrast, the graph and text representations had an increased level of first fixations throughout the experiment.

The visual attraction had a strong correlation with the first click. Here it was also the graph and text representations scoring the two highest levels of first click. Furthermore, the graph representation had the highest level of rational choices with 61.76% of the choices made by using the graph representation. It was closely followed by the picture representation with 58.62% rational choices, the text representation with 54.17% rational choices and the video representation with 47.83% rational choices. Indicating the graph representation being the representation, which is most suitable for the subject's information foraging before decision making.

The study also found evidence of strong effects of where the information is positioned in the information foraging behavior, especially the upper left corner also named 1. Position. The order which the subjects forage the information are also affecting their behavior.

Finally, this study discovered that subjects are sensitive towards the information value. This sensitivity affects the first clicks where graph and text representations are receiving considerable more first clicks compared to picture and video representations. This indicate that subjects are calculating the returned value in relation to the cost of retrieval which is in favor of the text and graph representations due to lower cost of retrieval.

From the findings of this study, it is recommended to keep in mind influence the position has on the traders foraging behavior. It is recommended that the Video representation is use to attract attention of the traders and then is supplemented with text and graph information to provide the

decision making information. It is further recommended that Saxo Bank provide the high value information at the identified key position and representation format, to minimize the information foraged to optimize the traders rational behavior.

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1. Introduction

The navigation between information may be influenced by various representations and it is the objective for this thesis to study how the navigation is influenced in financial decision making. Information Foraging Theory has been applied and acknowledged for its contributions to the research area of web navigation [Pirolli, 1999; Pirolli, 2005; Pirolli, Fu et. al. 2005; Blackmon, 2012]. The amount of information on the web is increasing rapidly and the need to understand how the human attention to the information is allocated seems more relevant than ever before [Pirolli, 1999]. Blackmon elaborates and asks how people are able to detect that one information source is more optimal than another [Blackmon, 2012]. Information is often presented by various representations like graphs, videos, pictures, and texts, which yield different information scent of its value, and it would be obvious to ask how the human attention is allocated when presented with these different representations.

This study will contribute to this research area by examining how information foraging behavior appears in a context of financial decision making under conditions of uncertainty, as this field of research within the area of financial decision making has not yet been thoroughly investigated. This is one of the reasons why this thesis will study the information foraging behavior in financial decision making.

The perspective on human attention creates the foundation for an explorative research, where the information foraging behavior in financial decision making will be the focal point of the study. Individuals are not solely capable of making rational choices and this thesis might be able to provide new knowledge that can enlighten this area and improve both the way information is represented and the way to structure your interface. In this situation optimization models can be used to analyze the behavior according to what is the most rational information foraging behavior. The potential benefits from new knowledge regarding how individuals allocate their attention between various representations is particular interesting for the Danish based investment bank - Saxo Bank - who showed an interest for this area of research. Individual's ability to find and make rational decisions based on the information available is essential for the success of their financial decision making. New knowledge about this area will strengthen Saxo Bank's ability to compose websites and information systems, which present the information in ways that, maximize rational decision making.

Human attention is consumed by information, which increases the demand on effective representations of information in order to make rational decisions [Pirolli, 1999]. Here the information sources, called representations in this thesis, have a substantial role in the decision making and the attention they attract [Pirolli, 1999]. An experiment will be developed, as the purpose of the experiment is to investigate the subject's ability to allocate their attention efficiently between the representations. How they estimate the expected value returned from the information foraged will be an important parameter to determine the quality of their decisions.

Information Foraging Theory describes and provides reasoning for human information search and gathers behavior, however it does not provide the technology to capture this behavior. Eye-Tracking technology is the answer to this issue. The use of Eye-Tracking technology will make it

possible to capture human attention instantly without relying on the users own perception of their attention. Eye-Tracking technology can create the patterns of the subject's information search and gathering behavior in a financial decision making situation. The Eye-Tracking technology demands a controlled environment to ensure that the measurable variables in focus are the only variables affecting the subjects foraging behavior [Holmqvist, 2011]. This is why an experiment has been developed in order to comply with this requirement.
The experiment developed for this thesis makes it possible to control the surroundings and generate the appropriate decision making situation without distractions. On the basis of Information Foraging Theory and the Eye-Tracking technology, are the essential variables defined to be the first fixation, the first click and the choice made. These variables help to identify the pattern of the subject's information foraging behavior. The first fixation will provide knowledge about the attraction of the visual stimuli. The first click will provide insight into the selection of information and how it is affected and thirdly, the choice will provide knowledge about how rational the subjects make financial decisions and ultimately which kind of information foraging behavior that underlies. All three variables will provide new knowledge that will make it possible to analyze which representation of information is most suitable when traders are foraging information before decision making.

1.1. Research Question

In accordance with the introduction, this thesis will investigate how representation, position, and information value influence a financial traders ability to forage for the rational information in a financial decision making context. In order to contribute with new knowledge in the field of information foraging - under conditions of uncertainty, this thesis will examine the behavior within a stock trading context by answering the following question:

Which representation of information is most suitable when traders are foraging information before decision making?

This main question can be broken down into three sub-questions. These sub-questions are created to increase the understanding of the information foraging behavior and illustrate the operationalization of the main question:

1. ***What are the visual preferences for information in a decision making context?***

2. ***How do the variables, representation, value, and position influence the selection of information?***

3. ***Do position and representation affect a financial trader's ability to forage for the most valuable information and ultimately affect their decision making?***

By answering the presented questions, this thesis is expected to produce valuable knowledge supporting the Information Foraging Theory, with emphasis on financial decision making under conditions of uncertainty. The results will contribute with comprehensive insights on user's information foraging behavior and their visual preferences in financial decision making under conditions of uncertainty.

1.2. Delimitations

This section outlines the delimitations made in this thesis in relation to the experiment conducted, the subjects participating and the produced knowledge.
The focal variables have been the representation, the information value and the position. It is important to minimize the effect of unwanted variables, which is not part of the focal variables, to ensure that the selected focal variables intentionally affect the information foraging behavior in the experiment and these are measurable and quantifiable. The experiment has been conducted in a laboratory with the use of a developed webpage and it has been developed from scratch in order to control the information foraging behavior and the affecting variables.

The conducted experiment will study the information foraging behavior in buy situations and not the behavior in sell situations. This means that options like sell or keep a stock will not be an option, and different degrees of leverage will neither be an option. This will minimize the complexity of the experiment and make it possible to carry out within the timeframe of this thesis.

The study draws from a small number of ten subjects deemed representative for the traders and potential traders Information Foraging behavior. The studied segment has mainly consisted of students from Copenhagen Business School with a financial education and a few subjects who also work within the finance industry. The subjects are between 20 to 30 years old. The behavior observed from this segment can therefore not represent the large client base that Saxo Bank currently has, but reflected potential clients. A gender differentiation cannot be made due to the fact that only one of the subjects in the experiment is female. Differences in behavior have not been studied in this thesis, because it goes beyond of the scope of the project.

While TradingFloor.com remains the foundation of the initial inspiration for the problem situation, it will not be anything else than a setting of the context for the experiment. TradingFloor.com will function as project scope and area where the problem is identified. Some concepts from TradingFloor.com will be transferred to the actual experiment in order to simulate a real trading behavior and aligned it to the behavior of TradingFloor.com.

The Eye-Tracking equipment is placed at CBS in the Department of IT Management office, the equipment is setup in a lab environment, and it is not possible to adapt the equipment into the studies natural environment. The equipment used for this study is a SMI Red, which is a stationary monitor. Even though the experiment is not conducted in the natural environment of the financial trader, the lab environment reflects some of the key features.

1.3. Readers Instruction

Reader's instruction will provide an overview of the different chapters of the thesis and a short description of the key elements each chapter contain.

Chapter 1: Introduction
The first chapter presents the topic of the research, the reason for this research and the research questions that will be answered.

Chapter 2: Theoretical framework
Here the theoretical framework will be described in detail and explain how Information Foraging Theory is applied to the context of this study.

Chapter 3: Methodology
This chapter describes the methods applied to this study in order to achieve a reliable data collection. The research approach and the explorative perspective will be explained according to the scope of the research. Furthermore will the structure of the experiment be presented in a protocol and the control-mechanism used to ensure a high level of data quality will also be described.

Chapter 4: Results
The results are structured in three parts according to the three sub-questions each with individual variables used to measure the information foraging behavior. The three sub-questions will together answer the main research question.

Chapter 5: Discussion
This discussion chapter discusses the theoretical and methodological framework applied. It furthermore discusses the results of the analysis and its implications.

Chapter 6: Recommendations
This chapter will provide recommendations on how the findings can be implemented and used in the operation of Saxo Bank's Tradingfloor.com platform.

Chapter 7: Conclusion
This chapter will summarize the findings of the study and directly answer the stated research questions.

Chapter 8: Reflections
This chapter will present what we have learned and some of the challenges we encountered.

2. Literature Review & Theoretical Framework

This chapter outlines the theoretical foundation of this study by looking into the concept of Information Foraging Theory. The theory will work as an explanatory model and its applications are presented in relation to the context of financial decision making. Afterwards, the theory will be discussed in relation to its relevance, how it supports the use of Eye-Tracking technology and the accompanying methodology. The literature review will not cover all aspect of Information Foraging Theory within the research domain due to lack of relevance and applicability.

2.1. Information Foraging

Information Foraging Theory is an approach to understand how people seek, gather and consume information [Pirolli, 1999]. This review of Information Foraging Theory will present relevant concepts and ideas that will lay the foundation for this thesis. It will furthermore provide the basis for the research questions. Underlying assumptions will be described and placed into the financial context of this study and the experiment conducted as well. The theory is justified because it provides explanations for human behavior and strategy when seeking information in order to complete their respective tasks [Pirollo, 1999]. In the same way information foraging can explain the data collected from this study with a credible framework.

The theory is created from an evolutionary ecological perspective. Proposing that Information Foraging Theory is analogous to evolutionary ecological explanations of food foraging strategies in anthropology and behavioral ecology [Smith & Winterhalder 1992; Stephens & Krebs 1986]. The behavior found in food-foraging anthropology is stated to be relevant in the information foraging context seen today. In other words, human behavior and strategies have not been through the same development compared to the environment it is applied. Despite the change from food-foraging to information foraging it is still the same fundamental concepts and strategies ruling the gathering, selection and consumption processes. From this perspective information foraging has a fundamental hypothesis that still is relevant today and it follows;

> *"...when feasible, natural information systems evolve towards stable states that maximize gains of valuable information per unit cost." [Pirolli, 1999, page 3].*

The hypothesis applies to cognitive systems and can therefore be characterized as a guideline for the human behavior and strategies observed in information foraging situations [Pirolli, 1999]. Information Foraging Theory is a popular theory for describing web-browsing behavior [Pirolli, 2005; Liu, 2004]. This behavior can be measured through the use of Eye-tracking where measurable elements as fixations can provide detailed observations about the behavior, which will be explained in detail in section 2.2 Eye-Tracking Methodology. The theory can provide the necessary concepts to understand the observed information foraging behavior within the context of financial decision making. The theory can be applied to the problem area and clarify how and why individuals make the strategic choices they do [Sandstrom, 1994].

2.1.1. Optimal Foraging Theory

Optimal Foraging Theory states that humans forage in ways that maximize their gained return of energy or valuable information per unit time [Pirolli, 1999; Sandstrom, 1994]. Secondly Optimal

Foraging Theory provides rationality for the understanding and explanation for how humans search, gather and consume information in the best possible way. Optimal Foraging Theory also describes the human information foraging behavior and strategy in relation to what is the most rational behavior, but on the other hand it accepts that human's exhibit bounded rationality [Pirolli, 1999]. Eye-tracking technology helps to provide an insight to understand the actual strategy of information foraging behavior by identifying the fixations and the clicks. Optimization models can be used to analyze the behavior according to what is the most rational information foraging behavior and in general consist of three components stated by Pirolli et al. (1999):

1. *Decision assumptions:* Deciding whether to pursue specific information content or deciding how much time to process a collection of information.

2. *Currency assumptions:* How to evaluate your choices. Information Foraging Theory sees information as a currency and assumes it can be maximized, minimized and stabilized.

3. *Constraint assumptions:* Defines the relationship between decision and currency variables. Constraint assumptions also define the limits as a result of interface structure and task structure. Combined with the user populations abilities and knowledge, makes it possible to analyze the rate, which a person can navigate through an interface of an information system, or the value of results returned by search technology [Pirolli, 1999].

Decision assumptions, *Currency assumptions* and *Constraint assumptions* are all part of the optimization model. These assumptions can analyze the optimization of information foraging in the context of this thesis. There is a subject choosing among alternatives and deciding when to pursue specific information (*Decision assumption*), a currency which the subject measures costs and benefits (*Currency assumption*), certain constraints that are beyond the actor's control which limits his or her behavior and a strategy set that specifies the actor's available options (*Constraint assumptions*). The degree of sensitivity to risk is defined by the actor's choices. Through the strategy applied containing the combination of all the choices and decisions that are available, an analysis of the actor's risk sensitivity can be evaluated. In this study the focus will be more geared towards sensitivity to the information value and representation and how it affects the choices, but with use of the same principles described above.

There is an underlying assumption of the Optimal Foraging Theory stating that: "*organisms will behave as if they are optimizing some fitness-related currency or set of currencies...*" [Sandstrom, 1994], the assumption is justified with the logic of cost-benefit analysis. This is leading to all information foraging activities can be analyzed in regard to the value returned and the cost incurred. Two parameters are defined from an economic perspective and additionally differentiate the cost incurred in two subcategories [Pirolli, 1999]:

1. *Resource Currency returned*: The information value gained from retrieval.
2. *Cost incurred*: The cost associated with access, recognition and handling cost of the information incurred.

a. *Resource costs*: The direct cost of pursuing the information typically measured in time, money or used calories.
b. *Opportunity costs*: The benefits that could be gained by engaging in other activities, but are forfeited by engaging in the chosen activity.

The economic driven perspective of the information foraging behavior provide an approach to analyze the information foraging behavior observed from the developed experiment. An analysis can explain the subject's foraging preferences and makes it possible to evaluate their choices. Eye-tracking technology can measure this, and is able to identify the subject's preferences and choices by providing knowledge about their eye movement though fixations and clicks.

The structure of the economic perspective should be seen from a dynamic perspective because the task often changes over time. The value or cost is consequently defined in relation to the embedding task, which often changes over time [Pirolli, 1999]. In the same way as relevance of specific sources are not intrinsic properties of information representatives. Specific sources can only be assessed in relation to the embedding task environment [Schamber, Eisenberg, & Nilan, 1990]. Overall there's a correlation between the task to solve and the value of the information consumed, as if the task changes and becomes of higher priority, the consumption of information for that specific task will also be increased. Optimal Foraging Theory can with great success be applied to human choice phenomena and can be applied to situations in order to assess and predict behavioral solutions to recurrent environmental features [Sandstrom, 1994]. Optimal Foraging theory provides the means to operationalize concepts like information strategies, goals, and various currencies in relation to the studied behavior. Furthermore it makes it possible to formulate questions about the decision making and the existing constraints, with the objective of predicting the information foraging behavior [Pirolli, 1999]. This is also the case with this thesis where the research question and the sub-questions are based on the Information Foraging Theory.

From the logic of cost-benefit it is tempting to regard the human behavior based on optimization models and as rather optimal. Even though it is not always the case when observing the human behavior from the perspective of optimization models, which the next section will explain.

2.1.1.1. Human Rationality

The use of a model that states to find the optimal information foraging behavior should not be considered to be a hypothesis for humans always behaves in certain ways that are optimal for their choices. The definition of human behavior as rational, with perfect information and infinite computational resources is replaced with a more nuanced and successful hypothesis, thus human exhibit bounded rationality or alternatively makes their decisions based on satisfaction [Simon, 1955]. As stated in the Pirolli article [Pirolli, 1999] human rationality is not classically rational and therefore may not make rational decisions.

Subjects may experience preferences towards different kind of visual representations of information. Especially in financial situations where you are under pressure and try to find the option that optimize your decision. This pose the question whether humans can make the rational choice between available alternatives or do humans get influenced by factors like what position the

information is placed, the visual representation, or do the values of the information influence the choice. That is the main question, now it is determined that human behavior exhibits bounded rationality.

2.1.3. Information Patches, Diet and Scent-Following

Information foraging operates with concepts of *information patches, information diet and information scent following* [Pirolli, 1999]. These concepts are used to characterize and assess the profitability and prevalence of information sources. In order to assess and pursue information that maximize the returned value, proximal perceptions of information scent is used to obtain maximum value from the information available. In other words, decision makers are assessing the profitability and prevalence of information sources based on the proximal perception of the information scent. Decision makers can therefore decide which information that will maximize their information diet based on returned valuable information per unit time [Pirolli, 1999].

2.1.1.2. Information Patches

Finding and accessing information is denoted information patches [Pirolli, 1999]. Earlier it was established that an optimal information forager is a subject capable of finding the best way to maximize the rate of valuable information gained per unit cost or time, given the constraints of the task environment when searching, gathering and consuming information. Constraints defined as a combination of the cost of finding and accessing the sources and the profitability they contain. Information patches are divided into two types of patches:

1. *Between-patch* is the behavior a forager shows when getting from one information source to the next.
2. *Within-patch* describes the behavior when the forager is in the patch and consumes the information source. Here the forager is faced with a decision whether to continue to forage the patch chosen or leaving it in order to search for a new patch [Pirolli, 1999].

An example from the food foraging analogy illustrate the concept of *between-* and *within-patch*, as the animal forage the food the amount decreases and finally it will be completely consumed. The animal is faced with a situation where the expected future gains from the current patch chosen to forage will diminish to a point where the gains from staying in the chosen patch are smaller than the expected gains that could be made from leaving the patch and searching for a new and more valuable patch. The decision of determining to stay *within-patch* or searching for new patches is based on quantitative formulations of patch models in Optimal Foraging Theory. This thesis will not go into details regarding the quantitative formulations.

The article by Pirolli [Pirolli, 1999] subdivides two examples of *between-patch* activities: enrichment activities and *scent-following* activities. It is assumed that foragers will allocate their time to *between-patch* and *within-patch* activities in a way that maximize their overall rate of gaining valuable information per unit cost. While traditional patch models of Optimal Foraging Theory deals with the context of non-moldable environments and its constraints, it is not the case

with the information forager [Pirolli, 1999]. The information forager can mold the structure of the environment to fit the applied strategy. Examples of this enrichment process, is to minimizing the average cost of getting from one information patch to another and thereby minimizing the *between-patch* foraging cost. Creating information patches that yield higher returns of valuable information, which will increase the foragers *within-patch* return of valuable information by refining keyword queries for a search engine, in order to the list with results presented have higher proportions of relevant document citations [Pirolli, 1999]. A third method to enriching the information patches is to make use of filtering processes. This is also the case with many email systems known today. In the context of this experiment, the interface will not be moldable. The consequence from this omission is expected to be a change in the information foraging behavior because it is the only moldable variable left for the subjects. Therefore it is expected to see changes in behavior from the subject, because they will optimize their information foraging behavior according to the Optimal Foraging Theory. The results will go into depth with potential changes in behavior.

2.1.1.3. Information Diet and Scent-Following

Two other important concepts in Information Foraging Theory are *Information Diet* and *Scent-following*. These two concepts explain information foraging behavior when navigating through physical and virtual spaces in relation to find great yielding patches [Pirolli, 1999].

- *Information Diet* models address decisions about the selection and pursuit of information items. Here it is essential to construct the diet so it optimizes the gain of energy or value per unit time.
- *Information Scent-following* models address the identification of information value from proximal cues. It is also defined as the imperfect perception of the value, cost or access path of information sources obtained from proximal cues, such as icons representing the information sources.

Information foraging uses the term *Prevalence,* describing the occurrence of the prey or information. In the same way information foraging defines terms like *Handle* and *Profitability* to express time to find and consume, and energy returned respectively. In this specific context of which representation of information that is the most suitable for financial traders, the information scent is a particular interesting parameter to investigate further. The information scent can give insights into which sources that provide the best proximal cues and give the best imperfect perception of the sources value. With the use of the Eye-Tracking technology, this thesis will be able to identify the visual preferences based on various representations of information and their position. By analyzing these proximal cues into depth it will strengthen the knowledge about trader's visual preferences and make it possible to compare the preferences with their choices. This will be presented in chapter 4. Results.

The Information Foraging Theory brings many relevant concepts that will be used in the study of the information foraging behavior in financial decision making. This thesis will furthermore analyze the behavior when the subjects experience uncertainty, which has not yet been analyzed in the area of information foraging and financial decision making. However, Pirolli has analyzed

strategy choices under risk and uncertainty thoroughly in the research area of economics and psychology, but not the area, which this study focuses on [Pirolli, 1999].

2.2. Eye-Tracking Methodology

Eye-Tracking will be used as the analysis tool and the methodological framework to make the information foraging behavior measurable. Eye-Tracking technology allows the researcher to investigate and measure the movement and the focus of the eye in a given context [Holmqvist, 2011]. This makes it possible to connect with Information Foraging Theory and explain the behavior recorded. The measurements of Eye-Tracking focuses on different types of movement of the eye [Holmqvist, 2011], within this study the Eye-Tracking measurement fixation will be used primarily. By applying Eye-Tracking technology to the context of this thesis, the technology is capable of producing data illustrating the initial proximal perception of information, we as humans reveal with our first eye contact with the information [Holmqvist, 2011]. Here it is possible to gain insights into potential effects from representation of information before making a decision based on this information. Therefore, the use of Eye-Tracking helps to get an understanding of subject's perception of the representations of information and how they evaluate the value of the different representations.

The book *Eye Tracking - A comprehensive guide to methods and measures* [Holmqvist, 2011] is used as the foundation for both the method for the data collection and the analysis of the data collected. The choice of method is revolved around the completely detailed method description and guidance throughout the field of Eye-Tracking from this book. The book helps identify the pitfalls and good practices when conducting a study with Eye-Tracking technology. The research of this thesis revolves around the traders' information foraging behavior. The use of Eye-Tracking technology combined with interviews and a questionnaire provides the necessary information to identify factors, including representation, position, and information value, that influence the traders behavior and their choice of information within trading. These factors, which are affecting the traders behavior, will furthermore help to identify to what degree the representation of information influence the behavior of the subjects.

The initial stage in Eye-Tracking methodology is the problem identification. The Eye-Tracking methodology uses different methods of identifying the problem, *the explorative pilot*, *the fishing trip*, *theory-driven operationalizations* and *operationalization's through traditions and paradigms* [Holmqvist, 2011]. The explorative pilot and the fishing trip are based on initial conducted research to identify potential areas, which could be measurable with the Eye-tracking technology. The *theory-driven operationalization's* and *operationalization's through traditions and paradigms* are based on previous research. Using previous research and previously developed theories as the foundation for developing a research question and hypothesis' enables the researcher to apply new elements to the previous theories or use the theory in a new case [Holmqvist, 2011]. In this thesis is the Information Foraging Theory used as the primary theory in a financial decision making situation.

As part of the experimental design work it is essential to understand how the subjects react in a certain situation. Identifying what is causing the subjects actions helps to understand the path they are taking. Information foraging will be used to identify these elements to create an understanding

and an explanation of the subjects' behavior. This can be used to eliminate some of the paths the subjects might take. Understanding the domain and the elements, which are measurable within ease the developing process of the experimental design:

> *"... with the most important factors identified, controlled, and systematically varied, we can confidently claim to have a sound experiment design."* [Holmqvist, 2011, p. 75]

Dependent and independent variables are the factors, which are affected by the design of the experiment. The dependent variables are the factors chosen as measurement in the experiment for this thesis. The main dependent variables are the information value, representation and position. In this experiment it is important to identify how the factors measured is affected by the changes made by the researchers. Some of the changes made are the different positions, the representation of information and the value of the information. The dependent variable is the factors that the manipulations directly affect when conducting the experiment and the independent variables is the item or product changed indirectly. Identifying as many as possible of the dependent and independent variables in the experiment increases the researcher's control. This is an important factor within the Eye-Tracking methodology, and it is expressed in the following manner:

> "*A perfectly controlled experimental design is the ideal, because it is only with controlled experimental designs that we are able to make statements of causality. That means, if we manipulate one independent variable while keeping all other factors constant, then any resulting change in the dependent variable will be due to our manipulated factor, our independent variable (as it is the only one that has varied).*" [Holmqvist, 2011, p. 74]

This experiment will place itself between the optimal solution with one variable and the more realistic with more than one variable. This study uses three variables and the consequences of this will be clearly evident in the result chapter where it has been a priority to show the effects of the individual variable.

2.2.1. Parameter Applied

The measurable factors, which are fitted for this type of experiments, are fixations and clicks. Fixations are when the eye is focused on element more than 100 milliseconds, which is defined by the equipment. These fixations can be interesting in several different matters. In this experiment are the first fixation and the order of the fixation itself two very interesting elements, because the fixations could indicate if their initial visual interest leads them towards the visual stimulating information rather than the rational choice. The Eye-Tracking will, in combination with the clicks on the different information representations (cards), provide an insight into the information foraging behavior of the subjects and their decision making process. The clicks are used in relation to the first click on a certain object and in what order the clicks are made on the different cards. This enables an analysis of the correlation between visual stimuli and choices, which provides patterns of the subject's information foraging behavior.

2.2.2. Design Considerations

To ensure the validity of the results of the experiment it is important to decrease or eliminate the chance for *false negative* or *false positive* results [Holmqvist, 2011]:

1. *False negative* results are often due to programming errors in experiment and falsely recordings of the wrong eye-movements.
2. *False positive* results are when a positive or correct confirmation of a result falsely is assumed negative due to the analysis of the Eye-Tracking.

To minimize risk of these two scenarios occurring, a unique and controlled website has been made, instead of using a real and fully functional website. Keeping the design simple and eliminating unnecessary elements from the experiment. This method has through the design process of the experiment been used as a general design rule. The number of participants may affect the result of the recordings, a too little sample size or too few trials of a specific task, may give a false negative result.

It is important that the subjects are given an idea of the task they are performing, but the purpose of the study should not be revealed. Subjects are likely to act differently if they know the aim of the study before the experiment is conducted [Holmqvist, 2011].

2.2.3. Tasks

The subjects complete 11 tasks while the Eye-Tracking experiment is taking place. The tasks in Eye-Tracking experiments are one of the most sensitive elements of the process and it is therefore important that the task is neutral regarding the objective of the experiment. Previous Eye-Tracking studies have identified the following three criteria as an element to fulfill a good task [Holmqvist, 2011]:

1. The task should be neutral with regard to the experimental and control conditions and should not favor any particular condition (unless used as such).
2. The task should be engaging. An engaging task distracts the subjects from the fact that they are sitting in, or wearing, an eye-tracker and that the researchers are measuring their behavior.
3. The task should have a plausible cover story or be non-transparent to the subject. This stops the subject from second-guessing the nature of the experiment and trying to give the researchers the answers that they want. When the experiment itself causes the effects expected it is said to have *demand characteristics* [Holmqvist, 2011, p. 77].

These three criteria above are important to incorporate in the development process to ensure that the overall task and the different subtasks of this experiment are upheld to a high quality.

The first criteria are used to develop the overall principle of the task and the experiment. The second criteria are implemented in the development process as different incentives are based on the performance. The third criteria are used in the development of the scenario of the experiment, which is developed as a real trading situation.

When a task does not fulfill the three criteria above it may alternate the result of the experiment, because of influence from the tasks presentation. An unfulfilled task could lead the subjects to lose

focus, look outside of the monitor, daydreaming or serve as an incentive to create their own tasks. These scenarios will all alternate the result of the experiment [Holmqvist, 2011].

2.2.4. Areas of Interest

Areas of interest (AOI) are a predefined area of a scene or scenario, which is of special interest of the experiment. When using AOI's the researcher often assigns different AOI's to specific areas, which has a precise hypothesis or measure of specific interest regarding the experiment. The researcher can simplify the use of AOI's in eye-tracking research by constructing AOI's around the different elements and comparing how many eye movements that occur across the elements and within the elements. In this experiment the interest in the different cards of information is highly relevant, which makes the subjects behavior when presented with these different representations of information very interesting? How the AOI has been used in practice can be seen in the figure below, where the AOI's are displayed and used for the further data analysis.

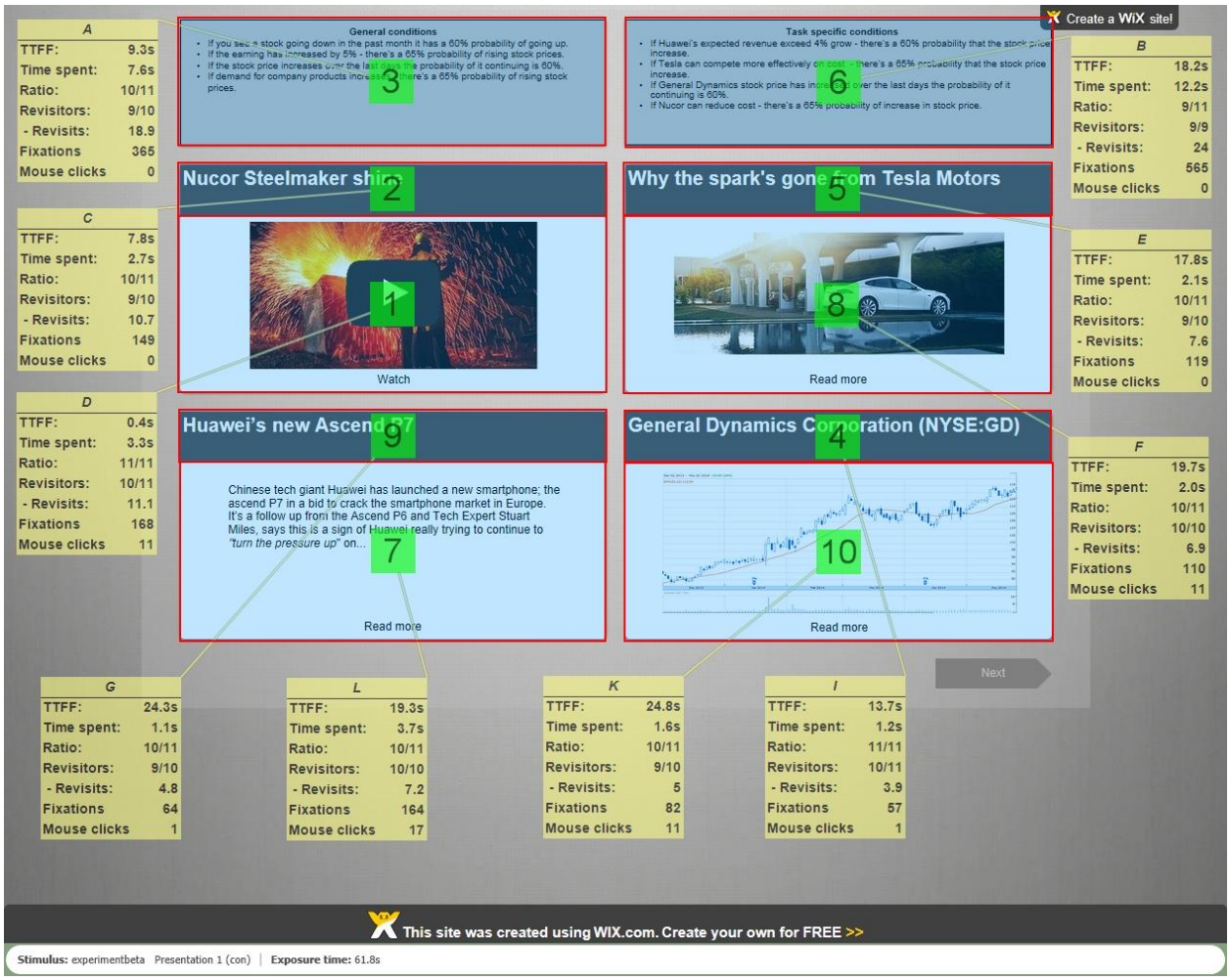

Figure 1: Practical use of AOI in the experiment

The areas between the AOI's are referred to as *Whitespaces* [Holmqvist, K. 2011]. Due to the complexity of the tasks and the problem situation in the experiment are fixations in the *whitespace* indicating a mental process, afterthoughts, or mental imagery while solving the task. The behavior within and between the different AOI's may show the preferences of the information and how the

subjects forage based on the presented information. The behavior through the different AOI's identified the subjects preferred order of the presented information.

This understanding of the behavior through the different AOI's is very interesting and can be identified with the use of AOI Strings. The AOI strings can help to identify the sequence of the fixations. An AOI string provides this sequence in a string of letters, which identify the order the AOI's are entered. An example of this procedure could be "A-B-A-C- D-B-G-F", where each of the letters represents the different AOI's in the scenario. According to Holmqvist et al. (2011) the subjects improve their memory of an objects position for every new fixation on the object:

> *"This has the implication that fewer fixations will be required to locate once they have been encoded and a memory representation accumulated through multiple fixations."* [Holmqvist, K. 2011].

It is therefore important that the AOI's position change do not affect the value of different information in the tasks. The memory of the position of a specific AOI is therefore important to have in mind both when designing the experiment and analyzing the data. A subject's memory of the positions of the different information could result in very short time between leaving the entered information till entering a new, because the subject is aware of the position of the wanted information.

The aforementioned Eye-Tracking methods, which are applied in the research process, will be described in detail in the section Protocol. The Protocol section will furthermore describe how the different methods are implemented and how it affects the outcome of the experiment.

2.3. A Combined Approach

Information Foraging Theory and Eye-Tracking methodology complement each other quite well, which can be said to be the conclusion after reading the information foraging and eye-tracking sections above.

What we have learned from these chapters and what we shall bring with us to the upcoming chapters are the following: Eye-Tracking is a technology from which it is possible to measure and record the detailed pattern of the eyes, which reflect the subject's location of their attention. Making it a suitable tool to study how subjects maximize their gains of valuable information by using different representations of information and what representations that is most suitable in decision making situation. Insights into what the theory defines as their information diet and how the different information representations have different proximal cues, which lead to information scent following. Eye-Tracking can record how the subject's evaluate the proximal cues from the different representations used in the experiment and how that influences their selection of information (their diet).

Furthermore, the theory provides the concepts like the decision-, currency-, and constraint assumptions which make it possible to analyze and interpret how subjects optimize their information foraging behavior from the data collected with the Eye-Tracking technology. First fixation, first click, choices, and pattern of behavior are measurements where Eye-Tracking can

provide data. These measurements are essential to answer the research question of which representation of information is most suitable for traders.

In order to measure these selected measurements it has been necessary to conduct the experiment in a laboratory. This will enhance the data as representative for the representations profitability, their handling cost, the patterns in behavior, and the subject's bounded rationality when foraging information, because it is in a controlled environment where the three variables are known: position, information value, and representation. AOI's will be applied to the experiment, making it possible to explain the Between- and Within-patch behavior of the subjects.

Lastly, the theory complements the method in a manner that makes it possible to explain the behavior to third parties and provide the reasoning for some representations are better suited than others in the context of finance.

3. Research Methodology

This chapter will explain the methodological approach applied in the study of information foraging behavior, in the context of financial decision making. The chapter will focus on the data collection methods, empirical approach, sources of data and empirical focus.

3.1. Production of Knowledge

The design of the research method is divided into three phases; an explorative phase, data from the experiment, and the results. The data collection for this thesis will be a combination of both qualitative and quantitative data to ensure that the researcher provides an objective analysis and view of the studied phenomenon. Furthermore this thesis will develop an experiment from which the quantitative data collection will be conducted in.

The explorative phase will increase the domain knowledge of the trading environment, which helps to identify the design, the measurable variables, and the delimitations of the experiment. Knowledge that is essential in the development of an experiment which shall work as a framework for the information foraging behavior, wanted to observe and analyze. Qualitative methods such as interview are used to gain detailed knowledge. A protocol of the experiment is developed to ensure that other scientists are able to recreate the experiment with the purpose of either reproduce or verify the data.

The data collection from the experiment will be generated with the use of Eye-Tracking technology. The Eye-Tracking method is used to identify the measurable variables and how these can be measured. These measurable variables are the eye movement of a subject in the given scenario, measuring the fixations and the pattern of this eye movement behavior. The Eye-Tracking technology provides a great amount of quantitative data and in order to explore potential reasons for the observed phenomenon a questionnaire is placed in the end of the experiment.

The data analysis is divided into three sub-sections according to the three sub-questions of the main research question of this thesis. The main research questions *"Which representation of information is most suitable when traders are foraging information before decision making?"* will be answered through the following three sub-questions. Each of the three sub-questions will work as a sub-section in the analysis of the data from the experiment.

The first part of the analysis is designed to answer the first of the three sub-questions regarding *"What are the visual preferences for information in a decision making context?"* This analysis is important in order to understand how the representation of information affects the subject's behavior, and will be used to generate the basic understanding of the subject's visual preference and behavior in the further sub-question. The second part of the analysis will be based on the second stated sub-question *"How do the variables, representation, value, and position influence the selection of information?"* This part of the analysis study how subject select information and identify whether the behavior of the subjects is aligned with their visual preferences. The third and final part of the analysis answers the third sub-question *"Do position and representation affect a financial trader's ability to forage for the most valuable information and ultimately affect their decision making?"* The three sub-questions are answering the main research question when

combined, because they cover three important concepts of Information Foraging Theory: the visual preference, the selection of information, and how these affect the decision making, named choices in this thesis.

The analysis of the collected Eye-Tracking data will be analyzed according to the presented information foraging concepts like, *Scent-following* from the information sources, *Cost* and *Value* of retrieval. Additionally, first fixation is used to answer the first sub-question, which indicates what the subjects find most visually attractive and how do this visual attraction align with the retrieved value. The Information Foraging Theory will, based on its framework provide explanations for the information foraging behavior recorded with the Eye-Tracking equipment. This theory and method fit together well.

The three phases described in the above sections are illustrated in the figure 2. The figure shows the natural progression in the development of knowledge and how the first phase lead to second, and the second to the third. This is the framework for the knowledge production created by this thesis:

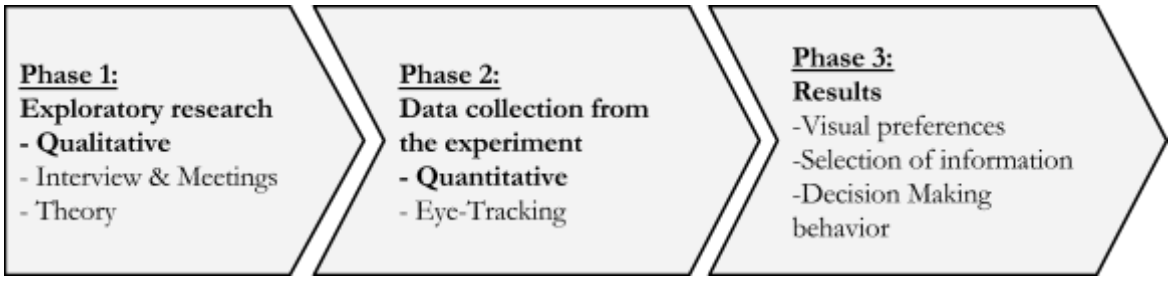

Figure 2: Data collection

3.2. Choice of Case and Organization

The case organization used in this thesis is the Danish investment bank Saxo Bank. Saxo Bank has shown great interest in the research area of information foraging in financial decision making and has provided substantial domain knowledge about financial decision making.

Saxo Bank introduced the social trading platform Tradingfloor.com in the first quarter of 2014. Providing a new social way of trading where they will intensify new ways of presenting information like with the use of videos [Børsen.dk, 1]. Saxo Bank is very interested in the specific context of this study explains Jeffrey Lins, Head of Research and Innovation with the following quote;

> *"I think it (the scope of this thesis red.) would be highly fascinating [...] extremely relevant for Saxo Bank"* Jeffrey Lins, Head of Research and Innovation [Saxo Bank, 2014, April 2, 51:40 min.]

Moreover, Saxo Bank have contributed domain knowledge in the development process of the experiment and to a large extent ensured the experiment was in line with their design criteria present at Tradingfloor.com. This design process involved several meetings with Saxo Bank's Jeffrey Lins.

Saxo Bank is considered relevant as case organization due to preliminary meetings and interviews indicated that the scope of this thesis was highly relevant for their further development of the platform. Besides substantial contributions in regards to the experiment, Saxo Bank has been involved in the development of an appropriate scope.

Saxo Bank has with their presentation of Tradingfloor.com opened up for a new platform with different representations of information, which should strengthen the way individuals gain financial knowledge [Børsen.dk, 1]. While Tradingfloor.com provides information in different representations like videos, graphs, texts, and pictures, Saxo Bank has discovered that the different representations receive different levels of clicks. More specific, the video representation receives more clicks compared to the other representations. This observation made by Saxo Bank was partly the foundation of the scope of this thesis in combination with Information Foraging Theory.

From Tradingfloor.com this thesis uses several characteristics like uncertainty, decision making, different representations, the value of information, the specific information used, the task the subjects need to complete, the narrative, the design of the experiment, and the subjects. These elements are all applied to the experiment in order to create the settings for the experiment that will make it possible to record the information foraging behavior intended. The element and how they are applied to the experiment will be described in the Protocol for the experiment.

Tradingfloor.com is suitable as case because it provides a relevant context where the problem can be studied. By creating an experiment relatively similar in the fundamental settings compared to Tradingfloor.com it has been possible to measure the observed problem within a domain closely related to the actual real domain. Furthermore, the context of decision making, which is a fundamental part of tradingfloor.com, is an appropriate context to observe the behavior of the subjects. We know from the Information Foraging Theory that individuals have limited attention to allocate between information and this makes it relevant to explore the best possible way to represent information in order to improve the way individuals use information.

