

INFORMATION PROCESSING OF FINANCIAL NEWS: THE ROLE OF COGNITIVE DISSONANCE AND INFORMATION AVOIDANCE

Research in Progress

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Abstract

Although traditional behavioral theories suggest that agents seek out as much information as possible in order to make an informed decision, recent studies indicate that humans may also be motivated to avoid new information that might lead to a potentially unpleasant emotional response. Such human characteristics become even more relevant in financial markets where information in the form of financial news is intended to serve as an important basis for financial decision-making. This paper therefore aims to enhance the understanding of how humans perceive information embedded in financial news. For this purpose, we conduct a controlled NeuroIS laboratory experiment and utilize advanced methods from statistical learning to systematically analyze the information processing of financial news. Overall, this study aims to contribute to Information Systems theory by adapting the theoretical concepts of cognitive dissonance and information avoidance to financial markets in order to better understand how decision-makers process and act upon information.

Keywords: NeuroIS, behavioral finance, information processing, cognitive dissonance, information avoidance, decision-making, cognitive bias, decision analytics.

1 Introduction

Cognitive processing of information plays a key role in decision-making by enabling humans to choose actions in a controlled manner from among a set of alternatives. However, various studies in the Information Systems discipline have shown that human agents do not rely solely upon cognitive reasoning when processing given information (Browne and Parsons, 2012). For instance, recent studies indicate that humans are likely to prevent or avoid the acquisition of available but potentially unwanted information in order to avoid cognitive dissonance (Albarracín and Mitchell, 2004; Hart et al., 2009; Sweeny et al., 2010). According to Sweeny et al. (2010) humans avoid information for three reasons: (1) the information might threaten cherished beliefs about the self, others, or the world; (2) the information might demand undesired change or action; and (3) the information or the decision to learn the information might lead to unpleasant emotions. In related research, the phenomenon of *information avoidance* is primarily explained by the preference for attitude-consistent information in terms of *cognitive dissonance* theory (Case et al., 2005; Frey, 1982). Here, humans experience dissonance, i. e. an unpleasant state of anxiety, in response to inconsistency between their cognition and behaviors (Frey, 1982; Hart et al., 2009; Smith et al., 2008). Information avoidance behavior is of particular relevance in financial markets where traditional behavioral theories regarding human decision-making suggest that investors seek out as much information as possible in order to make an informed decision (Wilson, 1999). Here, obligatory financial news disclosures ensure that all market participants are equally provided with information and serve as an important source of information for investors before exercising ownership in stock (Gidófalvi and Elkan, 2001). These documents follow a predefined structure and typically consist of multiple segments that make agents likely to form initial beliefs at an early stage (i. e. after reading the news headline) (Muntermann and Guettler, 2007). Yet, it is unclear whether the nature of financial news encourages a tendency among investors to eschew the acquisition of further information that potentially threatens their initial beliefs.

Hence, this paper addresses the following research question: How do the effects of information avoidance and cognitive dissonance affect the human decision making when reading financial news? For this purpose, we conduct a controlled NeuroIS laboratory experiment that uses measurements of physiological parameters (heart rate, skin conductance, eye gaze fixation patterns) to systematically analyze the neuro-physiological information processing of human agents. This enables us to shed light on the underlying cognitive and affective processes that may cause agents to avoid potentially relevant information.

Our contribution is two-fold. First, this paper contributes to IS theory by adapting the theoretical concepts of cognitive dissonance and information avoidance to a financial market problem. We thereby explore whether the textual content in financial news can lead to an undesired emotional state that causes humans to avoid potentially relevant information. Second, we use a novel approach based on neuroscience methods and tools to measure and investigate the effects of affective and cognitive processes on human decision-making. Altogether, this research provides ample scope to inform the design of tools and decision support systems that rely on information in the form of written text.

The remainder of this article is organized as follows. Section 2 establishes the background of our study by introducing the role of affective and cognitive processes in news perception. Based on studies from the related literature, we also introduce our research model, which incorporates the effects of cognitive dissonance and information avoidance in relation to the information processing of financial news. Section 3 introduces the setup for our controlled laboratory experiment. Finally, Section 4 illustrates the way in which we plan to test our research hypotheses and Section 5 outlines our further research agenda.

