Management of Information Processes in the Workplace: Implications of Contextual Factors and Decision Makers' Individual Factors

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- **Research Paper 3** 'Email Management Strategies: Their Effects on Email Management Performance': Under review in the *Journal of Business Economics*

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Summary

Through digitization, the information environment has changed massively along different stages of the information process in the workplace. Not only the amount of available information pieces, but also the range of information presentation formats as well as the availability of various information channels have increased noticeably. In addition to this, further contextual conditions of the information-based decision-making process have altered, such as the time available for making a decision. On the one hand, these changes can support decision-making and the solving of tasks. On the other hand, they can evoke negative consequences, such as a severe rise in workplace stress or a sharp increase in the number of interruptions during work. Within the decision-making process, these changes can considerably affect an individual's cognitive load and can even lead to information overload, which describes the state when the information processing requirements exceed an individuals' capacity to process information, with symptoms such as performance deterioration. From the topic of a strongly increased cognitive load and the presence of information overload originates to a great extent the need for an improvement of the information process. It can be differentiated between different categories of causes of an information overload, comprising contextual and individual factors, which lead to symptoms of information overload that are related mostly to the performance of an organization, measured, i.e., in terms of decision-making accuracy or of general performance. To reduce information overload and to improve the information process, the focus should be on symptoms of as well as on causes of information overload.

Consequently, the present dissertation analyzes factors that address both of these aspects. It investigates the influences of contextual factors as well as decision makers' individual factors that are assumed to influence an individual's cognitive load and decision-making on measures of different stages of the information process in corporate decision-making in order to identify how this process can be improved. The investigated stages in this dissertation comprise those of information acquisition, information processing, and information management. The factors analyzed are measured through experiments and questionnaires. Regarding the increasing use of diverse communication channels, particularly email communication has become an integral part of the everyday communication at work, so that this dissertation targets not only the information overload phenomenon within the information process but also email overload, respectively.

The relationship between contextual factors and decision makers' individual factors and measures of different stages of the information process in corporate decision-making is depicted in an overarching research model. Its related superordinate research question is divided into more detailed research questions, which are examined in three individual research papers. Therefore, the dissertation at hand contains two parts: Part 1 gives a comprehensive overview. It provides the motivation for the research topic, the research model of the dissertation and related research questions, the relevant literature and hypotheses, the research methodologies used within the respective research paper, the summary of the three research papers, as well as the conclusion. Part 2 consists of the three research papers.

Research Paper 1 'Effects of Time Pressure on the Amount of Information Acquired' examines the influence of time pressure on the amount of information acquired non-sequentially, i.e. at one point in time. In addition to this, it researches in what way payoff

schemes and information costs influence the amount of information used for decision-making when time pressure is present. Thus, Research Paper 1 considers the stage of information acquisition. Laboratory experiments were conducted to analyze these effects. The results reveal that under time pressure, individuals acquire fewer pieces of information in the decision-making task. While no effect is shown for the influence of time pressure in conjunction with a negative payoff scheme, the results reveal an effect of its interaction with the level of information costs for acquirable information. When relatively low information costs and time pressure are present, more information is acquired.

Research Paper 2 'Presentation Format Choice and Choice Awareness: Experimental Studies Analyzing the Effects on Underlying Factors of Intrinsic Motivation and Task Performance' focusses on the influences of presentation format choice (i.e., graphs versus tables) and choice awareness on underlying factors of intrinsic motivation, i.e. autonomy and competence, and subsequent decision makers' performance in symbolic and spatial tasks. Within this context, aspects of cognitive effort and of cognitive fit are examined. Research Paper 2 addresses the stage of information processing and comprises online experiments. The results within symbolic tasks indicate that task performance decreases through the provision of choice by itself, but that it increases when the decision maker chooses tables to solve symbolic tasks. When the decision maker is allowed to choose the presentation format in symbolic tasks and perceives autonomy, performance increases as well. No important effects were found within spatial tasks. Further, choice in general was found to contribute to perceptions of autonomy and competence. By contrast, choice in conjunction with the awareness of having a choice increases perceptions of autonomy but decreases feelings of competence.

Research Paper 3 'Email Management Strategies: Their Effects on Email Management Performance' addresses different email management strategies (zero-inbox, to-do list, alertness, prioritization, folder organization) that can be applied by email users and their effects on email management performance. Research Paper 3 targets the stage of information management and its research methodology consists of an online survey. The results reveal that all investigated email management strategies are measurable constructs and that the strategies are applied more often with higher levels of email volume and of perceived usefulness of the email client. Of these strategies, especially the zero inbox, i.e. keeping the email inbox at zero, and the to-do list, i.e. using the email client as a to-do list, strategies increase the email management performance.

Overall, the dissertation analyzes the influence of various contextual factors and decision makers' individual factors, that are assumed to influence an individual's cognitive load and decision-making, on measures of different stages of the information process in corporate decision-making in order to identify how this process can be improved. With this, it provides a holistic analysis along the information process of how to improve this process, it extends information overload research, and it deepens and supports (newer) cognitive theories. Besides this, the dissertation provides managerial implications for the information behavior in the workplace and offers future research implications.

Zusammenfassung

Durch die Digitalisierung verändert sich die Informationswelt entlang verschiedener Stufen des Informationsprozesses am Arbeitsplatz. Nicht nur die Anzahl an verfügbaren Informationen, sondern auch der Umfang an Informationspräsentationsformaten sowie die Verfügbarkeit verschiedener Informationskanäle sind merkbar gestiegen. Daneben verändern sich weitere kontextuelle Bedingungen des informationsbasierten Entscheidungsfindungsprozesses, wie zum Beispiel die Zeit, in der eine Entscheidung getroffen wird. Auf der einen Seite können diese Veränderungen die Entscheidungsfindung und die Aufgabenlösung unterstützen. Auf der anderen Seite können sie auch negative Konsequenzen, wie einen erhöhten Stress am Arbeitsplatz oder einen enormen Anstieg der Häufigkeit an Unterbrechungen, hervorrufen. Innerhalb des Entscheidungsfindungsprozesses können diese Veränderungen die kognitive Belastung eines Individuums beeinflussen und damit ggf. eine Informationsüberlastung hervorrufen. Die Informationsüberlastung beschreibt den Zustand, wenn die Informationsverarbeitungsanforderungen die individuelle Informationsverarbeitungskapazität übersteigen. Auswirkungen einer Informationsüberlastung stellen zum Beispiel Leistungsverschlechterungen dar. Von dem Thema stark erhöhter kognitiver Belastungen und der Gefahr von Informationsüberlastung rührt zu weiten Teilen die Notwendigkeit her, den Informationsprozess zu verbessern. Insgesamt kann zwischen verschiedenen Kategorien von Gründen, bestehend aus kontextuellen und individuellen Faktoren, für eine Informationsüberlastung unterschieden werden. Die Gründe führen zu verschiedenen Symptomen einer Informationsüberlastung, welche meistens in Zusammenhang mit Leistungsverschlechterungen gebracht werden. Um die Informationsüberlastung zu reduzieren und den Informationsprozess zu verbessern, sollte der Fokus nicht nur auf den Symptomen, sondern auch auf den Gründen für eine Informationsüberlastung liegen.

Daher untersucht die vorliegende Dissertation Faktoren, die beide Aspekte adressieren. Sie untersucht den Einfluss von kontextuellen Faktoren und individuellen Faktoren des Entscheidungsträgers, von denen angenommen wird, dass sie die kognitive Belastung eines Individuums und die Entscheidungsfindung beeinflussen, auf Faktoren verschiedener Stufen des Informationsprozesses in der unternehmerischen Entscheidungsfindung. Das Ziel ist herauszufinden, wie dieser Prozess verbessert werden kann. Die untersuchten Stufen in der Dissertation sind die Informationsbeschaffung, die Informationsverarbeitung und das Informationsmanagement. Die Daten für die Analysen wurden mit Experimenten und Fragebögen erhoben. Bezüglich der ansteigenden Nutzung verschiedener Kommunikationskanäle ist insbesondere die E-Mail-Kommunikation zu einem festen Bestandteil der täglichen Kommunikation am Arbeitsplatz geworden. Daher untersucht die Dissertation nicht nur die Informationsüberlastung, sondern auch die E-Mail-Überlastung innerhalb des Informationsprozesses.

Die Beziehung zwischen kontextuellen Faktoren, individuellen Faktoren des Entscheidungsträgers und Faktoren verschiedener Stufen des Informationsprozesses in der unternehmerischen Entscheidungsfindung ist in einem übergeordneten Forschungsmodell dargestellt. Die damit verbundene übergeordnete Forschungsfrage ist unterteilt in detaillierte Forschungsfragen, die in drei einzelnen Aufsätzen bearbeitet werden. Aus diesem Grund besteht die Dissertation aus zwei Teilen: Teil 1 beinhaltet einen Überblick, welcher die Motivation für das Thema, das Forschungsmodell der Dissertation und die Forschungsfragen, die relevante Literatur und die Hypothesen, die Forschungsmethoden zur Datenerhebung in den drei Aufsätzen, die Zusammenfassung der drei Aufsätze sowie die Schlussfolgerung umfasst. Teil 2 besteht aus den drei Aufsätzen.

Aufsatz 1 ‘Effects of Time Pressure on the Amount of Information Acquired’ untersucht den Einfluss von Zeitdruck auf die Anzahl nicht-sequentiell eingeholter Informationen.

Außerdem untersucht dieser inwiefern verschiedene Auszahlungsschemata und Informationskosten die Anzahl eingeholter Informationen unter Zeitdruck beeinflussen. Aufsatz 1 betrachtet demnach die Stufe der Informationsbeschaffung. Es wurden Laborexperimente für die Datenerhebung durchgeführt. Die Ergebnisse zeigen, dass unter Zeitdruck weniger Informationen in der Entscheidungsaufgabe eingeholt werden. Der Einfluss eines negativen Auszahlungsschemas hat unter Zeitdruck keinen Effekt auf die Menge an eingeholten Informationen. Wenn die Teilnehmer aber unter Zeitdruck stehen und mit relativ geringen Informationskosten konfrontiert sind, zeigen die Ergebnisse, dass Sie mehr Informationen einholen.

Aufsatz 2 ‘Presentation Format Choice and Choice Awareness: Experimental Studies Analyzing the Effects on Underlying Factors of Intrinsic Motivation and Task Performance’ beschäftigt sich mit dem Einfluss der Auswahlmöglichkeit für ein Präsentationsformat sowie mit dem Bewusstsein für diese Auswahl auf zwei zugrunde liegende Faktoren der intrinsischen Motivation, d.h. mit Autonomie und Kompetenz, und wie sie sich auf die Aufgabenperformance in symbolischen und räumlichen Aufgaben auswirken. In diesem Kontext werden Aspekte der kognitiven Anstrengung und des sogenannten kognitiven Fits betrachtet. Aufsatz 2 bezieht sich auf die Stufe der Informationsverarbeitung und besteht aus Online-Experimenten. Die Ergebnisse zeigen in symbolischen Aufgaben, dass die Auswahl für ein Präsentationsformat allein betrachtet zu einer schlechteren Aufgabenperformance führt. Sie führt in symbolischen Aufgaben aber zu einer besseren Aufgabenperformance, wenn Tabellen ausgewählt werden oder wenn der Entscheidungsträger Autonomie empfindet. In räumlichen Aufgaben konnten hingegen keine relevanten Effekte identifiziert werden. Daneben zeigen die Ergebnisse, dass die Auswahl für ein Präsentationsformat zu erhöhten Wahrnehmungen von Autonomie und Kompetenz führt. Wenn jedoch ein Bewusstsein für diese Auswahl vorhanden ist, werden Wahrnehmungen von Autonomie zwar erhöht, Wahrnehmungen von Kompetenz aber reduziert.

Aufsatz 3 ‘Email Management Strategies: Their Effects on Email Management Performance’ adressiert verschiedene E-Mail Management Strategien, welche genutzt werden um E-Mails zu managen, und inwiefern sie die E-Mail Management Performance beeinflussen. Aufsatz 3 zielt damit ab auf die Stufe des Informationsmanagements. Die Forschungsmethode zur Datenerhebung besteht aus einer Online-Umfrage. Die Ergebnisse zeigen, dass für alle untersuchten E-Mail Management Strategien messbare und valide Konstrukte identifiziert werden konnten. Weiterhin wurde herausgefunden, dass alle E-Mail Management Strategien häufiger bei einem hohen statt einem geringen „E-Mail Volumen“ und einer hohen statt einer geringen „wahrgenommenen Nützlichkeit“ der E-Mail angewendet werden. Zudem zeigen die Ergebnisse, dass insbesondere die Strategien Zero-Inbox, d.h. die E-Mail Inbox wird versucht auf null zu halten, und To-do-Liste, d.h. der E-Mail Client wird als To-do-Liste verwendet, die E-Mail Management Performance steigern.