3.3. Data Collection

This thesis uses a combination of qualitative and quantitative information sources to ensure a more accurate view of the studied phenomenon [Andersen 2008, Harboe 2006]. The data collection is based on the Eye-Tracking data as primary source of information. However, the circumstances of this thesis, that it was not possible to make the Eye-Tracking measurements on the real platform due to too many degrees of freedom, have led to a development of an experiment in form of a website.

Qualitative interviews with relevant stakeholders in Saxo Bank have been conducted in relation to the development of the experiment from which the Eye-Tracking technology will be used to extract the information, which shall answer the stated research question.

The analysis is based on the quantitative data provided by the Eye-Tracking technology from the experiment. It was a necessity to develop the experiment from scratch in order to take advantage of the Eye-Tracking in full due to the control of more variables.

3.3.1. Qualitative Information - Explorative

This thesis uses semi-structure interviews in order to gain detailed domain knowledge, which is essential in order to uncover the problem area and gain understanding of the observed phenomenon [Harboe 2006]. It was important to conduct interviews with a key stakeholder to gain firsthand experience with the observed phenomenon.

A thematic framework was chosen as base for the interviews, in this case different theories and methodologies such as Eye-Tracking methodology and Information Foraging Theory mainly composed the frame. The development of the interviews were driven by the answers given by the interviewee and additional clarifying questions were asked if necessary. Furthermore, the explorative phase is essential because it is an effective way to structure and target the subsequent quantitative data collection [Anderson. B, 2008].

Jeffrey Lins - Head of Research and Innovation, has been the main source of domain knowledge and he has throughout the process proved to be essential for both domain knowledge and development of the experiment as well. According to [Harboe. T, 2008] the subjects used for the interview need to be a key stakeholder, which is clearly evidenced by the great interest and the extensive knowledge that our key stakeholder Jeffrey Lins has demonstrated through our interviews. Besides Jeffrey Lins, another stakeholder - Christian Villumsen, Head of Portfolio Office - has been participating in one of the meetings and has been a contribution to the explorative phase. Christian Villumsen has had a minor influence on the scope of the experiment and has mainly contributed to the explorative phase in relation to confirm the relevance of the scope and issues identified by Jeffrey Lins. All of the interviews can be found on the CD accompanying this thesis.

After a couple of meetings with Jeffrey Lins, it became clear that the observed phenomenon, how elements that are visually stimulating have higher click-rates, should be formulated as a research question and analyzed. Additionally, the complexity of the financial environment in which trader's trade became clear. It is a highly complex environment with many correlations and numerous elements, which have effect on their behavior. The observed phenomenon should therefore be tested in vitro, in order to control as many degrees of freedom as possible [Harboe, T, 2008].

In order to create the experiment from which research questions will be answered, the creation of an experiment protocol was carried out. The purpose of the protocol is to include readers into the design phase and development process, and provide insights into why the experiment is designed, as it is in order to answer the stated research questions.

The interviews had an additional function: they were working as a feedback mechanism and enabled changes to the design of the experiment to be quickly implemented. After each meeting, the solutions found relevant were implemented and at the next meeting the results was presented. This iterative development process of the experiment ensured a high level of quality and consistency with Saxo Bank's requirements.

Besides the interviews and meetings, there has been a substantial e-mail exchange with Jeffrey Lins. The advantage with the e-mail correspondence has been quick clarification on specific matters.

3.3.2. Choice of Subjects

The selected subjects participating in the experiment are identified to be exclusively from Copenhagen Business School (CBS) and are either students or graduates. All the selected subjects have a financial knowledge from respective study programs and some had personal interest within the field of financial investment. The use of non-naive subjects gives a more generalizable and valid result of the experiment, because it is conducted on subjects with similar backgrounds as the majority of Saxo Bank's clients, according to our assumption about Saxo Bank clients. Some subjects participating in the experiment were contacted through the interest organization FinanceLab. The members of this group all have a great interest for the financial market and trading according to their website [financelab.dk]. Saxo Bank has furthermore provided some subjects in the form of their student employees, who all have an educational background from CBS.

According to professor Ravi Vatrapu, responsible for the Eye-Tracking equipment at the Department of Information Management at CBS, there exist a rule of thumb that you need around eight to twelve subjects in order to provide a sufficient group of subjects and provide tendencies from the results conducting a standard Eye-Tracking experiment. The final number of subjects completing the experiment was ten, where one subject was female and the rest males.

3.3.3. Quantitative Information

The data collected through the developed experiment are quantitative. The experiment is developed to answer the stated research questions and demands use of both Eye-Tracking technology and Information Foraging Theory. While Eye-Tracking technology is a tool to capture human eye-movement within this specific context, Information Foraging Theory provides the underlying explanation for the human behavior regarding information searching, gathering, and consumption.

To analyze the different tasks and understand the subject's behavior it is important to identify how Information Foraging Theory and Eye-Tracking method complement each other. The experiment is divided into eleven tasks and each task contains four different cards of information. These cards are created to fit the Eye-Tracking methodology requirements. An example of requirements from the Eye-Tracking methodology is to clearly divide the screen into sections and name the cards of information, to compensate for minor offsets in the data samples [Holmqvist. K, 2011]. When the requirements are fulfilled, the frames for Eye-Tracking are in place and the data can now be collected. The Eye-Tracking technology provides a wide range of information when the recording is completed. Hence, the analysis of the comprehensive data material will be a major part of this thesis. The use of cards makes it possible to observe the information foraging behavior because the cards are aligned with the Eye-Tracking requirements. The tasks and the cards will provide the framework from which the first fixation, first click, and choices can be measured.

The clicks help identify the different choices made by the subjects when completing the tasks. Combining the clicks with the first fixations can help understand the information foraging behavior, because it provide data about the subjects visual preferences and their selection of information as well. In relation to information foraging it will be possible to analyze their behavior

and judge if the subjects behave according to the visual attraction or the optimal information foraging.

The first fixations of the Eye-Tracking technology can be measured within the AOI's presented in the section Eye-Tracking methodology. The AOI's are used to identify were the subjects forage information, which help to identify what behavior the subjects have. These AOI's can be identified with the information foraging concept *Patches*, which refers to the area where subjects forage information. The AOI's will be created to fit the defined cards of information, which is the 'food' source in the experiment. The AOI's can provide insight into potential correlation between the subject's eye movement (first fixation) and their actions (first click and choice).

The AOI strings identify the order of which the AOI's are entered. The use of AOI strings can identify whether there tend to be a pattern when collecting information and whether it is affected by the representation, the information value, or the position of the information. The data collected can be understood with the Information Foraging Theory concept *Scent*, which provide an insight of the information value and how strong this value is revealed by the information source. The scent explanation can also provide an understanding of why and how the subjects act in a certain way. From the data collected it will be possible to identify whether the subject's behavior are influenced by the representation or position to be irrational, or whether they tend to act rational. The AOI strings will mainly be used in the third subsection of the analysis; to answer the third stated sub-question.

A control mechanism is implemented in the experiment in form of a few questions. These questions are placed as an extension of the tutorial in the beginning of the experiment. It will test whether the subjects understand both the *General Conditions* and how to solve the tasks. The *General Conditions* determine the value of the information based on potential events, which could occur within the information in the cards. The data from the control mechanism are providing an overview of the ten subjects understanding of what determined the value of the information. Besides giving an indication of how well they understand the conditions, it also serves a different purpose. In case a subject does not understand the question asked about *General Conditions* and chose the wrong answer, they will be presented with a message telling them the right answer and provide them an explanation of why it is the right answer. By controlling if the subjects understand the experiment, it enhances the probability of showing the behavior intended and not the behavior based on their own perception of how to complete the experiment.

The experiment further includes a questionnaire after the experiment, which helps to collect knowledge of the subject's behavior in the experiment and control if it was affected by previous knowledge or actions. The questionnaire is used to increase the knowledge of the subjects and create a triangulation of the data from the Eye-Tracking experiment. This additional data from the questionnaire can confirm, reject or nuance the tendencies identified within the Eye-Tracking experiment. Furthermore, it makes it more transparent to see if the behavior observed is the actual information foraging behavior or just a behavior based on previous favoring knowledge for that specific company. The questionnaire will also be used as an evaluation tool to gather information about the subject perception of the experiment. Finally the questionnaire will gather basic personal information about the subjects.

3.4. Data Processing and Analysis Approach

The data collected from the Eye-Tracking technology have been processed according to the research questions to be answered. In this thesis it will be studied how subjects navigate and select information with the use of information foraging strategies and analyze the information foraging behavior created in decision making situations under conditions of uncertainty. The information foraging terminology, presented in the theory chapter, will be applied to analyze the observed behavior. The analysis approach for the experiment will be presented first and then will the analytical approach for the three sub-questions be presented.

3.4.1. Analysis Part 1 - The Experiment

In order to capture the subject's information foraging behavior it was important to make an analysis of the requirements for the experiment prior to the execution of it. To understand how the experiment is created a comprehensive protocol had to be developed and followed in detail to obtain a suitable environment.

The experiment is build out of elements essential to imitate the financial settings from which the problem originates. The *Tasks* and the *Decision making situation* sections are closely related and capture the context in which the observed information foraging behavior exists. It was important for Saxo Bank to identify and apply the necessary attributes to the experiment, in order to incorporate the results and solutions to their reality afterwards.

While trading in general has tremendous variables and a high level of complexity, it was important to concretize unclear complex concepts like uncertainty, decision making and rational behavior. The creation of conditions, which defines the probabilities and thereby the level of uncertainty embedded in the various representations, concretized the concept of uncertainty. In the same manner as decision making was operationalized into a situation where the subjects needed to choose one out of four different companies. The conditions purpose is to eliminate the accompanying uncertainty of investments, which the subjects have to optimize according to elimination of uncertainty.

The tasks have a right answer and sometimes more than one, which create space for subjects to act according to what is defined as rational behavior. On the other hand, the experiment is also creating less optimal choices that require less rational behavior or could be called affected behavior. This difference between the rational choice and the affected choice is important for the further analysis because it illuminates the potential preferences of various information sources used in the experiment. These financial concepts have been analyzed and operationalized in order to make them quantifiable according to the Eye-Tracking criteria used.

In the analysis of the experiment, it was identified that three variables affecting the information foraging behavior should be applied. The three variables are; position, information value, and representation.

3.4.2. Analysis Part 2 - Eye-Tracking

The main analysis in this thesis is based on the Eye-Tracking measurements from the developed experiment. The purpose of the analysis is to answer the three sub-questions and will therefore be structured according to these.

3.4.3. Research Question 1

The data analysis for the first research question regarding subject's visual preferences is based on the Eye-Tracking variable first fixation. The collection of these first fixation data will be analyzed according to the representation in order to see the effect of the representations.

The data will be aggregated in order to provide a total overview of the visual preferences across the eleven tasks. The analysis will further illustrate the impact of the high and low valued information and how it affects the subject's visual preferences. Afterwards, a behavioral analysis of the visual preferences will be displayed to show changes in the visual preferences. By doing so, it will be possible to analyze the effects the three variables have on the visual preferences throughout the experiments eleven tasks.

3.4.4. Research Question 2

The processing of the data used for the second sub-question of the analysis concerning the selection of information and how the three variables, representation, value and position influence the selection were analyzed from an aggregated approach. The aggregated approach of the selection of information will be including the information value. This will provide insight into the effects of information value and how it affects the subject's selection behavior. The variable used to define the selection behavior is the first click, which will indicate selection behavior of the subjects. As described in the section above 3.4.3 Research Question 1, this analysis will also illustrate the patterns in behavior relating to selection of information. The three variables will be included in the analysis in order to gain insight of their effects. The analytical approach used in this sub analysis will be more divided between the three variables, position, value, and representation compared to previous analysis approach. This is done to create a direct link between the single variable and its effect on the selection behavior observed.

3.4.5. Research Question 3

Third part of the analytical approach is concerning the influence by position and representation and how it affect the traders ability to forage the most valuable information and ultimately how it affect the decision making. The analysis will compare the variables *first fixation*, *first click*, and *choices* in order to analyze the correlation between them. The analysis will further study the level of rational choices and how it is influenced by the position, representation and order which the subjects forage information. In order to enhance the reliability of the aggregated result of their behavior, due to the fact that it is based on an average calculation of the recorded behaviors, the necessity for deeper analysis is evident. With a more detailed analysis of the individual's behavior, it will be obvious whether there is a similar picture of their behavior or whether it is characterized as being more polarized.

3.4.6. Summary of Research Approach

This section provides a summary of how the research has been conducted. The figure provides an overview of the research questions and the accompanying data sources. The result chapter is

divided into three sub-analyzes illustrated in the figure. The figure further shows how the findings from the first analysis are carried on to the next analysis. This is also the case with the next two analyzes. Each sub-analysis will answer the respective research sub-question.

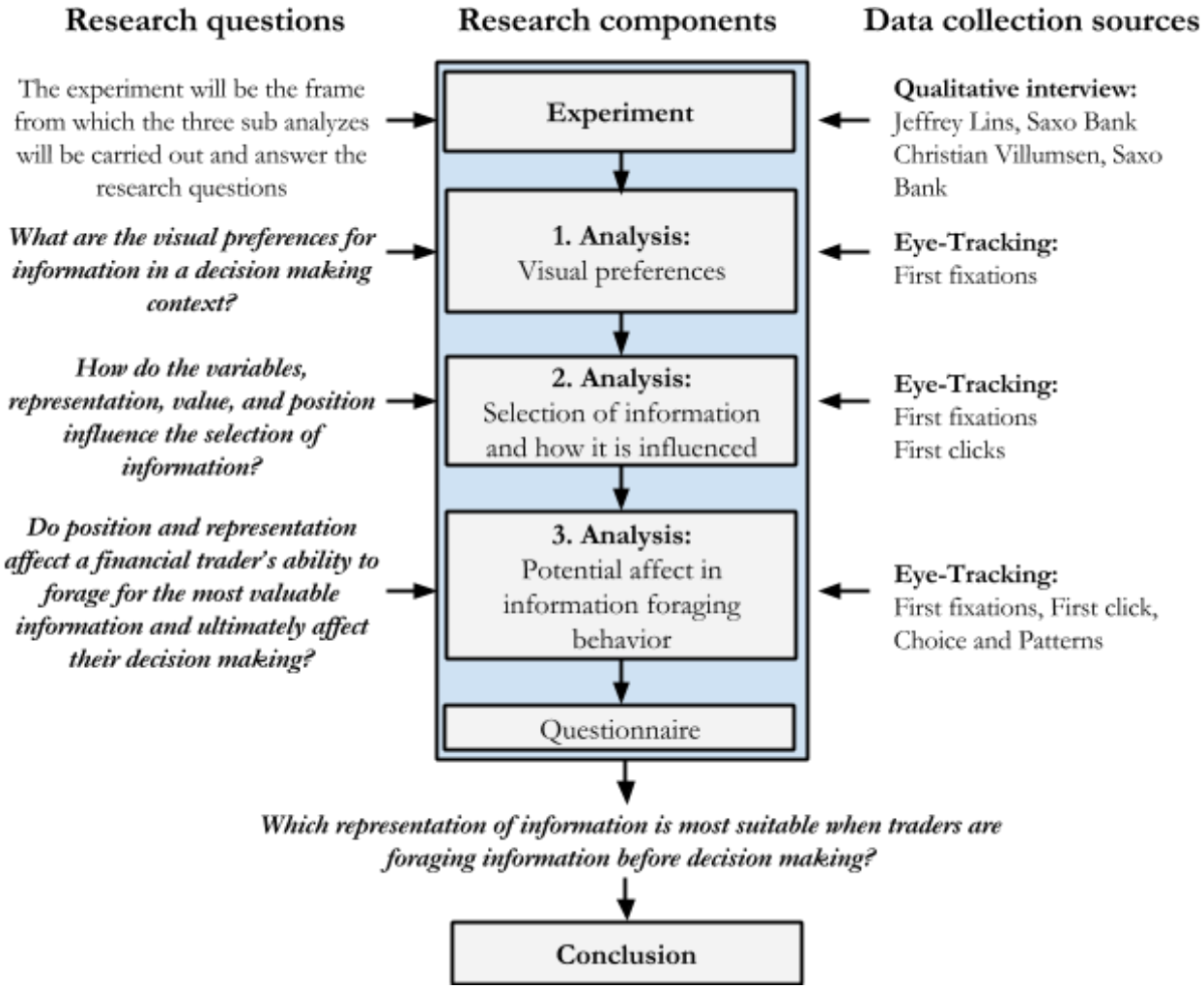

Figure 3: Overview of research approach

3.5. Protocol for the Experiment

It is important to develop an experiment for this study to understand the behavior of the subject in this specific context. The experiment is developed to simulate the real world scenario and to ensure that the environment from which the data are collected is controlled and manageable. By developing an experiment from scratch, unwanted noise and uncontrollable variables can be eliminated.

In order for this experiment to be successfully developed there is a need for a systematic review of its structure. The protocol will outline a clear overview of the frames for the experiment from which the results are produced. Established from the section *3.2. Choice of Case and Organization*, this experiment uses an array of elements from the specific context which the observed phenomenon exist. The array of elements consists of; uncertainty, representations, value of information, the information used, the task to solve, the narrative, and guidelines for the design.

Not all elements will be described in this protocol section, only essential element that contributes to better overview and understanding of the experiments structure.
The sub-sections are presented in the following, which indicate the structure of this chapter: *3.5.1. Experiment overview, 3.5.2. Presentation page, 3.5.2.1. Conditions, 3.5.2.2. Development of cards, 3.5.3. Decision making situation,* and *3.5.4. Overview of the task*. Elements not included here in the protocol section will be placed in chapter 11.7 Appendix 7 – Protocol for experiment.

3.5.1. Experiment Overview

The experiment overview illustrates the order, which the experiment is conducted and how the experiment comprises two parts - an economical and an information foraging scenario. The economic scenario puts the subjects in a decision making situation similar to a situation encountered by traders in an online trading platform. An economic context like this is created to encourage an information foraging behavior. Creating a controlled environment strengthen the desired information foraging behavior, which makes it easier to identify and capture the behavior with the eye-tracking equipment. The economic scenario is build up with four different stocks where the subject shall choose the most profitable one. The economic scenario is described in detail in the section *3.5.3 Decision making situation.*

The information foraging scenario is based upon the hypothesis that different visually stimulating information representations provide different information scent. This scenario is developed within the economic scenario so it becomes an integrated part of the economical scenario. By integrating the scenario into the economic scenario, the sense of realism is heightened [Pirolli, 1999].

The integration of the economical- and information foraging scenario respectively, have been illustrated below to show how the two scenarios are related and in which areas they interfere with each other. The illustration is created in a chronological order according to the experiment.

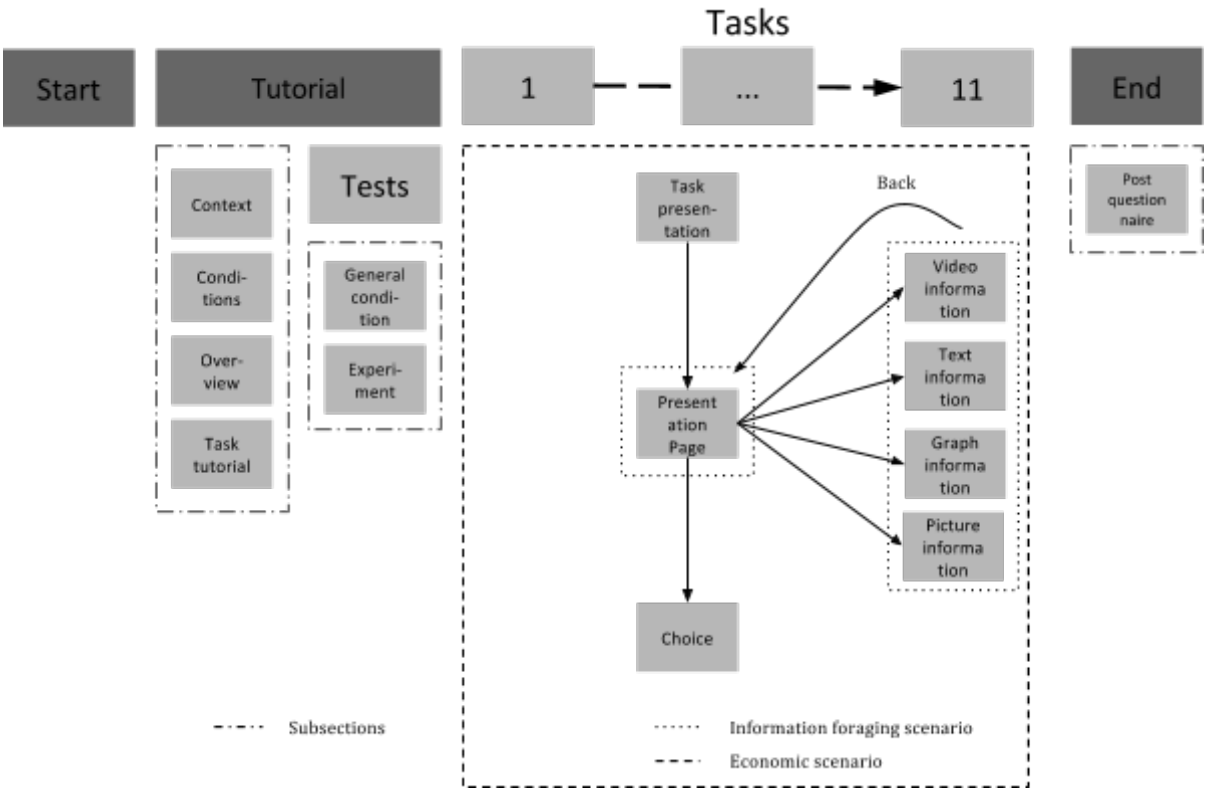

Figure 4: Scenario overview

The experiment is divided into different stages in order to create a natural flow throughout the experiment. By natural flow meaning that subjects get the necessary and right information at the right time and place in the experiment. Getting a closer view of the construction gives insights into the settings from which the result will derive from. Furthermore, it creates a fine overview of the stages and their content for the reader, facilitating a smoother understanding of the sections to come.

The first stage of the experiment is the start of the experiment. The second stage is the tutorial in which the scenario for the experiment is described, the conditions are presented, and an overview of the task and an interactive tutorial of the experiment are presented. The third stage is a test of the subjects understanding of the general conditions and the experiment process. The fourth stage is the actual experiment, which consists of 11 different tasks, which the participant needs to complete. The last stage is the end, which contains a questionnaire. The different elements from the different stages of the experiment will be described more detailed in the following sections.

3.5.2. Presentation Page

The presentation page is the build up by information cards, general-, and specific conditions. The four types of representations: graph, picture, text, and video are presented at the same page. The conditions will be available at the top of the presentation page in all 11 tasks. From the presentation page it will be possible to measure the visual preferences, the selection of information, and its correlation to the subject's choice.

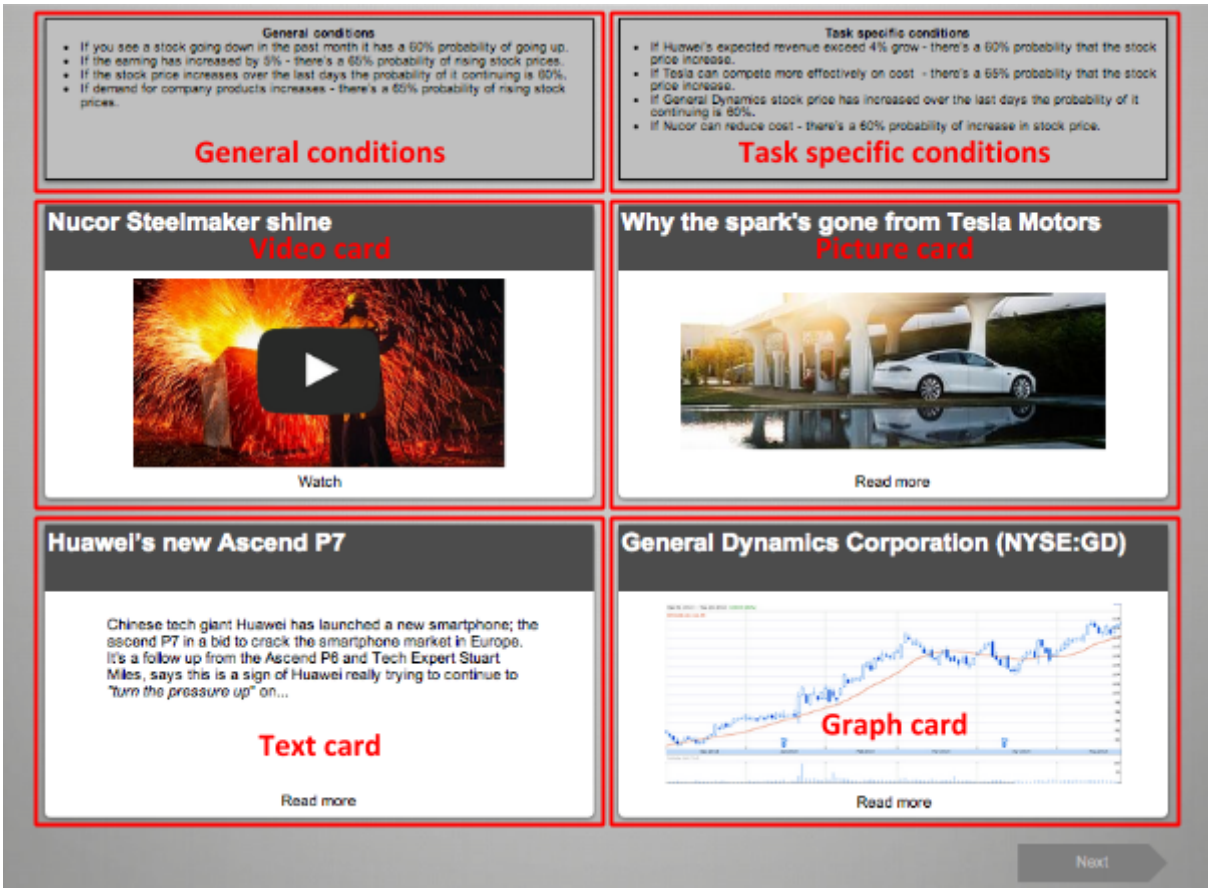

Figure 5: Presentation Page

3.5.2.1. Conditions

The conditions were developed as rules, which should indicate that if certain actions occur it will have the described consequence. The original concept of conditions that were developed at the meeting the 28th of April with Jeffrey Lins at Saxo Bank's headquarter.

The purpose of the conditions is to control the environment and to be able to identify which behavior would rationally be the *"correct"*. The conditions will affect the value of the information in the cards. The conditions will dictate which of the cards that provides most value to the subject foraging. It will therefore also work as an experimental instrument, which is controlling the variable of the information value and thereby the rational behavior of foraging. The conditions will work as a variable and an instrument to test whether the participant chooses the visual simulation or the rational choice.

The conditions are formulated in a short and precise fashion to minimize potential misunderstanding and provide a clear statement. The conditions should provide the subjects with some information, which could potentially eliminate risk of the presented investments. The conditions are all formulated with an "If" to reinforce that there is uncertainty involved.

In collaboration with Jeffrey Lins, the conditions are defined with high and low probability to eliminate too many degrees of the variable. In order to create a more tangible, precise and measurable action of the conditions, the probabilities will be displayed as percentage of the

probability. The use of probabilities indicates to what degree the statement in the conditions are likely to come true. To ensure the effect of the probabilities it need to be greater than 50% in order to eliminate the random change of 50%. Furthermore the probability of a condition cannot be 100%; this would encourage a behavior as in a treasure hunt or a quiz, where the subjects could eliminate all uncertainty by confirming the conditions in the information. To maintain the current level of realism of the experiment and to minimize the influence of conditions on the subject's behavior, it is identified that the probabilities should be between 60% and 70%. In order to ensure that the different conditions in the different tasks influence the subject's behavior differently.

The previously identified high and low probabilities for the conditions will be defined in percent as 65% probability for the high and a 60% probability for the low. The level between the high and the low probabilities is appointed to be 5%, this is to ensure that the subjects identify the difference and do not eliminate the low probabilities. The two identified variations, high 65% and low 60% will be used of all the conditions. The omission of probabilities expressed as high and low is due to the subjective evaluation of the words and their meaning. While one person assumes that high probability is between 95-99% another might think that 85-90% is defined as high. This will be avoided with the use of percentage.

Furthermore it was defined that there should be two different types of conditions, Task specific and general. They are further described in the sub-sections of Appendix 7.

3.5.2.2. Development of cards

The cards-composition has been developed with tradingfloor.com as a framework. The purpose is to create similarities from the Saxo Bank financial context, such as Tradingfloor.com, so results can be generalized. Examples from tradingfloor.com and input from Saxo Bank have been vital in the shaping of the experiment. The cards will be developed based on a stringent framework to ensure that the initial presentation and the representation of the information are standardized throughout the experiment and will have none effect on the subjects behavior due to differences in design.

An example of how the representation of information (cards) is presented below which illustrate how different articles are presented. From this example it is possible to show the fundamental frame, which the cards are build from. This is an example of how articles are presented at Tradingfloor.com. Examples representing the other three types of cards, video, picture and graph will be attached in Appendix 7 - section *10.7.3. Development of cards*.

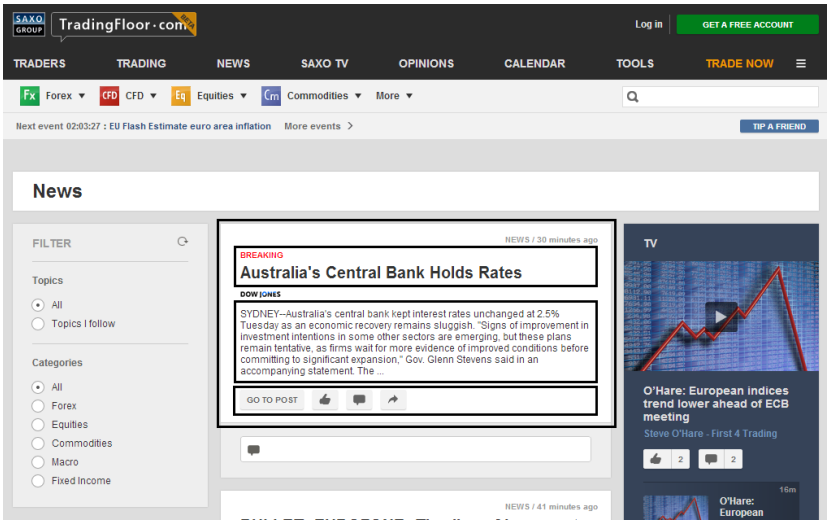

Figure 6: Presentation cards of information

The illustration above shows how the different cards of information are presented. Here it is the article that is brought into focus because it is a great example of the structural framework behind the cards of information. It is also an example of how the different information sources side by side are presented. In this example illustrated above, it is an article and a video that are presented.

To get a better view of the structure of the framework from which the cards of information are building, it is enlarged from the illustration above. The enlarged illustration below demonstrates how each card is divided into the following subareas, Headline (Australia's Central Bank Holds Rates), a Visual Element (Text appetizer) and Follow Information (GO TO POST).

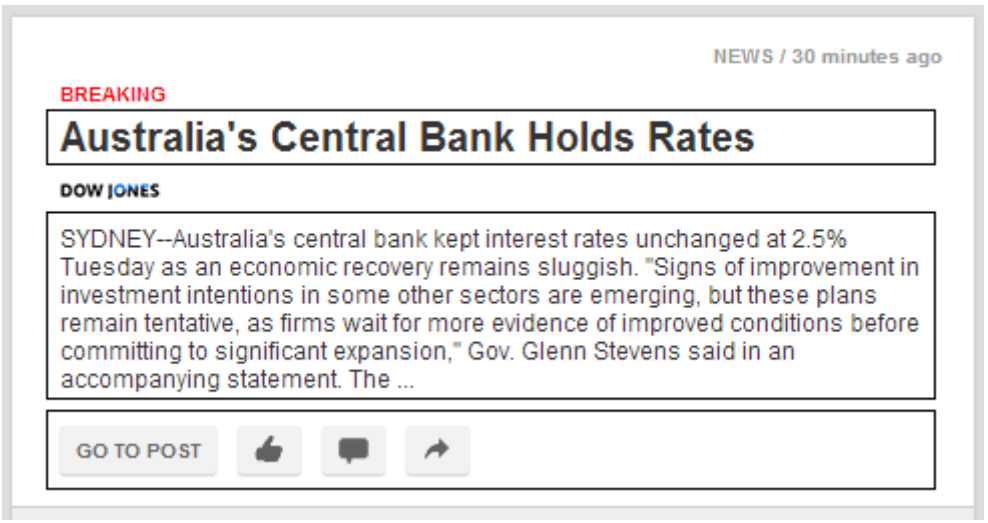

Figure 7: the structure of a card - Example with article

This structure will be fixed throughout the experiment because the retention of structure ensures a valid comparison between the different cards of information when presented at the presentation page.
Therefore the position of headlines and the representation will be limited as a variable in the analysis and can be kept out of influence.

The illustration below shows the framework, which will be used consistently throughout the development of information-cards. The framework is applicable for all four representations.

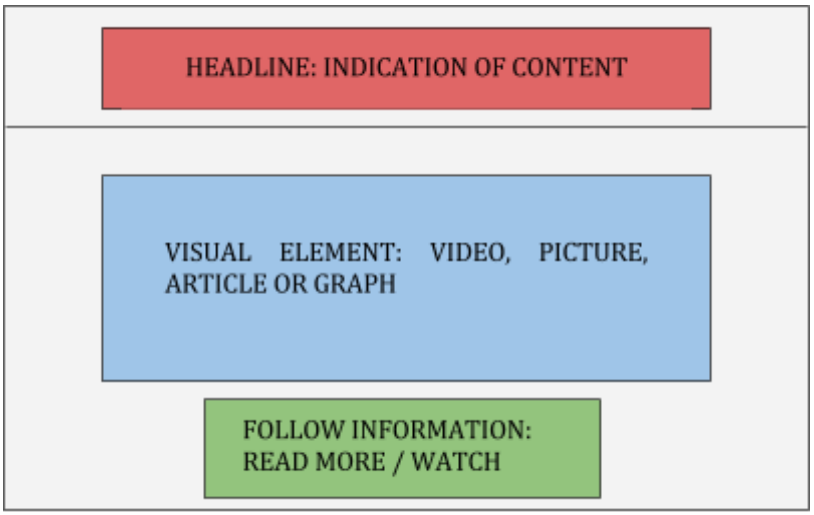

Figure 8: Composition of card - framework

The final concept of a card of information here represented as a text card is presented below. It follows the guidelines presented in the figure above: *Composition of card - framework*. As *Figure 7: The structure of a card - Example with article* shows this specific card has some natural advantages in the form of its scent. The scent here is very explicit in relation to the actual content to come and therefore also its value for the subject. While the text explains with few sentences what the article will be about, some of the other cards of information may not provide subjects with a scent identical in strength compared to the text card. Where this differentiation in strength of scent could be conceived as a potential problem due to the assumption that strong scent attracts more compared to weaker scent, it is the opposite case. It is the differences in scent, derived from their natural configuration as representations of information, which is interesting, and how some cards may create visual attraction despite their weaker scent. Differences in scent as a result of their design are an essential part of the experiment.

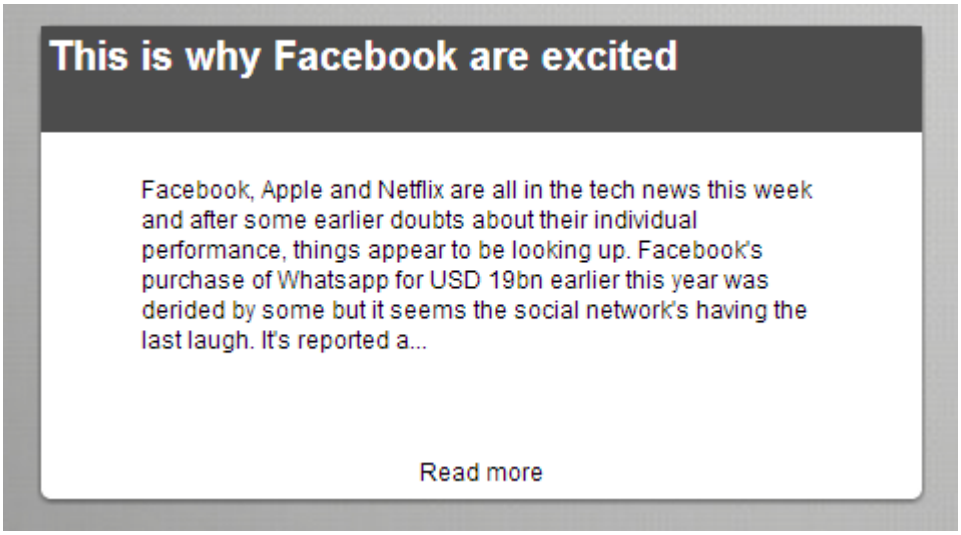

Figure 9: The final card of information

3.5.3. Decision Making Situation

The experiment is designed around a decision making situation combined with the information foraging process prior to a decision making situation. The experiment is build up around a representative task for the information foraging behavior in a financial context.

The starting point will be the financial context that will create the frame for the overall experiment. A central part of financial decision making is buying and selling, e.g. stocks, commodities or other financial instruments. This experiment will simulate a financial decision process where subjects will be asked to buy a stock. The financial decision has to be made based upon conditions for how you make a financial decision.

The complex assignment is to create an environment where we as scientists define the framework from which the subjects make their decisions. This is important because this experiment tries to connect the information foraged together with the subject's actual choice. The conditions are designed in such a way that at least one condition always eliminates 5% more uncertainty than the other conditions, except in one task where all conditions are the same. By eliminating uncertainty it makes the probabilities of making a successful trade and a profit higher compared to the presented alternatives in the experiment. Hence, one choice will be the rational best decision. So according to the arguments above conditions have two functions in the decision making process:

1. *"It provides subjects with a rational guide to minimize risk"*
2. *"Create the environment and reasoning to base their decision on"*.

The traceability between the two is clear and induces a specific behavior among the subjects. This inducement of a relatively rational behavior makes it possible to introduce the other alternatives, which subjects can choose between. The alternatives presented will be choices that are less or equally great in relation to minimize uncertainty, but on the other hand they might be more visually stimulating. It might be the card of information about Apple that has the highest probability of increase in stock price if the condition is confirmed in the information. This example will not necessarily result in subject choosing the rational choice, in this example the card of

information is represented as text about Apple, instead subjects might get visually drawn by the video-card or the graph-card. A visually attraction that contradict what is rational in economic neoclassical theory.

The subjects' decisions may or may not be affected by the visual stimuli presented in this experiment and how it is aligned with the economic rationale reasoning, but it will be studied. The information foraging behavior will be recorded and analyzed, then it will be possible to state if their visual preferences disrupt their ability to forage the right information.

Throughout the experiment, especially in the tutorial, the subjects are informed about the relatedness between conditions and their decision making process. It is almost the real world captured in a small bobble *"the experiment"* that still comply with the fundamental rules known from the real financial world, only in a much smaller scale and with less complexity. As mentioned before subject will be asked questions about their understanding of the experiment and the fundamentals for how this developed experiment works similar to reality.

One potential pitfall in the decision making process is subjects must pass through their preconceived knowledge. Despite several measures taken to prevent this from happening, it could appear and compromise the intended measurements. The awareness of this potential problem has been taken care of in relation to implementing tests and a questionnaire post the experiment. In cases where effect occur, it will likely be observed in the Eye-Tracking results, which quite clear shows, what representations that are part of the subject's behavior.

The decision making process and its characteristics has been designed around Saxo Bank's criteria for a realistic environment. The decision making process in the experiment is conducted with focus on the creation of results which are reliable and can be generalized to situations that Saxo Bank's clients commonly are in and thereby maximize Saxo Bank's utility of the results. That is also why the experiment to a large extent is an exercise in creating an environment that simulates reality.

A general decision making process within trading is build up by many different small neurological processes and the composition of many different information's from many different sources. It is a rather complex process with infinite degrees of freedom for the client making the decision. In an effort to limit the degrees of freedom the decision making situation are defined by four cards of information and four companies to choose between. It is once more a fine balance between creating a realistic experiment and creating a too realistic experiment that has too many degrees of freedom and confounding elements, in relation to the scientific objective.

The decision making process is illustrated below as a timeline which represent the steps the subjects go through in the decision making process within the experiment.

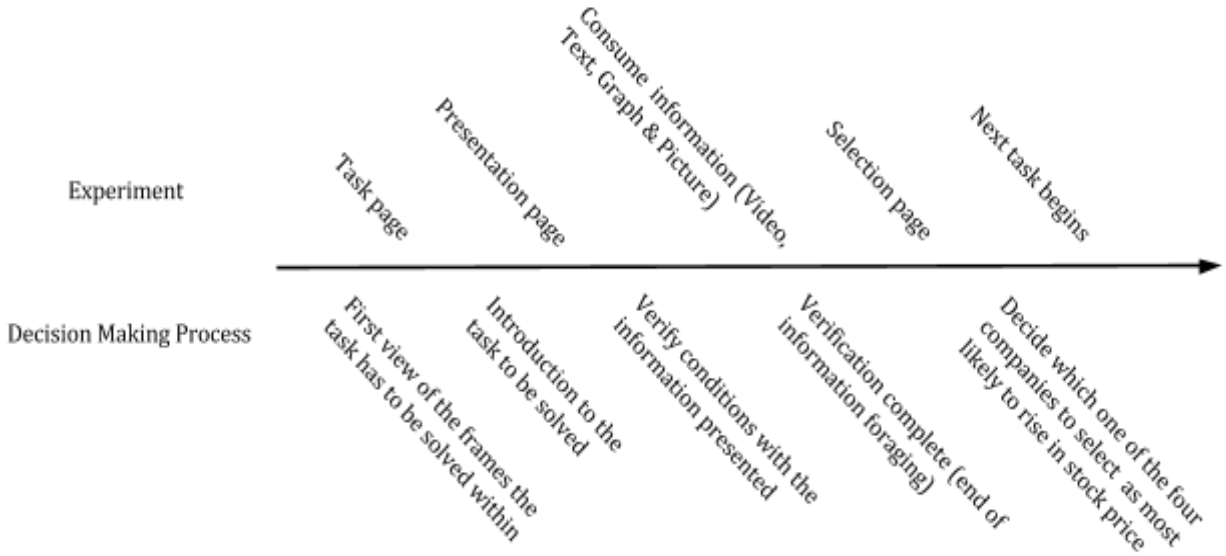

Figure 10: Decision making process within the experiment

Overall, the task and the decision making process will be based on buy-scenarios. As an effect of using buy situations the information's have to influence the stock price positively. This experiment will only cover the buy aspect of trading and will be described in the section delimitations.