2 Theoretical Background

Recent research indicates that humans can exhibit a tendency to avoid new information, even though processing this information might lead to more advantageous decisions (Sweeny et al., 2010; Wilson, 1999). This information avoidance phenomenon is based on a complex interplay between affect and cognition where inconsistency can give rise to a potentially unpleasant emotional state that might lead

to a conscious or unconscious incentive to avoid relevant information (Case et al., 2005; Hart et al., 2009). Information avoidance is also important when studying the way in which humans read and process information in the form of written text. In fact, reading can be regarded as a dynamic process in which the degree of affective and cognitive processing cannot be assumed to be fixed (Linderholm et al., 2004). The implications are of particular relevance in financial markets where textual information in the form of financial news is directly related to the decision-making of investors (Carter and Soo, 1999; Pröllochs et al., 2015). Financial news are regulated in terms of form and style and typically consists of two components: first, a headline that summarizes the content, and second, a body of text that contains a detailed description of a market relevant event (Muntermann and Guettler, 2007). However, the news typically exhibit a certain degree of disagreement between headline and body, since companies frequently frame their headlines using thematic manipulations and other impression techniques (Riley and Luippold, 2015). In the following, we hypothesize how reading financial news affects the cognitive and affective processes of human decision makers. Our understanding of the human information processing of financial news is summarized in the research model in Figure 1. In particular, we hypothesize that stronger affective processes in response to reading the news headline lead to a stronger initial categorization into positive or negative (H1). In addition, we hypothesize that a stronger initial categorization results in a higher degree of information avoidance in the processing of the news body (H2). Finally, we also expect that a higher degree of information avoidance results in a higher degree of decision confidence (H3). In the next sections, we detail our research hypotheses and provide evidence that studying the above effects is both a novel and relevant research area to Information Systems theory and practice.

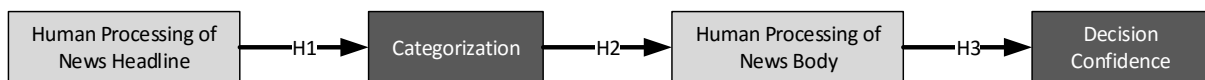


Figure 1. Research Model: The Human Information Processing of Financial News.

2.1 The Role of Affect in Processing of News Headlines (H1)

In the literature, the role of affective and cognitive processes in decision-making is often conceptualized in *dual system* models whereby the cognitive system is characterized as analytical and logical while the affective system is characterized as fast, automatic, and emotionally charged (Lee et al., 2009; Steinhart et al., 2013). In this context, cognitive processing refers to the part of decision-making that is carried out in a controlled manner based on certain criteria, whereas affect is a typically emotion-induced predisposition to behave either positively or negatively towards an objective or idea. Although the conceptualization of such dual system models is “*undoubtedly an oversimplification and an imprecise representation of the complex human mind,*” it is nevertheless useful for investigating human behavior (Lee et al., 2009, p. 174). As noted by Loewenstein (2000), “*important decisions induce powerful emotions in decision makers*” (p. 429) and hence financial decisions, due to their material consequences, inherently involve considerable levels of affective processing. Recent NeuroIS research has shown that affective information processing is a key driver in human financial decision-making, highlighting that information processing needs to be understood as a dynamic process which evolves over time (Astor et al., 2013; Teubner et al., 2015). As such, the degree of affective processing is directly related to the resulting motivations and beliefs (Jiang et al., 2007). During a dynamic reading process of financial news, the reader usually processes the headline first. Based on cognitive and affective processes, the reader consciously or unconsciously forms an initial categorization of the news as either positive or negative. Based on the above studies, we thus expect readers to form stronger initial beliefs about a news when they exhibit higher degrees of affective processing while reading a news headline. H1 states:

Hypothesis H1. *The stronger the affective processes in response to reading the financial news headline, the stronger the initial categorization into positive or negative.*