Die Dissertation untersucht den Einfluss von kontextuellen Faktoren und individuellen Faktoren des Entscheidungsträgers, von denen angenommen wird, dass sie die kognitive Belastung eines Individuums und die Entscheidungsfindung beeinflussen, auf Faktoren verschiedener Stufen des Informationsprozesses in der unternehmerischen Entscheidungsfindung um herauszufinden, wie dieser Prozess verbessert werden kann. Damit stellt die Dissertation eine umfassende Analyse für Verbesserungen entlang des Informationsprozesses bereit, sie erweitert die Forschung zur Informationsüberlastung und sie unterstützt mit ihren erhaltenen Erkenntnissen die Ansätze der neuen Kognitionswissenschaften. Daneben beinhaltet die Dissertation einige praktische Schlussfolgerungen für das Informationsverhalten am Arbeitsplatz sowie Implikationen für zukünftige Forschungen.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ACMAR 2020	17th Annual Conference for Management Accounting Research
C-A	Choice was provided and having this choice was emphasized
CFT	Cognitive Fit Theory
CLT	Cognitive Load Theory
C-NOA	Choice was provided and having this choice was not emphasized
ECU	Experimental Currency Unit
Ed.	Editor
Eds.	Editors
e.g.	exempli gratia (for example)
et al.	et alia (and others)
GEE	generalized estimating equation
H	Hypothesis
HCOSTS	Relatively high information costs
i.a.	inter alia (among other things)
i.e.	id est (that is)
LCOSTS	Relatively low information costs
M	Mean
N	Sample Size
NEG	Negative payoff scheme
no.	Number
NOC-A	Choice was not provided, and not having the choice was emphasized
NOCG-A	Choice was not provided, the participants were shown graphs in order to solve the task, and not having the choice was emphasized
NOCG-NOA	Choice was not provided, the participants were shown graphs in order to solve the task, and not having the choice was not emphasized
NOC-NOA	Choice was not provided, and not having the choice was not emphasized

NOCT-A	Choice was not provided, the participants were shown tables in order to solve the task, and not having the choice was emphasized
NOCT-NOA	Choice was not provided, the participants were shown tables in order to solve the task, and not having the choice was not emphasized
NOTP	No time pressure
NOTP-NEG-HCOSTS	Time pressure was not present, participants were facing a 'negative payoff scheme', and information costs were relatively high
NOTP-POS-HCOSTS	Time pressure was not present, participants were facing a 'positive payoff scheme', and information costs were relatively high
NOTP-POS-LCOSTS	Time pressure was not present, participants were facing a 'positive payoff scheme', and information costs were relatively low
ORSEE	Online Recruitment Software for Economic Experiments
p.	page
POS	Positive payoff scheme
pp.	pages
p	*p*-value
R^2	Coefficient of determination (proportion of the variance in the dependent variable that is predictable from the independent variable(s))
RP	Research Paper
RT	Reactance Theory
RWTH Aachen University	Rheinisch-Westfälische Technische Hochschule Aachen
SD	Standard Deviation
SDT	Self-Determination Theory
TP	Time pressure
TP-NEG-HCOSTS	Time pressure was present, participants were facing a 'negative payoff scheme', and information costs were relatively high
TP-POS-HCOSTS	Time pressure was present, participants were facing a 'positive payoff scheme', and information costs were relatively high

TP-POS-LCOSTS	Time pressure was present, participants were facing a ‘positive payoff scheme’, and information costs were relatively low
vs.	versus (against)
z-Tree	Zurich Toolbox for Ready-Made Economic Experiments

Part 1: Comprehensive Overview of the Dissertation

The first part consists of a comprehensive overview of the present dissertation. Therefore, **chapter 1.1** starts with the motivation for the research topic and points out which factors are investigated in this context. Moreover, it illustrates the research model of the dissertation, which is concerned with the influence of contextual factors and decision makers' individual factors on measures of different stages of the information process in corporate decision-making and depicts the underlying research questions. **Chapter 1.2** then describes the theoretical concepts and the current state of research of the research topic as well as of the factors that are analyzed within this dissertation. Afterwards, **chapter 1.3** depicts the research methodologies that are applied in the research papers of this dissertation. Hence, not only the rationale but also the designs used for the particular methodology are outlined. The summary of the research papers is given in **chapter 1.4**. Thereby, the underlying theory and hypotheses as well as the related findings are presented for each of the three research papers. Finally, Part 1 of the dissertation closes with a conclusion in **chapter 1.5**, which contains the key findings, theoretical and practical implications, as well as limitations and directions for further research.

After the first part, the second part of this dissertation comprises the three research papers:

- **Research Paper 1** 'Effects of Time Pressure on the Amount of Information Acquired' (Status: accepted for publication in the *International Journal of Business Science and Applied Management* in 2021)
- **Research Paper 2** 'Presentation Format Choice and Choice Awareness: Experimental Studies Analyzing the Effects on Underlying Factors of Intrinsic Motivation and Task Performance' (Status: working paper)
- **Research Paper 3** 'Email Management Strategies: Their Effects on Email Management Performance' (Status: under review in the *Journal of Business Economics*; Presented at the 17th Annual Conference for Management Accounting Research (ACMAR 2020))

1.1 Introduction

This chapter opens with a motivation for the research topic. Furthermore, the factors are derived whose influences on different stages of the information process in corporate decision-making are investigated in order to identify how this process can be improved. Moreover, the relationship between the derived factors and measures of different stages of the information process is depicted in the research model, and the underlying research questions of the dissertation are delineated.

1.1.1 Motivation

Due to the opportunities of a digitized information environment and a broad range of available communication channels, people are confronted with lots of information and face various information presentation formats as a basis for decision-making (Saxena & Lamest, 2018). These changes comprise a broad range of advantages as, for instance, they can facilitate work and support the solving of tasks (e.g., Dilla et al., 2010; Wainer et al., 2011). In contrast, these opportunities can also become disadvantages and lead to severe problems in the workplace, such as enormous workplace stress (Stich et al., 2017) or several interruptions of work flow (Basoglu et al., 2009). Since changes in the information environment lead to a more complex workplace (Saxena & Lamest, 2018) that is often accompanied by time restrictions (Kocher et al., 2019) and since cognitive processes are affected during decision-making, more information (pieces / formats / channels) may lead to more cognitive load for an employee. In addition to this, solving financial and accounting exercises by itself warrants high amounts of cognitive capacity (Basoglu et al., 2009). When the information supply or information processing requirements overrun the information processing capacity of an individual (Meyer, 1998), this individual is not able to process all information cues s/he has to deal with any more, and information overload rises with negative influences on performance (Eppler & Mengis, 2004; Ruff, 2002).

From the topic of a strongly increased cognitive load and the presence of information overload originates to a great extent the need to control the information-based decision-making processes of employees and with this, to improve this information process. Within their review article on information overload, Eppler and Mengis (2004) describe an information overload framework which illustrates that causes, comprising contextual and individual factors, lead to specific symptoms, which in particular constitute negative performance effects, and the need for countermeasures. Moreover, they state that to decrease information overload, not only its symptoms but also its causes should be addressed. As the present dissertation aims to identify

how the information process in corporate decision-making can be improved, and thereby, i.a., how information overload can be reduced, it analyzes the influence of contextual factors and decision makers' individual factors, that are assumed to influence an individual's cognitive load and decision-making, on measures of different stages of the information process, so that aspects of both symptoms and causes are addressed. In particular, information process improvements are analyzed at the stages of information acquisition, information processing, and information management. The purpose to improve the information process is specifically important for the top management of enterprises, as managers can provide guidelines and can alter the decision-making context of employees. Thus, it is also the goal of the dissertation to develop empirically based managerial implications, and to explain these implications from a cognitive perspective.

The relevance of the topic is shown by the mass of recommendations that propose actions for a stress-free and efficient work behavior (e.g., McMurtry, 2014; Pignata et al., 2015), by software tools that have been developed to manage information, such as tools that convert emails into tasks (Hemp, 2009), and by self-management methods and their training (e.g., Allen, 2015). All these types of advice aim to facilitate working, e.g., by allowing an individual to focus on the most important task, by helping to keep an overview, or by the avoidance of distraction. However, most of these types of advice lack empirical support.

Since information overload can be described "as the perception of being emotionally overwhelmed by life's events and demands" (Barley et al., 2011, p. 892) and since the investigated factors along the information process in corporate decision-making are measured through experiments and questionnaires within this dissertation, 'overload' always refers to a 'perceived overload' throughout.

1.1.2 Derivation of Contextual Factors and Decision Makers' Individual Factors

The dissertation analyzes different factors in the workplace that are assumed to affect an individual's cognitive load and her / his decision-making. Roetzel (2019) states that information overload describes a situation in which a set of information that the decision maker faces impedes her / his ability to make an optimal decision. Thus, the cognitive load imposed on the individual is higher than that which an individual can consciously process due to limitations in the cognitive capacity of the working memory (Gruszka & Nęcka, 2017), which comprises conscious cognitive processes (Paas et al., 2004). From a cognitive perspective, the reliance on nondeliberative (Wood et al., 2000) (System 1) processes, the increase of cognitive fit (Vessey, 1991), the increase of cognitive effort (Kanfer & Ackerman, 1989) – on condition that there are still free cognitive resources, and the reduction of extraneous cognitive load (Sobotta, 2016)

are relevant concepts that should be regarded for improvements of the information process in corporate decision-making. i.e. for reductions of cognitive load and the likelihood of an information overload to occur as well as for improvements in the control of information-based decision-making processes.

The reliance on System 1 processes originates from Dual-Process Theories (Kahneman & Frederick, 2002; Stanovich & West, 2000). These theories assume that two systems of reasoning and information processing exist: a heuristic system that provides a fast intuitive response (System 1) and an analytic system that slowly provides a more global solution (System 2) (De Neys, 2006). While System 1 gives intuitive solutions immediately, System 2 is assumed to supervise and, where appropriate, to correct these immediate solutions by applying a more deliberate solution (Kahneman & Frederick, 2002). Nonetheless, System 2 is not always able to remediate the proposed solutions of System 1 (Kahneman & Frederick, 2002), but it should be noted that if deliberate processes are not present, decisions based on fast intuitive processes can lead to good or even better performance (Kahneman, 2003). Whereas System 1 operates independently from working memory capacity, System 2 requires working memory resources (Evans, 2003). Therefore, the reliance on intuitive System 1 processes could be a countermeasure to increases in cognitive load.

The increase of cognitive fit is explained by Cognitive Fit Theory (CFT; Vessey, 1991). The theory suggests that the fit between the information presentation format, the decision-making task and the mental representation of the decision maker affects decision-making performance (Shaft & Vessey, 2006; Vessey, 1991). Thus, when cognitive fit is present, the solving of the decision-making task should require fewer cognitive resources.

Cognitive effort can be regarded as the proportion of the available processing capacity that a decision maker utilizes for the solving of a task (e.g., Tyler et al., 1979). Even if cognitive load imposed on the working memory is high and cannot be reduced, it is possible that a good decision-making performance can be achieved through an **increase in cognitive effort** due to self-regulatory processes, on condition that not all cognitive resources are already consumed (Kanfer & Ackerman, 1989). Thus, when high levels of cognitive effort are present, the individual can utilize free processing capacity when solving the decision-making task (e.g., Tyler et al., 1979) so that decision-making performance, and with this, the information process, might be enhanced.

The reduction of extraneous cognitive load is based on considerations of Cognitive Load Theory (CLT; Chandler & Sweller, 1991; Sweller, 1988). CLT is concerned with the reduction of cognitive load that is resided in the working memory so that unconscious

automated processes referring to the long-term memory are supported (Paas et al., 2004). The theory differentiates between three types of cognitive load: intrinsic cognitive load, extraneous cognitive load, and germane cognitive load (Paas et al., 2003). Intrinsic cognitive load describes the inherent degree of complexity of the information, extraneous cognitive load refers to an inadequate presentation of the information, and germane cognitive load arises when new information can be matched with already existing information for storage in the long-term memory (Sweller et al., 2011). According to CLT, it is crucial that the sum of intrinsic cognitive load, extraneous cognitive load, and germane cognitive load does not exceed working memory limits (Paas et al., 2003). Since extraneous cognitive load can be directly controlled through an adequate instructional design (Paas et al., 2003), e.g. by providing a suitable information presentation format (Sobotta, 2016), a reduction in extraneous cognitive load is a possible way to reduce the likelihood of an information overload to occur and therefore, to improve the information process.