3.5.4. Overview of the Task

The structure of the task is illustrated in the figure below and will be described in further detail in the following sections. This section will concentrate on the structure as a hole and the unique combination of information foraging and an economic decision making situation. This will give an insight into the development-process of creating a realistic and complex environment. Simulating a task trustworthy enough to be solved with the same seriousness as in real life cases.

Having in mind that the platform needs to support the eye-tracking technology, which means that the pages should be designed in order to provide measurable results. Result containing peoples visual preferences, their first eye-contact and the complexity of uncover whether subject behave according to classical rational behavior or are affected by the different visual stimuli presented in front of them.

The task is developed of several parts which all support the *Knowledge Crystallization Task*. The process in which a person gathers information in order to solve the task at hand, making sense of the information and assemble it into the form required e.g. an action, a note or a decision [Pirolli, P. 1999]. The knowledge crystallization task has three characteristics that have been applied in the design process of the task.

1. Use of large amounts of heterogeneous information
2. Ill-structured problem-solving
3. A relatively well-defined goal

1. Use of large amounts of heterogeneous information

The use of a large amount of heterogeneous information is reflected in the presentation page containing the four heterogeneous information's. It is debatable if four heterogeneous information's represented in the four cards, video, text, graph and picture, can be defined as a large amount! This concern is real but has limited effects. Although the amount of information presented is limited to a single representative of each representation of information, it is still capturing the concept of having heterogeneous information presented which the subjects have to choose between although it is in a minor scale. On the other hand it is debatable whether you can create an experiment that would not be minimized in scale of heterogeneous information in comparison to the real world. Despite the format are somewhat smaller there is still a clear transferred concept form the first characteristic in the knowledge crystallization.

2. Ill-structured problem-solving

The characteristic, ill-structured problem-solving, is conceptualized in the task by letting more than one way of solving the problem be open. The solution and the way to it can come from different paths. The various ways of solving the task is defined by General- and Task Specific Conditions plus representations. Subjects need to search through a set of, despite relatively limited, heterogeneous sources like videos, texts, pictures and graphs. In this specific experiment conditions and various representations have been applied to create an impression of what information foraging characterize as ill-structured problem-solving.

An environment where subjects will need to search through the information available from a set of heterogeneous sources [Pirolli, P. 1999]. That characteristic is reflected in both the *Presentation page* and the *Choice page*.

3. A relatively well-defined goal

The objective for the subjects is to choose the company most likely to increase its stock price. Subjects need to consider which company that has the highest probability while choosing the right information among the alternatives. It is a well-defined task with a quite clear goal. The decision making and information gathering process is more complex and comprehensive, but the goal is relatively clear all the way through the experiment.

The Task overview below illustrates the several pages subjects go through in order to complete the task. Furthermore it is divided into two sections respectively an information foraging scenario and an economic scenario.

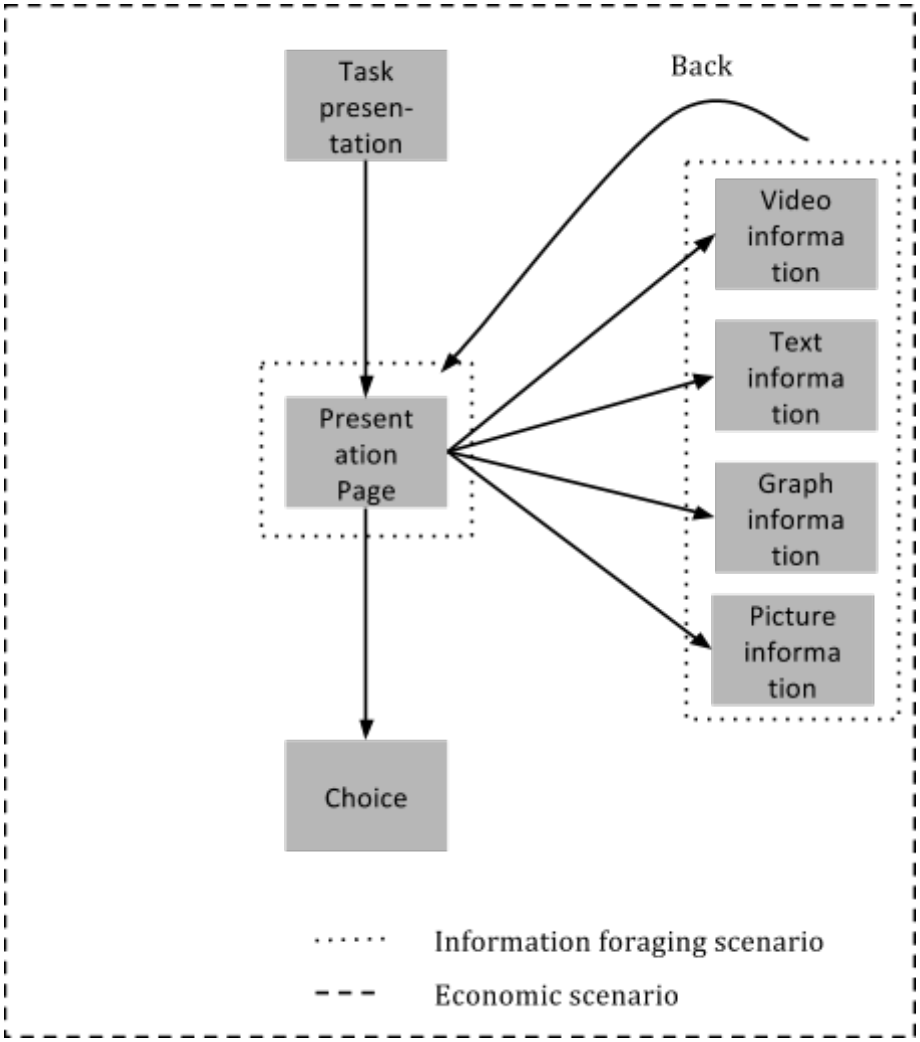

Figure 11: Task overview

3.6. Control-Mechanism

In this experiment, we have applied three control mechanisms: *3.6.1. Power of position, 3.6.2. Control mechanism in the experiment,* and *3.6.3. Result of post-questionnaire*. These three mechanisms will be presented in the following sections, but first a short description of how the subjects were introduced to the experiment in order not to affect their behavior.

The Eye-tracking equipment will be setup and calibrated prior of the experiment to fit the individual subjects. A set of standard guidelines has been developed in order to ensure the same presentation of essential parts of the experiment, presented in the same manner for each subject [Holmqvist, 2011, p. 134]. This set of standard guidelines consist of: Welcome to the experiment, Adjustment of equipment and participant, Presentation of tutorial and how subjects will participate in a competition based on their number of right answers. Can be found in Appendix 7 – Protocol for experiment. Then the experiment will be initiated and the recording of the eye pattern will begin.

3.6.1. Power of Position

One thing that influences the results is the position of the cards. Hence, it was decided to randomize the positions of the cards in order to minimize this potential influence. The randomization has been carried out so the four cards of information switch position according to the defined positions where 1. position is top left side and 2. position is top right side, 3. position is bottom right side and 4. position is bottom left side.

From the aggregated figure below, containing all four representations clearly show position one is getting most attention from the subjects. With a measure of 47.27% first fixations compared to the second highest with 22.73% first fixation, 1. position is getting more than twice as many first fixations compared to the second highest. The position getting second most attention is information placed in 3. position located in the bottom right side with 22.73%. Third in line are 2. position which is located in top right side with 20.00% first fixations. Closely followed by 4. position with 10.00% first fixations located in bottom left side.

Overall the figure shows a strong preference towards the 1. position compared to the other three positions. Additionally, the figure below is an aggregated figure of the four presentations, so independent of the representation there is a strong preference towards 1. position. While randomization of the representations should have minimized some effects of this position effect, it still looks like the position effect is present. Total position effects on the first click and the choice can be found in Appendix 8 - Control mechanism position.

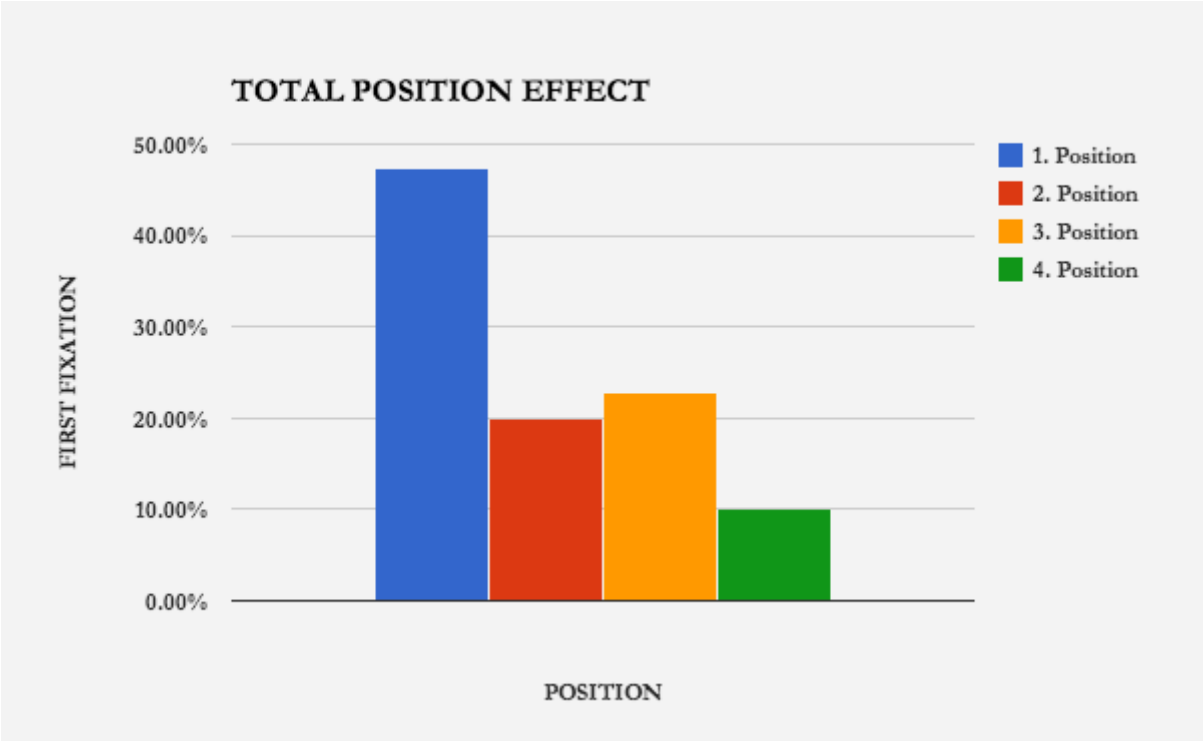

Figure 12: Total position effect

In order to establish that the position is the variable that is causing the highest percentage of first fixations in 1. position the two other variables, the variables *Value* and *Representation,* are

investigated as well. Further investigation of *Figure 13* shows that all four presentation formats have higher percentage of *First Fixations* when in 1. position. Overall, the four representations have higher percentage of first fixations and the influence of the position is independent of the presentation form. It also indicates that graphs, when located in 3. position draws a lot of attention (first fixations).

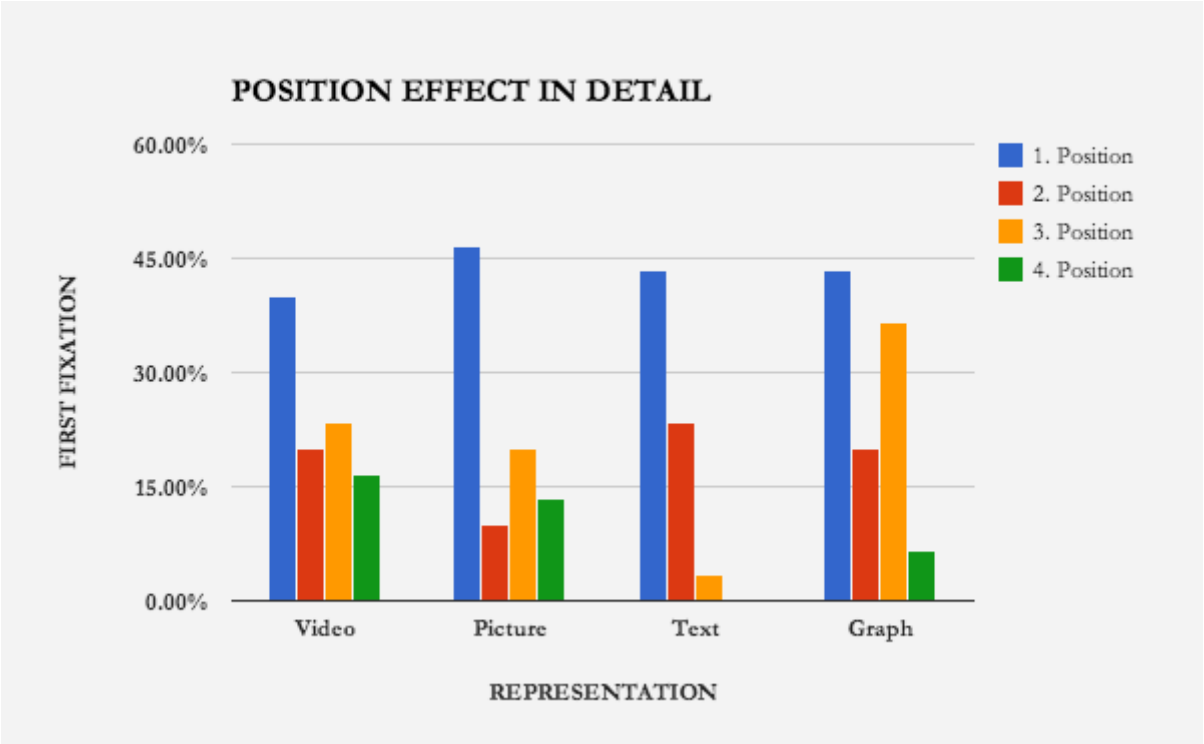

Figure 13: Position effect in detail (String Based)

One plausible explanation for the discovered power of position is to be found in the distribution of high and low probabilities between the four positions. Here it is evident how the cards of information in 1. position has a distribution favoring information with high probabilities. Meaning the strong position effect can be partly explained by the favoring distribution of high and low probabilities.

However, we evaluate the favorable allocation of probabilities not to be responsible for the position effect alone due to the limited practical implications for the experiment. Thus the favorable allocation do contribute to the positioning effect, we see the effect being limited. When it is not given more importance then argued above, we argue that the position effect is a consequence of habits.

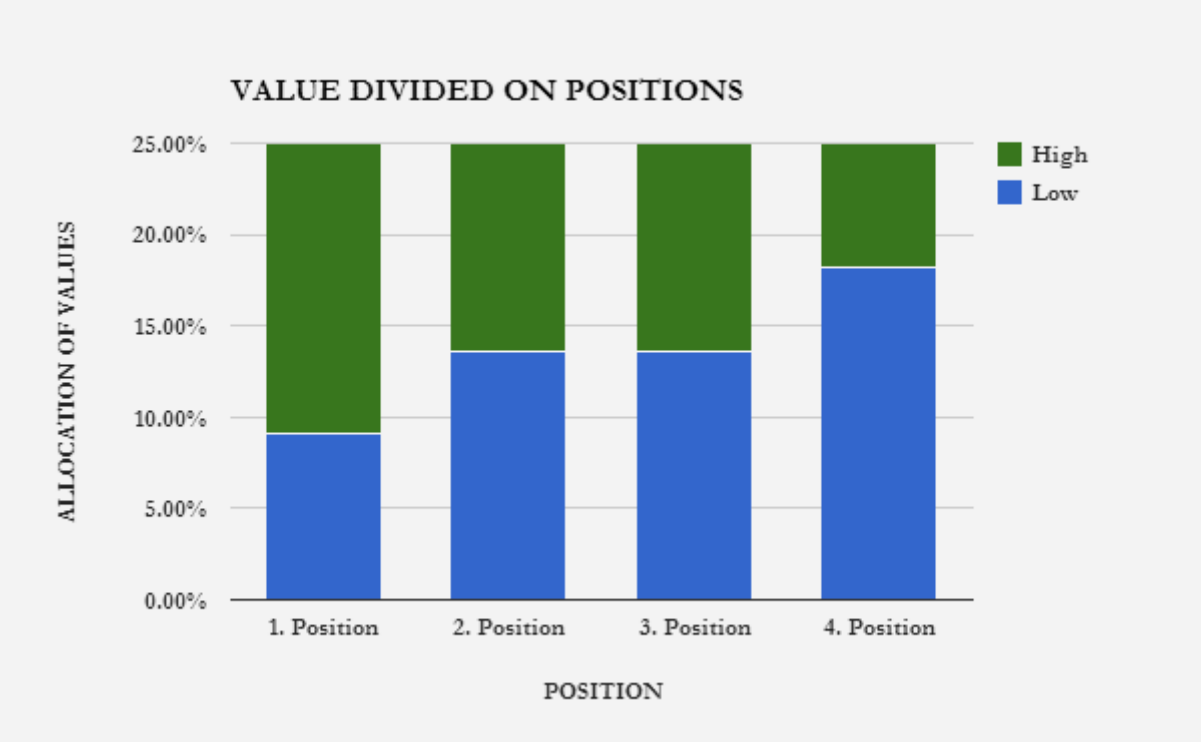

Figure 14: Value divided on position

3.6.2. Control Mechanism in Experiment

In order to enhance internal validity a questionnaire was created and placed after the tutorial in the experiment. The goal is to ensure the subjects have a strong understanding of the experiment, the general conditions and how they should solve the task presented. The questionnaire will by enhancing the subjects understanding of the experiment and the conditions they have to behave within, it strengthen the behavior observed from the subjects because we have strong indications of a good understanding of the experiment.

In regards to the General Conditions (GC) there is a high level of correct answers in all four questions. It seems like the level of right answer is increasing through the first three questions and then drops from 100% in the third to 80% in the fourth question. Despite the tendency is not consistent throughout the four questions about General conditions, the level of right answers are high. Regarding the two questions about the experiment (Test Q1+Test Q2) all subjects' answer the questions correct. This limits irrational behavior because the subjects exactly know the objective of the experiment and how it works. It also strengthens the correlation between the results and the behavior observed because it is established that subjects understand the experiment and how to solve the tasks.

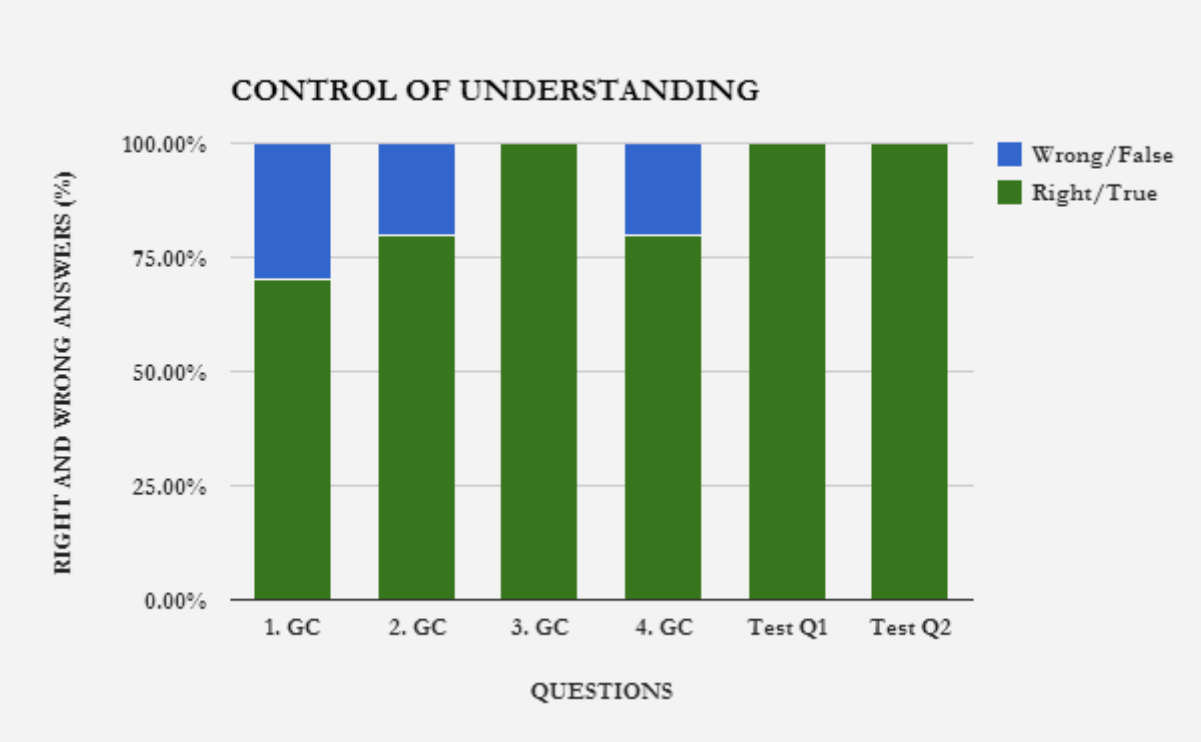

Figure 15: Control of understanding

3.6.3. Results from Post Experiment Questionnaire

The results from the post experiment questionnaire will be analyzed and put into context of the results of the experiment. The questionnaire had the purpose of triangulate the results by checking the subject's attachment to the used companies, and gather basic background information about them. The themes in the questionnaire are the following: evaluation of realism, company ties, and basic information about the subjects.

The subjects were asked to evaluate the experiment in order to collect knowledge about their perception of how realistic it was. From an overall perspective, all subjects evaluate the experiment to be realistic. With 20.00% subjects found it slightly realistic, 60.00% found it realistic, and 20.00% found it very realistic. Almost the same evaluation of the task can be seen, 10.00% found it slightly unrealistic, and the rest found it realistic. The decision making process was evaluated as being more unrealistic. There was 60.00% who found it realistic and 40.00% found it unrealistic. The conditions had the same rate of percentage as the decision making process.

The questionnaire would also focus on potential favoring ties towards specific companies. Asking the subjects if they have particular interest in one or more of the companies in this experiment. This can be used as explanation for information foraging behavior that cannot be explained by the eye tracking measurements. Companies like Google, Facebook, and Apple are followed most out of the 21 companies used in the experiment, where six, five, and five subjects are following them respectively. Four subjects each follow Alibaba and Vestas. If the subjects were affected in their information foraging behavior it should be expected to be crucially affecting the companies with the most followers, Google, Facebook, and Apple.

The results from the analysis for the first fixations do not indicate any correlation between companies being followed and the first fixations. First click did not neither show any correlation between the subject's selection of information and the companies followed with particular interest. The last measurement this thesis use is the choices made by the subjects. Any ties towards a specific company would show itself here, if it do show anywhere in the three measurements. However, there have not been any indications of company ties in the choices. The results from these data are conclusive regarding the existence of company ties in this experiment. Therefore, it is reasonable to conclude that no company ties have affected the results regarding first fixation, first click, and choices.

All subjects are within the age of 21-28 years old. Out of the ten subjects, nine are males and one is female. We asked the subjects if they knew others participating in the experiment which 40.00% of them did, but only one had been told about the experiment. It is therefore considered unlikely to have major influence on the experiment as a consequence of one subject telling others what the purpose is and how to behave. Only one of the subjects participating has participated in an eye tracking experiment previously.

The subjects trading experience was also evaluated and it was found that 20.00% on a daily basis search for information for potential investments – 20.00% weekly, 40.00% monthly, and 20.00% yearly. The subject's trade less compared to how often they search for information. One trade every week, one every month, and three once a year. Overall acceptable, when taking into consideration that the subjects are mostly students. The specific results of all the questions in the questionnaire can be found in Appendix 6 – Contact to subjects.

4. Results

The results are structured according to our three sub-questions. Meaning that the results and its accompanying analyzes are divided in three subsections. Following each subsection, a summary will be presented with the results of the analysis and how the result answers our sub-questions. The overall objective for our analysis is to answer the overall stated research question: ***Which representation of information is most suitable for traders foraging information before decision making?*** In order to set the scope of the analysis, three sub-questions will be answered through the three-step analysis.

First part of the results and analysis will find answers to the sub-question, which is formulated as follows: ***What are the visual preferences for information in a decision making context?*** Here will visual preferences for the subjects be analyzed and the detailed visual behavior will be presented to answer the question.

Second part of the results and analysis will focus on the selection of information and if choices are consistent with the most valuable content. The sub-question to answer is the following: ***How do the variables, representation, value and position influence the selection of information?***

Third part of the results and analysis will investigate if the subjects are affected in their ability to forage for the right information due to different visual stimuli. The sub-question is stated as follows: ***Do position and representation affect a financial trader's ability to forage for the most valuable information and ultimately affect their decision making?*** A simple definition of a decision is necessary, in order to determine how they might be affected. A decision is being made from an overweighting of some information or on the basis of partial information, which will be illustrated by the tendencies and preferences for certain representations found in section *4.4 Research question 3.*

After each of the three steps in the analysis, a summary will be presented with the findings of that particular analysis. This will be the frame for the analysis. Before the analysis can be initiated, the section about rational behavior is presented because it is an important part of the analysis in each analysis.

4.1. Rational Behavior

This section illustrates the most rational behavior through the 11 tasks of the experiment. The experiment has applied value to the content in form of probabilities in order to simulate rational and irrational behavior. Furthermore, the use of probabilities simulates uncertainty like in a real trading environment. The probabilities are divided into two groups with respectively 60% and 65% probabilities. The percentage signals how likely it is that a stock will increase its value in the future. When subjects find information that confirms the highest probability available it will represent the rational choice for the subjects and therefore this information should be foraged and the company represented should be selected. The companies with no color will represent the low probabilities, which is also the information with low value. Whereas the companies with a high probability will be marked with a blue color because this is the information with most value. As

established earlier the position and how many rational choices presented in each individual task are randomized as illustrated below.

Task #	Video	Graph	Picture	Text
1	Nucor	General Dynamics	Tesla	Huawei
2	eBay	Apple	Facebook	Blackberry
3	Twitter	Johnson & Johnson	General Dynamics	Facebook
4	Google	Apple	Alibaba	Nokia
5	SunEdison	Google	Fiat	Apple
6	Facebook	Just-Eat	Google	Alibaba
7	Microsoft	Tesla	Lloyds Banking Group	Samsung
8	Apple	Amazon.com	Twitter	Vestas
9	Google	eBay	SunEdison	Tesla
10	Fiat	Facebook	Just-Eat	Airbus
11	Facebook	Google	Microsoft	Apple

Table 1: Rational behavior

4.2. Research Question 1

This section will answer the first of the three sub-questions: ***What are the visual preferences for information in a decision making context?*** In order to identify if the visual stimuli affect the traders behavior, the first fixation is used as the measurable parameter to identify the visual stimuli. The first fixations provide an insight into the subject's perception of the different information's value and indicate the information scent from the different representations. The information scent gives an insight into the prima facie visual behavior of what representation of information has the highest visual attraction. The analysis will identify the patterns in the visual foraging behavior and identify the factors, which influence the subject's information foraging behavior. The answer will be based on the average behavior of the ten subjects. Finally, the key results will be presented in a summary in the end of this section.

4.2.1. Visual Stimuli

In order to answer the stated sub-question the following figure *16 Visual preferences* has been developed to compare the visual stimulation caused by the different types of representations with the one which is getting most visual attention by the subjects. From the figure it was found that the level of first fixations to the different representations varies in relation to the value they hold. The representation with the highest total level of fixations is the graphs.

When looking closer at the aggregated sum of first fixations, the graph cards attract 29.09% of the first fixation, which is almost ⅓ of the total first fixations. However it is important to be aware of the difference in the visual preferences when the information value varies between high and low value. Further investigation shows how the representation of graphs in cases where the value is low, have the highest percentage of first fixations of all four representations. This indicates that graphs are visually attractive, even in cases where the information has a low value due to its low probability of eliminating uncertainty. This overall visual preference for graphs, despite the low probability, could be due to easy retrieval of information. Graphs provide the information in a fast manner, and there is a limited cost in time to investigate the graphs for useful information compared to the video format. This is regardless of the value of the information being low. The cost of checking the information presented in graphs is low as a consequence of easy retrieval. The low cost by checking could be part of the reason for the high level of first fixations. Furthermore, graphs are a well-known representation in trading, meaning that subjects can have strong habits for this type of information when presented in graphs. The tendency of visual attraction towards graphs could lead to a similar tendency in the selection of information despite the information may not provide the most valuable content. This correlation will be investigated further in the third section of the analysis.

Looking closer at the other three representations, they are very close in percentage when comparing their first fixations. All three remaining presentation forms: video, text and picture are within the range 9-10% in first fixations with low valued information as illustrated below. Indicating a smaller visual preference for all three representations and this pattern will be interesting to follow in the subject's first selection of information in the second analysis section. We have determined that graphs are the most visually stimulating representation when the information value is low.

This trend with graphs is changing when the information value is high. The overall allocation of first fixations is different compared to when it is low. Here is the video representation getting the highest percentage of the first fixations with 18.18%. The picture is having 14.55%, the graph 10.91% and the text 10.00% of first fixations. This specifies that subject is more prone to fixate first on the video when the probability is high. The imbalance in first fixations is dependent on the value of the information. Information Foraging Theory uses information scent to characterize the identification of information value from proximal cues prior to the selection of information.

The subjects have the strongest attraction towards the graphs, from an overall perspective, which means that graphs in this experiment contain the strongest information scent. Graphs provide the best imperfect perception of value and hence the representation chosen the most. Information foraging also provides explanation for the high percentage of first fixations when the value is low. The cost incurred by retrieval from the graph is rather limited because graph representation is very fast in providing the information it holds. Based on the same principle, videos do not induce the same easy retrieval of information because the trader is subject to the total length of the video before being able to evaluate the value. The representation video has a greater opportunity cost compared to the graph due to the time of retrieval.

Practically, it takes longer to see the video and the subjects are not able to locate where the value in the video get presented. Especially, if the information you are searching for is not the most valuable for your decision making. The same principle seems to apply to text and picture as representations. The three representation forms: video, text and picture takes longer time to process compared to graphs. The signal of how long the different sources of information take to process is revealed in the information scent. The subjects have a strong visual preference for videos when the probability is high which could be explained by the value returned is more appropriate compared to the cost incurred of retrieval. In other words, the information scent is strongest with graphs and videos. However, because graphs have a smaller resource cost compared to videos that have a longer retrieval process, subjects will most likely retrieve from graphs when the value is low. When the information value is high the video is favored because the cost incurred is more aligned with the value returned. This identified evaluation process of the first fixation will also be applied in the further analysis of the remaining sub-questions. It was also found that information value have an effect on the first fixation, despite rather limited.

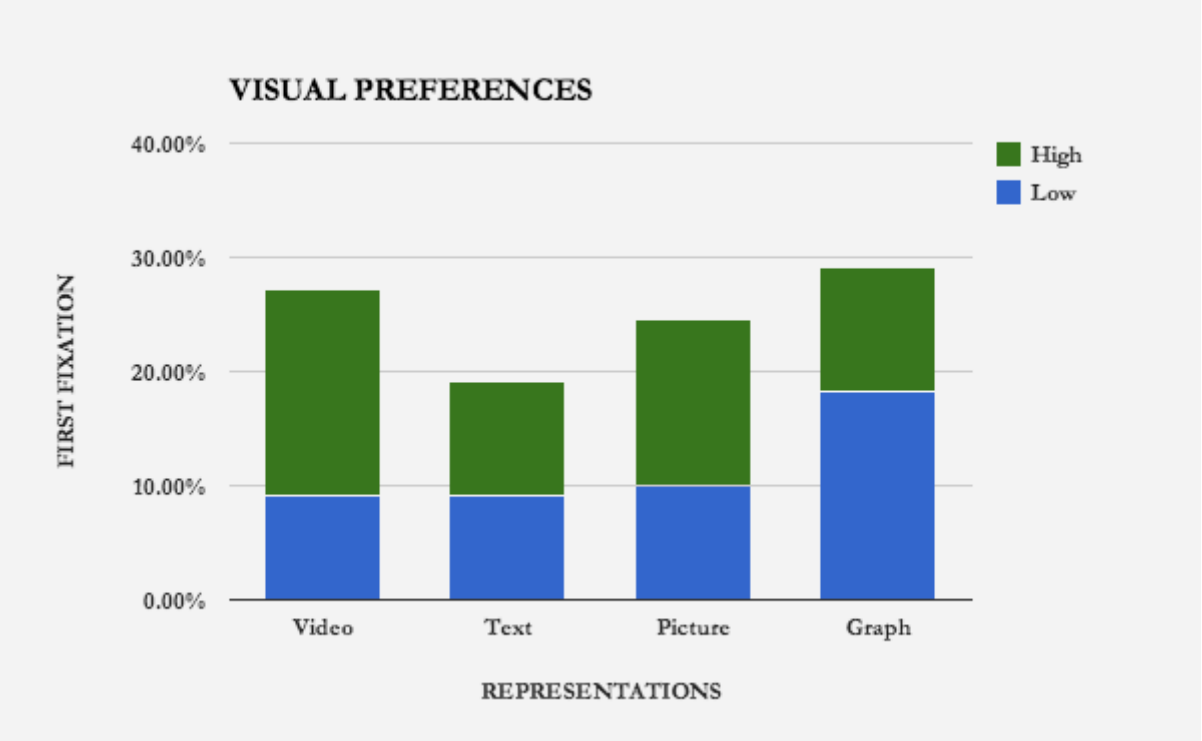

Figure 16: Visual preferences

4.2.2. Patterns in Visual Behavior

This section provide an in depth analysis of the subjects behavior in order to identify patterns. These patterns will be identified according to the three variables: position, value and representation. The subject's first fixation indicates their visual attraction, which identifies what they instinctively find most visually stimulating and initially find most interesting. The pattern of the first fixations on the different representations, how it is affected by the information value, and the position will collectively create the foundation for the identification of subjects visual preferences. Further, the figure *17 First fixations* can provide insight into potential visual preferences, which influences the foraging behavior and how this behavior deviates from the

rational behavior. Visual preferences will be analyzed in detail in the associated analysis of the third sub-question.

The figure 17 *First fixations* illustrate the visual pattern of behavior from the subject's first fixations. The average behavior through the tasks is shown with the black line. The color of the bobbles symbolizes the position of the information. The circles differ in size as a function of the number of subjects having their first fixation inside the representation card, also indicated by the white figure inside. When the numbers inside the circles are underlined, it indicates the information value as high and without underlining the value is low. The horizontal axis is the number of tasks and the vertical axis is the four representations.

The majority of the representations with the highest average of first fixations are positioned in first position marked blue. Furthermore, there is an overweight of information with high value - indicating an overweight of rational visual behavior. In detail, the text card tends to mainly attract the first fixations when it is positioned on the 1. position. The position directly reflects the number of first fixations on the text card. There tend to be a linear function of position effect, from first position to fourth position, where first position attracts the most interest and fourth position attracting the least. The first fixations for the text card when placed on the 4. position is 0, which occurs 4 times, this indicated that the text card has the least visually attraction of the four different representations. There is no strong evidence which points towards the text card being affected by the conditions. The evidence identify that the first fixations are evenly distributed between the high and low value.

The text element tend to increase in interesting through the experiment, the text card had four first fixations in the first five tasks and 17 first fixations in the last 6 tasks. This could indicate a learning effect, which point towards the text card being an effective information representation, which enable the subjects to identify the value of the information. This effect seems also to have had effect on the video representations. This representation has a declining level of first fixations first half of the tasks compared to the second half. Indicating that video representation not being an effective information representation. The fixed time it takes to watch a video could affect the subject initial interest of foraging information within the video cards. Another factor which could affect the initial interest for the video representations could be that it is relatively difficult to speed through or search for specific elements in a video compared to the static data in a text, picture or graph. The distribution of first fixations between the first and second half of the tasks for picture and graph seem to be relatively evenly allocated.

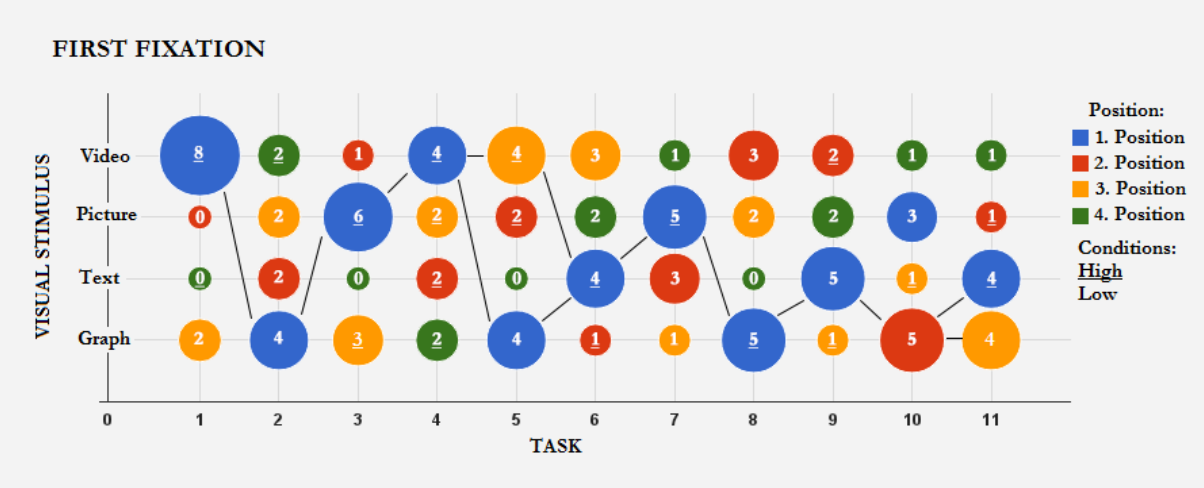

Figure 17: First fixation

The first fixations on the video representations tend to decrease as the subjects work their way through the experiment. The text representation tend to has the opposite interest curve, as the figure indicate there is an increased level of first fixations which is a sign of subjects ability to identify the value of the representation more easily due to the learning effect. These patterns illustrate an optimization of information diet as the subjects become aware of the characteristics of the different representations. The picture representation has a relatively evenly level of first fixations throughout the experiment. Furthermore, it has a great tendency to be the first fixation when it was positioned on the 1. position and it had a high information value. This combination tends to create the greatest information scent for all of the representations. The strongest information scent seems to be generated with the combination of the 1. position and the video representation, which is identified to provide a high visual stimuli. However, the video representations level of first fixations is decreasing which indicate that it is not favorable for the subjects.

It is identified that in 8 out of 11 tasks, the subjects tend to fixate on the rational most valuable information. Additionally, two tasks have a split between high and low information value which overall give the impression that subjects overall are able to visually identify the rational information. In these 8 tasks are the rational choices in 7 of them positioned on the 1. position, which could have had an effect on the subject's behavior when identifying their first fixation. In 2 of the 8 tasks were the majority of first fixations equally divided between the 1. position and the 3. position, which were represented as respectively a video and a graph. The identified behavior of the subjects illustrates the great influence of position, which tends to create a greater effect than the visual stimulus. Subjects tend to fixate on the video card first, when in first position and the information value is high. The position can be concluded to have great influence on the subject's behavior, greater than the representation and equally great compared to the information value, which also seem to have effect on the visual behavior observed.

Overall, the first position has the most first fixations in 8 of the tasks and additionally two tasks which has the majority of first fixations equally distributed with the 3. position. The second position has the highest level of first fixations in only one task, task 10. The 4. position does not

have the highest level of first fixations at any point of the experiment, even though it is the only rational choice of the second task and it is being presented as a video card which is considered visually stimulating. The findings regarding the effect of the positions on the subject's first fixation could be indicating that habits influence the visual fixations more than the representation form. The effect could be caused by habits of the reading direction of western languages and other habits from the use of various information systems, which cannot be excluded.

4.2.3. Summary

This section of the analysis will summarize the key results from above in order to answer the stated question: ***What are the visual preferences for information in a decision making context?*** The key elements from the analysis indicate several important findings. The level of first fixations is influenced considerably by the information value and the position, which the information holds. The representations are visually preferred in the following order: graph, video, picture and text representation. Furthermore, the video representation had the highest level of first fixation when the information value was high - 18.18% of the total first fixations. The level of first fixation for the video representation was declining through the eleven tasks. It is reasonable to assume a learning effect is present and the decline is a signal of video representations as not being an effective information representation.

It was identified that the graph representation had the highest level of first fixations when the information had a low value, also with 18.18% of the total first fixations. The visual behavior observed for the graphs also show a development in first fixation pattern. The level of first fixations increases through the eleven tasks, indicating an increase in visual preference for this type of representation. It is therefore indicating that graphs are an effective information representation. The development in visual patterns throughout the experiment has shown an increased awareness from the subjects regarding the representation indicating a visual preference. Moreover, it was identified that the position of the information cards had an influence on the first fixations. Identified by the average behavior the 1. position had the most first fixations through the experiment. This shows that the position had great influence on the behavior on the information foraging behavior. The first position are chosen even though the value of the information was low, which indicate that the effect of the position has a greater role in comparison with the value of the information.