2.2 The Role of Information Avoidance in Processing of News Bodies (H2)

Humans are likely to avoid information that might threaten cherished beliefs or demand undesired change or action (Sweeny et al., 2010; van 't Riet and Ruiter, 2013). In the field of psychology, this is largely explained by the preference for attitude-consistent information in terms of dissonance theory (Smith et al., 2008). According to the theory, people experience cognitive dissonance, i. e. an unpleasant emotion, in response to inconsistency between their cognitions and behaviors (Hart et al., 2009; Smith et al., 2008; Sweeny et al., 2010). Such inconsistencies in the human mind can lead to the conscious or unconscious tendency to avoid potentially relevant information (Case et al., 2005; Hart et al., 2009; Sweeny et al., 2010). In fact, defensive reactions, like avoidance, may be an attempt to regulate negative emotions (van 't Riet and Ruiter, 2013). We hypothesize that the human affinity for avoiding undesired information impacts the information processing of news bodies as follows. A strong initial belief regarding the content of the news, i. e. the categorization after reading the headline, is accompanied by the prospect that further information, i. e. the content of the news body, might change this initial belief. More specifically, further cognitive news processing might lead to cognitive dissonance and an unpleasant, undesired emotional state. To prevent contradictory information and its consequences, the reader might be motivated to avoid further information acquisition, i. e. processing the information contained in the news body. Consequently, news readers who have already formed a strong definite belief at the beginning of the reading process are expected to avoid the incorporation of subsequent text that potentially threatens their initial categorization. Thus, H2 reflects the notion that an already-formed initial categorization reduces the degree of processing with regard to succeeding information.

***Hypothesis H2.** The stronger the initial categorization, the higher the degree of information avoidance in the processing of the financial news body.*

2.3 The Role of Information Avoidance in Decision Confidence (H3)

Information avoidance can enable one to maintain or strengthen beliefs in the face of contrary evidence (Jones and Sugden, 2001; Nickerson, 1998). Moreover, humans generate and evaluate evidence in arguments in a manner that is biased towards their own beliefs and opinions (Jones and Sugden, 2001). As a consequence, the presence of contrary evidence can influence not only the information seeking behavior, but also the confidence in subsequent decision-making processes (Phillips et al., 2014). For instance, related studies have shown that agents who tend not to examine information that is potentially inconsistent with their views typically exhibit higher levels of decision confidence (Albarracín and Mitchell, 2004). Similarly, Jones and Sugden (2001) propose that confirmation biases “*increase the subject's confidence in the truth of the statement*”.

Apparently, these characteristics are of particular relevance in the case of financial news. Here, the initial categorization after reading the news headline might prevent the reader from the acquisition of subsequent information. The resulting ignorance of potentially relevant information might then strengthen initial beliefs and contribute to strong confidence. Based on this reasoning, we thus hypothesize that a higher degree of information avoidance regarding the processing of a financial news body positively impacts the degree of confidence with regard to a subsequent trading decision.

***Hypothesis H3.** The higher the degree of information avoidance, the higher the degree of confidence in the trading decision.*

3 Experimental Design

To test our research hypotheses, we conduct a controlled laboratory experiment. During the experiment, the participants read and categorize financial news in order to accumulate so-called monetary units (MUs), which are individually converted into real money and paid out in cash after the experiment. This procedure

ensures that all decision-making in this experiment is directly related to real monetary incentives and that participants perceive their behavior as relevant, experience real emotions, and make decisions with real consequences (Falk and Heckman, 2009; Smith, 1976).

3.1 Treatment and Session Structure

During the experiment, the participants take on the role of investors who make trading decisions based on reading financial news. The news items are selected on the basis of having either a positive or negative actual, historic stock market return of the company responsible for publishing the financial news in question. Before reading a financial news release, the participants are provided with an endowment in the form of one share of the corresponding company with a value of 1 MU. After reading the news, the participants are able to hold or sell their endowment. If a participant decides to hold the endowment, he/she will gain or lose MUs based on the percentage change of the real stock market return. If the participant decides to sell the endowment, he/she will keep the initial endowment. Every participant is subjected to every single treatment in the form of positive and negative news using a so-called within-subject design, i. e. each participant reads and categorizes the same sample of financial news. The fact that subjects act as their own control provides a way of reducing the amount of error arising from natural variance between individuals (Loftus and Masson, 1994). In order to avoid external effects, the order in which the news items are presented is chosen randomly for each participant. The entire process, referred to as a *trading session* in this paper, in which the participants read and categorize the provided financial news is divided into 6 events (see Figure 2). After an initial waiting time of 12 seconds, the participant receives initial information regarding his/her endowment. In a next step, the news headline is displayed (E1). After 10 seconds of reading time, the participant submits an initial categorization of the headline in terms of positivity or negativity on a seven-point Likert scale (E2). Subsequently, the news body appears for 60 seconds (E3). Then the participant decides whether to sell or hold the endowment (E4) and categorizes his/her confidence in the trading decision as either strong or weak (E5). Another 5 seconds later, the real stock price change and the corresponding payoff is revealed to the participant (E6). This process is repeated for all news items in the sample.