The dissertation focusses on different factors in the workplace that are assumed to be essentially associated with the reliance on System 1 processes, the increase of cognitive fit, the increase of cognitive effort, or the reduction of extraneous cognitive load. Moreover, previous research has pointed out that these factors are of particular relevance in the context of decision-making (e.g., Baumeister et al., 2001; Phillips-Wren & Adya, 2009). The factors analyzed can be grouped into contextual factors and decision makers' individual factors and are outlined in the following.

With respect to the **contextual factors**, one of the factors analyzed is **time pressure** because it is thought to induce cognitive stress (e.g., Keinan et al., 1987; Phillips-Wren & Adya, 2009) and to constrain the reliance on analytical ways of thinking (Finucane et al., 2000). Moreover, subcategories of the factor time pressure are considered: the factor **time pressure in conjunction with payoff schemes** as well as the factor **time pressure in conjunction with levels of information costs**. The kind of payoff scheme (either with a positive or a negative expected value) might be a crucial factor under time pressure, since studies have already shown that negative information, for example, the loss of money, involves more (thorough and conscious) processing than positive information, for example, the gain of money (Baumeister et al., 2001; Ito & Cacioppo, 2000; Peeters & Czapinski, 1990). Therefore, payoff schemes with a negative expected value might lead to more conscious cognitive thinking under time pressure and might be more cognitively demanding than those with a positive expected value. Further, it is assumed that higher levels of information costs require more conscious processing under time pressure than lower levels of these costs, since information costs and information benefits

must be evaluated (Connolly & Thorn, 1987) in order to identify whether it is reasonable to purchase more information.

A further contextual factor analyzed is **presentation format choice**. Having the choice, unless it is not overwhelming (e.g., Bollen et al., 2010; Iyengar & Lepper, 2000), might help to induce a fit between the external (i.e., the information presentation format) and the internal (i.e., the individual's task knowledge) representation of the task. This is because the decision maker can select the type of presentation format that fits best to her / his needs and preferences. Thus, cognitive fit is able to occur. As a consequence, fewer cognitive resources should be required for the solving of the decision-making task. Moreover, choice has been identified to be a core factor to enhance intrinsic motivation and to contribute to cognitive effort (Patall et al., 2008). Even if choice does not lead to cognitive fit and cognitive load is high, but has not reached the capacity limit, cognitive effort and cognitive load might interact with each other so that the danger of negative performance effects is minimized. In addition to this, a subcategory of the factor presentation format choice is examined: the factor **presentation format choice in conjunction with choice awareness**. Awareness is seen as the conscious perception (Brown & Ryan, 2003) of actually having a choice and the dissertation expects choice awareness to amplify the level of intrinsic motivation and to further increase cognitive effort. A level of cognitive effort that is high enough to overcompensate an increased load can therefore help to increase performance within the information process.

Regarding the decision makers' **individual factors**, one factor analyzed is **intrinsic motivation**. When a task is experienced as intrinsically motivating, decision makers will exert a higher cognitive effort (Meyer et al., 2004) so that s/he might be able to overcompensate increases in cognitive load (e.g., Kanfer, 1990). As already mentioned, choice has been identified to be an essential factor to increase intrinsic motivation. Hence, the dissertation investigates not only the influences of choice and choice awareness on intrinsic motivation, but also the role of intrinsic motivation in the context of the effects of presentation format choice on performance.

Besides this, **email management strategies** are investigated within this dissertation. According to the increasing use of different communication channels, particularly email communication has become an integral part of the everyday communication at work (e.g., Kalman & Ravid, 2015; Thomas et al., 2006). Therefore, the second individual factor comprises email management strategies which email users apply to manage their emails. Lots of email users complain to feel overloaded through, for instance, the sheer volume of the emails (e.g.,

Dabbish & Kraut, 2006). Thus, strategies that affect email management positively are assumed to help keeping the overview and to reduce extraneous cognitive load.

1.1.3 Research Model and Research Questions

On the basis of chapter 1.1.2, different contextual factors and decision makers' individual factors are assumed to affect an individual's cognitive load and her / his decision-making. The present dissertation analyzes how these factors influence measures of different stages of the information process in corporate decision-making. With this, the dissertation aims to identify how the information process in corporate decision-making can be improved, i.e. how cognitive load and the likelihood of an information overload can be reduced and how the control of information-based decision-making processes can be enhanced. In addition to this, it is the goal of the dissertation to develop empirically based managerial implications, and to explain these implications from a cognitive perspective. Hence, the superordinate research question of the dissertation is:

> *How do contextual factors and decision makers' individual factors influence different stages of the information process and how can this process be improved?*

The underlying research model for this question is illustrated in Figure 1.1.

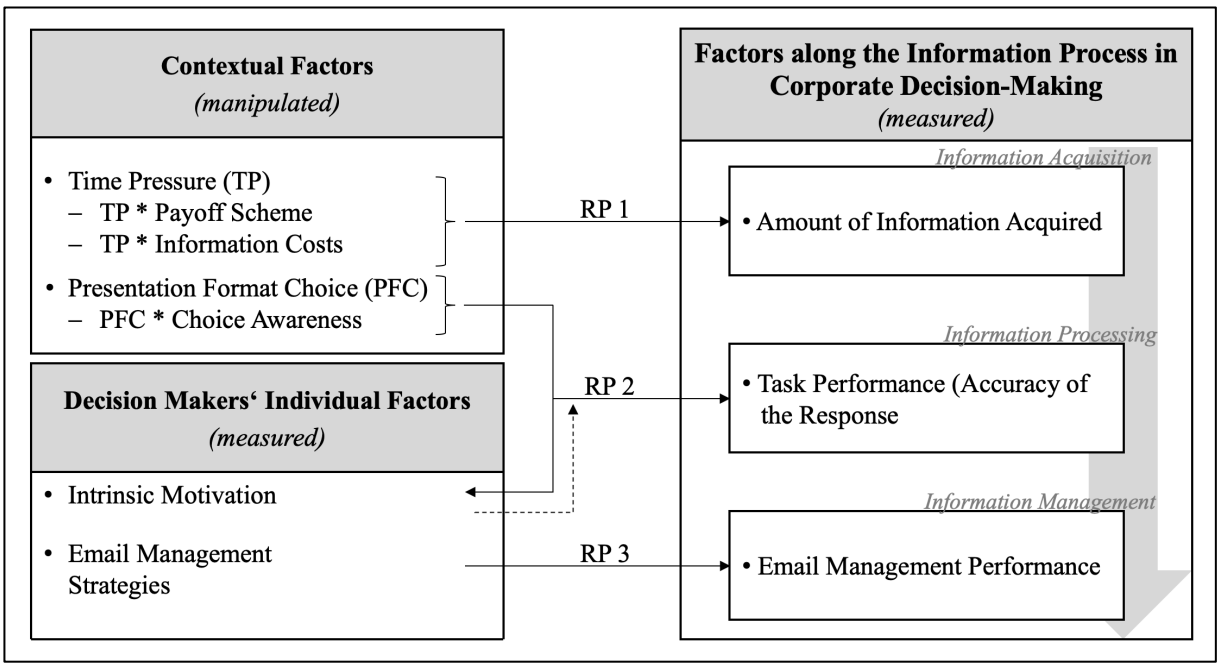

Figure 1.1: Research Model of the Dissertation
Note. RP refers to Research Paper.

Within the investigation of **contextual factors**, which were manipulated in experimental studies, the following factors are analyzed in the research papers: In **Research Paper 1**, time

pressure, as well as two subcategories of this factor, time pressure in conjunction with different payoff schemes and time pressure in conjunction with different levels of information costs, are investigated. Time pressure was manipulated through the imposition of tough time restrictions when decisions had to be made. The payoff schemes consisted of four possible outcome options and described the decision-based and environmentally condition-based additional payments for the participant. Information costs had to be paid for acquired information which could then be used as decision support within the experimental tasks. In **Research Paper 2**, presentation format choice as well as a subcategory of this factor, namely its interaction with choice awareness, are considered. In the experiments, participants were either allowed or not allowed to choose a presentation format (i.e., tables versus graphs) in order to solve accounting tasks, which consisted of symbolic or spatial questions. In this context, choice awareness describes the stimulation of the awareness of having this presentation format choice.

Decision makers' individual factors were measured via questionnaires, either within a post-experimental questionnaire or within a survey. In **Research Paper 2,** underlying factors of intrinsic motivation, i.e. autonomy and competence, are examined. In **Research Paper 3,** different email management strategies, such as the use of a zero-inbox strategy where the email user tries to keep the inbox at zero or at least as clean as possible, are investigated.

The effects of the contextual and individual factors are analyzed at different stages of the information process in corporate decision-making. These stages are based on the chronological order in which an individual decision maker is dealing with information, i.e., **information acquisition**, **information processing**, and **information management**. Research Paper 1 is concerned with the stage of information acquisition, Research Paper 2 considers the stage of information processing, and Research Paper 3 focusses on the stage of information management. The methodology consists of laboratory experiments in Research Paper 1, of online experiments in Research Paper 2, and of an online survey in Research Paper 3. All research papers were developed with my co-author, Peter Letmathe. Moreover, Research Paper 2 has been elaborated in cooperation with Marc Zielinski. Thus, the superordinate research question of this dissertation is divided into more detailed research questions that are investigated in three individual research papers.

Research Paper 1 'Effects of Time Pressure on the Amount of Information Acquired' deals with influencing factors on the amount of information acquired non-sequentially, i.e. at one point in time. More precisely, it focusses on the influence of time pressure on the amount of information used for decision-making. Furthermore, it investigates in what way payoff schemes and information costs influence the individual acquisition behavior

when time pressure is present. Although prior literature in this research field has already examined the role of time pressure for sequential information acquisition behavior (Mann & Tan, 1993), no information acquisition research studies have as yet investigated its influence when information acquisition is non-sequential. Studies dealing with non-sequential information acquisition are concerned with several topics, e.g. with the influence of psychological traits on the amount of information acquired (San Miguel, 1976) or with the ability of people to select an optimal amount of information for a specific decision model (Uecker, 1978). However, no prior research studies have examined the influence of time pressure by itself as well as its interaction with further contextual factors on the amount of information acquired non-sequentially so far. Apart from this, most studies have manipulated time as the only variable within experiments, even if interaction effects of it with other contextual factors were supposable (Spiliopoulos & Ortmann, 2018). Hence, a comprehensive investigation of the effects of time pressure as well as its interaction with further variables on the amount of information acquired non-sequentially is missing. Accordingly, the research questions of Research Paper 1 at the stage of information acquisition are:

1. *What is the effect of time pressure on the amount of information acquired by individual decision makers?*
2. *Does the effect of time pressure on the amount of information acquired depend on different payoff schemes in a decision-making task?*
3. *Is the effect of time pressure on the amount of information acquired different for various levels of information acquisition costs?*

Research Paper 2 'Presentation Format Choice and Choice Awareness: Experimental Studies Analyzing the Effects on Underlying Factors of Intrinsic Motivation and Task Performance' addresses effects of presentation format choice and choice awareness on underlying factors of intrinsic motivation, i.e. autonomy and competence, and subsequent decision makers' task performance. Up to now, research on presentation formats has been mainly concerned with aspects of cognitive fit, which describes the fit between the decision-making task and the representation of the problem (Vessey, 1991), i.e., how cognitive fit affects task performance (Vessey & Galletta, 1991; Wilson & Zigurs, 1999). However, no studies have investigated the effects of presentation format choice in combination with the stimulation of the awareness to have such a choice. Moreover, even if choice is seen as an indicator for intrinsic motivation (Deci & Ryan, 1987; Deci et al., 1991) and higher levels of intrinsic motivation lead to higher performance (Kuvaas et al., 2017), no approach in the literature has as yet examined the effects of presentation format choice and choice awareness

on factors of intrinsic motivation and subsequent performance. Therefore, Research Paper 2 is concerned with the cause-and-effect chains between choice as well as choice awareness, underlying factors of intrinsic motivation (autonomy and competence), and task performance. Hence, the following research questions are investigated at the stage of information processing:

1. *What are the effects of being able to choose the presentation format on task performance in symbolic and spatial tasks?*
2. *Do the effects of presentation format choice on task performance depend on the awareness of having a choice or of not having a choice?*
3. *To what extent do perceptions of autonomy and competence as factors of intrinsic motivation play a role in the context of the effects of presentation format choice on task performance?*

Research Paper 3 'Email Management Strategies: Their Effects on Email Management Performance' is concerned with improvements in email management in the workplace. Since email communication has developed into an essential part of the everyday communication (Kalman & Ravid, 2015), Research Paper 3 investigates different email management strategies that are applied by email users to manage their emails. The excessive over- or misuse of email communication can lead to email overload (Dawley & Anthony, 2003), so that it is important to identify effective and efficient email management strategies that can be applied universally for all incoming emails in order to minimize (the likelihood of) email overload and to improve the information process at the information management stage. Because an overload can affect performance negatively (Eppler & Mengis, 2004; Ruff, 2002), email overload reduction should increase email management performance. Besides lots of advice about how to handle emails, only single items for different email management strategies have been identified so far (Dabbish & Kraut, 2006). Since empirically validated constructs, consisting of multiple items, for analyzing different email management strategies are missing, Research Paper 3 identifies and examines email management strategy constructs that can be applied in order to manage emails. Moreover, it analyzes whether (and, if so, which) email usage factors influence the use of a particular email management strategy. Whereas prior studies are mostly concerned with single-item factors, such as the number of incoming emails per day (e.g., Barley et al., 2011; Kalman & Ravid, 2015; Mano & Mesch, 2010), Research Paper 3 tests whether the developed multiple-item scales for measuring distinguished email management strategies influence different email management performance measures. Thus, Research Paper 3 addresses the following research questions at the stage of information management:

1. *Are email management strategies measurable constructs?*
2. *Which email usage factors determine the use of a certain email management strategy?*
3. *Which email management strategies influence email management performance positively or negatively?*

Table 1.1 gives an overview of the variables researched and the research methodology used in each of the three research papers.