4.3. Research Question 2

The second part of the result chapter will answer the second stated question: ***How do the variables, representation, value and position influence the selection of information?*** The analysis will do so by analyzing the observed foraging behavior regarding the information-selection process. To get an overview of the foraging behavior, the starting point will be from an aggregated perspective. Furthermore, the three variables in this experiment will be analyzed according to the foraging behavior. The three variables are: representation, information value and position. Their potential influence will be the result of this sub-analysis. Here it will be discovered if content is key or other variables are influencing the subjects information foraging behavior.

4.3.1. Representation

This section provides an insight into how the representation affects the trader's behavior when selecting information to forage. The aggregated figure below illustrates the influence the four representations have on the selection of information and will be the focal point from which the analysis takes off.

The figure indicates that the most selected representation by first click is the texts with 30.91%, closely followed by graphs with 28.18%. The representation picture comes in third with 23.64% of first clicks and videos are the representation with the lowest percentage of first clicks with 17.27%. Both the text and graph card are benefitting from a great information scent. Providing subjects with a clear indication of the value that will be returned if one of these representations is selected. The level of clear scent of the returned value seems to decline in the following order: text, graph, picture and video. The better information scent, in form of a short resume or a small representation of the graph on the presentation page reveals the information value more accurate. The subjects are also enabled to get an overview of the information and evaluate if the information can contribute positively to their decision making process. Unlike videos and pictures, where subjects have little overview and ability to establish if the representation will provide valuable information before they actually see it. The picture representation has the same problem as the video but to a smaller degree due to picture representation also contains text. These cards, video and picture, makes it difficult to foresee the information value prior to the selection and this makes it difficult to construct an information diet that maximizes the gain of value per unit time.

According to Information Foraging Theory subjects will maximize their information diet, by identifying the information representations, that tend have the greatest information scent and reveals knowledge about the information, making the subject able to get an overview of the content and evaluate it. This explanation is plausible, but it needs more data to back it up or perhaps suggest alternative explanations. The effect from the three variables has still not been established and before it is analyzed, it is too early to draw any conclusions despite information foraging has an explanation. We now have an overview of the subject's preferences regarding the representation and need to find the correlation with the remaining two variables. The further analysis will emphasize the two variables: information value and position.

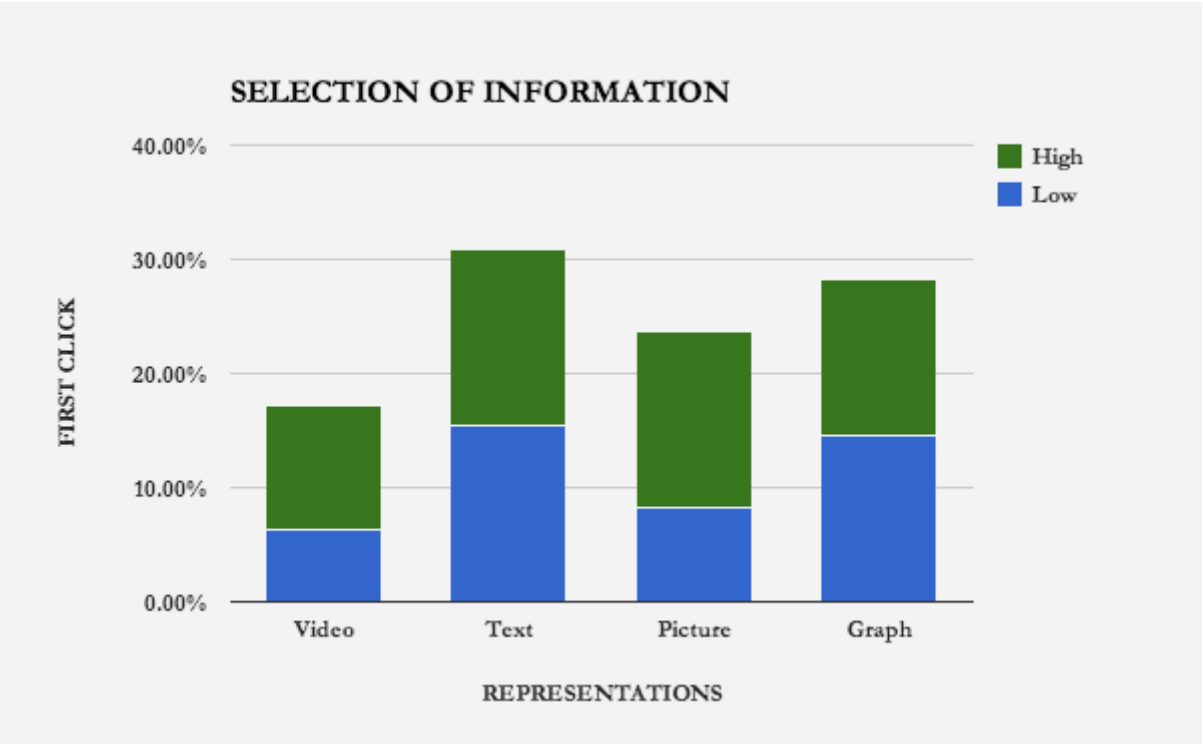

Figure 18: Selection of information

4.3.2. Information Value

There are observed two different information foraging behaviors depending on the information value. When the condition is low meaning the information content has a low value, there is a general tendency to favor the text and graph representations. Illustrated by the figure *18: Selection of information* above there is a considerable higher percentage of first clicks for text and graph compared to the video and picture representations, this is indicated through several findings.

The first finding is that different representations induce different selection behavior. This topic will be analyzed in detail in the third section of the analysis and will not be analyzed further here. The second finding is that subjects do not select the information solely because of the content. There are found deviations from the rational behavior. This becomes clear when looking at the distribution of first clicks between the information of high and low value. There were 36.84% of the videos total first clicks happened when the information had a low value. Of the text representation's first clicks are 50.00% of them made with the information being valued low and 34.62% of the first clicks on the picture representation information being valued as low. The last representation graph had 51.61% of its first clicks when it was being categorized as low valued information.

When looking at the percentage of the total number of first clicks within the four different representations, it becomes clear that text and graphs are the most popular representations to click on first, closely followed by the picture and at last is the video representation. This pattern of selection or preferences of information observed can be explained by Information Foraging Theory. Subjects are willing to use the text with 15.45% and graphs representations with 14.55% of the total first clicks, because they are easy to retrieve value from. In other words, despite the

information sources might not provide the best information available, the cost of retrieval is sufficiently low that it compensate for the value being slightly lower than the best alternative. While the video representation with 6.36% and picture representations with 8.19% of the total clicks have the opposite problem. These have a higher cost of retrieval and suffers from having a poorer information scent, which makes them less attractive to select, when the returned value do not compensate the cost of retrieval. With this in mind, it is interesting to see if the higher value compensates the higher retrieval cost. This can be investigated by looking at the distribution, when the information value is high.

Moreover, video and picture representations have poorer scent due to difficulties in estimating the content and its value from a picture compared to an appetizer text. When the conditions are high the distribution of first clicks is close to being evenly spread between the four representations of information. Hence, it strengthens the prediction described above saying that a higher compensation would be favorable for the video and picture. We now experience that both the picture and the text get 15.45% each of the total first clicks, graphs gets 13.64% and videos gets 10.91%. Here the distribution is more evenly distributed and illustrate the point of better compensation increase the retrieval from information sources like pictures. Subjects estimate the cost of retrieval in comparison to the returned value and find it more appealing. The analysis found that information value affects the selecting of information. Subjects tend to select graphs and text relatively more when the value is low and the selection is more evenly distributed when the information value is high.

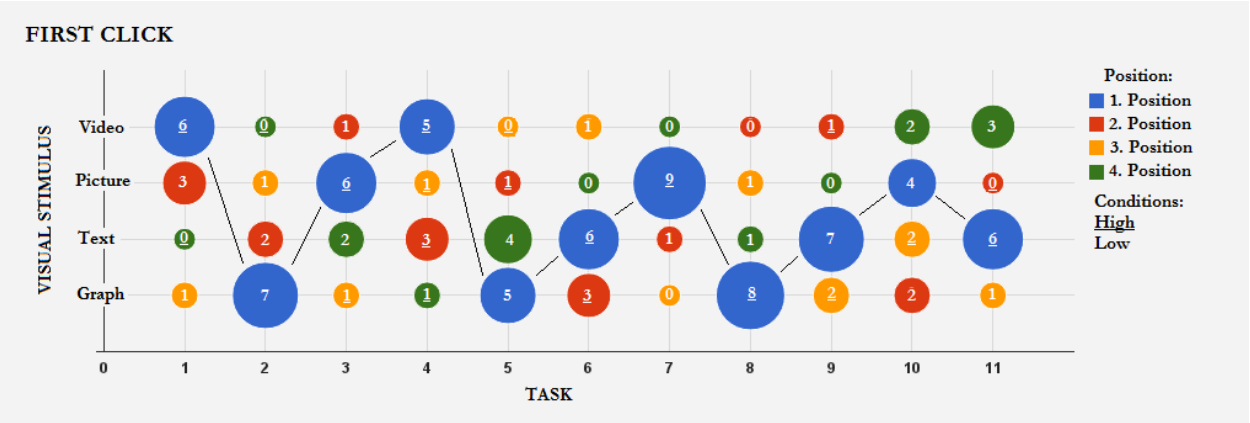

Figure 19: First click

4.3.3. Position

In figure *19: First click* the line indicates the average behavior of the first clicks through the tasks. Here it is identified that the position of the card has an even greater influence on the subjects selection behavior than the visually stimulus in form of representations when selecting the first information. The first click indicates that the subjects act slightly less rational than in their first fixation and rely more on the position of the card rather than the content it holds. When comparing the first fixation from first part of the analysis to these findings in this analysis, the first click indicate that the subjects becomes influenced to a greater extent by the position when selecting information than initially created by their visual instinct. This comparison of the different

measurable variables that create the selection behavior will be described in the third part of the analysis.

The card with most first fixation, averagely has one more click than the number of first fixations. This reveal a preference towards the card with most first fixation, indicating the subjects forage the information they fixate on first. Another pattern identified is that the subjects use the position to create a search behavior, which indicates an adoption of the environment by the subjects. The first position has 62.73% of the total first clicks through the experiment and then it is divided relatively evenly between the second, third and fourth position. The second position got 15.45%, third 11.82% and fourth 10.00% of the total first clicks - which is evaluated as a relatively even distribution. The order of the first clicks is as previously mentioned affected by the position, illustrating a tendency that generally follows the reading direction of the English language. The behavior of the first clicks tends to be more influenced by the text card compared to the level of first fixations. This could point towards a greater initial interest in the text cards. The text card is the information representation, which has been clicked on the most with 30.91% of the total first clicks. Of these first clicks are 55.88% made when the text card where on the 1. position, which is the lowest percentage of the four representations. This indicates that the text card is the representation, which is least, affected by the position.

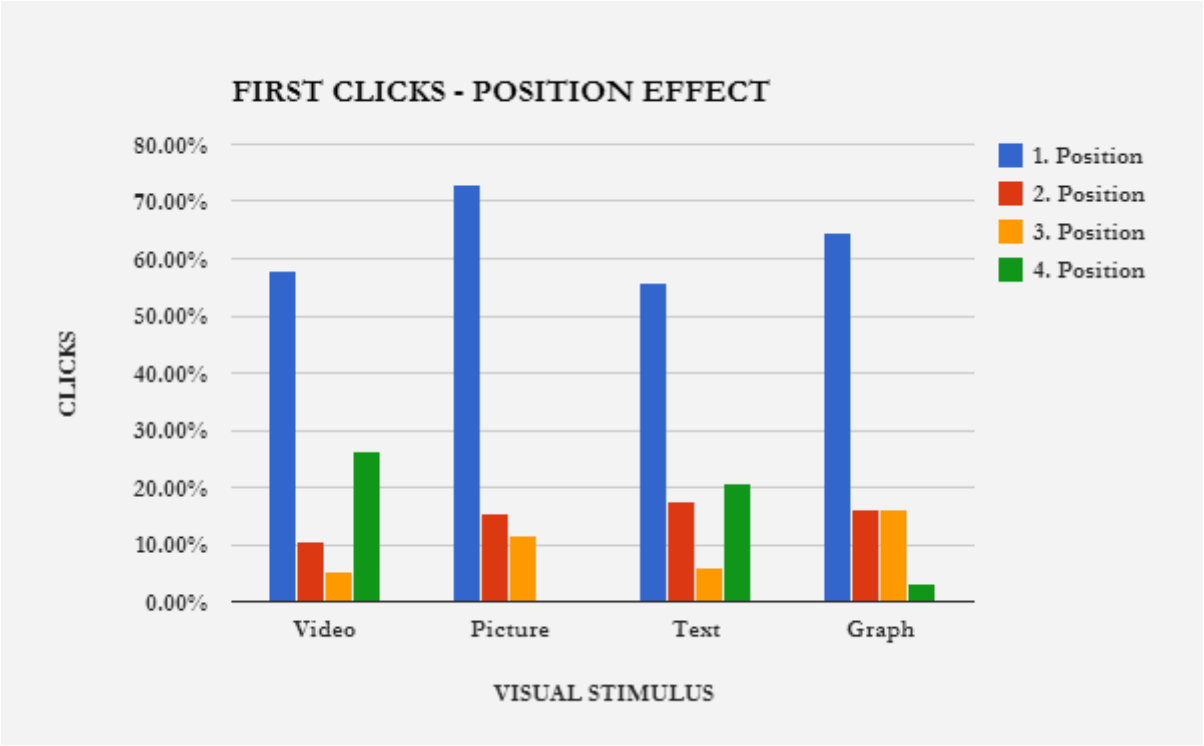

Figure 20: First click - position effect

The picture card tend to be the representation which is affected most by the position, it is chosen nineteen times in three different tasks were it is placed at the 1. position. This represents 73.08% of the total first clicks on the picture card, which is not clicked on a single time when placed at the 4. position and it is representing the largest spread. The average pattern of behavior illustrated in figure 20 shows that the subject's first clicks are identified to follow the position of the cards. The figure identifies which cards the subjects are willing to click on even though the value of the card is

identified as low. The two times the video card is clicked on most is the video identified to have a high information value. The video card is clicked on 5.26% of the total first clicks on videos on the 3. presentation page where it is valued high but it is not positioned on the 1. position. The picture card is clicked on the most in task 3, 7 and 10, where it is positioned on the 1. position. In both task 3 and 7 the picture card is clicked on the most when also being the high value card. In these two tasks the card is chosen to a larger degree than in task 10 where it has a low value.

The text card is clicked on most times in total, having 30.91% of the total first clicks. The text card is the only card which is selected the most times when being a low value, this occurs in task 9 where the text card is positioned on the 1. position and were selected by 70.00% of the subjects. The text card furthermore has the most clicks on the 4. position in a single task. This occurs in task 5 were the subjects tending to click on the irrational choices in 90.00% of the first clicks. The graph card has the most first clicks in 3 out of the 11 task, all three times when being positioned on the 1. position. Two out of the three times the graph card is positioned on the 1. position it leads to an irrational behavior by being clicked on when the information is of low value and therefore showing a preference towards the position of the card. These two behaviors for respectively the text and the graph indicate that the position of the card has a greater influence than the visual stimuli when being clicked on.

4.3.4. Summary

This section of the result chapter will present the findings to the second stated sub-question. ***How do the variables, representation, value and position influence the selection of information?*** It was identified that the variable representation has influence on the subject's first clicks. The text and graph representation have the highest percentage of first clicks from an aggregated perspective including both high and low valued information. Especially when the information is low, the text and graph representation get considerable higher percentage first clicks. It was furthermore found that the subjects, according to Information Foraging Theory, evaluate the text and graph representations to be easier to evaluate the returned gains compared to the resource cost of retrieval. Despite the information sources might not provide the best information available, the cost of retrieval is sufficiently low that it compensate for the value being slightly lower than the best alternative. The opposite tendency was found in the case with the video and picture representation. Here the cost of retrieval is higher and suffer from having a poorer information scent, which makes them less attractive to select, due to the returned value do not compensate the higher cost of retrieval.

It was found that the information value had effects on the selection of information. Text and graphs are most popular when the information value is of low value and when it is of high value the first click are relatively evenly distributed between all four representations. The distribution of total first clicks between the information of high and low value were 43.27% of the clicks being low and 56.73% being high. When divided between the four representations the following distributions were identified. The video representation has a distribution of 36.84% of its first clicks when the information value was low. Half or 50.00% of the first clicks on the text representation happened when the information value was low. The picture representation had 34.62% of its first clicks when the information value was low. Finally the graph representation had 51.61% of its first clicks when the information was of low value. The information foraging behavior was affected by the

information value and is influenced differently depending on the high and low valued information. The video and the picture representations had the highest percentage of first clicks when the information was of high value.

The last variable was the position of the information. It was found that the position influenced the selection process considerably. Dependent of the representation, the first position had considerable influence on the selection of the information. While the 1. position with 62.73% of the total clicks were very influential, the second, third and fourth had substantial less influence on the selection process ranging between 15.45% and 10.00% of the total first clicks.

Overall, these findings indicate that traders forage information based on primary first position of the information, have a preference for text and graph representations and are influenced by the value of the information. The influence from the information value is differentiated by the high and low value. Where the behavior in cases of low valued information is characterized by an efficiency calculation, returned gains compared to resource cost of retrieval of the information. This is a calculation in favor of the graph and text representations. This information foraging phenomenon is also observed when the information value is high. Here is the preference relative evenly divided between all four representations. Indicating subject's sensitivity towards the information value.

4.4. Research Question 3

The third part of the results will answer the third stated sub-question: ***Do position and representation affect a financial trader's ability to forage for the most valuable information and ultimately affect their decision making?*** In order to answer the stated question the previous two research question sections will be included to increase understanding of the subject's behavior when foraging information. Furthermore, the various choices will be included to understand how the foraged information affects the subject's choices. This will provide an increased knowledge of the decision making process and provide information about how representations affect the choices made by the subjects. Combining the knowledge of how the representations are affecting differently with the decision making behavior of the subjects, it is possible to identify whether some representations enhance a rational 'right' decision.

4.4.1. Decision Making Behavior

This first section provides the overall findings of the analysis and identifies the behavior of the subjects. The choices are defined by the company, which subjects choose to buy in the scenario presented in the tasks. The companies are represented through the different information cards, which have different representations and information value. The overall picture of the subject's choices identified in *Figure 21: Choice made in total* shows a small tendency towards the subjects choosing companies represented as a graph. The graph information is chosen the most times in five different tasks and it furthermore provides the information for 30.91% of the choices made in total.
This indicates that there is a preference for the graph representation. The graph representation have the highest percentage of rational choices made with 61.76%, which indicate that it provide information leading to the highest level of rational choices. Moreover, it is established from the

previous section *4.3. Research question 2*, that the graph representation is an easy and quick way to forage information.

The picture card has the second highest percentage of the choices indicating the information was easily understandable, supported by the second highest percentage of choices when the information value was high. This provides the foundation for their choice to be rational. The picture representation has 26.36% of the total choices and of these choices are 58.62% rational choices. The video card indicate that it have been difficult to understand the information or find the right element to confirm the conditions which is the confirmation of the information's value. This is based on the fact that only 47.83% of the subject choosing the company represented in a video card have selected the rational choice. The video card is furthermore the card chosen the fewest times with 20.91% of the total choices which is slightly less than the text card with 21.82% of the total choices. The text representation has facilitated a rational behavior in 54.17% of the choices made based on the text information.

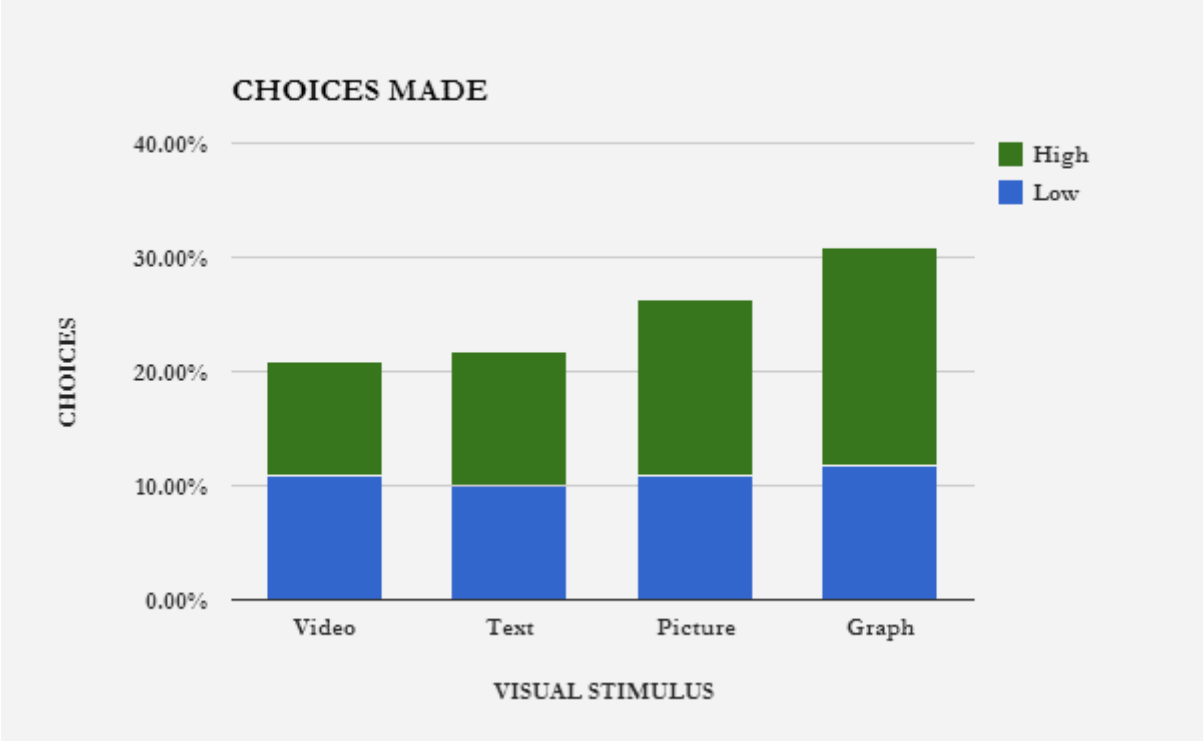

Figure 21: Choice made in total

The irrational choices are equally divided between the four representations indicating that there is no notable difference in preference towards any of them when having a low value from an overall perspective. The level of influence seems to be very identical in all four representations. The small difference between the representations is ranging from 10.00% for the text to 11.82% for the graph, when having low value. The overall pattern of the choices made indicate that there is a tendency of choosing the rational behavior. The rational choices in the experiment accounts for 56.36% of the total choices made. While from an overall perspective it appears the four representations have the same level of irrational behavior, it is not the case when looking at the individual representations. Here the ratio of rational and irrational behavior indicates the video

representation as the representation facilitating the least rational choices, followed by the text, picture and lastly the graph respectively.

4.4.2. Decision Behavior

The choices of the subjects identify whether the subjects are able to identify the rational choice "hidden" in the information of the four various representations. Also defined as the resource-cost of information retrieval. In order to do so the average behavior of the subjects are identified and illustrated in *Figure 22: Choices* below with the black line connecting the circles (the only line in the figure). The pattern is split in several of the different tasks, indicating that the tasks have been difficult, which also have been expressed by several of the subjects after completing the experiment. In addition, the split in choices can be interpreted as the presence of irrational behavior in the decision making, but only in tasks where the split is between a rational and irrational choice.

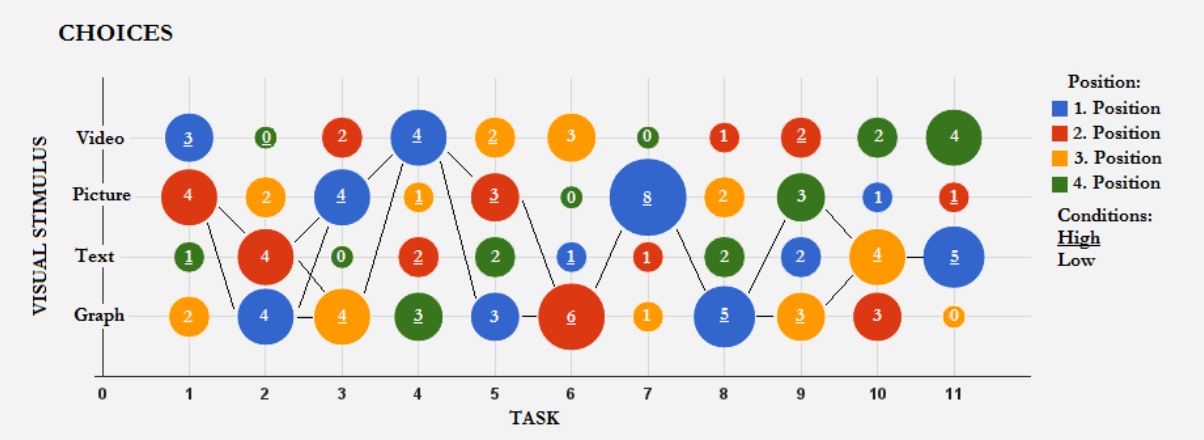

Figure 22: Choices

The pattern of choices illustrated above identifies a learning effect, indicating that subjects are making more rational choices through the tasks of the experiment. An example of this observed behavior is in the first two tasks where the subject behavior were rational in only 4 out of the 20 choices conducted, which also means that the remaining 16 companies chosen to buy was based on information with low value and therefore irrational decisions. Beyond the two first tasks was the level of choices made tend to be rather irrational, there is an increase in the level of rational choices in the remaining 9 tasks. The percentage of choices made being rational in the remaining 9 tasks is averagely above 50%, which indicate the increased rational behavior. In order to compare the individual representations and the value they hold it was necessary to analyze them within the same properties. As when the four different tasks, all with one representation with high valued information and only one representation is the rational choice. Here is the video representation the only representation, which is not selected, as a choice despite it is the only rational option. This indicate that information represented as a video is not applied as foundation for the decision making. The three other representations are all chosen the most times in their respective tasks. The picture representation is having most selections with 8, the graph with 5 and the text with 4 of the choices. This observation enhances the interpretation of the video representation as not being appropriate as representation when making decisions.

Moreover, the position of the representations shows a correlation with the choices made. From the above observation, it is important to be aware of the influence of the position. While the picture, text and graph were chosen most times in their task, picture and graph were positioned at the 1. position, the text positioned at the 3. position and the video at the 4. position. The effect induced by the position should not be underestimated, from the observations and the figure above it is clear that the position of the information create a greater effect on the behavior than the visual stimuli itself.

4.4.3. The Observed Foraging Behavior

In the two previous parts of the analysis it was discovered that the subjects have a characteristic information foraging behavior regarding first fixation and first click. These findings will be put into context of the decision making behavior. The answer to the first sub-question found that the representation, information value and position are variables, which are influencing the first fixation.

Tendencies were found indicating that the position affects the first fixations considerably. The upper left corner attracts most visual fixations and it is the only position with a considerable effect on the first fixations. It is reasonable to think this position effect is caused by for example the writing habits from the subjects. The information value is also influencing the information foraging behavior regarding the first fixation. Here it was found that with high valued information the video representation is most visually attractive while the graph representation was most attractive when the information value was low. Overall, the graph received most visual attention, despite not being the most valuable information. The graph is the representation, which tend to create the greatest visual attention of the four representations. These results indicate an information foraging behavior where the returned value is compared with the cost of retrieval. Further, the behavior indicates cost sensitivity towards retrieval and the representations influence returned value.

Text and graph representations are getting the highest percentage of first clicks whereas the picture and video representations are getting the lowest. This is consistent with the information foraging behavior observed regarding first fixation. The preferences found in the selection process are also consistent with the preferences found in the visual information foraging behavior. Furthermore, there is found a strong preference in the selection process. The distribution of first clicks between the four representations with high and low value give the following results. The representation with the highest percentage of first clicks when the information value was low is the graph with 51.61%. The text representation got 50.00% of its first clicks when the information value is low, the Video received 36.84% of its first click when it is low, and lastly the picture got 34.62% of its first clicks when it was low. When evaluating these results it was concluded that text and graph representations are selected to a large extent despite of low information value. These representations also create the highest level of irrational behavior in the selection of information, especially the graph with 51.61% of first clicks. In the selection behavior we furthermore found that position is affecting the first click variable.

The observed behaviors regarding first fixation and first clicks are combined in the figure below in order to create an overview of the similarities and differences in behavior. The rational behavior, which we compare with the observed foraging behavior, is illustrated with the letters H for high

and L for low information value. The different positions are given various colors described in the right side of the figure. The reasoning in this part of the analysis is that, if subjects select and utilize information that minimizes uncertainty they have a rational foraging behavior. The foraging behavior used in the figure below is the average behavior of the ten subjects. Individual deviations from the average behavior will be commented when they get relevant to present.

The figure shows a strong correlation between the first fixation and the first click, which is illustrated by respectively the green and blue line. It is identified that the subjects tend to click on the information they first fixate on. Furthermore, the correlation between the position, first fixation and first click is clear. This underline the strong influence the position has on the first fixation and first click. Namely the correlation between the choice, first fixation and first click is interesting for the investigation of rational and irrational behavior. It will be possible to see if there is inconsistency between the choice, first fixation and first click. This could be an indication of which representations that are affecting the trader's decision making. The average behavior of choices is deviating from the first click and first fixation. This is a clear indication of inconsistency between the first information subjects find visually interesting and then click on, and the information subjects base their decisions on. The subject's average choices are illustrated with the red line.

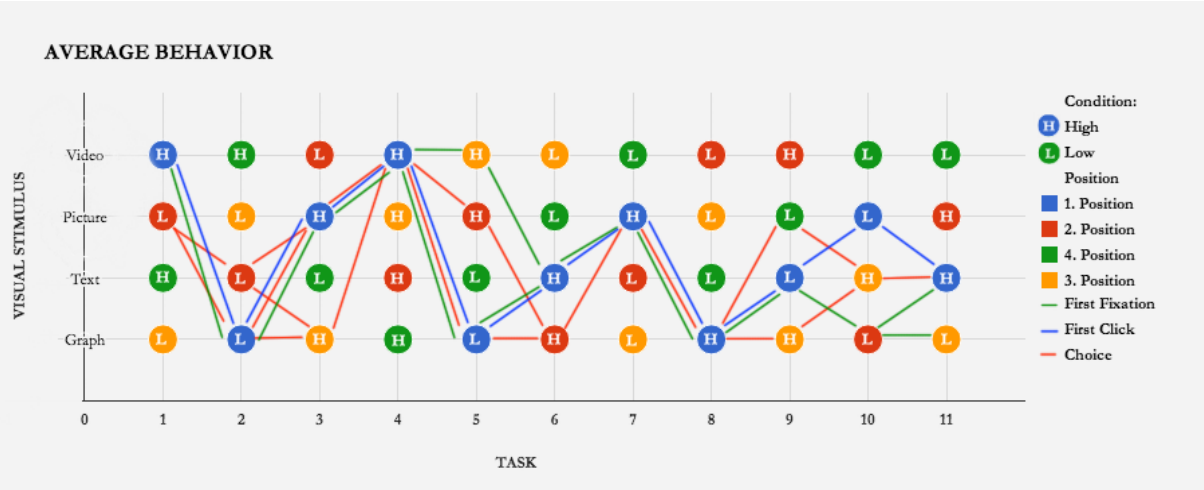

Figure 23: Average behavior

Overall there is a clear difference between which representations the subjects first fixate on, how many first clicks it get and whether it is the final choice. This is indeed an effect of the position, which the subjects experience, in their first fixation and first click. This finding is important in the characterization of the variables affecting the behavior. Moreover, subjects tend to chose more rational in the decision making process, compared to the behavior observed regarding first click and first fixation.

4.4.4. Correlation between Clicks and Choices

The following table identifies the order of the clicks divided between the information cards, and a pattern made by each of the 10 subjects in all the 11 tasks. *Table 2: Correlation between clicks and choices* helps to identify whether there is a general pattern of selection behavior regarding the order which the different information's are clicked on and the choices made. The table identifies

the order of which the information is foraged which also makes it possible to evaluate if for example the first or second click are critical for the final choice. The ten subjects are marked with a hash tag and the order is placed horizontally above the ten subjects selections.

In the 1. task there is a tendency which indicates that the subjects are influenced by the second information foraged when making their decision, even though ⅔ of these choices are irrational. On average the information, which was first clicked on, was used for 40.00% of the choices and of these are 65.91% rational choices. Entire 97.27% of the subjects continue to search for information, likely to evaluate if more valuable information is present in order to compose the best information diet possible. From a rational perspective this is unnecessary because the information value do not vary. The second information foraged tends to create the base of 33.64% of the choices made and with 52.78% of these choices being rational. Decisions based on the third entered information card is used in 14.29% of the subjects choices were 53.85% of these are rational. The pattern indicates that the subjects act more rational the less information they have to analyses.

There are 20.91% of the subjects who search for information beyond the 4. information card which also mean that at least 20.91% of the subjects enter an information card more than once. In this experiment 79.09% of the subjects find the information needed for their decision within the first four information's and therefore do not search for more information beyond the fourth entered information card. This behavior indicate that majority of the subjects are able to understand the information presented and found the information useful in their decision making process. There tend to be a decrease in rational choices after the first click from 65.91% to 52.78% in second click. As identified in the tables below only 35.45% of the choices made are based on the last information foraged. This behavior can be interpreted as an indication of subjects identifying the last card as more valuable than further information foraging. Of these choices are 48.72% rational choices based on the conditions. The rest will consequently be representing the irrational choice. This indicate that the remaining 51.28% of the subjects have identified that the resource cost will be greater than the value returned in form of additionally risk elimination by further information foraging.
The additional value further information foraging would bring do not compensate the resource cost incurred. This identifies that 64.55% of the subjects are not able to identify an information value, which exceeds the resource cost of the next foraged information.

Task 1	1	2	3	4	5	6	7	C
#1	G	P	V'	T'				G
#2	V'	P	T'	G	P	T		P
#3	V'	P	T'					P
#4	V'	P	T'					G
#5	P	G	T'					V
#6	V'	P	T'	G	G			V'
#7	P	T'	G	V'	T'			T'
#8	P	V'	T'	G	G			V'
#9	V'	P	G	T'				P
#10	V'	P	T'	G				P

Task 2	1	2	3	4	5	6	7	C
#1	T	P						T
#2	G	T	V'	P	P			P
#3	G	T	V'					T
#4	G	T	V'	V	P			G
#5	G	T	V'	P				G
#6	G	T	V'	P	T			T
#7	G	T	P	V'	T			T
#8	T	G	V'	V'	P			P
#9	P	V'	G					G
#10	G	T	P					G

Task 3	1	2	3	4	5	6	7	C
#1	P'	G'						P'
#2	P'	V	T	G'	P'			P'
#3	P'	G'						G'
#4	P'	V	T					V
#5	P'							P'
#6	T	P'	G'	V				G'
#7	G'	T	P'	P'	V	G'		G'
#8	T	G'	V	P'				G'
#9	V	T	G'	P'	G'			V
#10	P'	T	G'	V				P'

Task 4	1	2	3	4	5	6	7	C
#1	V'	T'	G'					G'
#2	P'	G'	V'	T'				V'
#3	G'	T'	V'					T'
#4	V'	T'	G'	P'				V'
#5	V'	T'	G'	P'				P'
#6	V'	T'	G'	P'	T'			T'
#7	T'	P'	G'	G'	V'			V'
#8	T'	G'	V'	P'				G'
#9	T'	P'	V'	G'				G'
#10	V'	T'	G'	P'				V'

Task 5	1	2	3	4	5	6	7	C
#1	T	P'						P'
#2	T	P'	G	V'				T
#3	T	P'						T
#4	G	P'	T	V'				V'
#5	G	P'	T	V'				V'
#6	G	T	P	V'				P'
#7	P'	G	T	V'				G
#8	T	P'	G	V'	G			G
#9	G	T						G
#10	G	P'	T	V'				P'

Task 6	1	2	3	4	5	6	7	C
#1	T'	V						G'
#2	G'	V						V
#3	V	G'						G'
#4	T'	G'	P	V				T'
#5	T'	G'	P	V				G'
#6	T'	G'	P	V				V
#7	G'	T'	V	P	G'			G'
#8	T'	G'	P	V				V
#9	G'	P	T'					G'
#10	T'	G'	P	V				G'

Task 7	1	2	3	4	5	6	7	C
#1	P'	V						P'
#2	P'	T	G	V				P'
#3	P'							P'
#4	P'	T	G	V				T
#5	P'	T	G	V				P'
#6	P'	T	G	V				P'
#7	P'	V	G	T				P'
#8	T	V	G	T				G
#9	P'	T	V	G				P'
#10	P'	T	G	V				P'

Task 8	1	2	3	4	5	6	7	C
#1	G'	T	P	V				T
#2	G'	T	V	P	V	T	T	V
#3	G'							G'
#4	G'	V	T	P				P
#5	G'	T	V	P				G'
#6	G'	T	P	V				G'
#7	P	G'	P	V	G			G'
#8	G'	V	T	P				G'
#9	T	G'	V	P	T			T
#10	G'	V	T	P				P

Task 9	1	2	3	4	5	6	7	C
#1	T	P	G					T
#2	G'	P	T	V				P
#3	T	G'						G'
#4	T	V'	P	G'				V'
#5	T	P	G'	V'	G'			G'
#6	T	P	G'	V'				G'
#7	V'	P	T					T
#8	T	V'	P	G'				P
#9	G'	P						P
#10	T	V'	P	G'				V'

Task 10	1	2	3	4	5	6	7	C
#1	T'	V	G					T'
#2	V	T'	P	G				T'
#3	V	G						G
#4	P	G	V	T'	G			G
#5	P	G	V	T'				P
#6	P	G	T'	V				V
#7	T'	P	G	V	T'			T'
#8	G	P	V	T'				G
#9	G	T'						T'
#10	P	G	V	V				V

Task 11	1	2	3	4	5	6	7	C
#1	V	P'	G	T'				V
#2	V	T'						V
#3	T'	V						T'
#4	T'	P'	V	G				T'
#5	T'	V	P'	G				T'
#6	V	P'	G	T'				V
#7	T'	V	G	P'				T'
#8	T'	P'	G	V				V
#9	G	T'	V	P'				T'
#10	T'	P'	V	G	G			P'

Table 2: Correlation between clicks and choices

4.4.5. Summary

This summary of the third sub-analysis will answer the third sub-question: ***Do position and representation affect a financial trader's ability to forage for the most valuable information and ultimately affect their decision making?*** The analysis found that the representation graph had the highest level of correct choices with precisely 61.76% of the choices being rational. The graph representation is chosen the most times in 6 of the 11 tasks which once more confirms the tendency that the information representation graph in majority of the times create the base for the subjects choice. From the percentage of rational choices based on the representation it is possible to see a tendency of what representation that lead to most right or wrong decisions.

The graph representation is the representation, which facilitates most rational choices with 61.76% of the choices being rational. Followed by the picture representation with 58.62% rational choices, the text representation with 54.17% rational choices and lastly the video representation with 47.83% rational choices. Despite the percentages are rather close, the tendency point towards that graphs are the most appropriate representation and videos are the least appropriate representation. Moreover, the average behavior of first fixation and first clicks identifies a clear correlation between the two, which indicate that the first fixation very much affect the first click. Despite this strong correlation between first fixation and first click it does not seem to correlate with the choices to the same degree as well. The pattern of the choices tends to be a little more rational than the first fixation and the first click. The gap between these two, first fixation and first click on the one side and choices on the other indicate a visual attraction which lead to a similar selection behavior but without affecting the choices. Position of the information had similar effect on the choices like it had on the first fixation and first click.

The position in upper left corner is most influential of all positions in both first fixation, first click and choices. Furthermore, it was identified that the order of the foraging behavior affected to what degree the behavior are rational. It was identified that the first foraged information had 40% of the choices. This tendency indicates that the subjects prefer to base their choice on the first information they forage. It was also identified that the choices made on the first foraged information generated the highest level of rational behavior with 65.91% of the choices being rational. This indicates that the subject's ability to make rational choices follows their ability to identify the most valuable information. The quicker subjects are able to identify the rational information the higher percentage of the choices are going to be rational.

4.5. Overall Results

The results from the three sub-analyzes are collected in *Table 4.3: Results* in order to gain overview of the overall results. They will be described in short formulations because they have already been explained in detail in their respective summaries. The results are divided according to the three research questions.

RESEARCH QUESTION	RESULTS
1. ***What are the visual preferences for information in a decision making environment?***	1. The order of representations, which attracted most attention: graphs, videos, pictures, and texts. 2. Video representations received the highest level of first fixations when the information value was high. 3. Graph representations received the highest level of first fixations when the information value was low. 4. There is an increased visual preference for graph representations, whereas video representations received decreasingly lower levels of first fixations. Picture and text representation's level of first fixations were constant. 5. Position has a great effect on the visual attention.
2. ***How do the variables, representation, value, and position influence the selection of information?***	1. The variable representation has influence on first click. 2. Text and graph representation received the highest percentage of first clicks (High and low valued information included) 3. Text and graph representations received higher levels of first clicks when the information value was low due to easier retrieval of information. 4. The level of first clicks was evenly distributed when the information value was high. 5. The variable information value has influence on first click. 6. Position has great influence on first click.
3. ***Do position and representation affect a financial trader's ability to***	1. The graph representation facilitates the highest level of rational choices with 61.76%. (Picture: 58.62%, text: 54.17%, and video: 47.83%).

forage for the most valuable information and ultimately affect their decision making?	2. There is a correlation between first fixation and first click. 3. The correlation between first fixation and first click do not affect the choices. 4. Position is most influential, when representations are placed in upper left corner regarding first fixation, first click, and choice. 5. The order, which the information is foraged influence the subjects ability to forage the most valuable information. 6. The choices made based on the first foraged information generate the highest level of rational choices with 65.91% of the choices being rational.