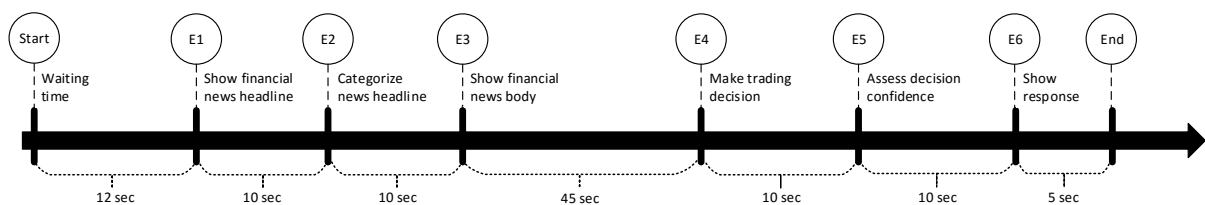


Figure 2. Session Structure and Time Intervals Between Events.

3.2 Selection of News

During the experiment, the participants categorize and trade *real* financial news in the form of regulated ad hoc announcements¹ that are written in English. This type of news exhibits several advantages: ad hoc announcements must be authorized by company executives, the content is quality-checked and several publications analyze their relevance to stock market reactions – finding a direct relationship (e. g. Muntermann and Guettler, 2007; Pröllochs et al., 2016a,b). The sample for the experiment consists of 50 financial news items that are comparable in terms of title length, body length and stock market reaction. We describe the news selection process briefly in the following. First, we select only pieces of news that feature a title length between 8 and 12 words. Second, we also select news items that exhibit a similar

¹ The financial news disclosures are kindly provided by Deutsche Gesellschaft für Ad-Hoc-Publizität (DGAP).

body length between 250 and 350 words. This choice is justified by the fact that the mean number of words per document in our corpus is 300 and the typical reading speed of university students is located approximately between 250 and 350 words per minute (Carver, 1989). In a next step, we aim to extract the effect of the financial news disclosure without confounding influences. For this purpose, we use the common event study methodology (Konchitchki and O'Leary, 2011; MacKinlay, 1997) to calculate a so-called daily *abnormal return* of the corresponding company that allows us to isolate the effect of an event, i. e. the publication of the news disclosure, from other general market movements (MacKinlay, 1997). In order to account for extreme and marginal stock price effects, we remove outliers and news that is not clearly positive or negative with respect to the corresponding stock market reaction. Specifically, we select only news that features an abnormal stock market return in a range between $\pm 1\%$ and $\pm 3\%$. Since stock market reactions are often based on prior expectations or external effects, the stock market return often does not follow the tone one expects based on reading financial news. To account for such imponderable influences, we remove news that features linguistic content that is not in line with the stock market reaction. For this purpose, we calculate a so-called sentiment value for each document using the frequently employed net-optimism metric (Demers and Vega, 2010; Henry, 2008) in combination with the *Henry Financial Sentiment Dictionary* (Henry, 2008). This approach is not only straightforward, but also produces reliable and highly interpretable results (e. g. Tetlock et al., 2008). As a final step, we anonymize all remaining news and randomly select 25 news items with positive abnormal stock market return and sentiment and 25 negative items, respectively. Here, the anonymization process eliminates the potential influence of prior stock market knowledge of the participants. This leads to a final sample size of 50 news items, i. e. 50 rounds in which the participants read and categorize news items.

3.3 Procedure and Implementation

Our experiment comprises a total of 100 university students, of which the participants represent a similar number of females and males (Schubert et al., 1999). The experimental software is implemented in Brownie Hariharan et al., 2017."Since this study requires a basic understanding of financial markets, all participants have to share an economic background, i. e. have to be enrolled in economics, finance, or a related discipline. We also ensure that all environmental conditions are in line with the requirements of the Society for Psychophysiological Research (Pivik et al., 1993).