Table 1.1: Overview of the Three Research Papers

<table>
<tr><th rowspan="3">Research Paper</th><th colspan="2" rowspan="3">Methodology</th><th colspan="4">Independent Variables</th><th rowspan="3">Dependent Variables</th></tr>
<tr><th colspan="3">Contextual Factors</th><th>Decision Makers' Individual Factors</th></tr>
<tr><td rowspan="7">1</td><td>Laboratory Experiments</td><td>Treat-ment</td><td>Time Pressure (manipulated)</td><td>Payoff Scheme (manipulated)</td><td>Information Costs (manipulated)</td><td rowspan="7">-</td><td rowspan="7">Amount of Information Acquired (measured)</td></tr>
<tr><td rowspan="2">1</td><td>1</td><td>yes</td><td rowspan="2">positive</td><td rowspan="2">relatively high</td></tr>
<tr><td>2</td><td>no</td></tr>
<tr><td rowspan="2">2</td><td>3</td><td>yes</td><td rowspan="2">negative</td></tr>
<tr><td>4</td><td>no</td><td>relatively high</td></tr>
<tr><td rowspan="2">3</td><td>5</td><td>yes</td><td rowspan="2">positive</td><td rowspan="2">relatively low</td></tr>
<tr><td>6</td><td>no</td></tr>
<tr><td rowspan="8">2</td><td>Online Experiments</td><td>Treat-ment</td><td colspan="2">Presentation Format Choice (manipulated)</td><td>Choice Awareness (manipulated)</td><td rowspan="8">Intrinsic Motivation (measured)</td><td rowspan="8">Accuracy of the Response (measured)</td></tr>
<tr><td rowspan="3">1: Symbolic Tasks</td><td>1</td><td colspan="2">yes</td><td>yes</td></tr>
<tr><td>2</td><td colspan="2">no; provision of graphs</td><td>yes</td></tr>
<tr><td>3</td><td colspan="2">no; provision of tables</td><td>yes</td></tr>
<tr><td rowspan="3">2: Spatial Tasks</td><td>4</td><td colspan="2">yes</td><td>no</td></tr>
<tr><td>5</td><td colspan="2">no; provision of graphs</td><td>no</td></tr>
<tr><td>6</td><td colspan="2">no; provision of tables</td><td>no</td></tr>
<tr><td>3</td><td colspan="2">Online Survey</td><td colspan="3">-</td><td>Email Management Strategies (measured)</td><td>Email Management Performance (measured)</td></tr>
</table>

Note. Research Paper 2 comprises two experiments, one containing symbolic tasks and the other containing spatial tasks. Both of these experiments consist of the same treatments.

1.2 Theoretical Concepts and Current State of Research

Various contextual factors and decision makers' individual factors can influence an individuals' cognitive load and decision-making along different stages of the information process. The need for information process improvements stems to a large extent from increases in cognitive load and information overload so that most prior literature in this research field is concerned with the topic of information overload. Thus, this chapter deals with the theoretical foundation of

the information overload concept. Moreover, the current state of research concerning the contextual and individual factors influencing measures on different stages of the information process is outlined.

1.2.1 Information Overload

Since information process improvements are closely connected to information overload reduction, the concept of information overload is described in the following. Moreover, its definition and cognitive considerations as well as literature on the causes of, the symptoms of, and the countermeasures against it are outlined. Causes of information overload comprise contextual factors and decision makers' individual factors and lead to symptoms of information overload, such as negative performance. Since it is necessary to focus not only on the symptoms of information overload but also on its causes in order to reduce information overload (Eppler & Mengis, 2004) and to improve the information process, the research model variables of this dissertation can be allocated to either the causes or the symptoms. This allocation is described at the end of this chapter.

1.2.1.1 Definition

Cognitive load refers to the load on the cognitive system when processing information (e.g., Paas et al., 1994). The literature assumes that when the amount of cognitive load increases, performance increases as well, but only until a certain point is reached (Teigen, 1994). This point is characterized as the individual capacity to process information, which depends on the cognitive constraints in terms of working memory limitations (Gruszka & Nęcka, 2017). Thus, when the cognitive load of the information supply or information processing requirements exceeds the individual threshold to process information, information overload arises (Kahneman, 1973; Meyer, 1998) and the individual is not able to handle all available information cues any more (Mano & Mesch, 2010). This definition of information overload has also been seen applied with regard to limited time: When the capacity of an individual does not permit the processing of all required information cues within a certain amount of time, information overload results (Eppler & Mengis, 2004).

To structure research on information overload, Eppler and Mengis (2004) outline a conceptual framework which incorporates five categories of **causes** of information overload. These are the information itself, the tasks and processes that need to be performed, the organizational design of an enterprise, the information technology that is (mis-)used within an enterprise, and the person dealing with the information. Thus, the causes comprise contextual factors and decision makers' individual factors. The framework further depicts that the causes

lead to specific effects of information overload, labeled as **symptoms**, and the need for effective **countermeasures** to affect the causes and to decrease overload. The framework is depicted in Figure 1.2.

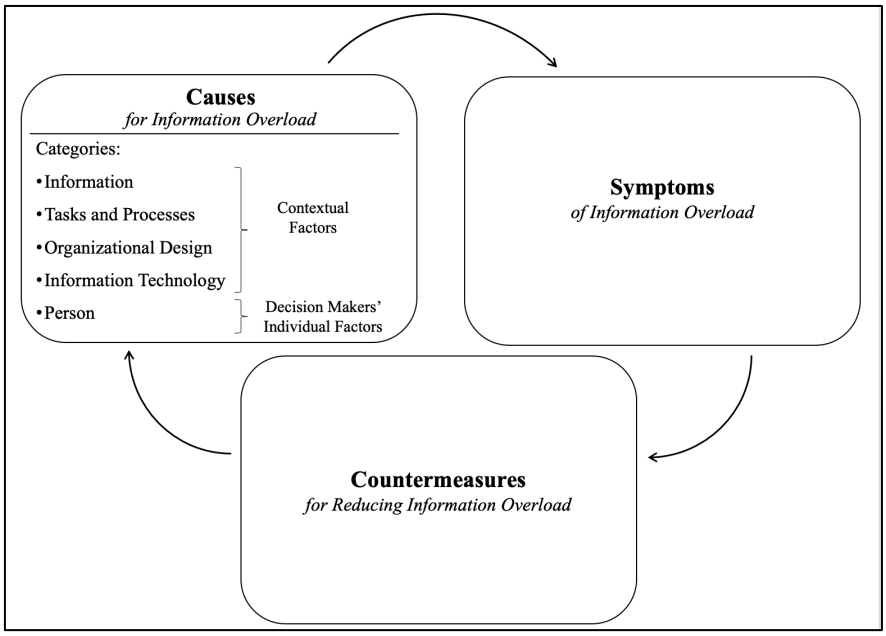

Figure 1.2: Framework for Information Overload Research (based on Eppler & Mengis, 2004)

1.2.1.2 Causes

In the following, the five causes are outlined. According to the **information** itself, the number of pieces of information are seen as one major cause of information overload (Bawden & Robinson, 2009) or related terms, such as negative work performance. For example in the context of email communication, the number of emails received and sent has been found to increase work distress (Mano & Mesch, 2010), which is also described as negative stress, since more emails have to be considered and the handling of more emails requires working memory capacity. Besides this, the quality of information can lead to information overload (Sparrow, 1999b) because additional cognitive processing for validating or decoding information is required.

With respect to **tasks and processes** that need to be worked on by using information, characteristics such as task complexity (e.g., Schick et al., 1990) are assumed to increase load. Moreover, decision-making under time pressure is regarded as a major reason for high levels of information load (Wright, 1974), as time pressure is assumed to increase task complexity (Chernev et al., 2015). Besides this, when the amount of available time to process information is too short to (deliberately) process all required information cues, information overload occurs (Eppler & Mengis, 2004). Furthermore, the number or frequency of interruptions while working on a task has been found to be a cause of high levels of cognitive load and in turn of low levels

of performance (Basoglu et al., 2009), since interruptions lead individuals to consider several tasks at the same time, so that structural and capacity interferences emerge (Kahneman, 1973).

Related to the **organizational design**, causes within the framework of Eppler and Mengis (2004) are, inter alia, the composition of the group or innovative technologies that are used within the organization. When a group is heterogeneous, e.g., employees have different histories or member statuses, Grisé and Gallupe (1999) note that each member of this group might create her / his own ideas, which require more communication and more information processing, and this might induce information overload. Besides this, the introduction of innovative information technologies can be seen as a cause of information overload, even if new technologies are needed and do have many benefits (Bawden & Robinson, 2009). Modern technologies are seen as a major cause, as they can produce huge amounts of information quickly, specifically when these are 'push' technologies which deliver information without request (Bawden & Robinson, 2009). As a result, the likelihood increases that an individual has to handle more information than s/he is capable of cognitively processing, so that information overload arises. Moreover, 'push' technologies might lead to interruptions (Speier et al., 1999) when working on tasks, since these provide information unrequested.

Referring to the **information technology**, innovative information technologies provide – often without request – more information than an individual can handle (Bawden & Robinson, 2009). Specifically email communication and the internet in general are seen as major causes of the information overload phenomenon (e.g., Allen & Shoard, 2005; Bawden & Robinson, 2009). It should be noted that the topic of information overload has not emerged due to the use of information technology but due to the misuse of this technology (Dawley & Anthony, 2003). On the one hand, the email technology bears advantages for workplace behavior, such as time- and location-independent communications (Wainer et al., 2011). On the other hand, the time spent on emails and the interruptions through emails can easily cause email overload (e.g., Barley et al., 2011; Szóstek, 2011). Apart from emails, other information technologies and even older / established communication channels can lead to information overload, such as a constantly ringing telephone or permanently incoming faxes (Edmunds & Morris, 2000).

Regarding the **person** who handles information, research has already found that personal characteristics, such as the level of experience, interact with information load (Swain & Haka, 2000). Furthermore, the senders and not only the receivers of information messages have been in the scope of research. According to this, Van Zandt (2004) states that the screening of outbound information influences the receiver's perception of information received, since if the sender does not screen the information message intensively, the likelihood increases that the

receiver will receive on average more messages of minor relevance. Moreover, particular work-related characteristics of an employee, such as the time spent on handling emails, have been found to increase information overload (Barley et al., 2011), probably because the employee is confronted with more emails than s/he can handle or with emails that trigger intensive work and cognitive load.