Table 3: Results

5. Discussion

In this chapter the challenges found in the different phases of the thesis will be discussed. The chapter will follow the development of the analysis with the three phases: *Phase 1: Exploratory research*, *Phase 2: Data collection from the experiment* and *Phase 3: Data analysis.* The figure below provides an overview of the structure and furthermore provides an insight into where the different challenges occurred.

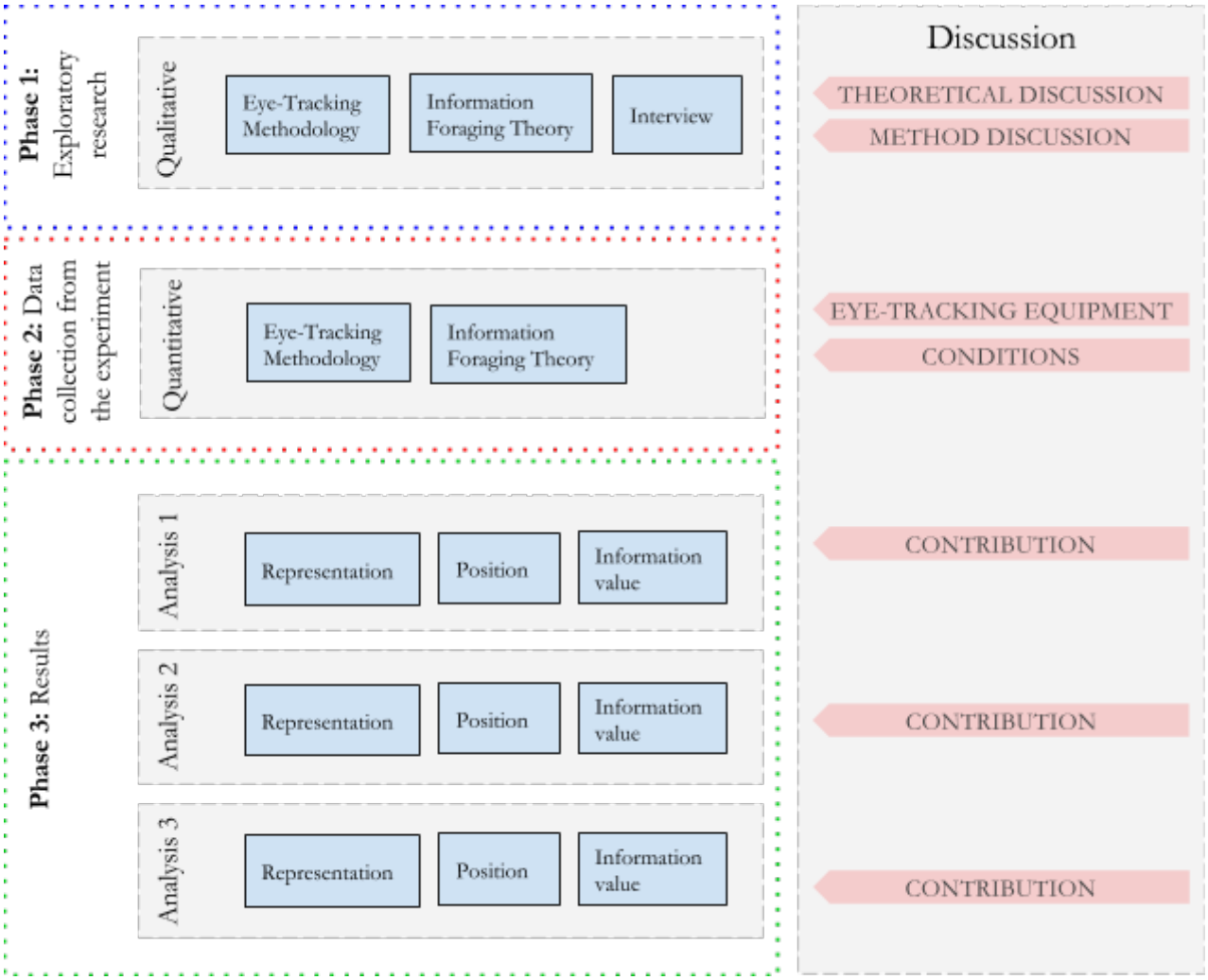

Figure 24: Discussion overview

5.1. Phase 1 - Exploratory Research

5.1.1. Theoretical Discussion

The use of Information Foraging Theory has been proven very beneficial for this study regarding analysis and understanding of the information foraging behavior recorded by the eye-tracking experiment. However it is important to identify pitfalls and the gaps in the theory when using information foraging in a decision-making context.

Making decisions often involves a time constraint, which has not been addressed in this thesis and can be defines as quick decision making. Quick decision making were not implemented into the

experiment in order to get a more real scenario where the subjects define their own time. Quick decision making means that the subjects would be forced to make decisions fast. An example of the relevance of quick decision making is the hummingbird which needs to forage food in order to be able to have enough energy to fly. The use of quick decision making could result in a different behavior of the subjects.

The effect of the decisions will never measure the real world, but this study has been very careful to construct an interface, a context, and a realistic decision making scenario, which should be taken serious as a experiment. A study constructed such a way that the subjects are in their own environment and making real decisions could lead to a different result, but will bring so many variables into play that it cannot be justified from an academic point of view.

Another implication of not using time limits is the imbalance in the subjects time consumption, some might use more time than others. This could be a variable influencing the results, but on the other hand this study uses variables, which is often defined by the subjects first actions. Such as first fixation, first click, and their choice which they only make one of. Therefore, it should not be a concern.

5.1.2. Method Discussion

The study of eye tracking allows the researchers to understand how a user's behavior is in a certain context. The eye tracking technology gives an insight, but it does not by itself tell what the user is thinking [Holmqvist, 2011, p. 71]. The method *Think out loud* could be used as a supplement to the eye-tracking to get more qualitative data about the cognitive process of the subject in the decision making situation. Making the data more qualitative enables the researcher to gain a deeper insight into why the subjects made the decision he did.

Time constraint

The experiment does not use any time constraint. By not using a time constraint the subjects are able to use as much time as they asses needed, this resulted in some subjects used more than one hour which could affect the subjects behavior due to becoming tried and thereby making irrational decisions. The use of a time constraint would force the subjects to make a decision quicker, which could result in them making poor decision, which they normally would not make, due to the stress of completing the task. Therefore, we find it worth mention in the method section as well because it can be debated whether it would have effect on the result if a time constraint were added to the method.

Subjects

The experiment uses non-naive subject. It could however be interesting to identify whether there is a difference in the behavior between non-naive and naive subjects. This could provide knowledge whether there should be a difference in the representation of information for new and experienced clients. Some subjects may have great personal experience with graphs and are used to work with them. We cannot change that and have stayed with the segment chosen.

Post experiment questionnaire
The experiment use a post experiment questionnaire which uses closed questions to identify any potential preconceived knowledge, which could affect the subject's behavior. Due to the fact that the questionnaire were placed at the end of the experiment meant that some of the subjects might be tired from completing the eye-tracking experiment and may therefore have rushed through the questionnaire to finish the total experiment quickly. This could affect the validity of the questionnaire. Closed questions do furthermore not enable the subjects to provide subject opinions or add new information about the process or their personal experience. A post experiment interview could provide a more detailed insight on how the subjects behaved in and understood the experiment.

Interview
The interviews conducted with Jeffrey Todd Lins were mostly conducted as open interview in order to cover a wide span of information's. Having the interviews on recordings enables us to ensure that the interviewee is cited correctly and that the information is understood in the right context. After each meeting, it became standard procedure to send the work done based on the meeting. Here would concepts and detail be checked by Jeffrey Lins in order to ensure that the experiment was aligned with the expectations of Saxo Bank.

5.2. Phase 2 - Data Collection from the Experiment

5.2.1. Further Research

This section will describe some of the key aspects of the research, which could be use for further research. It is recommended for further research to increase the size of the study to confirm the result in a larger scale analysis. Analyzing a larger segment should increase the validity of the results and thereby enable the researcher to provide a more generalizable result.

5.2.1.1. Eye-Tracking Equipment

The eye-tracking equipment includes an *Electro Dermal Activity* device called an EDA device this measures the electro dermal activity, which provides data on the skins ability to conduct electricity and measures the temperature of the skin. The EDA is not used for this study, due to the large amount of qualitative data provided from the visual elements trance by the SMI red device. The EDA data is furthermore not of interest for this study but it could be an interesting factor to measure for further research.
In this master thesis, it is chosen not to focus the cognitive element of an eye-tracking study and therefore is the Emotivy EPOC neuroheadset not used. This headset measures the subject thoughts, feelings, and expressions by tuning into the brains produced electronic signals. The potential use of the headset in further research could provide a more detailed insight into the cognitive process of the subject's decision making process. It will provide information on how the representations affect the subject's feelings. It could identify whether a specific representation create more confidence for the subject than other representations.

5.2.1.2. Conditions

This thesis has only focused on the High and Low ratings of probabilities to minimize the differentiation of the variables. In the experiment is the difference between high and low conditions predefined to be low of 60 and high of 65 percent. Further research could analyze the

difference in nuances and if the percentage of the probabilities has an effect on the subject's behavior. A research could focus on identify how the gap between the High and Low probability could affect the behavior of the subjects. Furthermore could a research of what percentage do the probability add more value than the presented information. An analysis of whether the percentages between high and low conditions have an influence on the subject's ability to act rational.

The use of false conditions could also be implemented into the experiment. False conditions could work to ensure that it is not a treasure hunt or a quiz on which information is best.

5.3. Phase 3 - Results

This section will provide insight into how the results of the analysis contribute to the research field and Saxo Bank.

5.3.1. Analysis: Visual Preferences

The first fixation identifies which of the representations have the greatest information scent and has the strongest attraction. The analysis of the visual preferences includes the variables representation, position and information value. As identified in the analysis the information value and the position had great influence on the level of fixation on a card. The visual preferences of the representations were identified to have the following order: *Graph, Video, Picture*, and *Text*.

The visual preferences found in this study are based on tendencies illustrating the Information Foraging principle of scent. What there is measured are the trends in their visual attention or their visual preferences as this study defines them. It has previously been mentioned that habits might play a role in the preferences, but it is debatable to what extent the effect of habits have on the visual attraction. When measuring the subject's level of attraction to the representations, the data is based on fixations, which is a split of a second. Therefore could the data from the first fixation be relatively valid as a performance indicator of the different representations scent. Which strengthen the argument of graphs being the most visually attractive representation, and not just due to habits.

5.3.2. Analysis: Selection of Information and how it is Influenced

The analysis found the following order of the first clicks, from highest too lowest of total percentage used was the following: *Text, Graph, Picture*, and *Video*. The analysis found that the subjects clicked on information which were relatively quick to retrieve and easy to create an overview of. The analysis furthermore found that the subject tended to act rational in 56.73% of the cases where they click on information of high value. The position of the information had once again great influence of the variables. There was also found sensitivity towards the information value. When the value was low than graph and text were preferred and when it was high the preference tended to be more equally divided between all four representations.

Where the visual preference can be argued to be the unconsciously and the instinctive visual preferences, the selection behavior can be seen as the conscious choice. Which also make room for the influence of habits. Here it could be interesting to study the role of habits and investigate the differences between non-naive and naive subjects. In order to establish the influence of the subjects habits and how they affect the information foraging behavior further study needs to be conducted. The results of the analysis furthermore identified that there is a correlation between the instinctive visual behavior and the conscious choice of the first click of the subjects. Here it could be interesting to elaborate the study for better understanding of the representations look and how changes in their appearance might change the preferences of the subjects. The look of the

representations used in this study are following the Saxo Bank design guidelines, but might differ from what the subjects are normally using when trading. With this in mind, the results found can be seen as dependent on the appearance of the representations and it is therefore debatable how generalizable the result really is. Despite this argument, we still argue that the results are generalizable to the Saxo Bank context, from where they are developed and where they will be implemented.

5.3.3. Analysis: Potential Effect on Information Foraging Behavior

It was found that the graph representation had the highest level of correct choices followed by the picture, the text, and then the video. It was furthermore identified that the 1. position induced most influential of all positions to the three measurements first fixation, first click, and choices. The result of the analysis identified that the use of graph and text representations was increasing, due to the relative easy process of foraging specific information from these two representations.

The results illustrated some tendencies regarding the subject's use of information and their final choices. Despite the data seems to indicate a correlation between the representation used and the level of rational choices made, the sample size can be debated and if it might just be the data, which falls out in a random way instead of actual behavior. When measuring the performance of the four representations, one will always be the highest and one will be the lowest, unless the scores are all equal which is not the case here. Because the scores are not equal, it is interpreted as a trend in the data. The trends found in the data have been described in detail, but here it would have been an advantage to have an absolute indicator of the trends. Instead much effort has been put into analyzing the correlations between the variables in order to substantiate the trends found.

6. Recommendations

This section provides the recommendations on how to use the results of the analysis. The order, which the recommendations are presented, will follow the order of the results chapter.

6.1. What should Saxo Bank do?

The question asked in the headline *"What should Saxo Bank do?"* will be answered by the recommendations in the three following sections. From an overall perspective, the recommendations are divided into the following three themes: 6.2 First part: Care about the visual structure, 6.3. Second part: Control what subjects choose!, and *6.4. Third part: What triggers the customers to make decisions?* These themes will be presented in the following sections and will form the overall recommendation for what Saxo Bank should do. As the reader will experience the improvements suggested are several important recommendations, all with the purpose to tell what the next type of actions should be in order to improve their business as an investment bank.

6.2. First Part: Care about the Visual Structure!

From the first part of the results concerning the visual preferences, the recommendations will take their beginning here. The first finding is that position plays an important role in the subject's first fixation. This study recommend Saxo Bank to prioritize the position of the information, in ways where the most important information will be positioned in the upper left corner of the interface. In this relation the study also found that the information the subject first fixate on also is the information they first click on. This correlation underline the importance of position the information at the right places the interface.

The second recommendation from the first part of the results is dealing with the subject's preferences for the representations of information. The study showed that while the graph received an increased number of first fixations, the opposite was the case with the video representations. The recommendation will concern strategic use of the representations, in order to ensure that subjects are not abandoning the site due to representations not suitable for the intended purpose. When presenting information as a video representation, the content should be complemented with the graph representation. This will strengthen the subject's ability to act and make decisions based on tangible information, which was preferred by the subjects participating in this study.

6.3. Second Part: Control what Subjects Choose!

The second part of the results is concerning the selection of information, which also outlines some concrete recommendations regarding the results. The first element, which Saxo Bank can use in their development of their interfaces, is the correlation between first fixation and first click. The practical implication of this correlation is the ability to control what the subjects click on in their search for information. When Saxo Bank wants their customers to pay attention to important information on their platform Tradingfloor.com, they will know that if the information is positioned in the upper left corner it will most likely be clicked on.

Secondly, the representations text and graph received the highest percentage of first clicks, from an aggregated perspective. The preference for these two representations needs to be taken into

consideration when Saxo Bank is selecting what representation to use for their information. The preference may very well be correlated with the subject's habits, but nonetheless it is important to be aware of the subject's preferences. It can be used to present information that Saxo Bank recommends their customers to act on. If Saxo Bank are using graphs and texts as representations there is a tendency towards subjects will be more likely to click on the information, especially compared to pictures and videos. Ultimately, it may influence the customer's ability and readiness to make a financial decision. Making their customers well prepared by using the preferred representations should be of high priority for Saxo Bank in order to ensuring as many customers as possible will make information financial decisions.

6.4. Third Part: What Triggers the Customers to Make Decisions?

The third and last part of the recommendations is based on the last sub-question and its results. These are concerning the factors that are affecting the decision making. The factors are position of the information and what kind of representation that has been used.

The first recommendation will be based on the tendency of graphs facilitating the highest level of rational choices. Closely followed by the picture and the text representations. This tendency gives the overall indication of a preference for tangible content, information that is static in front of you. Information the customers can react on and make their decisions on. On the basis of this tendency, it is recommended to Saxo Bank to utilize these mentioned representations in proportions justifying the preferences illustrated in this study. If the customers are favoring these representations then it should be taken into consideration when deciding what representation that should be used to present the information of tomorrow.

The second recommendation relates the order of which the information is foraged and support the argument of selecting the right representation is of great importance for the decision making. The study recommend that representations shall be aligned with the preferences of the customers due to the fact that there is a tendency of the first foraged information having the highest level of rational choices. In other words, customers are negatively influenced in their decision making when they feel a necessity to search further information for their decision making. Therefore it is important to present information in the representation suitable with the customer's preferences. Leading to a minimization of further search for information, when the customers are satisfied and their decision making will be in a better position for their future decision making. For Saxo Bank, such a recommendation will mean that their customers make better decisions and logically make more money, which is in line with Saxo Bank's objective due to its commission's structure. When the customers make money then Saxo Bank also make money.

An alternative recommendation is regarding their communication where Saxo Bank could attract the clients with the most visual simulation representation of information. The video representation were found to have the largest visual stimuli, therefore it can be recommended that the video representation can be used to attract the client attention. The video information should after being entered is complemented with additional information represented as graph and text. The supplement of the graph and the text information to the video will help the clients make better decisions as argued above in the previous section.

7. Conclusion

This thesis has examined the relation between the information that financial traders are visually stimulated by and what information they select prior to decision making. The relationship was examined in order to establish ***which representation of information is most suitable for traders foraging information?*** In order to answer this question, three sub-questions were created and answered. The sub-questions created the scope of the study.

The first sub-question was formulated like this: ***What are the visual preferences for information in a decision making context?***

We found that the subjects had a relatively strong visual preference for graphs and videos compared to pictures and texts. These visual preferences were observed to be sensitive towards the information's representation form. The information representations were visually preferred in the respective order: graphs, videos, pictures, and texts.

The development in first fixations throughout the experiment for the four representations indicate that video representation is declining in level of first fixations and the graph and text representations increased in first fixations. The development of first fixations for picture representation was steady through the experiment. These findings in the development of first fixations for videos, text, and graphs indicate a visual preference for graphs and texts rather than videos.

The subject's visual preference for graphs and text was influenced very little by the value of the information. Subjects have a stronger preference for the representation compared to the information value. The position had a strong influence on the first fixation. Overall, the representation placed at 1. position received most first fixation indicating the position as an influential variable.

The subject's initial visual preferences favor the video and graph, but through the experiment the preferences change in favor of the graph and text representations. In addition, the position has a strong influence on the visual preferences especially the 1. position in the upper left corner. The value of the information in the representations has little effect on the level of first fixations. Many subjects' first fixations are on the graph representation even though it is of low value.

The second sub-question stated was the following: ***How do the variables, representation, information value and position influences the selection of information?***

The different variables influence the selection of information differently. The four different representations, text, graph, video, and picture influence the subjects differently. The analysis identified that the text representation has the highest percentage of first clicks followed by the graph, picture and lastly the video representation. The analysis found that subjects tend to forage information from representations like text and graph, representations that are fast to retrieve information from and fast to provide an overview of the information and evaluate the value it contain.

The second tendency found reveals that subjects are willing to compromise on the information value when being compensated by faster overview and stronger scent from the information like graphs and texts. This meant that subjects had a preference for graphs and texts despite the representations would not contain the most valuable information in the given decision making. This sensitivity in selection of information is one of many great findings of this thesis. The subject's

first click was on high valued information 56.73% of the total clicks, a tendency indicating a slightly overweight of rational behavior regarding selection of information.
The position of the information seems to have the greatest influence on the subjects. The pattern of the average behavior through the experiment follows the 1. position relatively unaffected by the visual stimuli. This identify that the 1. position has the greatest influence. The other positions has limited effect on the information foraging behavior. Moreover, it is a characteristic behavior where first fixation and first click are closely aligned and means that subjects tend to click on the information that they first fixate on. In this experiment the behavior of the subjects have been affected by the position to a great extent. The representations text and graph are favored relatively more than the video and picture, especially when the information value is low. This difference in foraging behavior depending on the information value lead to the identification of subjects being sensitive towards changes in returned value from the information retrieval and the level of cost incurred by foraging from the relevant representation form.

The third and last sub-question stated in order to answer the overall question is: ***Do position and representation affect a financial trader's ability to forage for the most valuable information and ultimately affect their decision making?***
Overall, all the four representation formats create irrational behavior to some degree. It was found that the representation graph had the highest level of correct choices with 61.76% of the total number of choices made with the use of graph representation. The picture representation follows with 58.62% rational choices, the text representation with 54.17% rational choices and lastly the video representation with 47.83% rational choices. These percentages indicate that the use of video representations are leading to most irrational behavior and therefore negatively influence the trader's ability to forage for the rational and valuable information. Despite the percentages are relatively close, the graph representation is the best alternative as representation when selecting a format that limit irrational decision making and strengthen the traders ability to forage for the most valuable information. Besides the representation, another important factor influencing the choice is the position of the information. The 1. position has most influence of all positions to the three measurements first fixation, first click, and choices.
This study also found a correlation between the first fixation and first click. These two variables are aligned with each other, indicating that what the subjects first fixate on is also what they click on first. Despite the strong correlation between first fixation and first click, it does not seem to correlate with the choices to the same degree. The pattern of the choices tends to be slightly more rational compared to the first fixation and the first click.
The visual stimuli tend to create a preference which leads to a similar selection preference, but without affecting the choices made. Furthermore, the analysis identified that the order of which the information was foraged influenced to what degree the subjects behavior of choice were rational. Information being foraged first lead to 40.00% of the total choices made which is the highest level observed. There has been made most choices after first click compared to second and third click. This tendency indicates that the subjects prefer to base their choice on the first information they forage. It was furthermore identified that the choice made based on the first foraged information had the highest percentage of rational behavior with 65.91% for the choices being rational. This indicates that the subject's ability to make rational choices follows their ability to identify the most valuable information. The quicker the subjects are able to identify the rational information the higher percentage of the choices are rational.

Overall, there is a tendency of both position and representations are affecting subject's ability to forage for the most valuable information. Graph representations tend to be the most suitable representation because it has the highest level of rational choices.

In overall conclusion, this study found an answer to the overall question: ***Which representation of information is most suitable for traders foraging information?***
Evidence indicates that subjects in decision making situations have a strong visual preference for graphs and text representations. While the video representation also creates a high level of visual attention, the level decreased though the experiment. In contrast, the graph and text representations had an increased level of first fixations though the experiment. The visual attraction had a strong correlation with the first click. Here it was also the graph and text representations scoring the two highest levels of first click. This was one of the findings from this study that subjects click on the representations they first fixate on.

The graph was also the representation, which the subject used to base their decision on. Moreover, the graph representation had the highest level of correct choices with 61.76% of the choices made by using the graph representation being rational. The graph is the representation, which tend to induce the most rational decision behavior out of the four representations. The graph representation is closely followed by the picture representation with 58.62% rational choices, the text representation with 54.17% rational choices and the video representation with 47.83% rational choices. This shows that the graph representation is the representation, which is most suitable for the subject's information foraging before making a decision.

Furthermore, this study found evidence of several variables influencing the subject's information foraging behavior. There was a strong influence by the position of the representation of the information, especially the upper left corner also named 1. position. The choices are generally slightly more rational compared to first fixation and first click.
Another tendency found is the effect of the order of which the subjects forage the information and make their decision. Finally, this study discovered that subjects are sensitive towards the information value. This sensitivity affect the first clicks where graphs and texts are receiving considerable more first clicks compared to picture and video. This indicates that subjects are calculating the returned value in relation to the cost of retrieval, which is, once more, in favor of the text and graph representations.

8. Reflections

This section will present the thoughts we have had during the thesis and they will reflect what has been learned. The project has been more than a thesis symbolizing the end to our education. Therefore, the chapter is divided in three sub sections where the first will be about the experiment, because it has been a large and focal element in this study. The second section is dealing with the process and will focus on the phases and challenges in a project like this. The last section is conclusion on what we have learned from the project and how it positively contributes to our future working life.

8.1 The Experiment

The development process of the experiment demanded a great amount of research prior to the actual development. This process resulted in a heavy load of theoretical reading, to ensure that the correct steps were taken and in the correct order. This time consuming process affected the deadline of the project. Especially due to the new theoretical and methodological research area, which was new. Even though the process of developing new knowledge is very interesting and exciting, the use of either a known theoretical or methodological framework could have eased the process of understanding and combining them. In the end we are satisfied about how the two, Information Foraging Theory and Eye-Tracking methodology, complement each other.

Another element that was essential for the experiment was domain knowledge. Domain knowledge about trading, the interfaces, which is used, and all the hidden details you do not know are there unless you have someone to tell you. Like Head of Research and Innovation, Jeffrey Lins. We have had a great collaboration with Jeffrey Lins, but it took some effort to get the cooperation running. In the beginning we felt like Saxo Bank was not willing to invest their time in our project. We found out that it was important to outline the potential for the project to capture their attention. The people you want to collaborate with need to be able to see and understand the project before they are getting interested. We got the essential domain knowledge and were able to develop the experiment in line with our own and Saxo bank's criteria. It would have been considerably easier to make a classical thesis with use of many qualitative interviews, but not a challenge for our master. What we got was a great challenge and an opportunity to learn and solve new complex problems that might not would have been faced if we had chosen the traditional way.

8.2 The Process

Through the process of making the thesis there has been many challenges, but more victories. One of the elements particular interesting was the utilization of theories in practice. In the beginning you have an idea of some theories and methods you would like to use, but you are not sure they will fit the context. You read and debate with your thesis college in order to find the good arguments and limit potential pitfalls later on in the process. Along the way, it becomes clear what decisions are good and which are bad. We gave ourselves the time in the beginning to debate and the long argumentations, but in the end we think it was a good investment of the time.

8.3 What have we Learned

We have learned many things from this project, some of which are mentioned in the above sections. One of them is the attention to get fast feedback from our supervisor and Saxo Bank. In

the beginning of the project we had a tendency to perfecting the things we needed feedback on. Perfecting things take tremendous amount of time and in the beginning of a project you are not even sure if what you are perfecting is the right thing. It may have been a natural reaction to keep up with the level shown be Saxo Bank, but it slowed things down. Along the way we learned to deliver a product faster and make a small compromise with the quality. This was also the case with our supervisor, where it became clear that the process becomes much more fluent if we faster sent the things for external feedback.

From concept to design has been a process where we have been able to follow the effects of the decisions made early in the process. This has been interesting and demanded great overview of the project and a vision of what kind of results we would like the project to deliver.
Several times we were faced with complex problems and concepts, which we knew would need to be implemented into the project and the experiment in order to make it successful. This process often demands that you are capable of thinking two steps ahead. This is one important lesson learned.

Similar studies could be conducted on the news, teaching forums, and other information rich environments to identify whether there is a correlation on which information humans prefer to forage in general or whether it is bounded to the context. The results of this study could be applied to several different scenarios within Saxo Bank, from internal to external communication.

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10. Appendix

10.1 Appendix 1 - Development Tool

The website Wiz.com provide an intuitive and a relatively easy to use development tool [Wix.com, 2014]. It has been a conscious choice to develop a website because it is similar to the websites developed by Saxo Bank. Furthermore using a website helps to achieve a realistic environment for economic decision making. In order to maintain the real-world settings of the experiment is the taxonomy of the markets leading websites used as inspiration and to create the standard of design. The leading sites used to create the standard and the design of the experiment is Tradingfloor.com [tradingfloor, 2014], Bloomberg.com [bloomberg, 2014] and Morningstar.com [morningstar, 2014]. Tradingfloor.com is used as the main inspiration and the two other sites are used to confirm the tendensies found at tradingfloor.com and cofirm market standards for different types of presentation of information.

10.2 Appendix 2 – Eye-Tracking

10.2.1 Equipment

This master thesis project uses two different types of eye-tracking equipment, SMI RED and SMI Eye-tracking glasses. Both equipment's are based on the same technology, which uses an infrared camera. Infrared cameras give a clear image of the pupil and are able to identifying the corneal center. This type of eye tracking is the point-of-regard method where the eye movement is captured by video by selecting a focal point on the eye as a reference point. (Poole 2006, s. 2) One of the most recognized and commercialized methods of eye tracking is Goldberg & Wichansky's Corneal-reflection/pupil-centre method. This method uses the corneal reflection from the infrared camera to identify where the individual is looking. Tracking of the eye movement of an individual when completing a task can indicate the individual's thought process when using an interface.

The SMI RED eye tracker is an infrared camera installed underneath the monitor where it records the movements of the eye. The eye movement is captured and collected in a software in which the monitor recordings is combine with the eye movement recording. The SMI RED enables two add-ons via the software Attention Tool, an electrodermal activity (EDA) device and a emotiv (EPOC) neuroheadset. The EDA device measures the temperature and how the moisture of the skin caused by sweat changes the electrical conductance. The EPOC neuroheadset detects a subject's thoughts, feelings and expressions while completing a set of tasks giving an increased insight on decision making.

The SMI Eye-tracking glasses is a pair of glasses with a set of infrared cameras pointing towards the eyes to record pupils and a camera pointing forward to record the sight of the subjects. This technology allows the subjects to use the eye-tracking device in their natural environment and thereby give an insight in the subject's natural behavior in a scenario.

The pupil-corneal reflection method has three weaknesses of which the analyst has to be aware of when conducting the data collection.

1. Disturbance from a descending eyelid and downward pointing eyelashes can alternate the measurements.
2. Extreme gaze angles
3. Pupil dilation

10.3 Appendix 3 - Information and Companies

Facebook - 5 times, Google - 5 times, Apple - 5 times, Tesla - 3 times, Microsoft - 2 times, eBay - 2 times, Twitter - 2 times, General Dynamics - 2 times, Alibaba - 2 times, Nokia - 2 times, SunEdison - 2 times, Fiat - 2 times, Just-Eat - 2 times, Johnson & Johnson - 1 time, Blackberry - 1 time, Lloyds Banking group - 1 time, Samsung - 1 time, Amazon - 1 time, Vestas - 1 time, Airbus - 1 time and Huawei - 1 time.