The experiment comprises three stages. In the first stage, the measurement electrodes are attached and the participants have to successfully complete a computer-based quiz regarding the instructions of the experiment. This procedure ensures the full comprehension of its rules. The quiz is followed by an initial test round, in which no money is gained or lost. This allows us to introduce the experimental environment to the participants and reduce the impact of novelty. Subsequently, the experiment comprises a five-minute rest period in which the no actions are required from the participants. This allows us to assess a basic level of physiological arousal for each individual (Riedl et al., 2014; Teubner et al., 2015). The corresponding physiological measurements are used for normalization purposes in the analysis. In the second stage, the participants read and categorize the provided news on a graphical user interface. As visualized in Figure 3, the interface consists of three main components. The first component is the header at the top of the screen that is visible during the entirety of each round and provides each participant with information regarding his/her endowment. The second component comprises the visualization of the news. Here, the news headline and the corresponding body of the text are displayed in distinct fields. The third component consists of the news categorization and action interface. This component enables the participants to rate the news headline, make a trading decision and assess the corresponding confidence. Ultimately, this component also visualizes the trading response at the end of each round. Here, the participant receives information regarding the real stock movement and its individual payoff. The third stage of the experiment comprises a self-reported questionnaire that addresses participants' individual feelings during the experiment. The questionnaire is based on a series of statements with which subjects indicate agreement or disagreement on a seven-point Likert scale. The main purpose of the questionnaire

is to assess the degree of perceived excitement and individual relevancy. Ultimately, we also conduct a standardized risk aversion test to control for the individual risk attitudes of each participant. Here, we use the test by Holt and Laury (2002) which approximates the risk preferences of a participant based on consecutive decisions between two lotteries with different levels of risk and expected payoffs.

You are endowed with one share of company X.					
<p style="text-align: center;">Financial News Disclosure</p> <p style="border: 1px dashed gray; padding: 2px;">Company X unexpectedly announces negative earnings for the year</p> <p>With the close-the-books work nearly finished, company X will probably disclose a net loss before taxes for the year of approx. EUR 2.6 million. The reason for the deterioration are findings made by the auditors during the preparation of the financial statements that customer-related expenses and valuation allowances on current assets were not adequately reflected in the forecasts for the result of the fiscal year 2003. At the same time, an impairment loss has been recorded on the investment in the Polish subsidiary due to an amended view of market developments there and changes in the composition of shareholders. The deterioration in earnings as a result only affects the fiscal year 2003 and has no impact on the current year. In view of the earnings situation for 2003, the management board will not be able to propose a dividend payment for the year.</p> <p>The company has announced that the director responsible for finance, controlling and personnel, Mr. X, has asked the supervisory board in connection with this to terminate his contract with immediate effect. The supervisory board has complied with this request and at the same time decided that the portfolio for which Mr. X was responsible to date will be jointly managed by the other members of the management board until a suitable successor for the finance, controlling and personnel portfolio is appointed.</p>	<p style="text-align: center;">News Categorization</p> <p style="text-align: center;"> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> </p> <p style="text-align: center;">Negative Neutral Positive</p> <hr/> <p style="text-align: center;">Stock Market Decision</p> <p style="text-align: center;"> <input type="button" value="Sell"/> <input type="button" value="Hold"/> </p> <hr/> <p style="text-align: center;">Decision Confidence</p> <p style="text-align: center;"> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> </p> <p style="text-align: center;">Weak Medium Strong</p> <hr/> <p style="text-align: center;">Response</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Stock Movement</th> <th style="width: 50%;">Payoff</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">- 1.05%</td> <td style="text-align: center;">-\$0.21</td> </tr> </tbody> </table>	Stock Movement	Payoff	- 1.05%	-\$0.21
Stock Movement	Payoff				
- 1.05%	-\$0.21				

Figure 3. Graphical Illustration of the Trading Interface.