1.2.1.3 Symptoms

Apart from causes of information overload, many research studies have focused on symptoms of information overload. Symptoms describe effects on the behavior of an individual through information overload induced by the different causes. Identified symptoms in prior studies are, for example, the use of noncompensatory information processing strategies under time pressure (Payne et al., 1988), the ignoration of certain information (Edmunds & Morris, 2000), the feeling of losing control of the situation (Bawden & Robinson, 2009), stress with even possible damages to health (Bawden & Robinson, 2009), and suboptimal decisions in general (Eppler & Mengis, 2004). It should be noted that most studies agree on negative performance effects as symptoms of information overload (e.g., Chan, 2001; Ruff, 2002). In the same vein, Eppler and Mengis (2004) point out that the most important issue in this context is how these symptoms are related to the performance of an organization, measured, i.e., in terms of decision-making accuracy or in general performance. Thus, exemplary symptoms constitute inaccurate responses of employees or decreased general performance, such as a deceased email management performance.

1.2.1.4 Countermeasures

Examples of effective countermeasures against information overload are described in the following and are sorted in accordance with the schema that is used to categorize the causes within the framework of Eppler and Mengis (2004). With regard to the **information** itself, it should be generated conscientiously (Allert, 2001), structured well (Königer & Janowitz, 1995), and presented appropriately (Bawden & Robinson, 2009) since fewer cognitive resources are needed to process information with these characteristics. In addition to this, an improvement in information quality, e.g. in the comprehensibility, can promote information processing (Eppler & Mengis, 2004). According to the **tasks and processes**, the use of electronic systems can help to overcome or extend the limited human information-processing, e.g. through the storage of information (Grisé & Gallupe, 1999) that otherwise has to be kept in mind, thereby decreasing cognitive load, or through less time that is required for completing tasks so that the topic of time pressure, which can easily increase cognitive load, is less relevant. The creation of a

rational individual information management style (Bawden & Robinson, 2009) or the use of appropriate communication media, i.e., the use of email for communicating tasks that do not require the participation of others (Bellotti et al., 2005), which otherwise would require cognitive resources. Regarding the **organizational design**, organizations could give employees more time to perform the work (Schick et al., 1990), so that less or even no time pressure, which increases task complexity (Chernev et al., 2015), is present. With regard to the **information technology**, countermeasures against information overload that are mentioned in the literature are, e.g., systems that do not rely on 'push' technologies, since less information is received without being requested and is less distracting (Bawden & Robinson, 2009; Edmunds & Morris, 2000). Moreover, many software firms work on technical solutions for the improvement of inbox usability, for example, they work on software that automatically classifies or prioritizes receiving emails (Hemp, 2009; McMurtry, 2014). With such software, classifying and prioritizing emails by oneself is not necessary and cognitive resources are not utilized. At the level of the **person**, improvements of one's own time (Bawden & Robinson, 2009) and information management in general (Edmunds & Morris, 2000) or better screening skills in particular (Van Zandt, 2004) are named, among other things, as countermeasures against information overload. Reasons might be that the available time is used more efficiently and that less time and cognitive resources are required for managing and searching information. Besides this, an improved information management should relieve the working memory because fewer things have to be considered simultaneously. Moreover, Soucek and Moser (2010) found that work impairment decreased for employees who were trained to cope with information overload.

1.2.1.5 Allocation of Research Model Variables to Causes and Symptoms

The contextual factors and decision maker's individual factors of the research model of this dissertation can be allocated to the following cause-categories: **Time pressure** and the subcategories **time pressure in interaction with payoff schemes** and **time pressure in interaction with information costs** can be allocated to the **information** category, since pieces of information have to be processed under time pressure, task formats contain information that can affect task performance and payoff, and the amount or cost of information is taken into consideration. In addition to this, these factors can be assigned to the **tasks and processes** category because they constitute manipulation factors of the experimental decision-making task of Research Paper 1. Their allocation to the category **organizational design** is based on considerations that these factors can be induced by the work structure itself, e.g. organizations can influence the (non)existence of time pressure. Lastly, these factors can be assigned to the

information technology category, since information can be acquired via different distribution channels, and modern information technologies allow an easy and fast access of information. **Presentation format choice** and the subcategory of **presentation format choice in interaction with choice awareness** can both be assigned to the category **information** because task formats contain information relevant for the solving of the task. Furthermore, these factors can be assigned to the **tasks and processes** category because they represent manipulation factors of the experimental task of Research Paper 2. Besides, they can be allocated to the category **organizational design**, since the kind of presentation format provided, the option to choose between various presentation formats as well as the (non)awareness of having (no) choice for a presentation format can be influenced and designed by organizations. The allocation to the **information technology** category is grounded in considerations that presentation formats are presented though various information technologies, and especially modern information technologies allow many different innovative presentation formats. The **intrinsic motivation** factor can be assigned to the **person** cause-category because intrinsic motivation differs among individuals, and every individual perceives a different level of – or even no – intrinsic motivation for the handling of a specific task. In addition to this, the **email management strategies** factor can be assigned to this **person** category as well since everyone employs different strategies in their own email usage.

The allocation of the dependent variables of the research model of this dissertation is described in the following: The dependent variable **amount of information acquired** prior to decision-making can be assigned to the causes of information overload. More particularly, it can be allocated to the cause-category **information**, since a high amount of information is seen as one major cause of information overload (Bawden & Robinson, 2009). Besides this, all other dependent variables of the research model represent performance measures, namely **accuracy of the response**, and **email management performance**. Since negative performance effects, i.e., decreased accuracy or decreased general performance, constitute symptoms of information overload, these dependent variables of the research model can be allocated to the **symptoms**. When the cognitive load does not exceed the individual capacity limit, the decision maker can process all relevant information cues, thereby achieving a good performance, i.e., in terms of high levels of decision-making accuracy (Vessey & Galletta, 1991). With respect to email management performance, the email communication tool is an important determinant within the working lives of millions of employees around the world, but it is also seen as one of the major causes of information overload due to the huge amounts of emails that need to be processed every day (e.g., Kalman & Ravid, 2015; Whittaker, 2005). Therefore, the dissertation

does not focus only on the information management behavior of employees but specifically on their email management behavior. Research has already indicated that email plays an essential role in workplace overload which impacts performance negatively (Benselin & Ragsdell, 2016; Ruff, 2002). Thus, a form of email management that reduces overload should increase performance.

1.2.2 Contextual Factors

The contextual factors analyzed within this dissertation consist of the factors of time pressure by itself, time pressure in conjunction with payoff schemes, time pressure in conjunction with levels of information costs, presentation format choice, and presentation format choice in conjunction with awareness of having a presentation format choice. The current state of research according to these factors is outlined below.

1.2.2.1 Time Pressure

Time pressure, as used in the experiments of Research Paper 1, was defined as a strict and tough deadline for acquiring information and for decision-making. Since daily decision-making processes have to be performed under severe time pressure nowadays (Geisler & Allwood, 2018), it is an important issue in work life today (Lallement, 2010) and requires examination of how it affects the information process. Time pressure in decision-making is assumed to increase stress (e.g., Keinan et al., 1987) and may prevent deliberate thinking (Glöckner & Betsch, 2008). Altogether, time pressure has been identified to be a major reason for lower decision-making performance (De Paola & Gioia, 2016). Importantly, the performance under time pressure seems to be influenced by the ability to cope with time restrictions (Kocher et al., 2019). Besides this, individuals are often not able to process all available information cues in order to perform a task within the allotted time, which leads to information overload (Eppler & Mengis, 2004). In addition, time pressure is assumed to increase the number of interruptions because of checking the time visually (Mann & Tan, 1993). With more interruptions, the danger of overload increases (Speier et al., 1999), since these interruptions reduce the information processing capacity through switching between different contexts (Eppler & Mengis, 2004). The effects of time pressure on information processing have already been researched broadly (for a review, see Lallement, 2010). For example, research has found that time pressure leads individuals to accelerate the decision-making process (Ben Zur & Breznitz, 1981) or to neglect important cues and to rely on heuristics (Kruglanski & Freund, 1983). The present dissertation investigates time pressure effects on the information acquisition stage of the information process, i.e. it researches how time pressure influences the amount of information acquired

within the decision-making process. In some cases, it might be reasonable to acquire many pieces of information, whereas in other cases, the acquisition of only a few pieces of information seems reasonable. To control the acquisition behavior of employees, knowledge about their information acquisition behavior under time pressure would help to improve the information process. To the best of my knowledge, only the study by Mann and Tan (1993) has investigated the influence of time pressure when information acquisition is sequential. In an experiment, they found that participants under time pressure acquired fewer pieces of information. The present dissertation aims to identify whether this effect endures when pieces of information have to be acquired one after the other (non-sequentially).

In summary, time pressure seems to be an important influencing factor on information acquisition and decision-making behavior, since it induces stress due to restrictions in the time available. In addition to this, it seems to be a driver for fast intuitive processes which bypass the limited working memory.

1.2.2.2 Time Pressure and Payoff Schemes

Besides time pressure, payoff schemes with four possible outcome options were implemented in the experiments of Research Paper 1. The participants' payoff in the experiments depended, amongst other things, to a great extent on the outcome of the underlying payoff scheme. Since more aspects have to be considered during the decision-making process, the payoff scheme can increase information processing requirements (Eppler & Mengis, 2004) and can be an essential driver for information overload (Tushman & Nadler, 1978). The dissertation focusses on payoff schemes with two different endowments, and the expected values – without further information – of the two schemes are either positive or negative. Prior literature has already shown that the payoff structure, inter alia due to the endowment size, influences behavior and, therefore, the efficiency of an exit option implemented in a prisoner's dilemma game (Haesevoets et al., 2019). Moreover, individuals under time pressure focus more on negative than on positive aspects of information (e.g., Ben Zur & Breznitz, 1981; Huber & Kunz, 2007), and the processing of negative aspects is associated with more conscious processing (Baumeister et al., 2001; Ito & Cacioppo, 2000). In turn, more conscious processes are assumed to demand working memory capacity.

In summary, it can be noted that various payoff schemes influence the cognitive load of individuals under time pressure differently, leading to different amounts of information acquired.

1.2.2.3 Time Pressure and Information Costs

Parallel to the factor payoff scheme, different levels of information costs were implemented as an essential part of the experimental task in the experiments of Research Paper 1. Certain characteristics of information can contribute to increases in cognitive load (Sparrow, 1999a), such as its quantity, complexity, quality, frequency (Eppler & Mengis, 2004) or costs, since costs and benefits of information should be evaluated when making a decision (Connolly & Thorn, 1987), so that the information processing requirements are increased. Specifically, when information costs are relatively high, people tend to purchase only the amount of information that has a higher utility than or equal utility to related costs (Kraemer et al., 2006). Baethge and Fiedler (2016) state that individuals tend to use more time analyzing information when information costs are present. Moreover, the experimental study of Baethge and Fiedler (2016) reveales that when confronted with information costs, participants acquired significantly fewer pieces of information within an investment task with either free or costly information. In addition to this, the study by Kerstholt (1996) showed that under time pressure, relatively low information costs lead people to acquire more information in a dynamic task compared to relatively high information costs.

In conclusion, characteristics of an information, such as information costs, can influence the cognitive load and the information acquisition behavior of individuals under time pressure.

1.2.2.4 Presentation Format Choice

Within Research Paper 2, a choice of the presentation format was implemented in order to answer questions related to symbolic or spatial tasks. An information presentation format describes the mode in which information is presented (e.g., Kelton et al., 2010). In the experiments of Research Paper 2, either tables or graphs were selectable for answering the questions. According to CFT (Vessey, 1991), a fit between the decision-making task and the representation of the problem increases decision-making performance, since the cognitive system is able to handle information easily. Moreover, research has found that symbolic questions are best represented by tables and spatial questions are best supported by graphs (e.g., Umanath et al., 1990). Thus, a graphical presentation of data to solve symbolic tasks or a tabular presentation of data to solve spatial tasks might induce additional load on the cognitive system, thereby increasing the likelihood of information overload. Because the representation of the problem does not only address the external problem representation (the presentation format), but also the internal problem representation (within each individual), having the choice for a presentation format should be beneficial to inducing a fit. This in turn should decrease cognitive

load and the likelihood of information overload and improve the information process. Besides, choice is also assumed to lead to higher levels of decision makers' motivation and satisfaction (e.g., Chen & Koufaris, 2015). More specifically, choice has been found to be an essential factor that induces feelings of autonomy and competence (Patall et al., 2008). According to Self-Determination Theory (SDT; Deci & Ryan, 1985; Ryan & Deci, 2017), autonomy and competence, besides relatedness, are basic psychological needs of individuals, and their satisfaction leads to intrinsic motivation. In addition to this, intrinsic motivation is assumed to lead to higher levels of cognitive effort (Kanfer, 1990), and higher levels of cognitive effort may increase performance (Kanfer & Ackerman, 1989). Moreover, intrinsic motivation itself has been found to be positively associated with performance (e.g., Deci & Ryan, 2000; Kuvaas et al., 2017).