Table 4: Repetition of companies

10.4 Appendix 4 – Visual Preferences (Graphical Material)

10.4.1 Presentation Page 1

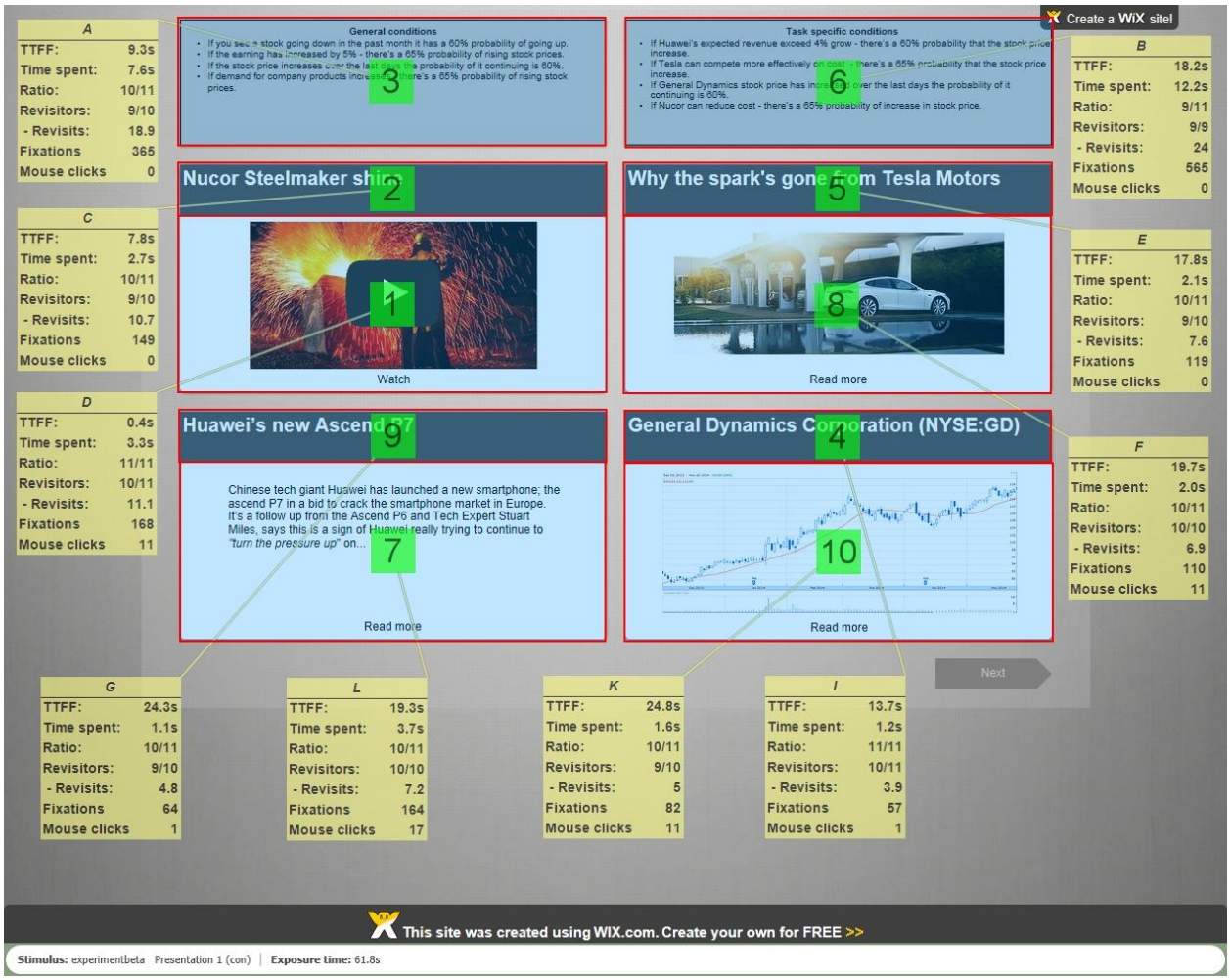


Figure 25: Presentation page 1

10.4.2 Presentation Page 2

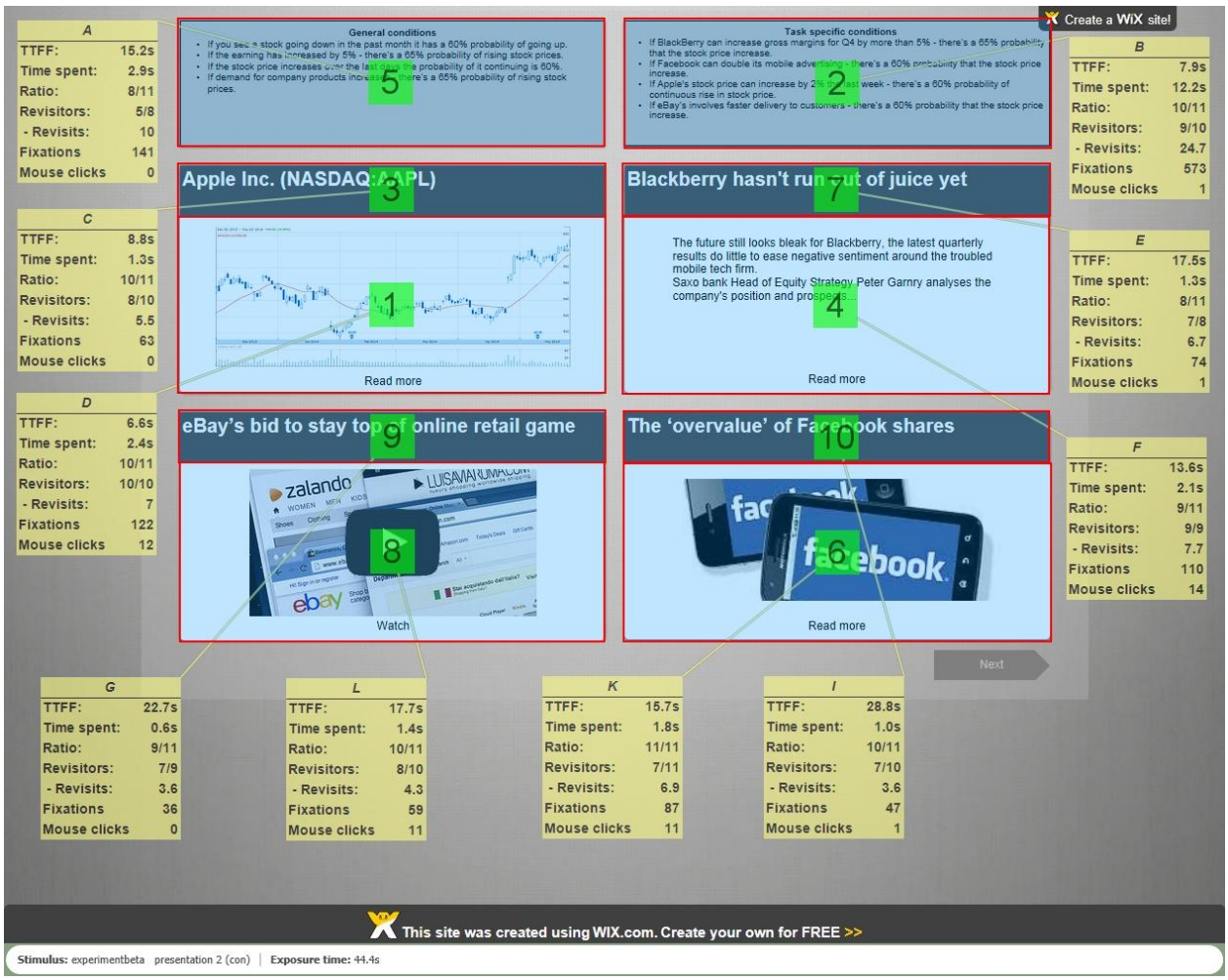


Figure 26: Presentation page 2

10.4.3 Presentation Page 3

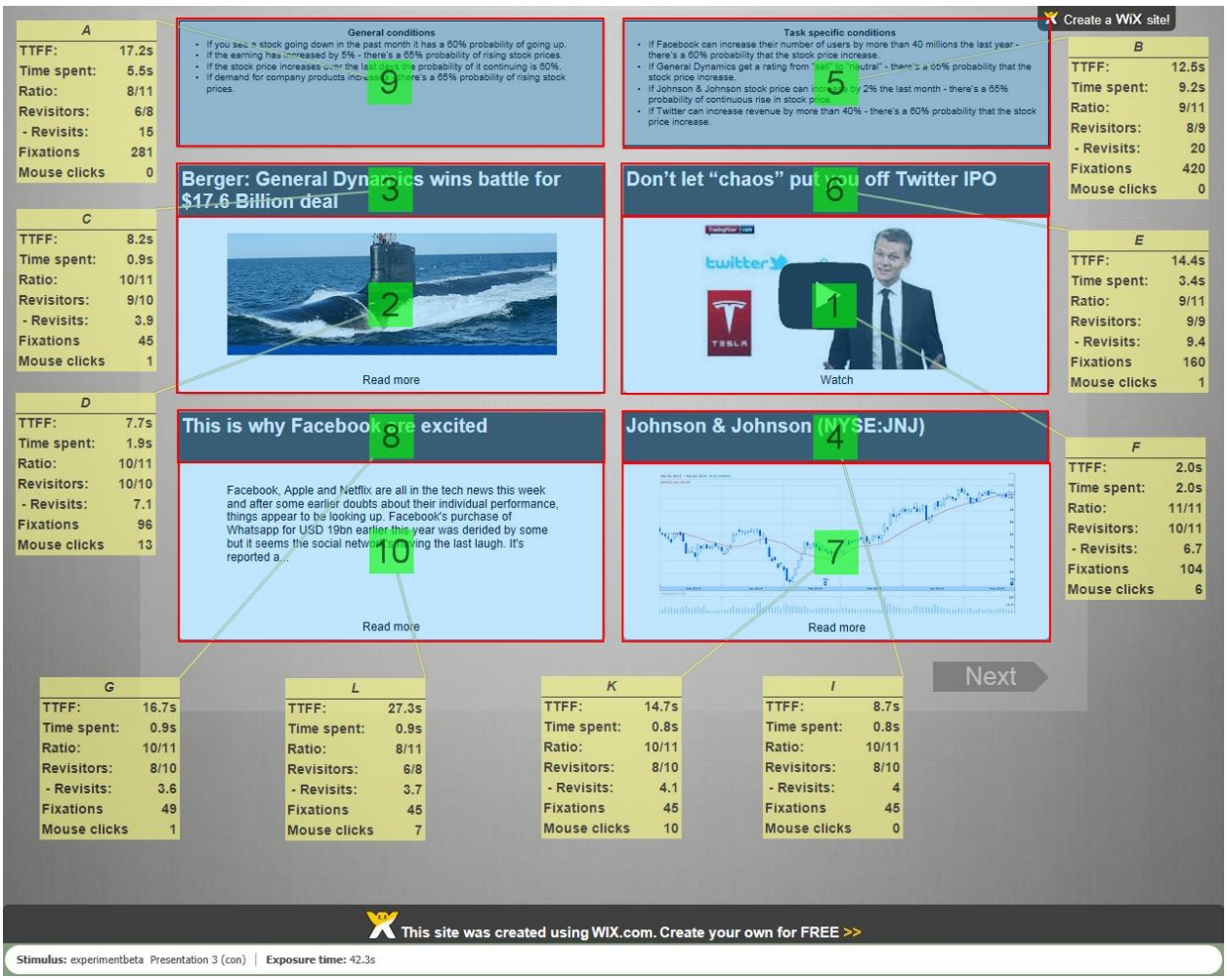


Figure 27: Presentation page 3

10.4.4 Presentation Page 4

Figure 28: Presentation page 4

10.4.5. Presentation Page 5

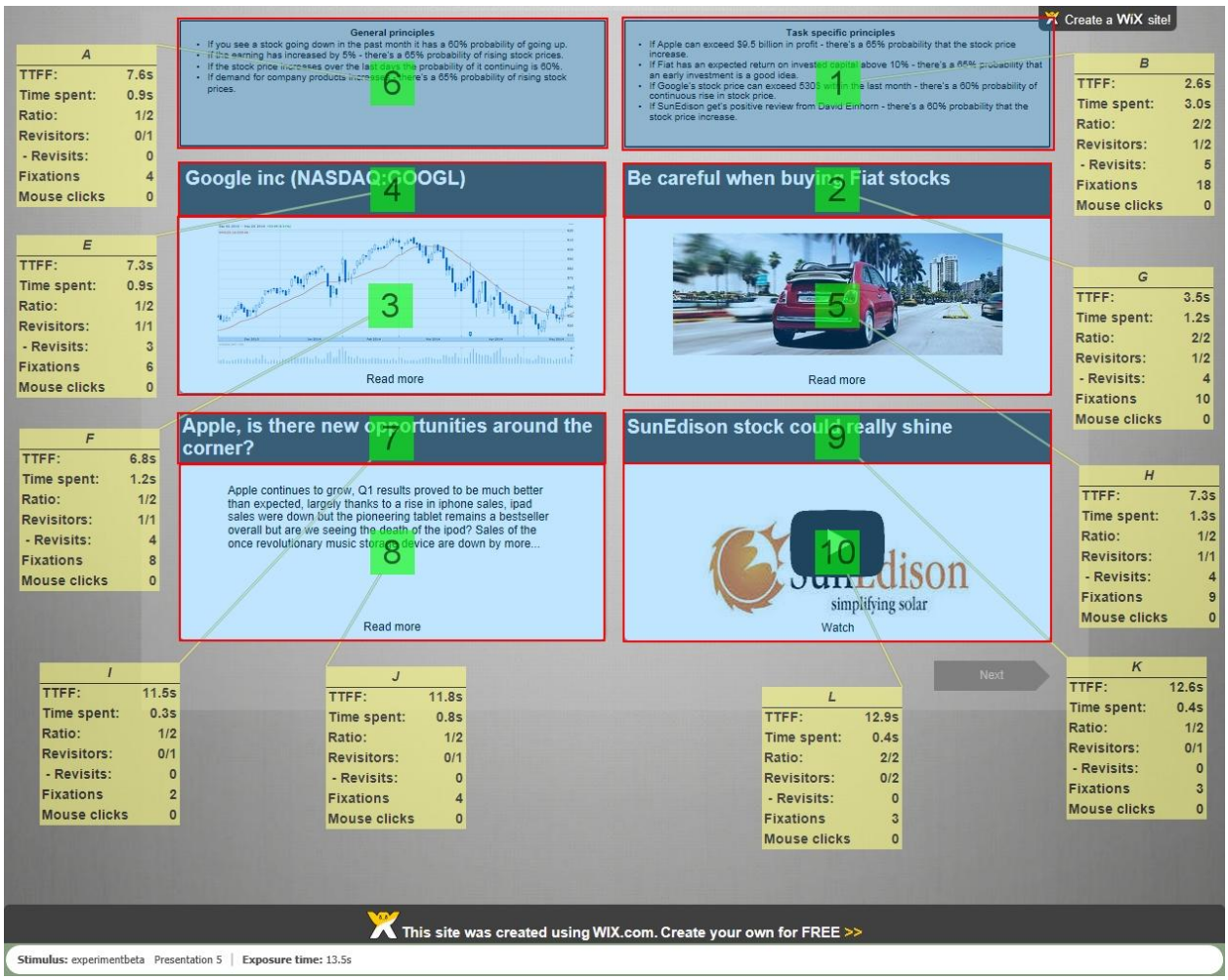


Figure 29: Presentation page 5

10.4.6. Presentation Page 6

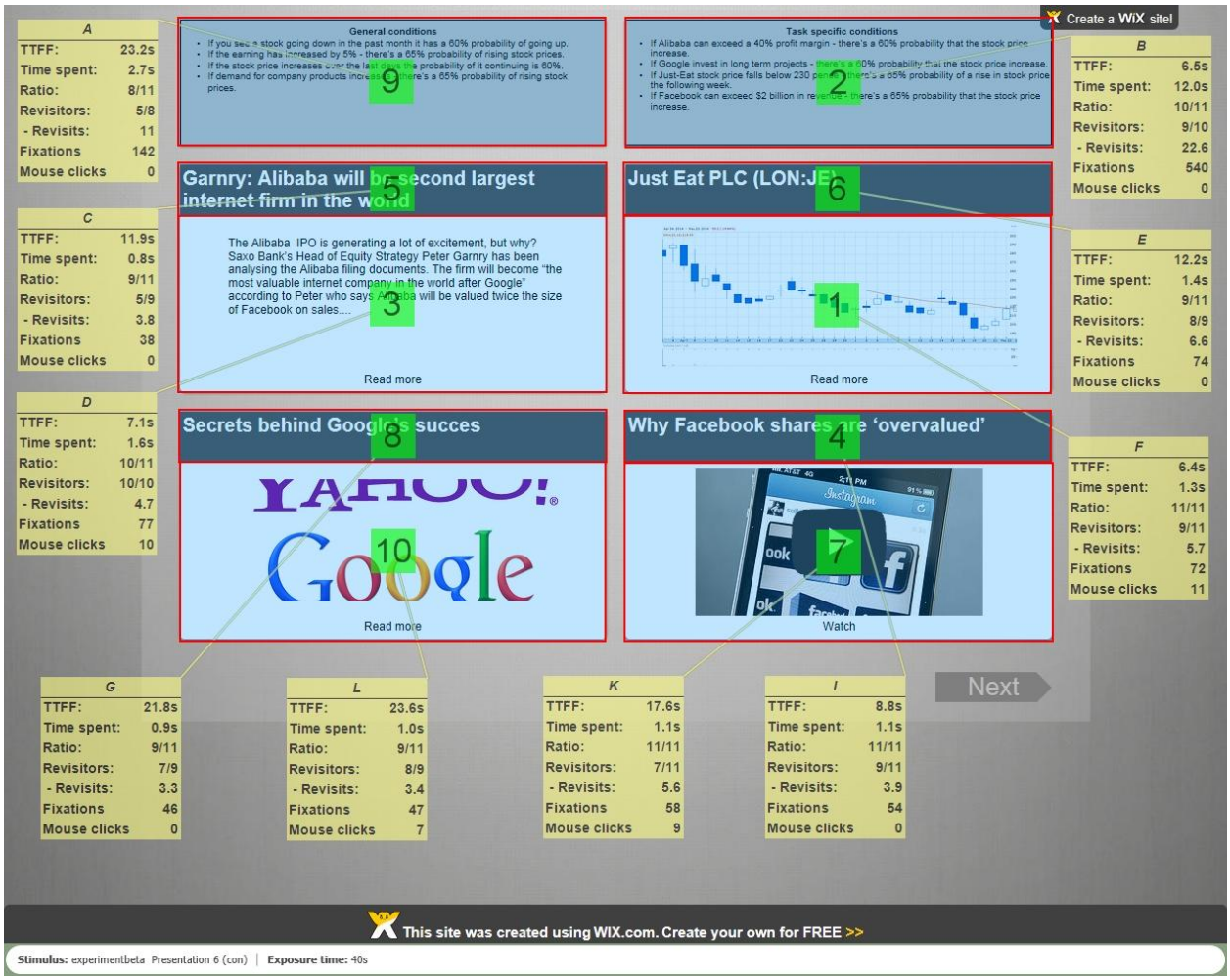


Figure 30: Presentation page 6

10.4.7. Presentation Page 7

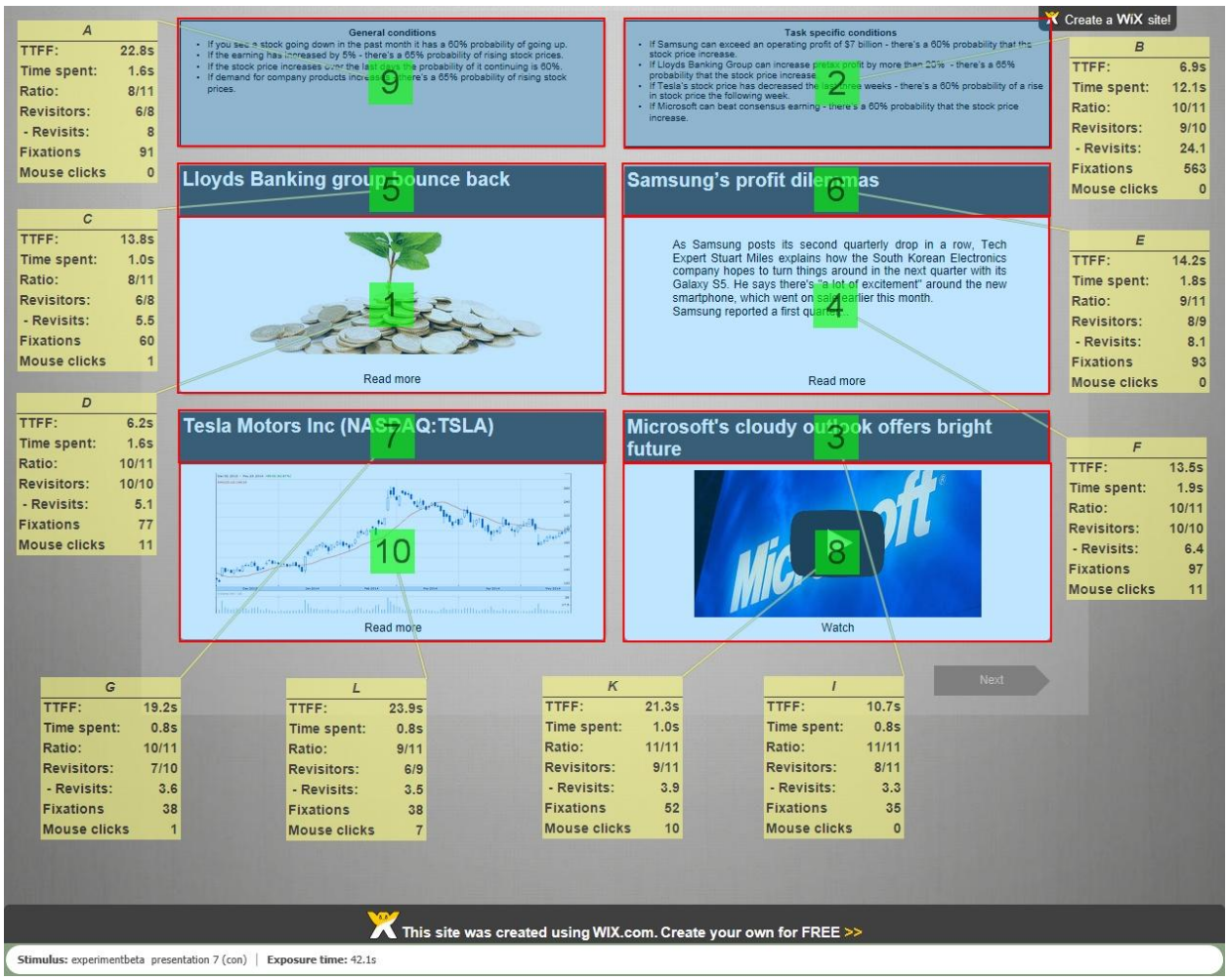


Figure 31: Presentation page 7

10.4.8. Presentation Page 8

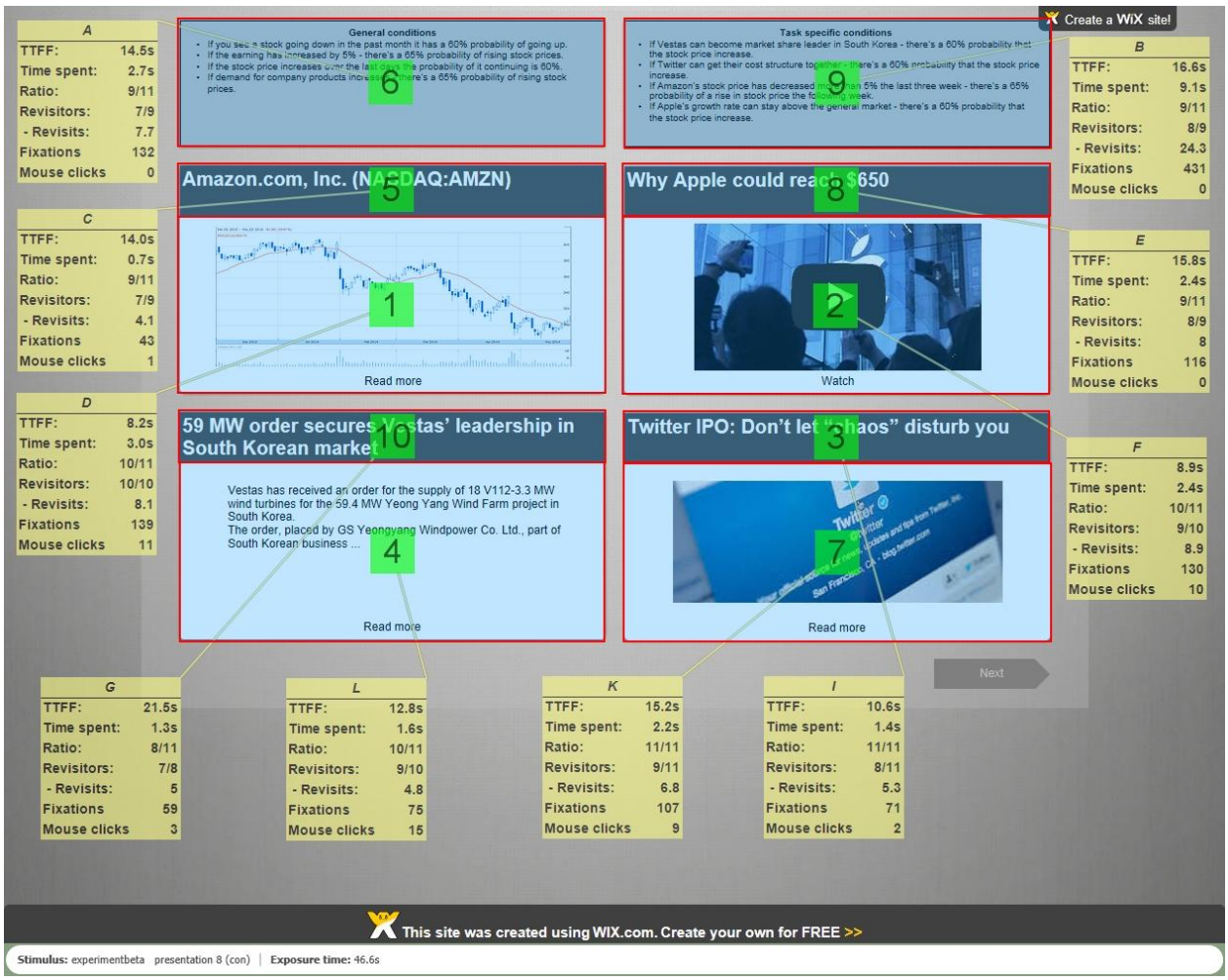


Figure 32: Presentation page 8

10.4.9. Presentation Page 9

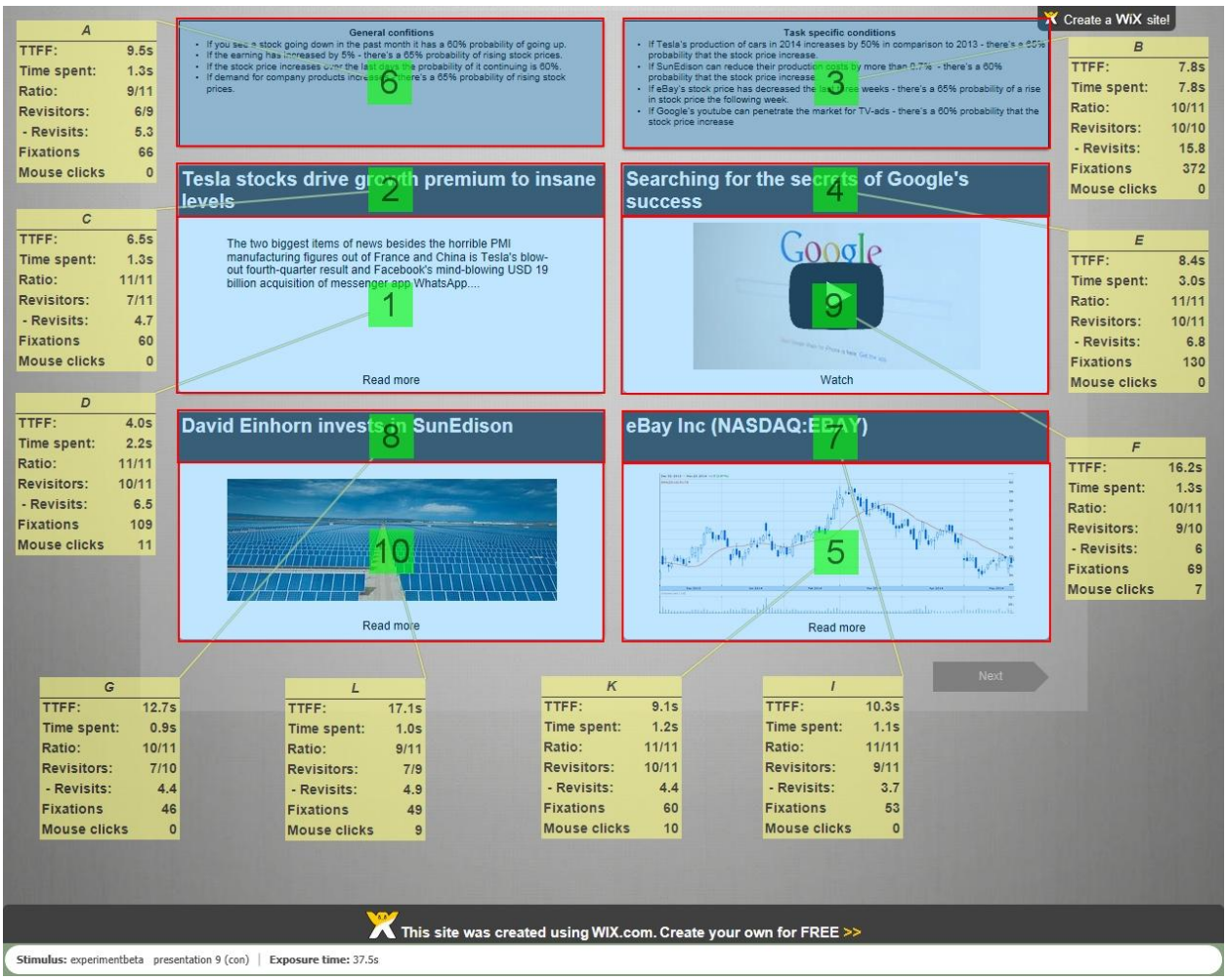


Figure 33: Presentation page 9

10.4.10. Presentation Page 10

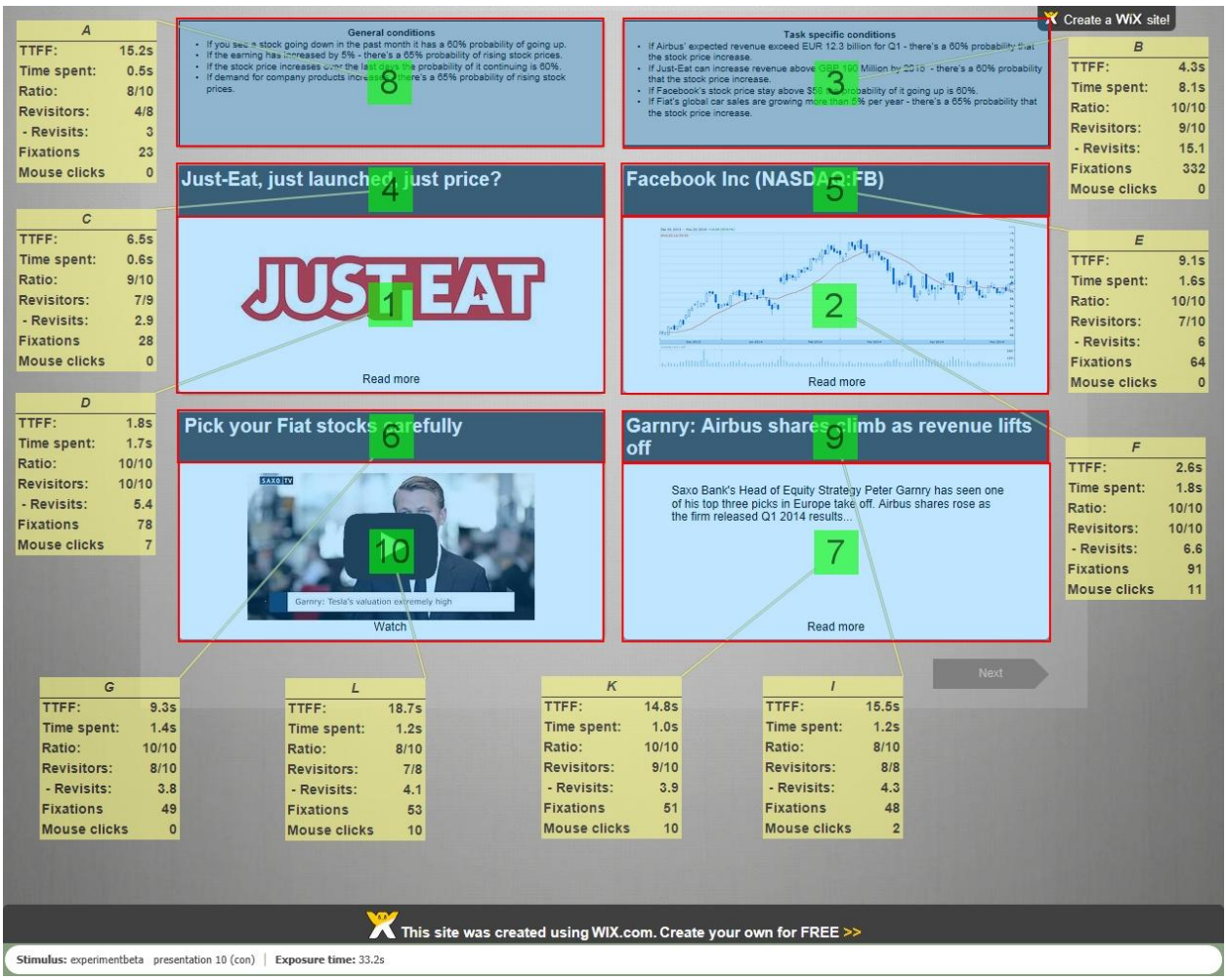


Figure 34: Presentation page 10

10.4.11. Presentation Page 11

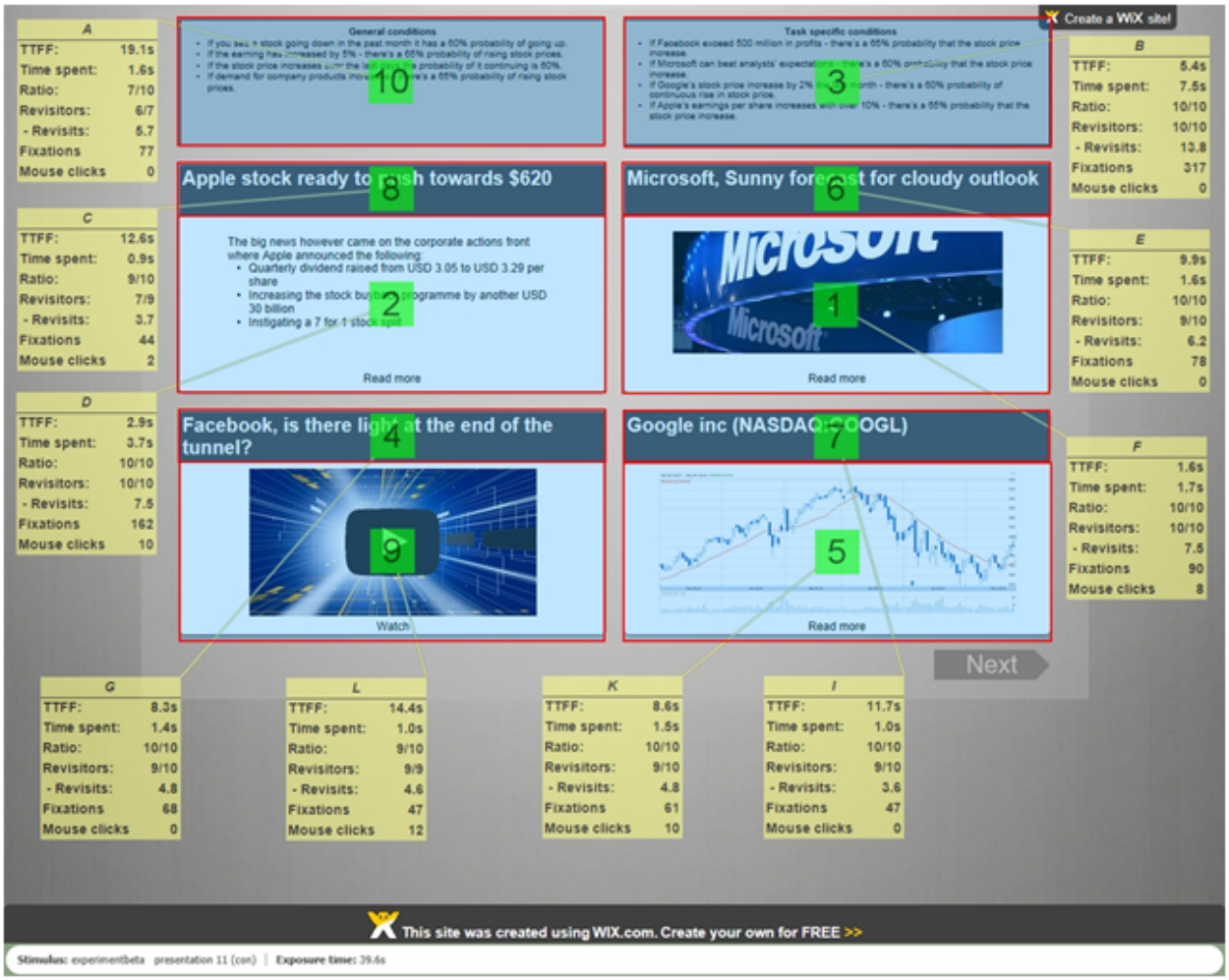


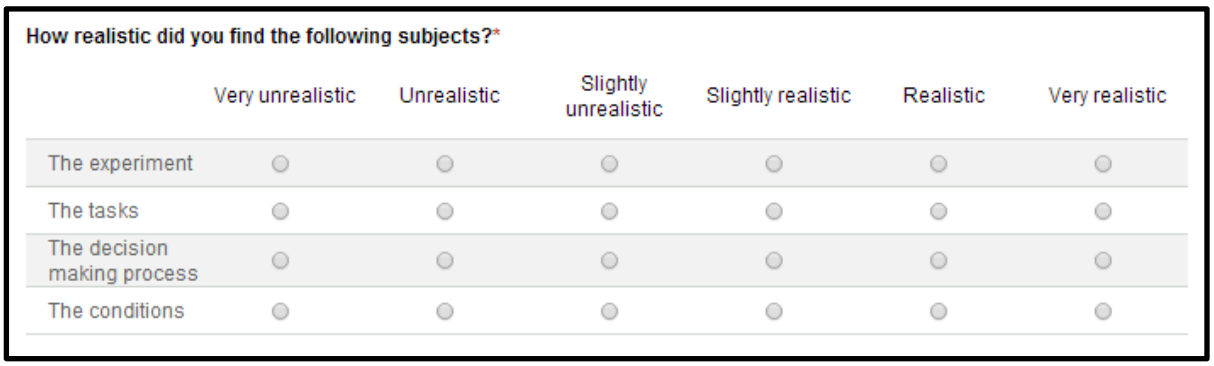
Figure 35: Presentation page 11

10.5 Appendix 5 - Post Questionnaire

10.5.1. Post Experiment Questionnaire

The post experiment will clarify potential irrational behavior in the experiment. It is developed to verify the design and development of the experiment. One of the purposes of the post experiment questionnaire is to identify whether any personal aspects could have affected the behavior of the participant.

In case subjects have a preconceived knowledge of one of the companies it might affect their choices and act in ways that are irrational according to the expected behavior. Affect will most likely be detected and can be used as an explanation for this undesirable behavior.
Another aspect that will be enlightened is how realistic the subjects found the experiment. Overall realism is a theme that will be used to evaluate the different processes, but from the subjects perception. Besides the experiment subjects will have to evaluate the tasks asked, the decision making process and the conditions imposed, in relation to how realistic they found them.
An example is the question about realism, where subjects are given six different options to choose between in the their answer to the following question:


How realistic did you find the following subjects?*

	Very unrealistic	Unrealistic	Slightly unrealistic	Slightly realistic	Realistic	Very realistic
The experiment	○	○	○	○	○	○
The tasks	○	○	○	○	○	○
The decision making process	○	○	○	○	○	○
The conditions	○	○	○	○	○	○

Figure 36: Realism question in the Post Experiment Questionnaire

Experience with trading is a quite vague formulation and do not capture the shades of frequency and how much subjects might search for information related to trading, all activities that contribute positively to their experience. Meaning that two subjects each having two years of experience can have widely different degrees of hands on experience. In the example, subject A might have traded four times a week and used teen hours a week searching for information, while subject B also having one year of experience, might only have traded once every quarter and used one hour a week. This is why questions about frequency and searching frequency have been added to the *Post Experiment Questionnaire*.

Figure 37: Frequency question in the Post Experiment Questionnaire

Subjects tend to behave in ways they assume the experiment and we as researchers want them to behave, trying to perform well according to their assumed conceived success criteria [Holmqvist, K. 2011]. Which may hamper their natural behavior and create a most favorable behavior not desirable for the experiment.

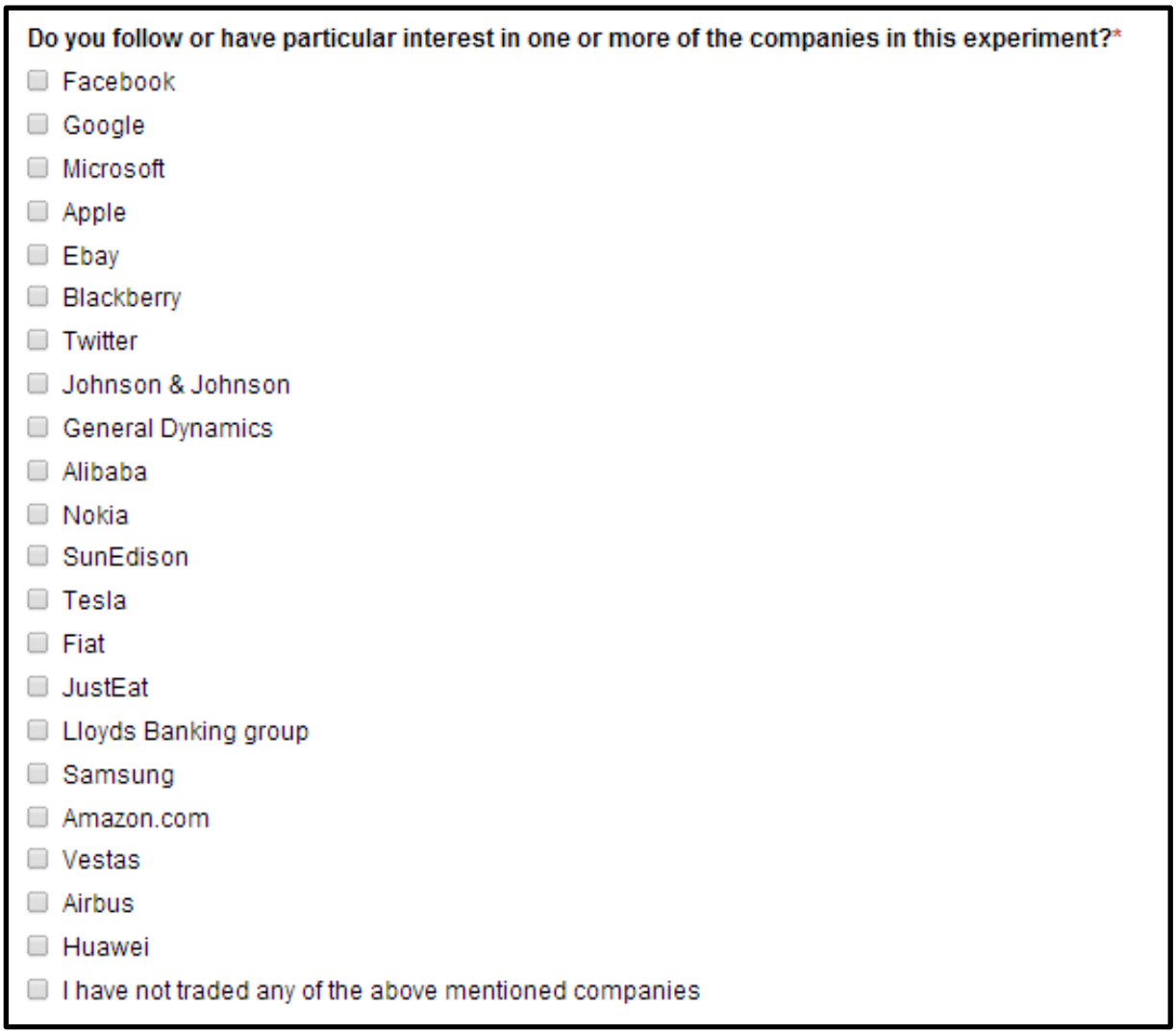


Figure 38: Company question in the Post Experiment Questionnaire

The questions are controlling if subjects have been in dialog with other subjects of the experiment and if they have been participating in an eye-tracking experiment before will be asked. This enhances the chances for detecting favorable behavior and logic explanations for the effects.

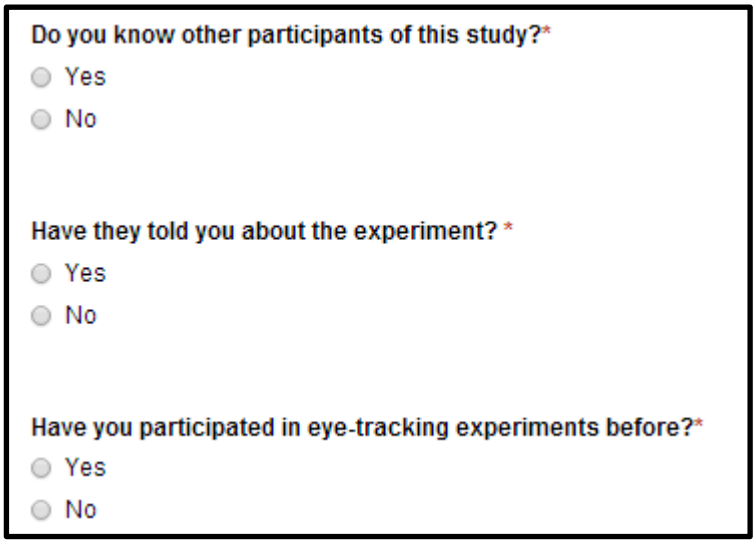


Figure 39: Preconceived knowledge question in the Post Experiment Questionnaire

The questionnaire is based on theories and principles from Jenny Rowley's article *"Designing and using research questionnaires"*.

The title is developed with the focus to give subjects a quick insight into the topic of interest. The title "Post experiment questionnaire" is short, clear and only intend to create an interest from the subjects. Beside the title, a short introduction of the questionnaires object and the expected time used will be presented. In order to increase the interest and involvement of the subjects, easy questions regarding the experiment are placed in the beginning.

The choice between open and closed questions has comprehensive effects on the data collected, and is therefore considered an important and active choice needed to be taken. In this questionnaire closed questions are used based on the assumption that "*Closed questions are quick for subjects*" - Rowley, J. 2014. Closed questions are used to get an overview of the subject's position on different statements. This type of questions makes the data easier to analyze and thereby draw conclusions afterwards. The subjects are presented to questions with different choices. These choices are developed from the Likert-scale and held the same in order to minimize confusing at the subjects. The Likert-scale is used because of its easy analyzability.
Despite closed questions are more difficult to design "*...because the researcher needs to know sufficient about the subjects population to be able to offer sensible categories for each closed question*" they provide a fast validation and results of subjects perception of the experiment

The article *Likert Scales and Data Analyses* by Elaine Allen I., 2007, identifies different sizes of a Likert-scale and how it affects the results. In the article, the Likert-scale optimal range is identified to be between five and seven choices. The design of the Likert-scale in the questionnaire is a scale of six options, which eliminates the neutral response, which makes it *"forced choice survey scale"* [Elaine Allen I. 2007]. The reason for not using a neutral answer option is confirmed by the study *"The midpoint on a Five-Point Likert-Type Scale"* [Armstrong, R. 1987]. This study identifies the "neutral" option as the "easy" answer which compromise the validity of a *"Neutral"* option, because the subjects who are undecided may use this option.

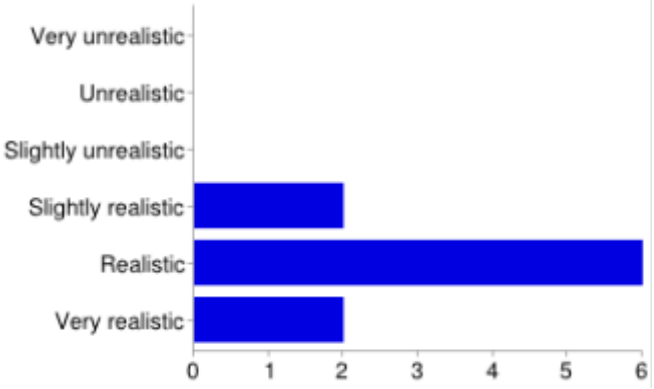
The Post Experiment Questionnaire is placed as an extension of the experiment and will open right after the experiment is finished.

This could be the result of the subjects being tired, bored or losing interest, due to the length of the experiment, the average time used to complete the experiment were XXXX. Subjects of scientific experiments tend to lose their interest over time especially if the experiment last longer than one hour, which some of tests did.

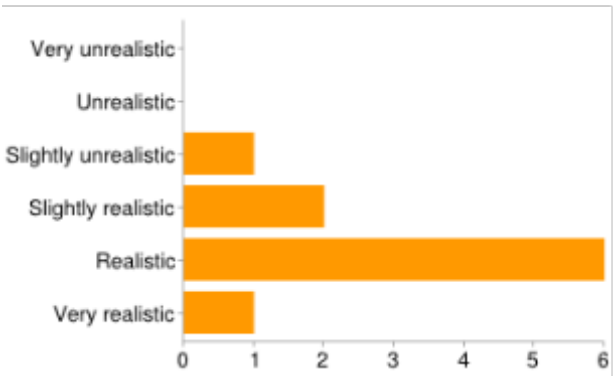
10.6.2. Results

The results of the questions within the matrix the following four questions:

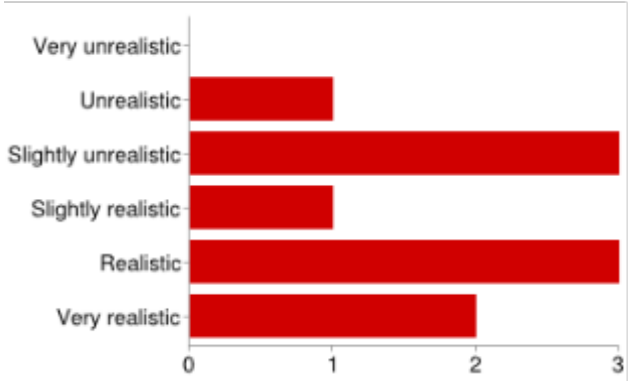
1. The experiment [How realistic did you find the following subjects?]
2. The tasks [How realistic did you find the following subjects?]
3. The decision making process [How realistic did you find the following subjects?]
4. The conditions [How realistic did you find the following subjects?]



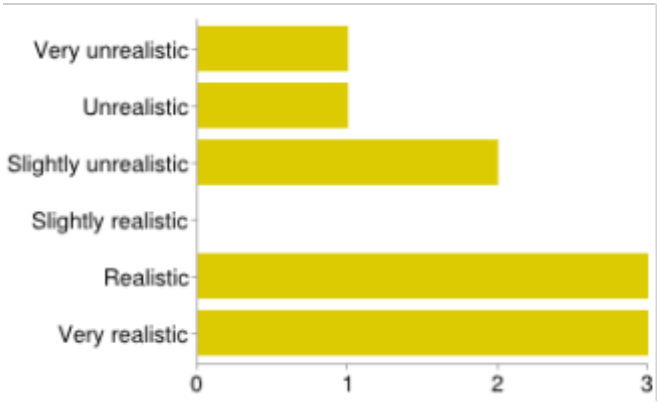
Very unrealistic	0	0%
Unrealistic	0	0%
Slightly unrealistic	0	0%
Slightly realistic	2	20%
Realistic	6	60%
Very realistic	2	20%



Very unrealistic	0	0%
Unrealistic	0	0%
Slightly unrealistic	1	10%
Slightly realistic	2	20%
Realistic	6	60%
Very realistic	1	10%



Very unrealistic	0	0%
Unrealistic	1	10%
Slightly unrealistic	3	30%
Slightly realistic	1	10%
Realistic	3	30%
Very realistic	2	20%

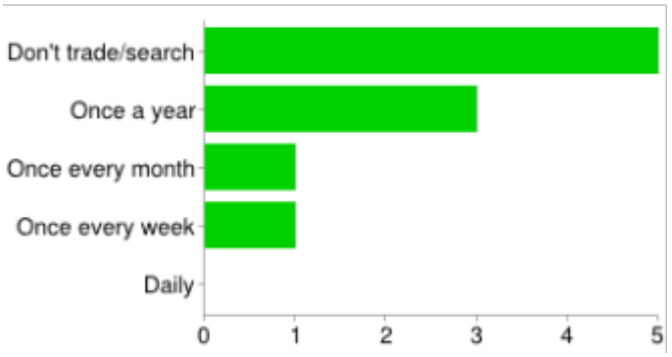


Very unrealistic	1	10%
Unrealistic	1	10%
Slightly unrealistic	2	20%
Slightly realistic	0	0%
Realistic	3	30%
Very realistic	3	30%

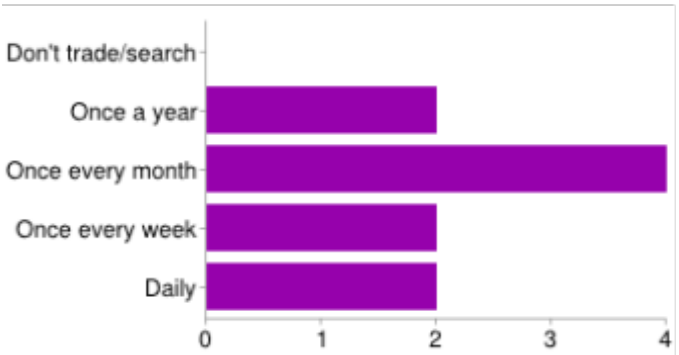
Figure 40: Result of post questionnaire - How realistic did you find the following subjects?