3.4 Measures

During the experiment, the news categorization and decision confidence of the participants is assessed with a seven-point Likert scale (see Figure 3). In order to model proxies of the cognitive and affective processes, we measure several neurophysiological parameters. An Tobii Pro X120 eye tracker is used to record eye movement patterns when reading the news headline and body of text. Measurement of eye-gaze-fixation patterns allow us to determine the degree of information avoidance when reading the news body (Léger et al., 2014). Heart rate measurements serve as a measure for overall arousal (Ortiz de Guinea et al., 2013; Teubner et al., 2015), while skin conductance response measurements determine the intensity of immediate emotions (Riedl et al., 2013; Teubner et al., 2015) in response to reading the news headline. In order to achieve sufficient accuracy, the eye tracking device is calibrated for each participant individually prior to the actual experiment. Moreover, all physiological measurements are normalized based on an initial 5-minute rest period. Finally, we assess the degree of perceived cognitive dissonance and information avoidance of the participants using the questionnaire from Sexton and Dugas (2008). This questionnaire is a 25-item self-report measure to rate the thoughts of a participant based on question items such as “I often do things to distract myself from my thoughts.” Moreover, because information avoidance is linked to emotional regulation, a questionnaire based on that of Gross and John (2003) is used to assess the individual emotional regulation strategies of the participants when reading positive and negative news.

4 Hypothesis Testing

We test our research hypotheses using the following methodology. First, we model the relationship between the degree of affective processing while reading the news headline and the subsequent categorization. For this purpose, we run a linear regression model using the measures for the heart rate, skin conductance, and eye-gaze fixation patterns to explain the categorization of the news headline on the seven-point Likert scale.

Specifically, we estimate a generalized least squares mixed-model (GLS) that simultaneously accounts for both between-subject random effects and fixed effects. As a result, significance testing for the explanatory variables allows us to test (H1). Second, we assess the level of cognitive processing while reading the news body using the eye-fixation measure. Here, a lower degree of cognitive processing is regarded as indicative of a higher degree of information avoidance. We then run a GLS regression using the initial categorization of the news headline as an explanatory variable to account for the degree of information avoidance while reading the financial news body. In a next step, significance testing for the explanatory variable allows us to test (H2). Third, we run a GLS regression using the degree of information avoidance while reading the news body as an explanatory variable and the categorization of the decision confidence on the seven-point Likert scale as a dependent variable. Significance testing of the explanatory variable allows us to test (H3).

Subsequent to hypothesis testing, we utilize methods from statistical learning to further evaluate the physiological measurements. More specifically, we use *Hidden Markov Models* to model the relationship between cognition, affect and news categorization. This method is a common choice in the related literature to analyze the output from neuroscience experiments because it allows to one distinguish between observable states, i. e. the physiological measure, and hidden states, i. e. the theoretical model (Cohen, 1998). As a result, this approach enables us to determine the relevant drivers in the human information processing of financial news that are directly linked to financial decision-making, revealing patterns of cognitive and affective processing that occur while reading financial news.

5 Conclusions and Further Research Agenda

In recent years, behavioral research has put a stronger focus on the role of affective processes in human decision-making. This raises the question of whether the interplay between cognitive and affective processes can lead to an undesired emotional state that causes humans to avoid potentially relevant information. Based on a review of the literature, we develop a research model that conceptualizes the effects of information avoidance and cognitive dissonance in the processing of information embedded in financial news. Using this theoretical model, we propose an approach to test the derived research hypotheses in a controlled laboratory experiment. The experimental design builds on recent developments in NeuroIS and focuses specifically on neurophysiological measures, which allows us to assess the interplay of affective and cognitive processes as well as their impact on financial decision-making.

At this stage, we have designed the experiment and prepared the required data, i. e. the financial news. In a next step, we will implement and execute the experiment in a controlled laboratory environment as described. After the completion of the experiment, we will test our research hypotheses and utilize methods from statistical learning to systematically analyze the physiological measurements. In further research, we plan to additionally investigate the degree of cognitive and affective processing in financial news across different types of investors, such as professional traders or analysts. Moreover, we will use the neurophysiological measurements to study the reception of financial news on the level of individual words. This approach will enable us to assess the information drivers in financial news by determining the individual importance of each word and word combinations. In a next step, the findings can be used in combination with text analysis methods to enrich existing financial sentiment dictionaries and to support companies in communicating their messages as intended. Ultimately, this study can help both individuals and organizations to automatically detect and respond to critical market developments, to put in place effective warning mechanisms, and to improve decision support systems. Moreover, understanding how humans perceive written information is not only relevant for the financial domain, but for any company that is subject to market dynamics. Since many text sources (e. g. product reviews, forum entries, etc.) consist of a brief summary in the form of a headline and a detailed description in the form of a textual body, this IS study provides ample scope for further research in various domains.

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