Altogether, it is reasonable to assume that the choice of a presentation format and its effects on cognitive fit, the underlying factors of intrinsic motivation, i.e. autonomy and competence, and cognitive effort increase decision-making performance and the information process.

1.2.2.5 Presentation Format Choice and Choice Awareness

In conjunction with presentation format choice, Research Paper 2 focusses additionally on how the awareness of having a choice between different data presentation formats, implemented through a visual prime in the experimental tasks, contributes to an enhanced task performance coming from an improved information process. Awareness can be described as the conscious perception and monitoring of the present environment (Brown & Ryan, 2003; Ryan & Deci, 2008) and refers to the conscious reception of task components. The conscious reception is associated with mindfulness, a state of attention to the present situation (Deci et al., 2015). Through mindfulness in turn, a stronger emotional connection is incurred, which increases higher perceptions of autonomy (Brown & Ryan, 2003). As autonomy-supportive environments allow the decision makers to satisfy their need for competence (Guay et al., 2001), the awareness of having a choice will enhance intrinsic motivation through perceptions of autonomy and competence. As mentioned before, intrinsic motivation is assumed to increase cognitive effort, and both intrinsic motivation and cognitive effort have been shown to increase performance (Kanfer & Ackerman, 1989; Kuvaas et al., 2017) which is associated with an improved information process.

In sum, it is reasonable to argue that the awareness of having a presentation format choice might enhance task performance in terms of decision-making accuracy of the response and improve the information process.

1.2.3 Decision Makers' Individual Factors

Decision makers' individual factors of information overload cover the factors of intrinsic motivation and different email management strategies that can be used to manage emails. The state of research according to these individual factors is presented hereafter.

1.2.3.1 Intrinsic Motivation

Within the dissertation, the participants' intrinsic motivation is investigated in the context of presentation format choice effects on task performance in Research Paper 2. SDT (Deci & Ryan, 1985; Ryan & Deci, 2017) relates to a framework that consists of several types of motivation, with extrinsic and intrinsic motivation being the most substantial forms. Whereas extrinsic motivation refers to an external locus of control and is often induced by external regulations, intrinsic motivation describes feelings of enjoyment and interest, and the behavior results from the feeling of self (Deci & Ryan, 1985, 2000). When intrinsically motivated, an individual's performance of a task results from her / his internal locus of causality and of the intrinsic stimulation of satisfaction (Ryan & Deci, 2000). Besides relatedness, SDT refers to perceived autonomy and competence as the immanent basic psychological needs of individuals and as the relevant factors of intrinsic motivation. Autonomy corresponds to the feeling that activities are controlled by oneself and not by external regulations (DeCharms, 1968), that they are volitional (Sheldon et al., 2003), and powered by the sense of self (Deci & Ryan, 2000). In autonomy-enhancing settings, the decision maker can choose procedures s/he feels competent with (Guay et al., 2001). Perceived competence as well results from feelings of having control, which is expressed in feelings of being able to meet the challenges of the task (Patall, 2012). Moreover, it describes the feeling of behaving effectively (Vlachopoulos et al., 2011). As mentioned before, when intrinsically motivated, decision makers devote more cognitive effort to performing a task (Kanfer, 1990), which in turn can positively affect performance (Kanfer & Ackerman, 1989).

Altogether, prior literature has found that intrinsic motivation leads to better performance (e.g., Kuvaas et al., 2017). Thus, with higher levels of intrinsic motivation and of cognitive effort, the information process might be enhanced.

1.2.3.2 Email Management Strategies

Research Paper 3 is concerned with email management strategies that can be applied to managing one's own emails. Email management strategies are therefore a further individual factor investigated in this dissertation. Bawden and Robinson (2009) state that email is seen as one of the most essential causes of information overload. In particular, email overload can be defined as facing more emails than an individual can handle, because too many emails are received, emails are poorly written, or the email system is being used for multiple activities apart from asynchronous information only (Thomas et al., 2006). The literature argues that email overload affects performance negatively (Ruff, 2002). In contrast, a well-adjusted email management should have a positive effect on performance. Many studies deal with email client design and with influencing factors on email overload. For example, Barley et al. (2011) tested the influence of email statistics, such as the time spent on emails, on email overload. The results show that the time involved with dealing with emails significantly increases email overload. Dabbish and Kraut (2006) investigated the influence of an individual's email volume, consisting of the number of emails received, read, and sent per day, and different email management tactics, measured as single-item variables, on email overload. The results reveal that email overload increases significantly by email volume, and decreases significantly by the single-item tactic "I try to keep my inbox size small." as well as by the single-item tactic "I check my email as soon as I see or hear that a new message has arrived." In addition to this, various studies deal with advice on how to handle emails, such as processing all emails at once or writing emails clearly so that there is no 'noise' for the recipient (Jackson et al., 2003; Vidgen et al., 2011).

In sum, a management of emails that decreases the cognitive load might decrease email overload and, synchronously, might increase email management performance and the information process.

1.3 Research Methodologies

The dissertation uses laboratory and online experiments as well as an online survey in order to investigate the influence of contextual factors and decision makers' individual factors on measures of different stages of the information process in corporate decision-making. In the following, the rationales for the application of the particular data collection method to answer the research questions, the designs of the experiments and the survey, and the variables used are presented.

1.3.1 Rationale for Applying Experiments and Surveys

Research Paper 1 consists of laboratory experiments which allow us to set up an artificial environment in which factors can be manipulated while other influencing factors on decision behavior can be held constant (Croson & Gächter, 2010). Moreover, the information supplied and the payment modalities can be regulated so that it is a controlled setting (Falk & Heckman, 2009). A controlled data generation in turn allows us to manipulate explanatory factors directly (Croson, 2002; Croson & Gächter, 2010) and to make causal inferences (Croson & Gächter, 2010). Experiments enable ceteris paribus observations of economic decision makers which otherwise could not be gathered (Levitt & List, 2007) as well as replications so that previous findings can be reproduced and verified (Croson, 2002). In addition to this, a post-experimental questionnaire also permits to collect individual factors. Apart from laboratory experiments, online experiments are used increasingly. In addition to the advantages of experiments already mentioned, the main reasons for an online data collection compared to a laboratory data collection are that it is less expensive, while a boarder population in different areas can participate easily, resulting in a higher statistical power (e.g., Birnbaum, 2004; Palan & Schitter, 2018; Reips, 2000). Nonetheless, the control of the experimental environment might be missing (Palan & Schitter, 2018) in experiments where the design is complex and where these environmental factors need to be stable across participants, so that experimenters need to be more attentive with these kind of experiments (Crump et al., 2013). Like a post-experimental questionnaire of experiments, the survey method enables researchers to gain information about the demographics, the social environment, the tasks, the preferences, or the opinions of someone (Moser & Kalton, 1971). Online surveys in particular bear advantages, such as reaching individuals in remote areas as well as those who are difficult to reach, or benefitting from an automated data collection in terms of effort and time (Wright, 2017).

With respect to the research model of the dissertation, contextual factors were measured within experiments, since these can build the artificial environment for the tasks to be performed in Research Papers 1 and 2. Thus, the influence of contextual factors can be investigated without any impairment through other factors. Because the design of Research Paper 1 required participants to concentrate in order to comprehend the experimental tasks and because it required complex calculations in the background of the experiment, the underlying research methodology consists of laboratory experiments. By contrast, the experimental design of Research Paper 2 was easy to understand for the participants, so that online experiments were utilized to collect the data.

The decision makers‘ individual factors within the research model of the dissertation were measured using questionnaires. To gather information about the intrinsic motivation of the participants within the experiments of Research Paper 2, a post-experimental questionnaire was implemented in the online experiments. The aim of Research Paper 3 is to identify how (well) people manage their emails and how these email management strategies influence email management performance. Therefore, a survey was used to generate the data basis. This was conducted online for the same arguments as mentioned above.

1.3.2 Designs

Since Research Papers 1 and 2 consist of different experimental tasks and Research Paper 3 comprises a survey, the designs of each method used are different from one another and described in the following.

1.3.2.1 Experimental Design of Research Paper 1

Research Paper 1 aims at examining the influence of time pressure and its interactions with the contextual factors of payoff schemes and information costs on the amount of information acquired in a decision-making task. According to the manipulation of these three influencing factors, Research Paper 1 consists of three laboratory experiments which were programmed in the Zurich Toolbox for Ready-Made Economic Experiments (z-Tree; Fischbacher, 2007). The experiments were performed in the experimental laboratory AIXperiment at RWTH Aachen University, Germany, and the Online Recruitment Software for Economic Experiments (ORSEE; Greiner, 2015) was used to recruit the participants. The three experiments comprised the same procedure and task structure, namely, an introduction phase, a main task, a post-experimental questionnaire, and an arithmetic problem task.

After the introduction phase, the main task in the form of a decision task under uncertainty started. In the task, which was inspired by Connolly and Thorn (1987), participants had to decide about whether an unused machine for the production of cakes should be taken back into operation. Re-operating was reasonable in the case of high future demand. Pieces of information about the future demand were acquirable non-sequentially from eleven distribution centers and each center provided one piece of information. Eleven pieces of information were provided, so that the calculations of conditional expectations and the optimal amount of information were not obvious. The particular pieces of information were drawn at random in the experimental task. If at least six distribution centers forecasted a high demand, the demand was regarded to be high, otherwise to be low. Before the inspection of acquirable information, there was an equal likelihood of high or low demand. In each experiment, time pressure (present, not present)

was varied and was manipulated by restricting the time available for every round. If participants failed to make a decision within the given time frame, the system made a random decision. Participants were randomly assigned to either the time pressure or the no-time pressure condition. To buy information, the participants received a budget. From the remaining budget, an additional payment was added or deducted in order to calculate the payment for each round which could be selected by lottery as the final payment. This additional payment in the form of a payoff matrix depended on the decision to operate the machine (yes, no) and on overall future demand. In Experiments 1 and 3, the additional payment was 10,000 experimental currency units (ECU) with a high future demand, and -8,000 ECU with a low future demand in the case of the decision to operate the machine. Since the probabilities for both of these conditions were 0.5 when no further information was acquired, the expected value for this scheme was 1,000 ECU and, therefore, was called 'positive'. In Experiment 2, the worst possible outcome option of the payoff matrix was varied: If participants decided to operate the machine and the overall future demand was low, their additional payment was -12,000 ECU instead of -8,000 ECU. All other values in the payoff scheme were unchanged. Therefore, when deciding to operate the machine without acquiring any piece of information, the possible outcomes were 10,000 ECU or -12,000 ECU. Since the probabilities for both conditions were 0.5, the expected value for this gamble was -1,000 ECU and this payoff scheme was called 'negative'. In Experiment 1 and 2, the direct costs for a piece of information increased with every piece of information by 68 ECU. These direct costs were added up to get the total costs for the acquisition of a certain amount of information. For example, in order to acquire two pieces of information 204 (= 68 + 136) ECU had to be paid. In opposition to this, in Experiment 3, the information costs were halved. For example, the total costs for the acquisition of two pieces of information were 102 ECU in Experiment 3.

After the main task, participants had to fill out a post-experimental questionnaire where, among others, a construct to measure the general risk aversion based on Mandrik and Bao (2005) was included in order to check for the robustness of the principal effects. Afterwards, participants were prompted to perform an arithmetic problem task (Ekstrom et al., 1976) in order to control whether quick calculation abilities played a role. At the end of the experiments, participants received their individual payment, consisting of their performance in the decision task and in the arithmetic problem task. The amount of information acquired was the dependent variable across all three experiments.

1.3.2.2 Experimental Design of Research Paper 2

Research Paper 2 investigates the influence of presentation format choice as well as in conjunction with the awareness of having a choice on underlying factors of intrinsic motivation, i.e. autonomy and competence, and subsequent decision makers' performance. Since these factors were manipulated or measured for symbolic and spatial tasks separately, Research Paper 2 contains two online experiments which were programmed in unipark[1] and conducted on the crowdsourcing platform Prolific[2]. Symbolic and spatial tasks were performed (in a random order) within one session, so that both experiments consisted of the same participants and manipulations. The experiments contained four parts, namely, a short introduction, a main task, a post-experimental questionnaire, and an arithmetic problem task.