The result of the second matrix:

Trade stocks [How often do you:] & Search for information for potential investments [How often do you:]



Don't trade/search	5	50%
Once a year	3	30%
Once every month	1	10%
Once every week	1	10%
Daily	0	0%



Don't trade/search	0	0%
Once a year	2	20%
Once every month	4	40%
Once every week	2	20%
Daily	2	20%

Figure 41: Result of post questionnaire - How often do you:?

Do you follow or have particular interest in one or more of the companies in this experiment?

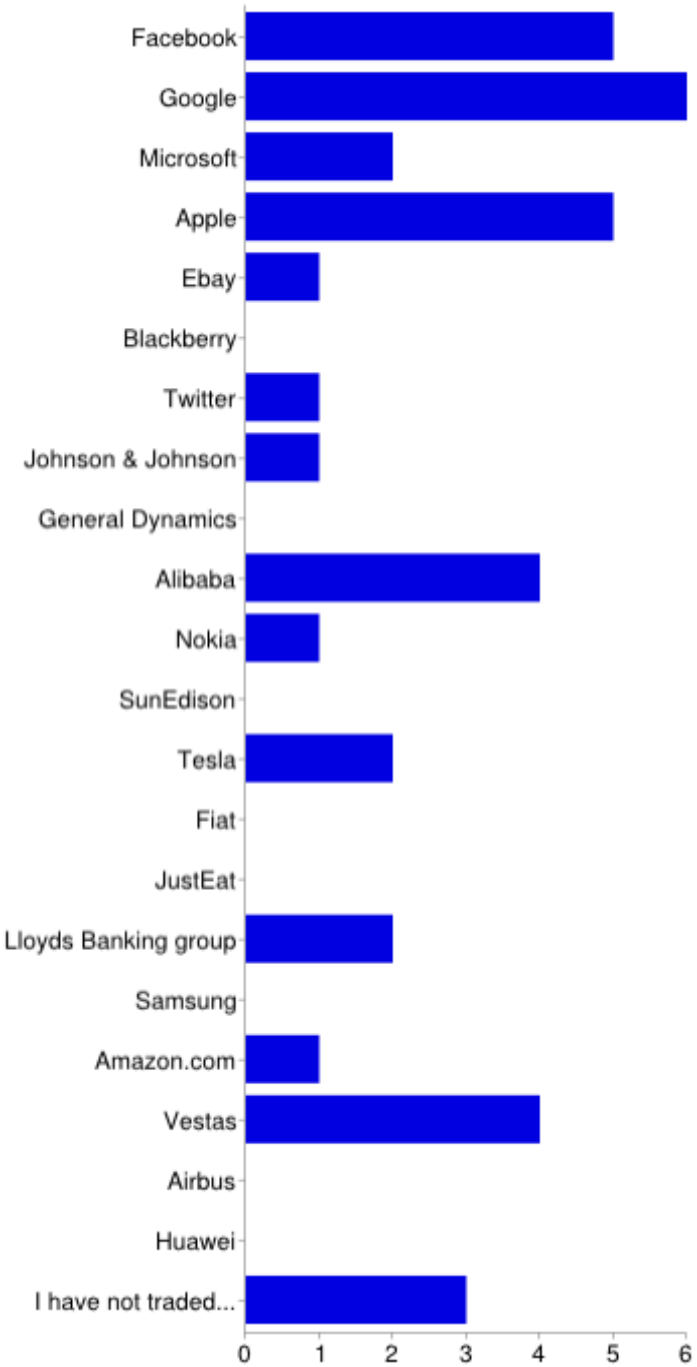
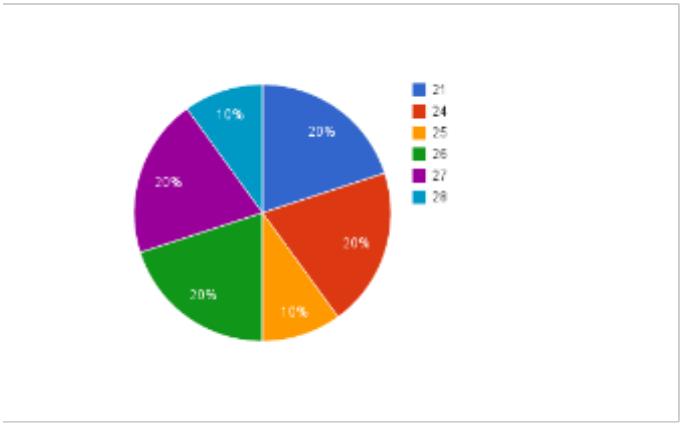


Figure 42: Do you follow or have particular interest in one or more of the companies in this experiment?

Facebook	**5**	13%
Google	**6**	16%
Microsoft	**2**	5%
Apple	**5**	13%
Ebay	**1**	3%
Blackberry	**0**	0%
Twitter	**1**	3%
Johnson & Johnson	**1**	3%
General Dynamics	**0**	0%
Alibaba	**4**	11%
Nokia	**1**	3%
SunEdison	**0**	0%
Tesla	**2**	5%
Fiat	**0**	0%
JustEat	**0**	0%
Lloyds Banking group	**2**	5%
Samsung	**0**	0%
Amazon.com	**1**	3%
Vestas	**4**	11%
Airbus	**0**	0%
Huawei	**0**	0%
I have not traded any of the above mentioned companies	**3**	8%

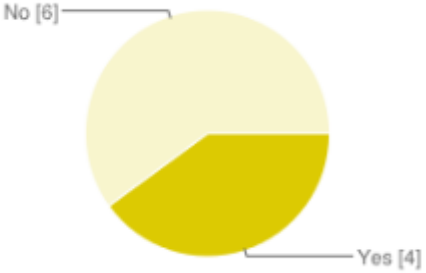
Table 5:Do you follow or have particular interest in one or more of the companies in this experiment?

The results of the following questions are presented in the following figure: What is your age? What is your gender? Do you know other participants of this study? Have they told you about the experiment? Have you participated in eye-tracking experiments before?

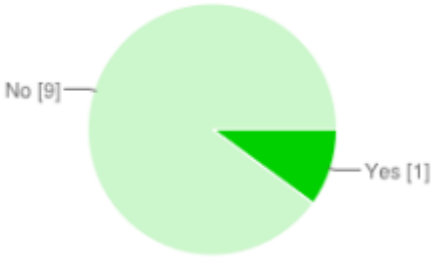


Age	Percent
21	20.00%
24	20.00%
25	10.00%
26	20.00%
27	20.00%
28	10.00%

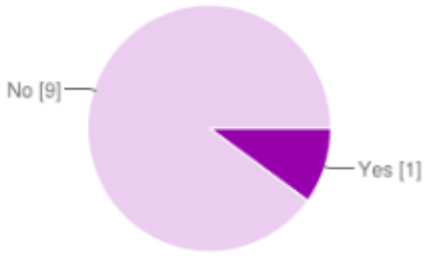
Female	1	10%
Male	9	90%



Yes	4	40%
No	6	60%



Yes	1	10%
No	9	90%



Yes	1	10%
No	9	90%

Figure 43: Result of the personal information

10.6. Appendix 6 - Contract to Subjects?

10.6.1. The Invitation to Eye-Tracking Experiment

The invitation is created with focus on selecting the relevant subjects for the Eye-tracking experiment. The invitation to the eye-tracking experiment will mainly be distributed through FinanceLab, this will ensure that most of the subjects, who get the invitation within the segment of interest. The subjects for the experiments are described further in paragraph subjects below. The invitation is developed through *Google Form* in order to enable the subjects to answer a couple of questions to identify whether they fit the subject profile or not.

Due to a lack response from the FinanceLab members and their Facebook followers, the invitation has been distributed to all CBS student via public message boards throughout the CBS campus. Furthermore has Jeffrey Lins created an interest for the project and distributed the invitation to student employees at Saxo Bank.

Description of the project

The title of the invitation is developed to give the subjects a quick insight into the area of interest. The title "Invitation to Eye-tracking experiment" is short, clear and only intended to create an interest from the relevant subjects.

The invitation initial present a short description of the project, the expected time used and the students conducting the research. This description helps the subjects to understand and relate to the project. By creating an understanding of what and how the subjects contribute to the research, it increased their incentive to join it.

Personal experience

The personal experience page is identifying three different aspects of the subject personal experience. The three aspects are trading experience, age and education. This will give the ability to select the subjects who can be a representative of the entire segment of the identified customers. To ensure the quality of the experiment it is important to eliminate all naive subjects in this study.

According to the focus of the study it is important to identify the subjects knowledge and experience within topic. The invitation has three questions about different areas from where a subject may gather experience and knowledge within the financial market. The first question is "*Years of trading experience*" were five different levels of experience is identified in a multiple choice question.

The second question is about their age this will to some degree verify the answer in the two other questions. The third and last question is *"What is your current or highest completed level of education?"* this question gives an insight into the Educational background and potential identify is the subject is a student or a stakeholder from the market.

The following pages were deleted in order to minimize the invitation, making it quicker and easier to complete for the subjects. The subjects were asked if they are interested in "Participation in Eye-tracking" which is the next page in the invitation. This simply direct the subject in two different directions one in which they are asked about their E-mail address for further communication and one presenting the possibility for getting a brief presentation of the results.

The decision of deleting this part were based on the assumption that the subjects entering and filling out the Google Form invitation were already interested and willing to participate in the eye-tracking experiment. The registration of the participants was due to the update of the invitation been move to the 2 page of the invitation.

The final invitation is only a description of the project and then the Google Form where the subjects are asked the previous mentioned personal experience questions and asked to fill in their email for further contact.

10.6.2. Subjects

The choice of subjects to the experiment of this thesis is identified to be mainly students or graduates of Copenhagen Business School. Students are in general naive subjects, but the selected students for this study is financial knowledge students from relevant study programs or with personal interest within the field. The use of non-naive subjects gives a more generalizable and valid result of the experiment, because it is conducted on subjects with similar backgrounds as the majority of Saxo Bank's customers.

The subjects for the study will mainly be contacted through the interest organization FinanceLab members. The members of this group all have a greater interest for the financial market and trading, than regular students and graduates. FinanceLab represent both students and graduates therefore will the subjects possibly both be students and people who work within the industry. Saxo Bank has furthermore provided some subjects in the form of some of their student employees, as mentioned in the previous section "*The Invitation to Eye-tracking experiment*".

The selection process of the subjects will be executed in different phases. The first phase of selection is to identify the subject's different backgrounds to eliminate the topic naive subjects. The following phase will be an invitation to an eye-tracking experiment.

At the meeting with Saxo Bank, the possibility of using actual customers and users as a verification of the tendencies found to complement the students segment. This possibility in this study is a nice to have, but will be a great supplement for further research within this research field.

The number of subjects was indicated to be 50 subjects in the meeting at Saxo Bank, April 2. 2014 by Jeffrey Lins [Saxo Bank, 2014, April 2]. This number of participants reflects the degree of generalizability need for the study. In a study with only four subjects it is likely that the subjects participating will deviate from the average person within the segment.
According to professor Ravi Vatrapu, whom is Eye-tracking equipment responsible at Department of Information Management at CBS, identify a rule of thumb that you need around 8-10 subjects for each level/segment when conducting a standard study. Due to the fact that this study is a master's thesis and therefore resource and time limited. The identified number of participant is 8 - 12 to reach a level of satisfaction for this project.

10.6.2.1. Incentives

Incentives can be a good catalyst to increase the number of participants and motivate to behave in certain ways. In this case the use of a combination of a gift, competition and a monetary incentive.

1. All subjects participating will receive a bottle of wine
2. All subjects will compete for a gift certificate of 400 DKK. to gavekortet.dk[1]

A bottle of wine will be handed out to all participants. This will symbolically compensate their time spend to participate one hour averagely and show our appreciation for their participation.

Ensuring participants won't hurry through the experiment in the fastest possible way will be addressed by using a element of competition. Explaining participants that their answers will be rated and ranked according to the scores of the other participants and the participant with the highest score will be awarded with a gift certificate of 400 DKK. Performing well should therefore be of higher importance than getting through the experiment. Furthermore higher concentration and focus in the experiment, in order to achieve better performance, will be a result of the incentive structure.

Subjects consist of former- and current financial students, all with some degree of economic knowledge. By using the association FINANCELAB[2] as communication channel to attract subjects it enhances the probability of assembling a group of subjects with a basic financial understanding. Besides FINANCELAB, Saxo Bank has also provided assistance to come in contact with relevant subjects. Throughout the communication with potential subjects, focus has been on producing new knowledge and learning something new. How this experiment can contribute with knowledge beneficial to both subjects and us has been highlighted. Focus on learning new things as an incentive derives from an interview with Jeffrey Lins, where he emphasize this alternative perspective on why traders want to be great at what they are working with. Expressed in the following quote.

> *"...We [Traders red.] want to achieve certain goals by learning new things..."*
> *Jeffrey Lins* [Saxo Bank, 2014, April 2, 18:54]

[1] A site providing gift certificate which can be used in a wide variety of stores.
[2] FinanceLab is a non-profit student organisation with 1,800 registered members. Their objective is to be the prime point of contact between the financial industry and the academic world.

The quote describes how the motivation behind traders works and gives the impression that traders have a desire to learn new thing in order to achieve their goals and prove their worth. This desire to learn new things is an important factor in the selection of what type of incentive to use in order to increase the number of subjects wanting to participate. That is the main reason for an increased focus on the narrative of producing new knowledge. Likewise how the experiment can contribute with new knowledge to each individual subject who choose to participate in the experiment. This incentive-strategy will likely be more appealing to the people suitable for this experiment.

10.7. Appendix 7 – Protocol for Experiment

10.7.1. Development of Presentation Page

The development-process of the presentation page is described in this section. It is important to understand the process of the evolution of the page and how the different criteria's for the experiment has contributed to this evolvement. The development of this page has evolved through three stages, and is based on meetings with Saxo Bank lead by Jeffrey Lins and supervision sessions with Jonas Hedman and Ravi Vatrapu. Through the three stages the complexity of the experiment will evolve to fit requirements and to delimited potential problems.

10.7.1.1. First Stage

The first draft was mainly developed from the meeting with Saxo Bank on April 28th. Throughout the meeting the presentation of cards were discussed and developed, which is described previously in section 5.2.2. Development of card and specific for each cards in the subsections, which are located in the sections below. The criteria's for the first stage were developed from the understanding that there should be between two or three different cards on the presentation page. The original concept was based on keeping the experiment as simple as possible, which involved measuring each card against each other. This would involve a large number of trials and comprehensive number tasks to be completed by each of subjects. The original concept of "keeping it as simple as possible" is kept as a red thread throughout the evolvement

Further development in collaboration with Ravi Vatrapu identified no problem in presenting all the three cards on the same presentation page. Introducing the three different cards on the same presentation page, it decreased the possible combinations of cards to only one combination.

The three different cards at the time, which were defined as relevant for this study was: a text card, a graph card and a video card. To ensure that the position of the different cards has no influence, the following table was developed to present the different combinations for a presentation page.

The different combinations are calculated using the permutation formula: $\frac{n!}{(n-r)!} = P$. When adapting the formula to this scenario the following calculation is made: $\frac{3!}{(3-3)!} = 6$

The permutation identifies the different combination when the order of the elements is important for the outcome. This ensure that the order has no effect on the choice of cards it's important to change the position in the different tasks.

The table below shows the six different representations calculated from the permutation formula.

1	2	3	4	5	6
Text	Text	Graph	Graph	Video	Video
Graph	Video	Text	Video	Text	Graph
Video	Graph	Video	Text	Graph	Text

Table 6: The different permutations of the presentation page

10.7.1.2. Second Stage

The second stage is a further development of the first stage. This was mainly developed in collaboration with Jeffrey Lins. He identified a great interest in adding a picture element, this lead to the development of the card as described in section 10.7.3.5. Picture card. The Four different developed cards would fit into the three slots on the presentation page. According to Jeffrey Lins, the order of the cards has no relevance for Saxo Bank and therefore is it not importance for this experiment to identify the different orders. This identifies 4 different presentation pages, where the four cards are represented "against" each of the different cards. This gives the following possible combinations of cards on the page: 1 {T,V,P}, 2 {T,V,G}, 3 {T,P,G} and 4 {V,P,G} these combinations are calculated with the formula: $\frac{n!}{(n-r)!(r!)} = C$

The design of the presentation page, started with showing three different cards as presented in the following figure 10.20. The design was focused on only presenting the cards and not has elements that could interfere the subject's behavior unintentionally, such as commercials, logos or unused information. The information in the cards would be the teaser and also work as a button to enter context of the cards.

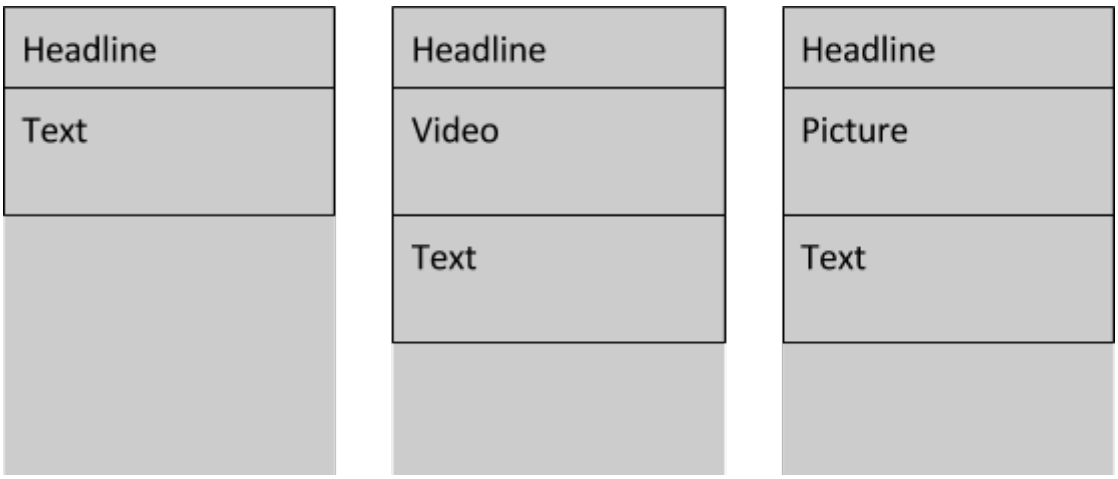


Figure 44: The second stage presentation page

10.7.1.3. Final Stage

The final draft is a further development of the previous stage and the evolving are mainly based on new meetings and as a result of the obstacles encountered in the design process. One of the major obstacles encountered were how to create a statistically valid design. The obstacle of ensuring that the cards are equally presented against each other, this involves four different options of

presentation pages. This setup requires a relatively large subject group and requires several trails through each of the presentation pages in order to ensure the validity of the tendencies found at the subjects performance. The solution for this encountered obstacle was to present the four different cards on the presentation page all together. The four different cards will be presented on the presentation page this gives a static environment for the experiment. When controlling both the information and the representation in the experiment. This opens the opportunity to analyze, when adjusting the variables for each of the cards. This allows the experiment to analyze all three research questions within the same design.

Furthermore tradingfloor.com does also use different cards with different representation to present different information's. The design and representation on tradingfloor.com is used as inspiration for creating the format of the presentation page.

In addition to the cards the conditions are as described in section 5.2.1. Conditions earlier placed on the top of the page to ensure that the subjects are able to remember the conditions of the information foraging. This concept was developed in collaboration with Ravi and Jonas in a supervision session the 20th of May. The two different conditions, the general and the task specific, were added the presentation page to ensure that the subjects do not lose focus on the "meal" or begin to forage for unintended "meals". The different conditions were added at the top of the page and without any added visual stimulation to ensure that it do not distract. To ensure that the focus is held on the four cards is the font of the conditions size 10 and in black. The condition is presented in the same format, which is in form of a box as show in the illustration below. The color of the boxes is a slightly darker grey than the background to keep it as neutral possible.

Figure 45: Presentation of the conditions

The General conditions are place in the top left and the task specific in the top right to create a balance on the page. The task specific conditions change according to the task as described in the section 10.7.2.2. Task Specific Conditions.

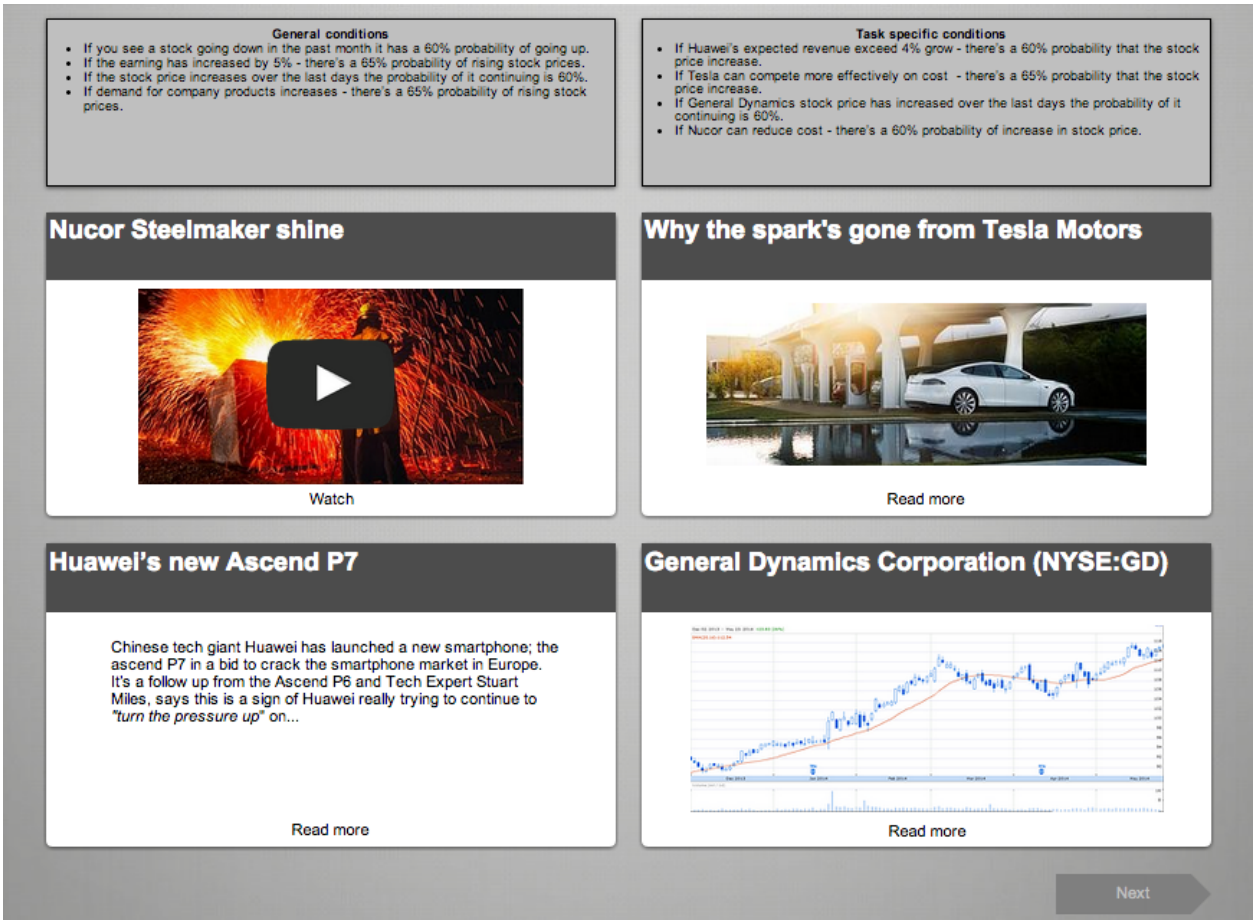


Figure 46: The final presentation page

The presentation page is beside the two condition cards developed of the four information cards. The cards are all developed with the same format. The standard formation of the cards helps to create a standard format for the presentation page. The position of the four cards is locked to eliminate the noise of potential changes in the representation. Because this study focus on the relation between the different cards it is therefore not relevant to create a presentation page without one of the cards.

As a measure to prevent that the subjects do not learn or adapt a specific behavior when foraging information in the experiment the location of the cards on the presentation pages is randomized. To ensure this randomization of the cards, has all possible presentations formats been identified. The positions for the cards are identified with a number in order to identify the specific position in the randomization process.

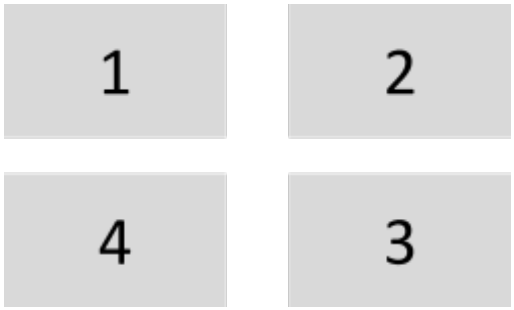


Figure 47: Identifying the position of the card

The permutation-formula as described previously will be used to identify the different presentation pages. In this calculation are the four different cards (n) and the presentation page is the four different card positions (r). $\frac{n!}{(n-r)!} = P$. The result of this calculation is that there are 24 different presentation pages. $\frac{4!}{(4-4)!} = 24$

The table below shows the 24 different presentations and a number to identify each specific representation. The position of the cards will in the following table use the format {1,2,3,4} to identify the position of a card. The representation marked as bold is the 10 chosen representations to be used in the experiment. These representations have been selected as representative of the 24 possible permutations.

1 {T,P,G,V}	5 {T,P,V,G}	9 {T,G,P,V}	**13 {T,G,V,P}**	17 {T,V,P,G}	**21 {T,V,G,P}**
2 {P,T,G,V}	6 {P,T,V,G}	**10 {P,G,T,V}**	14 {P,G,V,T}	18 {P,V,T,G}	**22 {P,V,G,T}**
3 {G,T,P,V}	7 {G,T,V,P}	11 {G,P,T,V}	**15 {G,P,V,T}**	19 {G,V,T,P}	**23 {G,V,P,T}**
4 {V,T,P,G}	8 {V,T,G,P}	12 {V,P,T,G}	**16 {V,P,G,T}**	20 {V,G,T,P}	24 {V,G,P,T}

Table 7: Representations

The criteria for the selection were to ensure that each of the four cards was represented as close to equal as possible on each of the four positions. To prevent that the experiment shows any affect towards a particular position has the focus been on distributing the different cards equally. The reading direction of the English language is from left to right and therefore is the main focus on the top left card and the top right card. The different cards are represented respectively with 3 Text cards, 3 Picture cards, 3 graph cards and 2 video cards on both position 1 and 2. This is to ensure that the influence of the position of the cards is minimal.

The different presentations formats used and the order of them is presented in the list below. The order of the presentations has the criteria a specific card may not be presented on the first position two task in a row.

Task	Presentation format # {1,2,3,4}
1	16 {V,P,G,T}
2	3 {G,T,P,V}
3	22 {P,V,G,T}
4	4 {V,T,P,G}
5	15 {G,P,V,T}
6	13 {T,G,V,P}
7	2 {P,T,G,V}
8	23 {G,V,P,T}
9	21 {T,V,G,P}
10	10 {P,G,T,V}
11	1 {T,P,G,V}

Table 8: Final randomization

Lastly the final element on the presentation page is a next button, which let you move to the choice page.

10.7.2. Conditions

This section will provide an increased insight into the general and task specific conditions.

10.7.2.1. General Conditions

The general conditions will initially be presented in the beginning of the tutorial. It's position and design will been described in section 10.7.4. Tutorial. The general conditions will additionally be placed on all the information rich pages such as the presentation page and each of the cards of information pages, this is further described in the sections 5.2. Presentation Page and in the subsections of 5.2.2. Development of cards.

The general conditions could generally affect all the different presented information. They are developed to be dependent on a general type of action rather than a company specific event. The four general conditions are all developed such that it first present the occurrence which need to be met and then present the degree of the probability of the action to happen. The four general conditions are presented below.

1. *If you see a stock going down in the past month it has a 60% probability of going up.*
2. *If the earning has increased by 5% - there's a 65% probability of rising stock prices.*
3. *If the stock price increases over the last days the probability of it continuing is 60%.*
4. *If demand for company products increases - there's a 65% probability of rising stock prices.*

1. The first general conditions only deals with the price of a stock. These conditions could increase the demand for cards of information with graphs due to the nature of its representation. It could furthermore provide the subjects with a condition, which is relatively quick and easy to find. The time period for this condition is one month.

2. The second general condition is about earnings, which can ultimately affect stock prices for all companies. This information representation will typically eliminate information presented as a graph due to the fact that the graph cards present the stock price.

3. Third general condition is also about the development of the company's stock price. Stating that momentum in rise has a 60% probability to continue. Even though both general condition 1 and 3 results in a 60% probability of the stock price will increase, they do not represent all possible actions/scenarios/consequences. Condition 1's stock price changes are measured over a timespan of the last month and Condition 3's stock price is measured over the last days. Here the time period is the last days.

4. An increase in demand will generally lead to increased earnings, which has a 65% probability of leading to a rise in stock price. In the real world a majority of companies will react positively to an increase in demand, on the assumption that they will create a greater profit. A projected higher demand of a company's product has therefore direct effect on the company's turnover.

10.7.2.2. Task Specific Conditions

The Task Specific Conditions are developed from the same principles and building blocks as the general. These will be described in detail in sections below. The Task Specific Conditions differentiate from the general conditions because they are only relevant in the presented task and they are all specific to a single company.

The different combinations of high and low conditions on the 4 different positions have been calculated to ensure that all the different possibilities have been identified. The permutation formula used for this calculation is $n^r = P$. This formula calculates when the order of n, the number of different conditions in this case a High and Low probability, is important and when repetition of n also is allowed. This provide the following calculation for our experiment: $2^4 = 16$. According to the natural time limit i.e concentration, 16 variations will overlap the time limit

In the following table 10.6: Randomization of conditions is the 16 different permutations of the conditions presentation variations displayed. Of the 16 different identified variations were 11 identified to fit the demand of the experiment. The 4 variations, which were not identified as fitting, were filtered out due to excessive resemblance to other variations. The argument for not choosing variation number 6 is when all conditions have the same value, the difference between the conditions are the same and should therefore generate the same behavior of the subject as variation number 5. The argument for not choosing variation number 11 to 14 is again that the difference between the different information's are the same as in variation number 1 to 4. This selection of the presentation variations were also enforced to fit the experiment time which should

be under 1 hour to ensure full concentration from the subjects. In the pilot testing it was discovered that the time used to solve one task was 4 minutes averagely. With an average time of four minutes time's 11 different variations of the task equals 44 minutes. Furthermore the tutorial is rated to take 10 minutes to conduct in average from the pilot testing. Despite wanting to test all sixteen variations of the task it would simply be too challenging for the participants and their concentration. 16 times 4 minutes equals 64 minutes plus 10 minutes tutorial equals 1 hour and 14 minutes, which exceed the time limit.

Variation Number	Video	Graph	Picture	Text	Task Number
1	H	L	L	L	**2**
2	L	L	H	L	**7**
3	L	H	L	L	**8**
4	L	L	L	H	**10**
5	H	H	H	H	**4**
6	L	L	L	L	
7	H	L	H	L	**5**
8	L	H	L	H	**6**
9	H	L	L	H	**1**
10	L	H	H	L	**3**
11	L	H	H	H	
12	H	H	L	H	
13	H	L	H	H	
14	H	H	H	L	
15	L	L	H	H	**11**
16	H	H	L	L	**9**

Table 9: Randomization of variations

The number in the left column indicates the different variations of conditions. The right column identify in which task the presented combination is used. Randomizing the variations of the conditions is to ensure that the subjects do not identify a pattern, which could alternate their instinct when foraging information. The randomization order of the different variations were

conducted by randomly selecting a variation till all the different variations were selected, this were conducted by using random.org's[3] Random Integer Generator.

The task specific conditions are developed of two parts. The first part of the conditions is the event, which needs to be confirmed in order for the conditions probability to be met. The second part describes the action the event will result in and the degree of probability for it to succeed. These parts are separated by a hyphenate to ensure the previously defined requirements of keeping it short and clear. A general principle of the development of conditions is to provide the name of the company in the beginning of the sentence. Providing the name of the company in the beginning makes it easy for the subjects for navigate quickly through the different conditions. An easy and quick overview of the conditions should help to minimize the time spent in the condition box. Below are two different examples of task specific conditions the first is with a high probability and the second is with a low probability. The main differences between the two examples are in the percentage of the probability.

Example of a High task specific condition.

If General Dynamics get a rating from "sell" to "neutral" - there's a 65% probability that the stock price increase.

An example of a low task specific conditi

If Google's stock price can exceed 530$ within the last month - there's a 60% probability of continuous rise in stock price.

These two examples of conditions are based on the foundation all Task Specific Conditions throughout the experiment is created from.

10.7.3. Development of cards

This section provides a more detailed insight into the development of the cards.
Examples from trandingfloor.com, video representation, picture representation, and graph representation.

[3] http://www.random.org/integers/

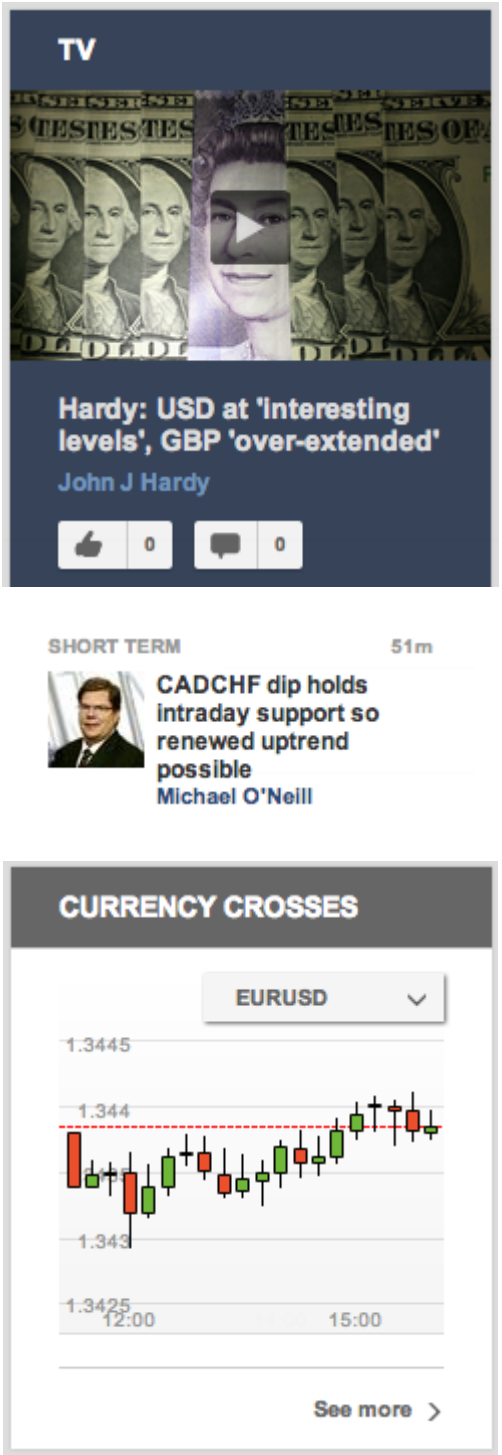


Figure 48: examples of representation, Tradingfloor.com

10.7.3.1. Headlines

The experiment contains 11 tasks and thereby 11 presentation pages, one to each task. Each presentation page has four cards of information, illustrated by the *Presentation Page*-example below. Where each card has it own individual headline attached. On the basis of the following example below it is clear that the content of the various cards is different from each other. The headlines follow two rules of design in order to prevent strong differences in scent from the headlines. Headline design criteria are as follow:

1. Each headline shall contain the company name, which the content is about.
2. The headline shall not provide hints confirming the condition for that specific card and company.
3. Keep formulations as neutral as possible without damaging the credibility of the information sources.

The first rules shall ensure equal scent based solely on company names. By representing the company name in all headlines the subject should not be affected based on this factor. The second rule shall eliminate potential quick answers based upon the headlines solely. It is unwanted for subjects to behave in ways that don't display their information foraging behavior. Being able to "spot" the right answer based on headlines would reduce the experiment to a quiz and create results not intended. According to the third rule headlines should be kept as neutral as possible. If a headline has been too affecting towards one of the companies or conditions, it has been reformulated to a version without strong affect on the subject. Third criteria also state that neutrality must not be at the expense of credibility. It is a fine line between making it too easy and too unrealistic. The foundation for the headlines has most times been the existing headline, which has been evaluated based on the three criteria.

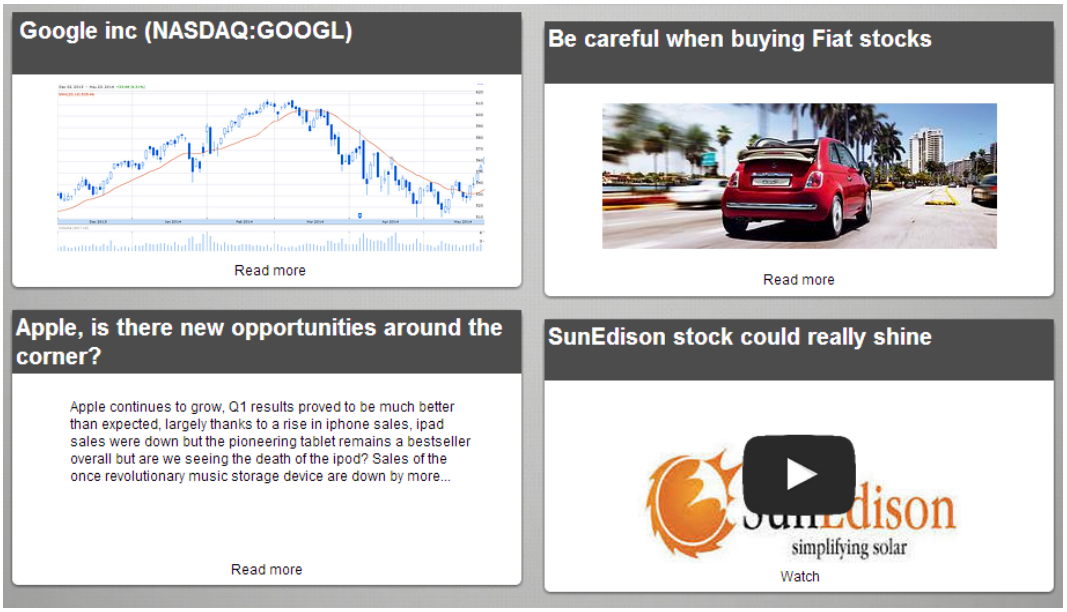


Figure 49: Development of headlines

The only exception to the established criteria for headlines is graphs. These cards of information will be without the same type of headlines known from the other cards. Graphs will be presented with a headline including the company name as the only attribute. The reason for this differentiation is to simulate the same trend as in the real world. Graphs are often accompanied only by the company name they represent information about. The example above illustrates the manner in which graphs are presented throughout the experiment using their official stock name e.g. Google Inc. (NASDAQ:GOOGL). This small hint should for subjects with an economic background and a financial interest is easy to interpret, as a sign of the graph will illustrate the stock price.

10.7.3.2. Video

All videos used in this experiment have been gathered through Tradingfloor.com. Videos are frequently used by Tradingfloor.com to communicate trends, market analyzes and forecasts for future development. The selection criteria for the videos have been; accuracy, preferably about 2 minutes long and providing a clear message. Videos not fulfilling these criteria have been discarded. Because all video are retrieved from Tradingfloor.com they are relative similar in length, the content presentation and the degree of factual information presented. The length of the videos strives to be around 2 minutes in average. Some may be longer and vice versa. Overall there are not remarkable differences between the videos used in the different presentation pages. It is important that the videos do not differentiate too much because it can create unwanted affect. In the case of a quite long, 5 minutes long video and an unclear message can lead to a behavior that avoids videos in the rest of the experiment. In order to prevent this negative effect, videos has been selected based on the criteria described.

In the same way it has been an objective to ensure that the videos contain specific information about the actual company. With some specific information about the company it is possible to connect the video to the specific task condition and thereby confirm the condition and solve the task. There are several reasons for using existing videos from tradingfloor.com. It is an advantage to simulate an environment similar to the real environment the subject usually navigates in because it enhances the credibility. In order to illustrate behavioral mechanisms that are going on and provide accurate recommendations, subjects should have the feeling of realism when watching the videos. Realism is key in order to simulate user behavior as if it was studied in real life. Tradingfloor.com has provided the project scope and implicit also the environment which the behavior has occurred in.

Another pragmatic argument is that the tradingfloor.com videos are already created and therefore has the criteria's have the experiment been established to suit the videos. To use already finished videos are highly timesaving. It is questionable if it is possible to create videos of the same quality regarding content and presentation given the time and resources for a master thesis. Despite a timesaving aspect it has been a key priority to select videos suitable for this experiment.

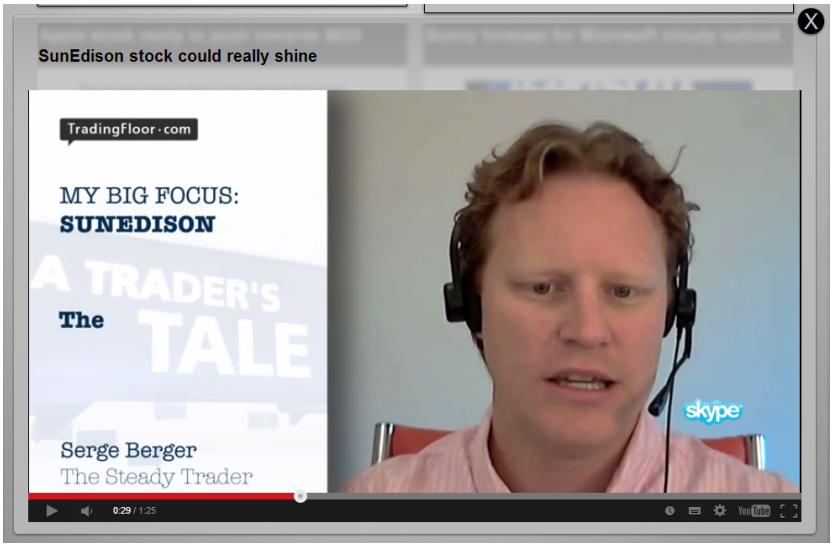


Figure 50: Video-card

10.7.3.3. Text-cards

The text cards are selected based upon the criteria: accuracy, preferably no longer than 2 minutes to read and it has to provide a clear message for the respective company. The majority of texts used have been retrieved from Tradingfloor.com. The advantage of using text from Tradingfloor.com is the standardized terminology.

Furthermore it was important to ensure videos don't reveal the specific information in the first line. The specific information needs to be found to confirm the condition is generally placed somewhere in the middle of the text. Not in the first line and neither in the last. This is an active choice in cases where the specific information is revealed early in the text, it has been replaced. This is done because it facilitates the foraging behavior wanted.

The illustration below is an example of what subjects will be presented with when choosing the text card at the presentation page.

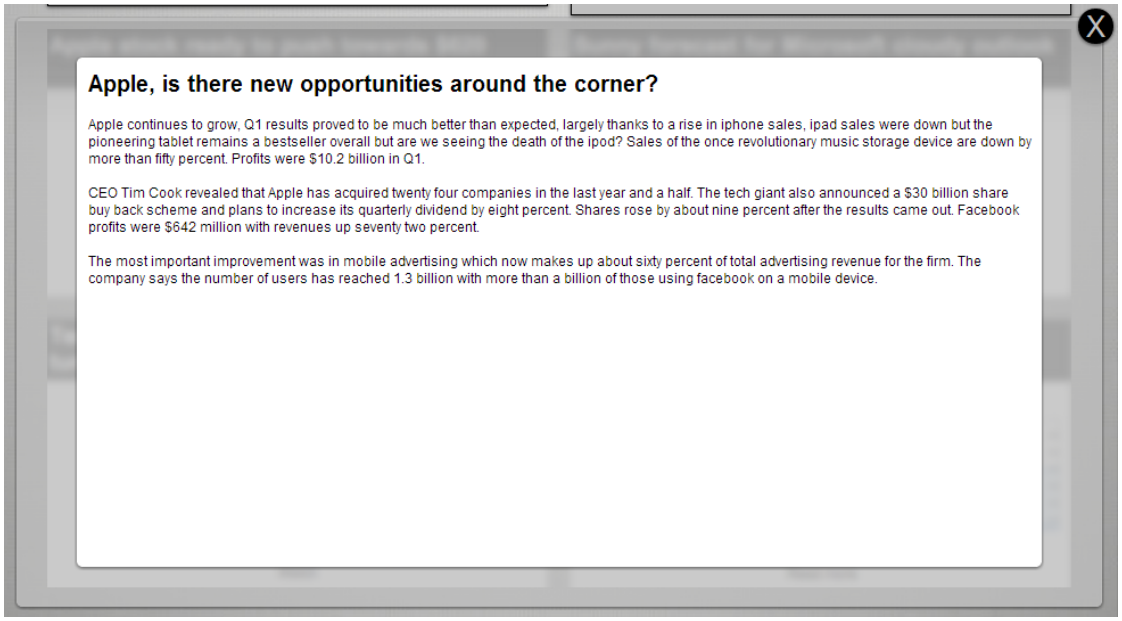


Figure 51: Text-card

The text has to give some scent of what the information is, similar to what scent the picture and the graph provide. The scent provided with the text, need to be aligned with real world presentation in the same scenario. These sites were used as inspiration to identify the common practice for presenting information in a text format. Saxo bank's social trading site Tradingfloor.com, Bloomberg's news site on Bloomberg.com and Morningstars.com.

10.7.3.4. Graph-cards

The subjects will be presented to a graph showing the shock price. The stock price will be of a period from December 2013 to the end of May 2014 and illustrated with the candlestick presentation. The Candlestick presentation is a general accepted way of showing the fluctuations the price goes through during the day. It contains more information compared to a normal line-graph such as open price, closing price, lowest price- and highest price of the day. Parameters, which gives an indication of the fluctuations and daily volatility in the stock prices. Candlestick graphs are a popular tool at Tradingfloor.com as well, which furthermore enhances the realism of the experiment.

The graph-card will besides the graph contain a short text. The text will not contain information confirming the conditions, but will only work as a setting in order to achieve realism.

Figure 52: Graph-card

The figure above shows what the subjects will see if they click on the graph in the presentation page.

10.7.3.5. Picture-card

The picture cards will contain a relevant picture and text. It will differentiate itself by having a picture showing for example a brand name, a product or some other closely related visual motive. The pictures are selected, as information in the other cards, from the following criteria: accuracy (scent), length equal to two minutes of reading and provide a clear message about the respective company. Pictures have been found either on Tradingfloor.com or through Google search, having in mind that they shall fulfill the criteria established.

The text used in the picture cards have been chosen based on the selection criteria as described earlier for text-cards.

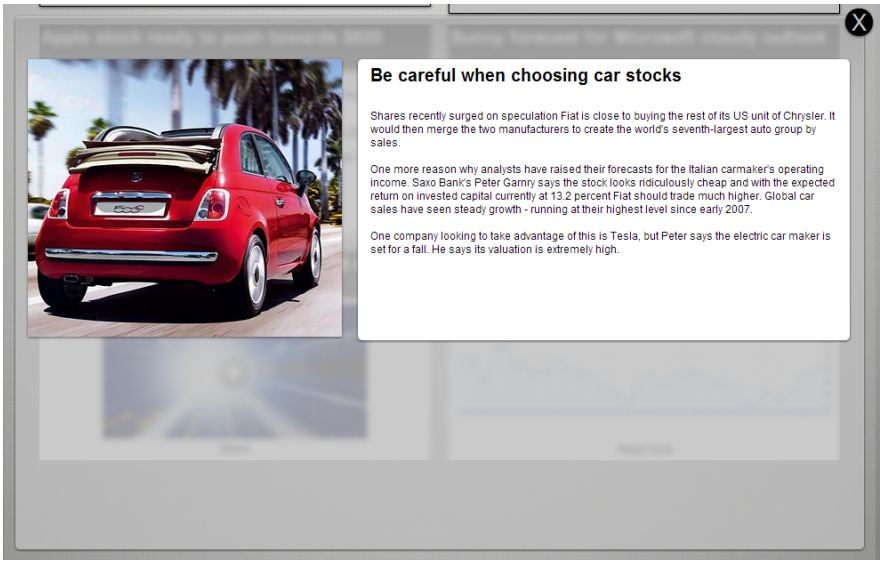


Figure 53: Picture-card

10.7.4. Tutorial

Before any participant is presented to the actual experiment, they are presented with a user friendly tutorial that explains the context, the task and the semantic of how to solve it. The idea of the tutorial is to provide a smooth introduction to the experiment, so that the participant becomes familiar with it. From pilot testing it was found necessary to describe some parts better, in order to make them more understandable and intuitive. Moreover it has shown that it is important to clearly outline when the tutorial starts to avoid confusion as some subjects already thought that they have started the actual experiment. The tutorial is build of four explanatory elements: Context, Conditions, Overview and Task tutorial.

10.7.4.1. The Context

The Context is developed to generate a specific state of mind for the subjects when conducting the experiment. The objective is to develop an alternative world with a comfortable environment for the subjects to create the feeling they are in familiar surroundings. The Context furthermore makes use of storytelling of a situation where a trader is researching for his next investments. Storytelling is creating the incentives for the subjects to act as they are in a trading situation.

"You have grouped possible investments in 11 stacks of 4 companies, in each stack you need to choose 1 company out of 4 alternatives. Based on the information you need to select 1 company you find compatible with your risk profile, which is always to eliminate as much risk as possible."

The Context furthermore provides an insight into the process of the experiment and the actions need to be taken by the subjects. The text above alludes that the subjects will complete eleven different tasks and will have to select one of the four presented stocks in each of the tasks. The text creates the incentive to minimize the risks of the investments, which refers to the performance measure of the experiment.

10.7.4.2. Conditions in Tutorial

The subsequent part of tutorial works as a guide to explain how the world works in this experiment. The experiment will not be able to simulate the high level of complexity similar to the real world. Therefore it is necessary to explain the chosen mechanisms that actually are implemented in the experiment, so subjects will be aware of what is important and what is not. Furthermore the tutorial will emphasize the importance of not to use any preconceived knowledge. The decision making process should only be based on the conditions and the information presented. This point will be stressed in the tutorial and further in the experiment.

The illustration below shows what the subjects will be viewing. There is a presentation of the general conditions and two speech bubbles will give an explanation of the things they point at. Speech bubbles will be used throughout the tutorial because it is an intuitive way of explaining the functions of the elements in the experiment while still in the same settings as the experiment.

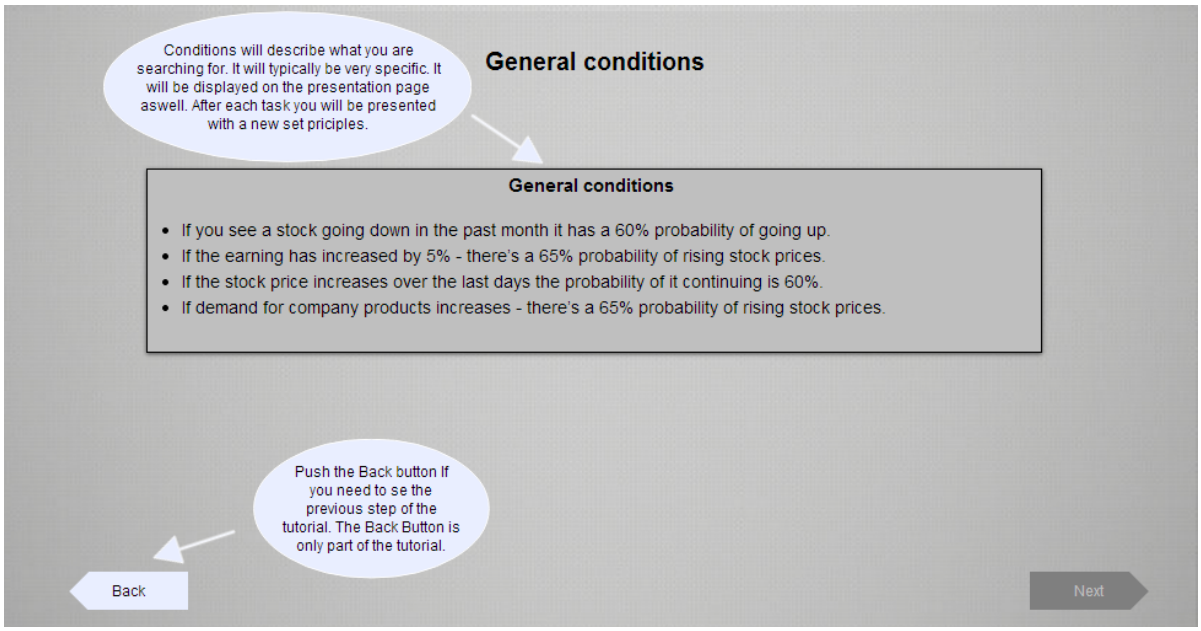


Figure 54: Presentation of general conditions in tutorial

10.7.4.3. Tutorial Overview

An overview of the task and the activities that you go through to complete the task is presented. By giving the subjects an insight into the process it decrease the chance for developing frustrations in the process of completing the tasks.

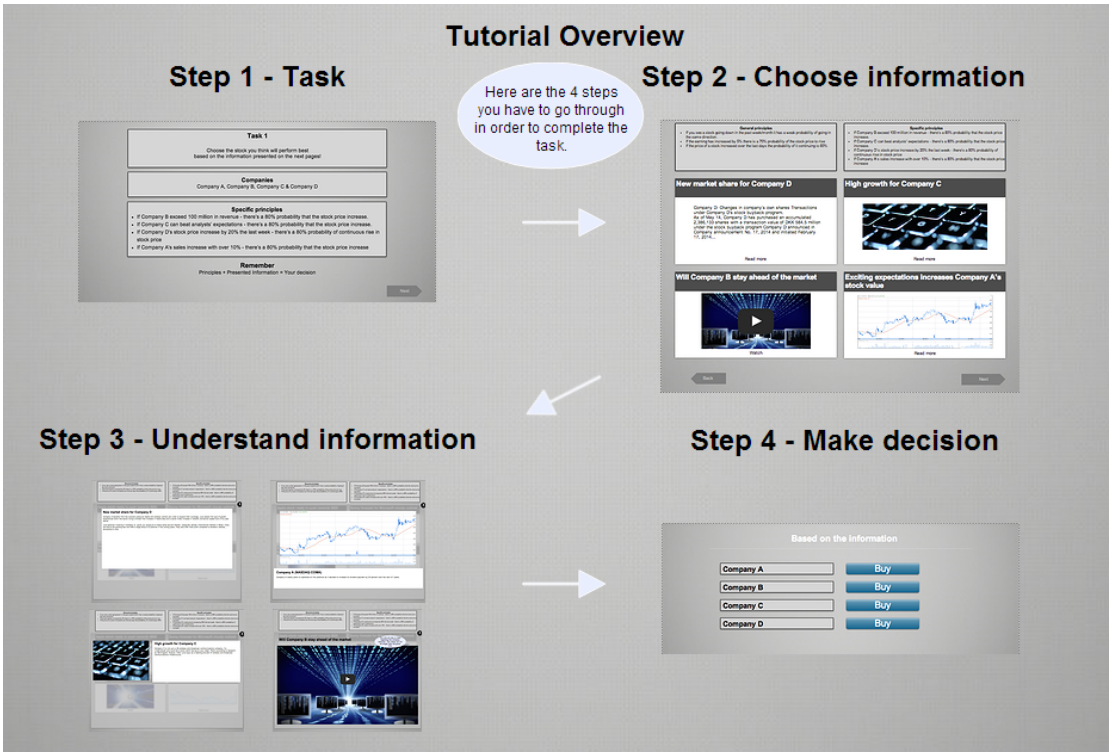


Figure 55: Presentation of Task Overview in the tutorial

With an understanding of the process and the task the subjects should increase their concentration on completion instead of mentally wandering off. The overview can also give subjects clear instructions of what and how to do things so they don't use time and energy on things irrelevant for the experiment. This point is especially important in this context were eye-tracking technology is applied. In order for results being clear and analyzable from the eye-tracker it is necessary to limit unnecessary noise from the experiment and the results. The tutorial can facilitate a cleaner measurement of subject's eye-behavior and is an important element in order to achieve desired results.

10.7.3.4. Task Tutorial

In the same way as General Conditions were presented will the Task Specific Conditions be presented in the same settings as in the experiment.

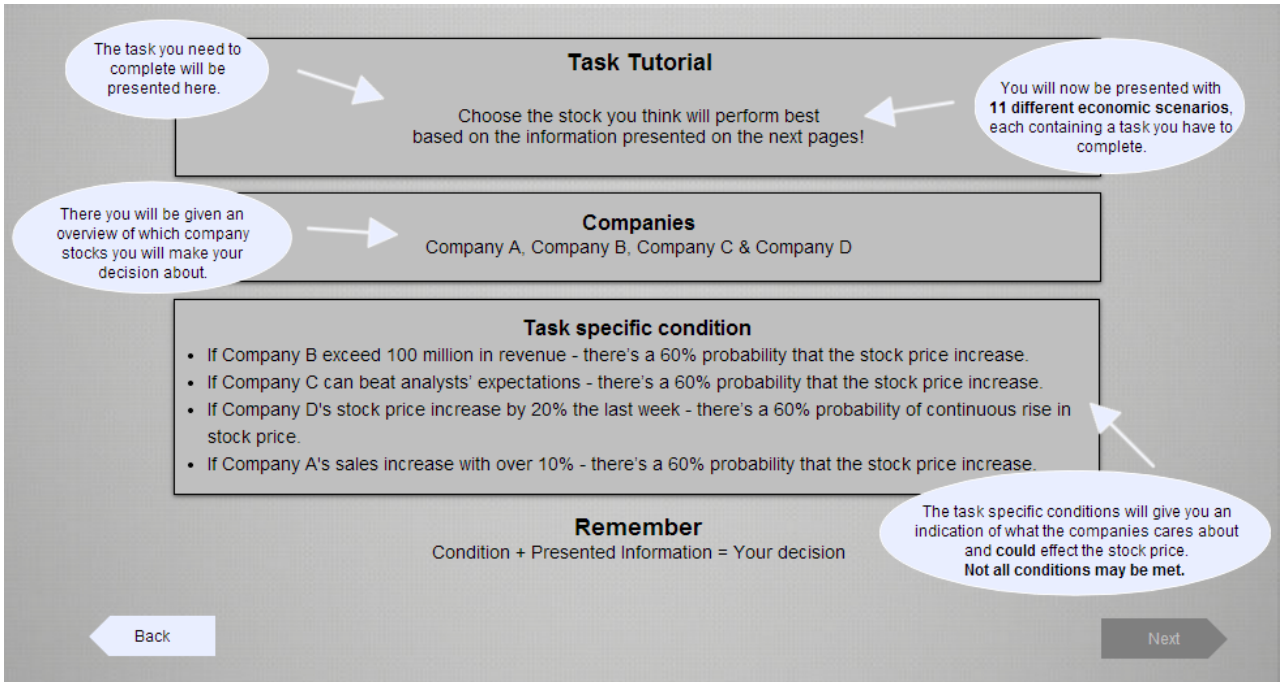


Figure 56: Presentation of Task in tutorial

The illustration above shows how speech bubbles are used to explain the elements in detail. There is focus on telling subjects which companies to choose between and how the specific conditions are formulated for these companies. The large speech bubble provide the subjects with the information *"not all conditions may be met"*, this could affect their behavior and their priorities when foraging. The speech bubble at the top right provides the subject information on the length of the experiment. These elements in the speech bubbles has been marked with bold in order to emphasize the importance of them in the experiment.

10.7.4.6. Test - General Conditions

Making sure that subjects understand the conditions are essential to the experiment. In case of subjects not understanding the conditions they will not behave in ways that minimize risk and the experimental context - information foraging under risk will not successfully have been applied. Hence it is important and of high priority to get subjects to understand the conditions. There is implemented a test, right after the tutorial has finished explaining the General Conditions, which will test if subject understand how they work. Below is presented how the conditions are tested:

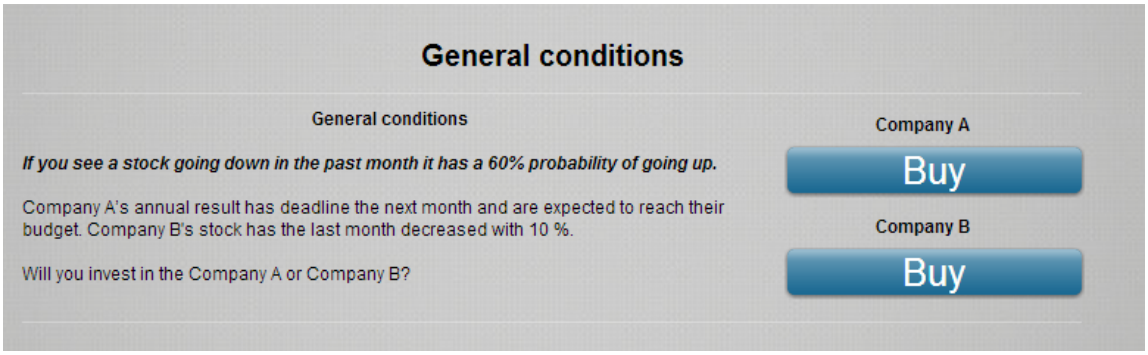


Figure 57: Presentation of Testing General Conditions

In the illustration above subjects are asked to answer which company that fulfill the condition stated. Depending if they answer correct or incorrect, there will be showed a message telling whether they answered Correct or Wrong and explaining why it was correct or wrong.

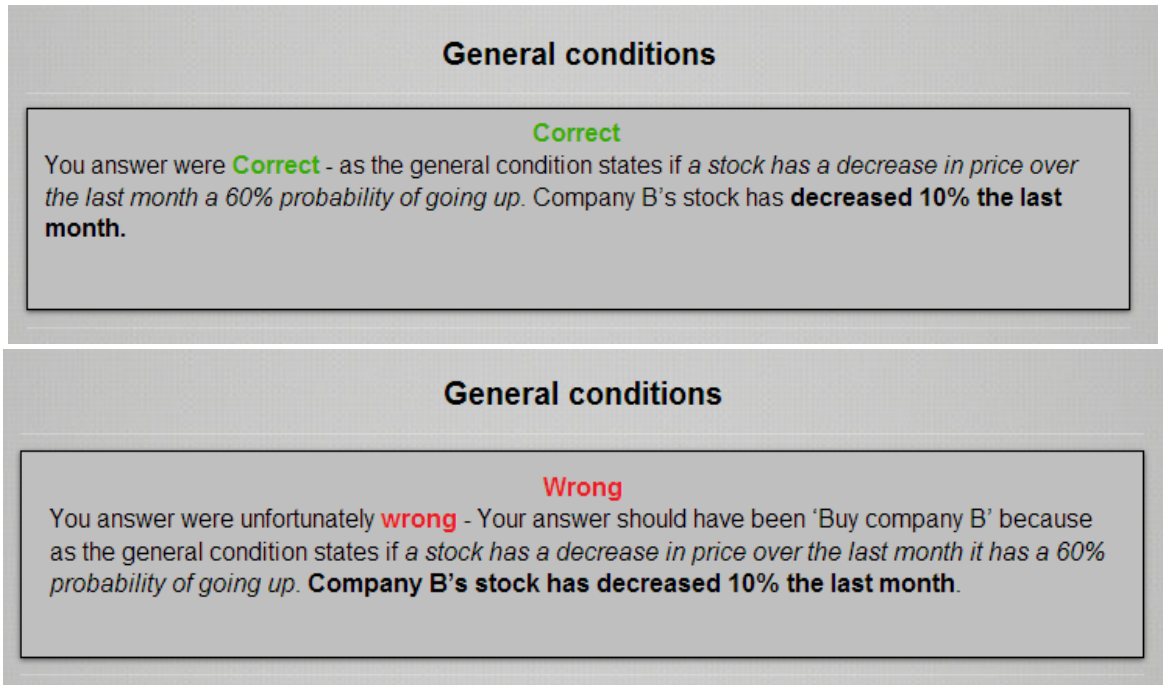


Figure 58: Testing General conditions: Right and Wrong answer

This learning process will be repeated for all four general conditions giving the subjects a chance to learn and understand the conditions of the experiment.

10.7.4.6. Test - Purpose of Experiment

The last element in the tutorial is in continuation of the test of General Conditions. A test of subjects understanding of the task they need to solve. The structure is the same as illustrated with the General Conditions. Here subjects need to judge if the statement presented is true or false. They will get feedback on their performance as in the previous test.

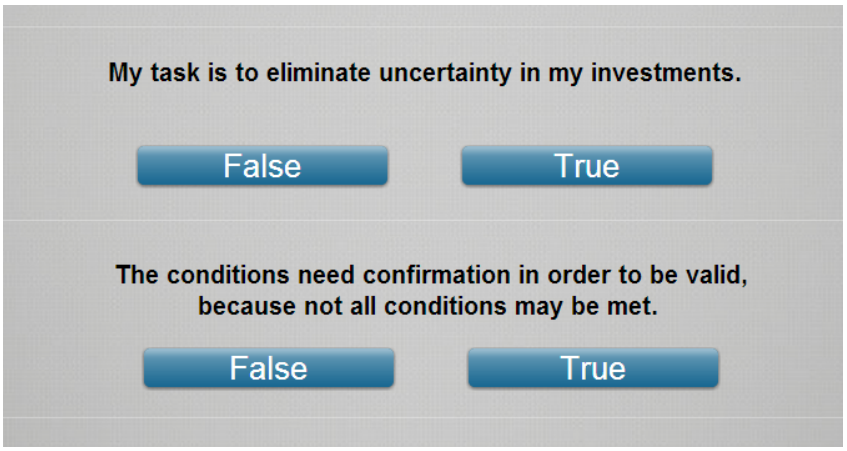


Figure 59: Testing of tasks

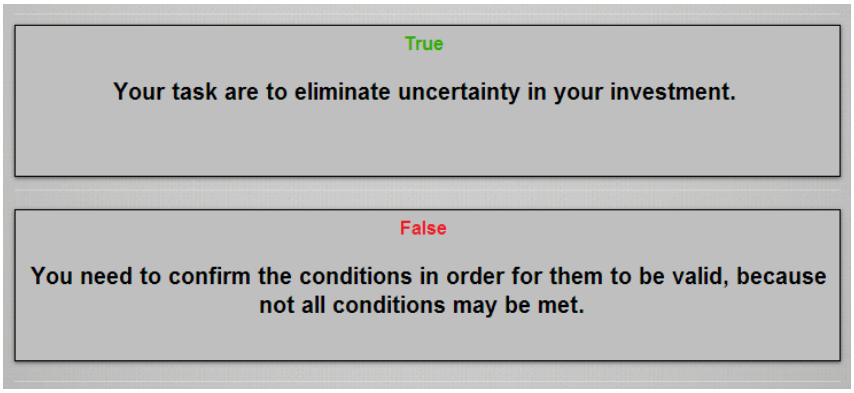


Figure 60: Testing of Tasks: In case of right and wrong answer

By testing subjects understanding of the task it is a way to increase the validity of their answers. The testing will confirm if subjects have the mindset requested and aligned with the experiments objective.

10.7.5. Overview of the Task

This section provides a more detail insight into the task of the experiment and development of it.

10.7.5.1 The Task

The experiment contains a task to solve and it is the same all the way through the experiment. The information used in each task is going to be different in each task. Subjects will go through 11 different tasks, each with different companies and information. The task will be presented first before any information foraging activities start. When a task is completed the next task will be presented and indicate that the task is completed. Subjects won't see a page telling them the task is completed because it will be an unnecessary extension of the experiment and can create frustration. The solution chosen is faster and more intuitive.

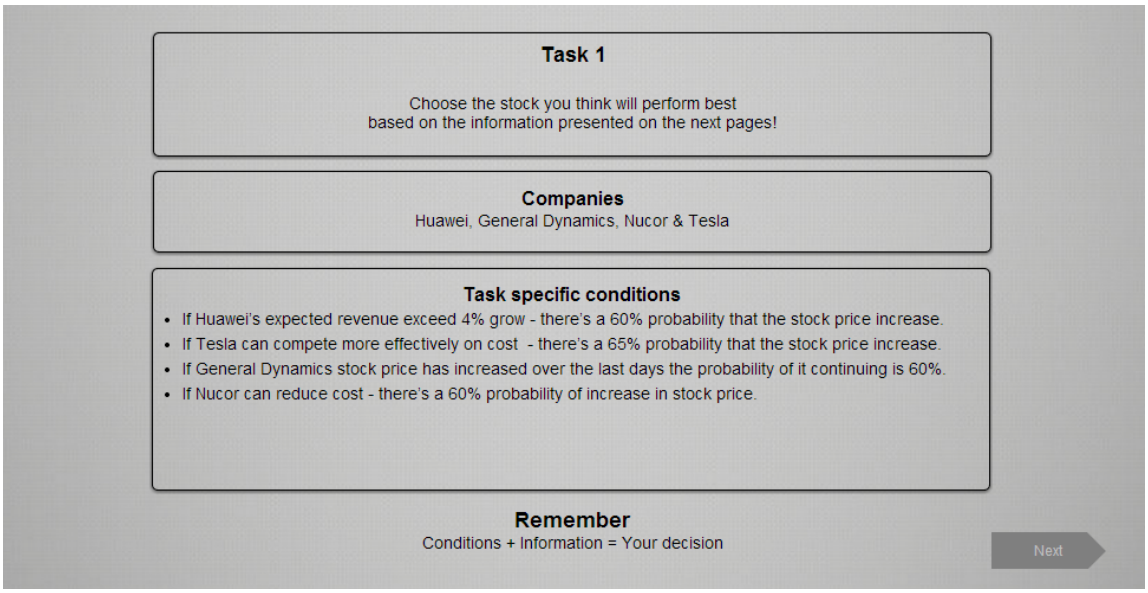


Figure 61: The Task

The task is based upon a decision-making situation where subjects have to chose one company out of the four different companies represented, based on the four information's available on the presentation page. The task page is build up by three elements: The Task, Companies to choose between and the Task Specific Conditions.

The task is formulated in the following terms:
Choose the stock you think will perform best based on the information presented on the next page!

Next element is the companies you can choose between. They will change each time, in order to limit learning effects. The companies in this example are stated as follow:
Huawei, General Dynamics, Nucor & Tesla.

Last element of information is the Task Specific Conditions. These will provide information about the specific conditions that needs to be confirmed by one of the information cards on the next page, called *the presentation page*. Subjects have been told that both the General- and Task Specific Conditions will be displayed on the presentation page therefore it is not necessary trying to remember them. The task specific conditions:

- *If Huawei's expected revenue exceed 4% grow - there's a 60% probability that the stock price increase.*
- *If Tesla can compete more effectively on cost - there's a 65% probability that the stock price increase.*
- *If General Dynamics stock price has increased over the last days the probability of it continuing is 60%.*
- *If Nucor can reduce cost - there's a 60% probability of increase in stock price.*

10.7.6.2. Variation in Companies

The experiment makes use of existing and well-known companies. Companies that reasonably can be assumed to be well-known in the general public. This raises the question of company ties. The companies used are:

Facebook, Google, Microsoft, Apple, Ebay, Blackberry, Twitter, Johnson & Johnson, General Dynamics, Alibaba, Nokia, SunEdison, Tesla, Fiat, Just-Eat, Lloyds Banking group, Samsung, Amazon, Vestas, Airbus and Huawei.

Table 10: Companies represented in the experiment

There are both pros and cons for using real companies. They will be listed here in order to be explicit why it gives more advantages compared to disadvantages to the experiment. The number of companies has been selected in order to achieve a high level of variation. One advantage of using multiple companies is the limitation of effects of company ties. Subjects may still have company ties towards one or more of the companies used in the experiment, but the effect of these company ties will be relatively limited. In order to explicit the point there will be an example of the two different scenarios, low number of companies and high number of companies.

In the case of using 4 different companies it has a large impact on the experiment and analysis if the subjects have an affect towards one or more of the companies used. Using 21 different companies the effects of company ties becomes relatively limited. This is one of the reasons why it is reasonable to use a greater number of companies instead of a limited number of companies.

If company ties should exist and occur in the experiment it will likely be noticed in the control mechanism built into the experiment. To ensure that company ties will be discovered a questionnaire has been developed and added to the end of the experiment as an extension. The post experiment questionnaire contains a specially designed question to detect possible company ties. The question asked is:

Do you follow or have particular interest in one or more of the companies in this experiment?

Thereafter all companies in the experiment are listed and can be marked if you have a particular interest in one or more of them. These control mechanisms will be able to give explanation to potential weird or irrational behavior. An example of this could be subjects characterized as Apple fans and of their products creating positive company ties in tasks where Apple is one option out of the alternatives to choose between. Here subjects have the choice to mark that they follow Apple more extensively and this can be a plausible explanation for the specific behavior experienced. Which will lead to choices made by subjects do not represent their information foraging behavior in the specific context but instead their preconceived knowledge of in this example Apple. This is not in the interest of this thesis.

Another advantage by using well-known companies is subject's inquisitiveness towards these companies. Real companies makes it possible to use real life events and its information in the tasks making it more realistic regarding the economic context it is conducted in. This can provide the realistic context needed in order for subjects to exercise the foraging behavior similar to what it would be exercised in the real world. Alternatively, fake companies could be used because it would eliminate all company ties towards well-known companies. But given the complexity of the experiment and the limitations to a master thesis it will not be possible to develop videos, articles, pictures and graphs from scratch for the fake companies. It is simply too comprehensive. The next best alternative is to use well-known companies and incorporate control mechanism for potential company ties.

Which of the companies who will make money is secondary for the experiment and will work as a facilitator for simulating the information foraging behavior in a financial environment. After the subjects have made their first eye-interaction with the information cards, the rest will be secondary in the context of information foraging stimulation. Nevertheless it is still interesting to document their behavior regarding their second and third choices. This will show how the behavior corresponds with the probabilities and the economic rationality will also be of interest.

10.7.6.2.1. Randomization

The 21 companies fill out the 44 cards of information this results in some companies are represented more than once. This is due to the selection criteria of the information, which limit the supply of material fitting these. The most represented companies are Apple, Facebook and Google

who all are represented 5 times but with different information. The representation of the companies somewhat reflect the availability of Tradingfloors.com videos under the development process and are therefore a realistic sample of the supply and demand of information at the given time.

The randomization of the companies was developed with a couple of rules to eliminate some combinations. The first rule is developed to ensure that there is no company ties towards any particular company in a specific task, therefore is no company presented twice in the same task. Having two or more information's about the same company represented in the same task could result in the participant adding up the information to create a greater tie towards a company compare to another. Or on the other hand, if subjects are experiencing Apple represented in both video and text at the same page might only chose one of them caused by feelings of redundancy.

The second rule will prevent that the same company is presented in the same card format two times in a row. This is to eliminate any perception of repetition of the same information presented twice in same format.

In order to prevent a learning effect about the companies, the randomization of the presentation order has been applied to the experiment. This randomization prevents the previous mentioned learning effect, which could result in irrational behavior by the subjects and their choices. The randomization with the added rules created the following order of information cards, which is presented in the table below. The information for the different cards was selected randomly until all the cards were filled.
The table illustrates how some companies can be represented in more than two tasks after each other, but won't be represented with the same information source. For example Facebook is presented as a video in the first-, as a picture in the second- and a text in the third task. This follows the previously presented rules of randomization.

Task number	***Video***	***Graph***	***Picture***	***Text***
1	*Nucor*	*General Dynamics*	*Tesla*	*Huawei*
2	*eBay*	*Apple*	*Facebook*	*Blackberry*
3	*Twitter*	*Johnson & Johnson*	*General Dynamics*	*Facebook*
4	*Google*	*Apple*	*Alibaba*	*Nokia*
5	*SunEdison*	*Google*	*Fiat*	*Apple*
6	*Facebook*	*Just-Eat*	*Google*	*Alibaba*
7	*Microsoft*	*Tesla*	*Lloyds Banking Group*	*Samsung*
8	*Apple*	*Amazon.com*	*Twitter*	*Vestas*

9	*Google*	*eBay*	*SunEdison*	*Tesla*
10	*Fiat*	*Facebook*	*Just-Eat*	*Airbus*
11	*Facebook*	*Google*	*Microsoft*	*Apple*

Table 11: The companies' presentation

There's an overview of the how many times the companies are represented in the 11 different tasks of the experiment in 11.8.6.2. Variation in Companies.

10.8 Appendix 8 - Control Mechanism Position

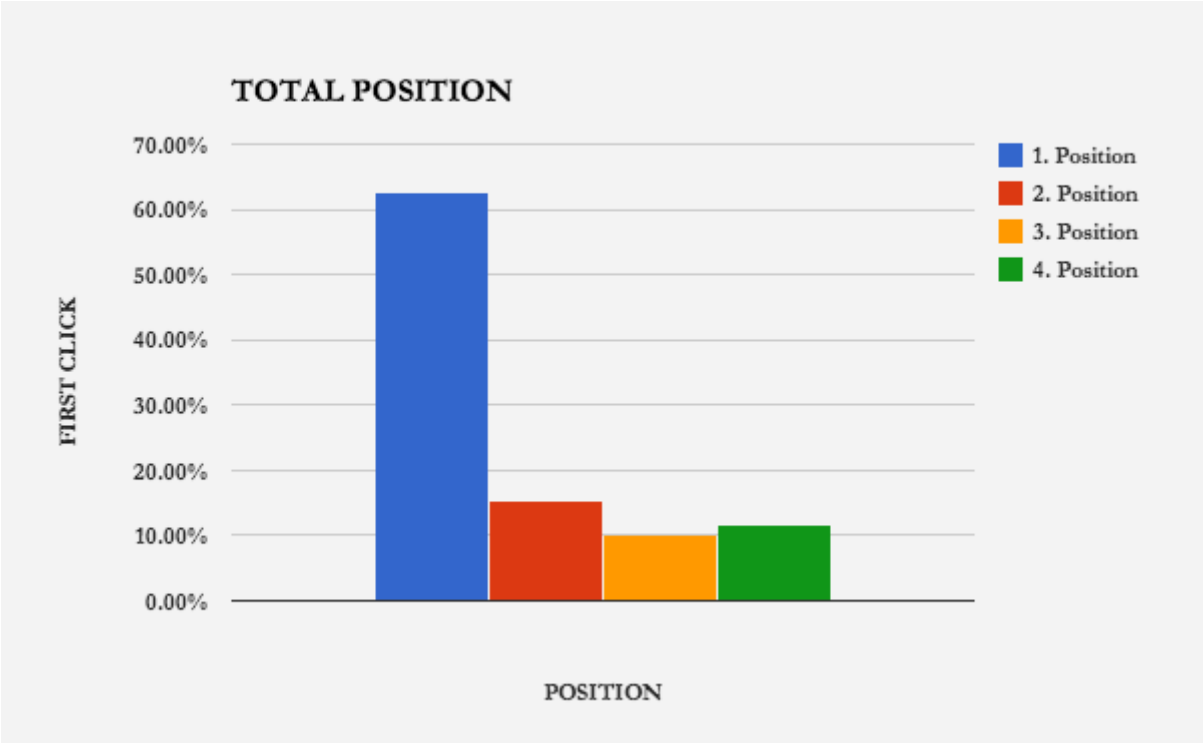


Figure 62: Total Position First Click

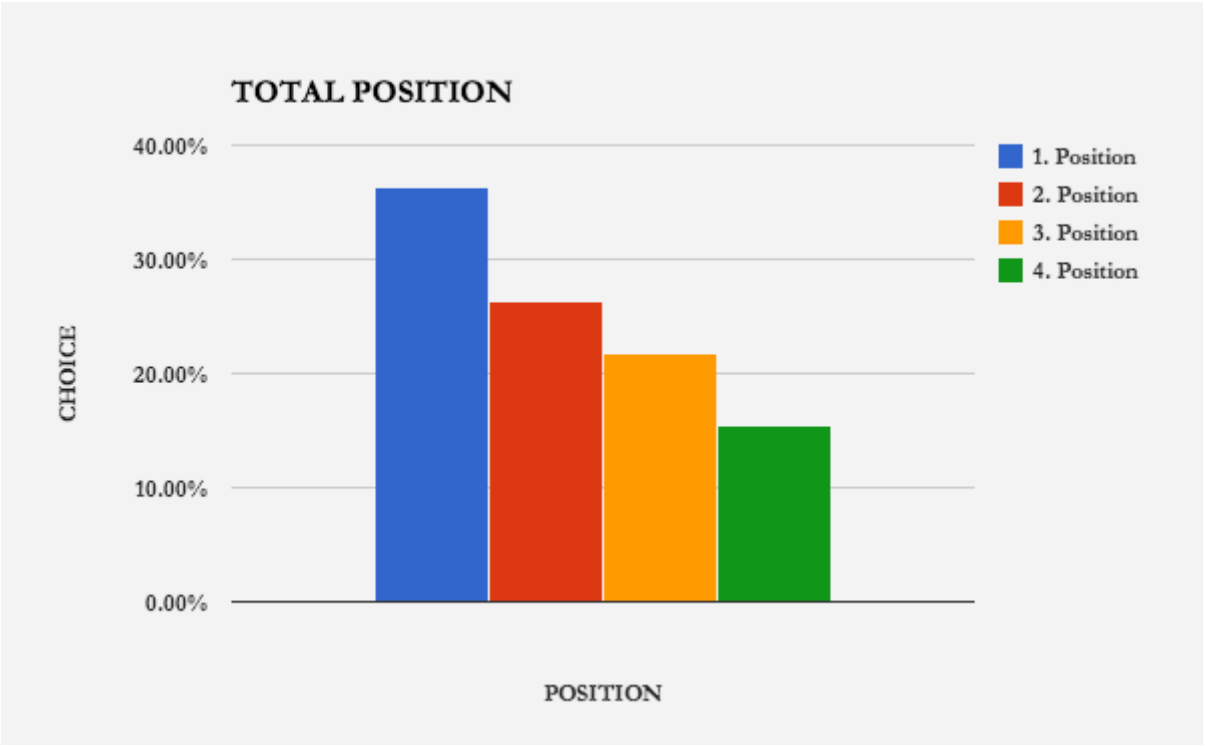


Figure 63: Total Position Choice