The experiments started with a short introduction. In the main task, which was related to those used in the studies of Wilson and Zigurs (1999) and of Vessey and Galletta (1991), participants had to answer correctly and as fast as possible different questions regarding the quantity of chairs that a carpentry firm has sold in the last year. In Experiment 1, eight symbolic questions were asked, such as 'What is the combined quantity sold in April and June?' or 'What is the average quantity sold in October and December?' and had to be answered with a (decimal) number. In Experiment 2, eight spatial questions were asked, such as 'Does the quantity sold increase more (decrease less) from April to May than it does from September to October?' or 'Is February the month with the lowest (highest) quantity sold in the January to March period?', that had to be answered with 'yes' or 'no'.

To answer the questions, four different formats existed in which information was presented: A table with frame lines, a table without frame lines, a graph with data marking, and a graph without data marking. The factors 'choice of a presentation format' (present, not present) and 'awareness of having a presentation format choice' (present, not present) were manipulated. The participants that were given the choice were allowed to choose one of several formats in order to answer a particular question. In contrast, participants without a choice received either only tables or only graphs in order to answer the questions. The manipulation of the awareness of having a choice was implemented through a visual prime: When choice and awareness of this was given, the participants were explicitly informed that they would be allowed to choose a format instead of being assigned one. When no choice and the awareness of this was given, the participants were explicitly informed that they would not be allowed to

[1] https://www.unipark.com
[2] https://www.prolific.ac

choose a format and that they would be assigned one. Participants were assigned randomly to the particular conditions within the experiments.

The intrinsic motivation of a participant was measured, among others, within the post-experimental questionnaire. Moreover, to check for the robustness of the primary effects, participants had to report whether they used any aids to solve the task. Afterwards, participants had to perform as many calculations as possible in an arithmetic problem task which was based on Ekstrom et al. (1976). This was implemented in order to control whether quick calculation abilities influenced the main effects. At the end, the participants were paid a fixed amount of money. Since Research Paper 2 aims to investigate performance effects of presentation format choice as well as in conjunction with the awareness of having a choice, and with the underlying factors of intrinsic motivation, the performance indicator accuracy of the response constitutes the main dependent variable.

1.3.2.3 Survey Design of Research Paper 3

The aim of Research Paper 3 is to identify email management strategies, which email usage factors determine the use of a certain strategy, and how these strategies effect email management performance. To this end, an online-survey was programmed in unipark[3] and finally conducted on the crowdsourcing platform Prolific[4].

After a short introduction, questions related to email management performance and the use of email management strategies were asked. In order to have a comprehensive range of items that are linked with email management performance and to strengthen the results and implications of this study, we included different performance constructs into the study. The construct efficacy of email use (adopted from Dabbish & Kraut, 2006) and the work effectiveness scale (adopted from Mano & Mesch, 2010) were included in the survey, since both can be found in the email literature but comprise different performance-related items. Additionally, a modification of the individual management performance scale (adopted from Muhammed, 2006) was implemented in the survey, as it aims at the individual performance. These constructs represent the dependent variables of Research Paper 3. For the email management strategies, a full set of these strategies was included in the survey through the combination of already existing items in prior literature and the identification of new items. The strategies zero-inbox, to-do list, alertness, prioritization, and folder organization were implemented via multiple items and participants were prompted to indicate their

[3] https://www.unipark.com
[4] https://www.prolific.ac

(dis-)agreement with statements according to these items. Control variables are, among others, email statistics, such as the amount of emails received or sent within the past 24 hours, as well as constructs for the perceived usefulness of the email client (adopted from Davis, 1989) and for the need satisfaction (Deci et al., 2001; Ilardi et al., 1993; Kasser et al., 1992). After the survey had been completed, the participants got a fixed amount of money.

1.4 Summary of Research Papers

Three research papers investigate the overarching research question of this dissertation. The three research papers are summarized in this chapter by outlining the theoretical foundations and derived hypotheses as well as the key findings of each paper separately.

1.4.1 Research Paper 1

Research Paper 1 'Effects of Time Pressure on the Amount of Information Acquired' investigates the influence of time pressure when considered alone as well as in conjunction with different kinds of payoff schemes and information costs on the amount of information acquired. The related theory, hypotheses, and key findings are exposed in this chapter.

1.4.1.1 Theory and Hypotheses

The hypotheses of Research Paper 1 are grounded on prior studies in this research field and on the Dual-Process Theory (Kahneman & Frederick, 2002; Stanovich & West, 2000). The theory assumes that two systems of information processing and decision-making exist. While System 1 is characterized as automatic or intuitive, System 2 is described as controlled or deliberative. In judgmental processes, the impact of a variable is usually raised by System 1, while System 2 can lower the impact through deliberation (e.g., Kahneman & Frederick, 2002). Since System 2 is constrained by the capacity of the working memory (Evans, 2003), the presence of time pressure can inhibit deliberate considerations but does not necessarily have a negative impact on automatic processes (Glöckner & Betsch, 2008). Consequently, participants under time pressure might decide fast, without thinking deliberately about how many pieces of information to acquire. Based on prior research (e.g., Mann & Tan, 1993), it is hypothesized that under time pressure, fewer pieces of information are acquired when information are acquirable non-sequentially.

With regard to the influence of the interaction of time pressure with a payoff scheme that consists of a negative expected value, compared to a payoff scheme with a positive expected value, the hypothesis is based on studies that agree on the existence of a negativity bias

(Kanouse & Hanson, 1987; Rozin & Royzman, 2001), i.e. that negative pieces of information have a greater effect on individuals than positive information. Since it is assumed that negative information requires more conscious processing than positive information (Baumeister et al., 2001; Ito & Cacioppo, 2000), it is possible that under time pressure a payoff scheme with a negative expected value induces a shift from intuitive processes (induced by time pressure) to more conscious processes, thereby leading individuals to acquire more pieces of information.

From the rational perspective, higher information costs lead people to acquire only information with a higher utility than or equal utility to the costs for information (Kraemer et al., 2006). Additionally, the study by Kerstholt (1996) has shown that under time pressure, more information was acquired sequentially when information costs were relatively low. Based on this, participants facing relatively low information costs under time pressure might acquire more information. Derived from prior studies, it can be argued that costs seem to be an essential factor in the decision-making process, so that participants might neglect other aspects apart from costs within the choice context under time pressure. The derived hypotheses and the evidence of these are illustrated in Table 1.2.

Table 1.2: Hypotheses and Related Evidence of Research Paper 1

Hypotheses		**Evidence**
H1:	Participants under time pressure acquire less information than participants without time restrictions.	supported
H2:	Participants confronted with a negative payoff scheme and being placed under time pressure acquire more information than participants confronted with a positive payoff scheme and being placed under time pressure.	not supported
H3:	Participants facing relatively low information costs and being placed under time pressure acquire more information than participants facing relatively high information costs and being placed under time pressure.	supported

1.4.1.2 Key Findings

In all Experiments, time pressure during information acquisition and decision-making was manipulated. Thus, one half of the participants was placed under time pressure and the other half did not receive any time restrictions. With respect to the influence of the kind of payoff scheme that was implemented into the task, this consisted of either a positive expected value (Experiments 1 and 3) or a negative expected value (Experiment 2). The influence of different levels of information costs was also tested. While the costs for acquirable information were relatively high in Experiments 1 and 2, they were relatively low in Experiment 3.

The results of Experiment 1 show that participants who were placed under time pressure acquired significantly fewer pieces of information in the decision-making task (H1). It seems

that people under time pressure perceived stress, decided quickly, had no time to process information deliberately, and therefore, relied on fast cognitive processes.

The results based on data of Experiments 1 and 2 together indicate no effect for the interaction term of a negative payoff scheme in conjunction with time pressure on the amount of information acquired (H2). As a consequence, a higher negative payment in the case of the decision to operate the machine and an overall low demand in the negative payoff scheme in combination with time pressure does not generally seem to lead to a shift from System 1 thinking (through time pressure by itself) to System 2 thinking. The results also show no effect of being confronted with a negative payoff scheme instead of a positive payoff scheme on the amount of information acquired. Thus, previous support for this effect from the literature should be treated with caution.

The results based on data of Experiments 1 and 3 together imply that participants under time pressure and confronted with relatively low information costs acquired more information (H3). By contrast, the influence of the level of information costs by itself has no significant influence on the amount of information acquired. Thus, the weighting of relatively low information costs has an effect on the decision makers only when they are pressed for time. Under time pressure, information costs might appear to be so cheap that the acquisition of more information seems reasonable (even if it is not) and that the effect of time pressure, which leads people to acquire less information, is abrogated.

1.4.2 Research Paper 2

Research Paper 2 ‘Presentation Format Choice and Choice Awareness: Experimental Studies Analyzing the Effects on Underlying Factors of Intrinsic Motivation and Task Performance’ analyzes presentation format choice and choice awareness as influential factors for intrinsic motivation and subsequent task performance. The related theoretical foundation and hypotheses as well as the resulting key findings are depicted in this chapter.

1.4.2.1 Theory and Hypotheses

The related hypotheses of Research Paper 2 are based on CFT (Vessey, 1991), SDT (Deci & Ryan, 1985; Ryan & Deci, 2017), and Reactance Theory (RT; Brehm, 1966; Brehm & Brehm, 1981). CFT assumes that when the external problem representation, which describes the kind of presentation format in which information is presented (Kelton et al., 2010), matches the decision-making task and leads to an accurate mental (internal) representation of the problem, cognitive fit occurs and results in higher task performance (compared to no cognitive fit) (Shaft & Vessey, 2006; Vessey, 1991). The theory differentiates between two kinds of external

problem representation, i.e. symbolic and spatial representations. Prior research has depicted that symbolic tasks are best supported by tables, while spatial tasks are best supported by graphs (Umanath et al., 1990; Vessey & Galletta, 1991). Having the choice of a presentation format can help to achieve a cognitive fit, since decision makers can select the presentation format that supports their cognitive abilities. Even if cognitive fit does not occur when choice is given and cognitive load is high, further cognitive effort may be raised due to self-regulatory processes (Kanfer & Ackerman, 1989). Since a high persistence of cognitive effort enhances task performance (e.g., Moller et al., 2006; Vallerand, 1997; Zapata-Phelan et al., 2009), it can be assumed that cognitive load and cognitive effort interact with each other, so that the negative performance effects induced by a high cognitive load might be overcompensated.

Awareness is seen as the conscious perception of the surroundings (Brown & Ryan, 2003; Ryan & Deci, 2008), so that choice awareness in decision-making tasks with presentation format choice can be seen as the conscious perception to monitor the choice options as well as the conscious reception of task components and options. The conscious reception is related to mindfulness, which describes the state of receptive attention of the actual environment (Brown & Ryan, 2003; Deci et al., 2015). Mindfulness in turn leads to a stronger emotional connection and attention to the action so that decision makers focus more on the act of choosing relative to decision makers without choice options (Brown & Ryan, 2003; Deci et al., 2015). A driver of being aware of states and conditions is that of visual priming (Lin & Murray, 2014; Wiggs & Martin, 1998). Priming describes the display of a stimulus in order to influence an individual's perception of a certain situation (Murphy & Zajonc, 1993), such as a clear visual information that highlights the option of having a choice between different data presentation formats in order to solve a particular question. Thus, decision makers who are visually primed to have a presentation format choice within the decision-making task will perceive a higher cognitive effort, which results in a higher performance than those who are not explicitly primed to have this choice.

According to SDT (Deci & Ryan, 1985; Ryan & Deci, 2017), perceived autonomy and competence belong to the basic psychological needs, besides relatedness. Moreover, the theory assumes that when these feelings are satisfied or supported, intrinsic motivation rises. Since choice supports feelings of personal control, it is regarded as one factor that supports feelings of autonomy (e.g., Patall, 2019; Patall et al., 2008). Autonomy-supportive environments in turn enable the satisfaction of the need for competence (Guay et al., 2001). Thus, the provision of choice affects not only feelings of autonomy but also of competence as factors of intrinsic motivation. In the context of SDT, it is assumed further that high levels of intrinsic motivation

influence performance positively (Kuvaas et al., 2017). When a decision maker is intrinsically motivated, s/he raises high levels of cognitive effort for the process (Kanfer, 1990) and the solving of the task, thereby increasing task performance (Zapata-Phelan et al., 2009). Based on these assumed positive effects of choice on intrinsic motivation and on task performance (e.g., Patall, 2019; Patall et al., 2008), as well as of higher intrinsic motivation on performance (Kuvaas et al., 2017), it can be inferred that intrinsically motivated decision makers under the provision of choice should achieve a better task performance.

Since awareness is seen as the conscious perception of the surroundings (Brown & Ryan, 2003; Ryan & Deci, 2008) and as another factor that influences feelings of autonomy (Deci et al., 2015), the awareness of having a choice within a decision-making task might intensify the effects of choice by itself on factors of intrinsic motivation and subsequent performance. Moreover, RT (Brehm, 1966; Brehm & Brehm, 1981) assumes that when the freedom of a range of alternatives is threatened and regarded as being difficult to restore, a high motivational reaction is shown in order to recover this freedom. Additionally, the decision maker might perceive that a removal results from a managerial distrust in her / his competencies. Since the awareness of having a choice could raise feelings of autonomy and competence, it is possible that decision makers explicitly aware of having a choice perceive higher levels of intrinsic motivation. The derived hypotheses and the findings are listed in Table 1.3.

Table 1.3: Hypotheses and Related Evidence of Research Paper 2

Hypotheses		Evidence
H1:	Subjects who can choose the information presentation format perform better than subjects having no choice.	not supported
H2:	Subjects who are aware of having the opportunity to choose the information presentation format perform better than subjects who are not explicitly aware of having a choice	not supported
H3a:	Having a choice, subjects with a higher perception of autonomy perform better than subjects with a lower perception of autonomy.	supported in symbolic tasks; not supported in spatial tasks
H3b:	Having a choice, subjects with a higher perception of competence perform better than subjects with a lower perception of competence	not supported
H4a:	Subjects who have a choice perceive a higher autonomy than subjects who have no choice.	supported
H4b:	Subjects who have a choice perceive a higher competence than subjects who have no choice.	supported
H5a:	Subjects who are aware of having a choice perceive a higher autonomy than subjects who are not explicitly made aware of having a choice	supported
H5b:	Subjects who are aware of having a choice perceive a higher competence than subjects who are not explicitly made aware of having a choice.	not supported

1.4.2.2 Key Findings

According to symbolic tasks, the following results have been found:

Tables significantly increase task performance in terms of the accuracy of the response. It seems as if tables best support symbolic tasks, leading to a cognitive fit and a subsequent increase in performance. Prior studies have already inferred that decision makers favor the use of tables over graphs, since they are confronted more often with tables than graphs (Vessey & Galletta, 1991).

The results for the influence of choice by itself show that choice does not enhance performance (H1). Decision makers who were given a choice might have coped with the task more intensively, so that cognitive load increased. Moreover, a possible increase in cognitive effort through having a choice does not seem to be able to compensate the negative effects of an increased cognitive load. By contrast, when tables are chosen, performance increases. However, when choice is given and decision makers are made aware of this choice, task performance is not enhanced (H2).

When decision makers are exposed to a choice setting and perceive higher autonomy, the task accuracy can be significantly increased (H3a). The provision of choice and higher

perceptions of autonomy simultaneously seem to raise cognitive effort that is enough to compensate the negative effects of an increased cognitive load, with positive effects on the accuracy in symbolic tasks. Interestingly, the interaction effects of choice and perceptions of competence do not yield a significant effect on task performance (H3b).

Due to spatial tasks, the results yield no important effects.

With respect to the relationship of choice and the psychological forces of perceived autonomy and competence, choice is found to be a significant determinant for feelings of autonomy and of competence (H4a and H4b). The decision maker might perceive the task to be intrinsically motivating and might experience freedom in performing it. Furthermore, the decision maker might perceive that s/he will be able to effectively solve the task. Besides this, the results show that while choice awareness increases feelings of autonomy (H5a), it decreases feelings of competence (H5b). The emphasis on presentation format choice seems to further promote higher perceptions of autonomy. An explanation for the significant decrease in competence through the emphasis on choice might be that the decision maker is more aware that the decision task consists of two parts instead of only one part when choice is provided (through the selection of a presentation format and the solving of the task). Thus, s/he might feel less competent to perform both task components adequately.

1.4.3 Research Paper 3

Research Paper 3 ‘Email Management Strategies: Their Effects on Email Management Performance’ investigates the measurement and use of different email management strategies that can be applied by email users. Moreover, it researches how these strategies influence email management performance. The related theories, hypotheses, and key findings of Research Paper 3 are outlined in this chapter.

1.4.3.1 Theory and Hypotheses

The hypotheses for Research Paper 3 are grounded in attention theories (Kahneman, 1973) and CLT (Chandler & Sweller, 1991; Sweller, 1988). According to the Structural and the Capacity Theory, which are two attention theories (Kahneman, 1973), the overall amount of attention that can be drawn on items is limited. Actions that consume attention simultaneously therefore interfere with each other. While the capacity model assumes that interference occurs when the individual is no longer able to process all relevant information cues, the structural model explains interferences with the situation when two activities require the same psychological processes simultaneously. Irrespective of how interference appears, both theories agree that its consequence is an increase in cognitive load, so that attention can only be paid to one activity

at the cost of the other (Speier et al., 1999). CLT deals with the management of working memory load (Paas et al., 2004) and differentiates between intrinsic, extraneous, and germane cognitive load (Paas et al., 2003). Since intrinsic cognitive load refers to the form of the information itself (Sweller et al., 2011) and cannot be reduced, extraneous cognitive load, which relates to the information presentation context, can be minimized. When intrinsic and extraneous cognitive load leave available capacity, germane cognitive load is able to occur (Van Merriënboer & Sweller, 2010) which supports automatic processes and schema construction (Sweller et al., 2011). Email management strategies should therefore help to reduce the extraneous cognitive load.

The zero-inbox strategy describes a behavior where email users try to leave their email inbox at zero. Thus, outstanding emails can be regarded as visual reminders, so that an overview can be kept, less concurrent information has to be borne in mind, and less interferences should take place. Moreover, the visibility of outstanding emails only, instead of all emails received, should reduce the extraneous cognitive load. Literature has already shown that unfulfilled goals or tasks can impair the focusing on other, later goals or tasks (Masicampo & Baumeister, 2011b) and that an effective plan can help to reduce interferences and to focus on a certain goal (Masicampo & Baumeister, 2011a). Previous studies have identified that an inbox-clearing behavior can be associated with a decrease in information overload (Dabbish & Kraut, 2006; Kalman & Ravid, 2015). Thus, the zero-inbox strategy should help to reduce the cognitive load so that the working memory can be relieved and performance can be enhanced.

In the same vein, the to-do list strategy, which describes the use of the email client as a to-do list in order to keep a person's attention on relevant information, might lead to an increase in email management performance. The list can help to avoid forgetting things and to focus on certain activities, so that less concurrent pieces of information have to be kept in mind. Moreover, the to-do list can help to keep an overview, so that the extraneous cognitive load can be reduced, working memory can be relieved, and performance can be increased.

An alertness strategy means that the email user is alert to incoming emails. When being email-alert, i.e. when having the email client permanently open or when checking for new emails frequently, this results in more interruptions (Jackson et al., 2001; Jackson et al., 2003). Interruptions lead to interferences (Kahneman, 1973), which can increase the cognitive load (Speier et al., 1999), so that performance deteriorates (Kahneman, 1973). Consequently, an alertness strategy is assumed to impair email management performance.

In contrast to this, the use of the prioritization strategy describes the behavior to prioritize certain emails, i.e. to work on the most important emails first. Mackay (1988) already describes

users of this strategy as those who restrict their email checking, which can be interpreted as the opposite behavior to an alertness strategy. Moreover, through prioritization, email users have to keep fewer things in mind, since they focus on certain emails / information. Thus, the use of this strategy should decrease the cognitive load imposed on the cognitive system and help an individual to pay attention to certain information, thereby increasing performance.

The folder organization strategy is characterized by the sorting of emails into different folders. With this strategy, email users experience control over their emails, but this comes at the expense of the need for a lot of cognitive effort to set up folders (Whittaker & Sidner, 1996). Moreover, the sorting of emails into specific folders (Ducheneaut & Bellotti, 2001) and the remembering of folder definitions (Ducheneaut & Watts, 2005) can require cognitive effort as well. Therefore, cognitive load cannot be reduced and the folder organization strategy might decrease email management performance. The related hypotheses and results are depicted in Table 1.4.

Table 1.4: Hypotheses and Related Evidence of Research Paper 3

Hypotheses			**Evidence**
H1a:	The greater the use of the zero-inbox strategy, the higher the	individual email management performance.	supported
H1b:		efficacy of email use.	supported
H1c:		work effectiveness.	partially supported
H2a:	The greater the use of the to-do list strategy, the higher the	individual email management performance.	supported
H2b:		efficacy of email use.	not supported
H2c:		work effectiveness.	supported
H3a:	The greater the use of the alertness strategy, the lower the	individual email management performance.	not supported
H3b:		efficacy of email use.	not supported
H3c:		work effectiveness.	not supported
H4a:	The greater the use of the prioritization strategy, the higher the	individual email management performance.	not supported
H4b:		efficacy of email use.	not supported
H4c:		work effectiveness.	supported
H5a:	The greater the use of the folder organization strategy, the lower the	individual email management performance.	not supported
H5b:		efficacy of email use.	not supported
H5c:		work effectiveness.	not supported

1.4.3.2 Key Findings

In a first step, it was tested whether the different email management strategies are measurable constructs, since no validated multiple-item scales exist in the literature. Based on existing items from prior studies and the identification of new items, the results show that all investigated strategies are measurable constructs. In a second step, it was identified which email usage factors determine the use of a particular email management strategy. The results show that with higher levels of email volume, such as the number of emails received, and perceived usefulness of the email client, all investigated strategies are used more often. Finally, the influence of the different email management strategies on email management performance measures were investigated. The results reveal that the zero inbox strategy increases significantly the individual email management performance (H1a), the efficacy of email use (H1b), and partially also the work effectiveness (H1c). Moreover, the to-do list strategy enhances significantly the individual email management performance (H2a), and the work effectiveness (H2c), but not the efficacy of email use (H2b). In sum, the two strategies zero-inbox and to-do list increase at least two of the three performance measures. The strategies might reduce the cognitive load and number of interferences, as they function as external extensions of the working memory and present all outstanding emails / information in a clear way which otherwise have to be kept in mind. The alertness strategy does not decrease but increases partially significantly the individual email management performance (H3a) and the efficacy of email use (H3b), and has no significant effect on the work effectiveness (H3c). Through an alertness strategy, interruptions are more likely with negative effects on performance (Jackson et al., 2001, 2003). By contrast, it can also help to get the job done, since job-related information is inspected immediately (Dabbish & Kraut, 2006; Mano & Mesch, 2010). The prioritization strategy, on the one hand, increases significantly the work effectiveness (H4c) but on the other hand, decreases the efficacy of email use (H4b) and has no significant influence on the individual email management performance (H4a). An increase in work effectiveness might result from the fact that email users can focus on particular emails without paying attention to other (unimportant) emails. By contrast, a decrease on the efficacy of email use might come from the cognitive effort that is needed for categorizing emails, so that the cognitive load cannot be reduced through it. The folder organization strategy is associated neither positively nor negatively with the three different performance measures (H5a-c). The number of folders used and how they are used might be important to consider when investigating this strategy's direction of influence on email management performance.

1.5 Conclusion

Within this chapter, the key findings of the individual research papers and theoretical as well as practical implications are outlined. At the end of this chapter, limitations and directions for further research are presented.

1.5.1 Outline of Key Findings

This dissertation analyzes the influence of contextual factors and decision makers' individual factors on measures of different stages of the information process in corporate decision-making in order to investigate how this process can be improved. The following contextual factors are analyzed: time pressure, time pressure in conjunction with different payoff schemes, time pressure in conjunction with different levels of information costs, presentation format choice, and presentation format choice in conjunction with the awareness of having a choice. In addition to this, the following decision makers' individual factors are investigated: intrinsic motivation and the use of different email management strategies. According to the dependent variables investigated in this dissertation, the following measures are used: amount of information acquired, accuracy of the response, and email management performance. Among other things, the increasingly relevant topic of information overload calls for improvements of the information process.

Research Paper 1 comprises contextual factors only and addresses the amount of information acquired. More specifically, it is concerned with the influence of time pressure on the amount of information acquired in a decision-making task. In the setting, information can be acquired non-sequentially at a certain cost and can be used as decision support. Besides time pressure, its interaction with different payoff schemes containing decision-based and environmental condition-based additional payments, and its interaction with different levels of information costs are investigated.

Research Paper 2 refers to both contextual factors and decision makers' individual factors and their impact on task performance. In particular, it focuses on presentation format choice effects on underlying factors of intrinsic motivation and subsequent task performance (accuracy of the response). Moreover, the effect of being aware of having a choice is analyzed as well. The analyses take aspects of cognitive fit, the fit between the task and the presentation format, and cognitive effort into account.

Research Paper 3 concerns decision makers' individual factors only and investigates their influences on email management performance. It identifies different email management strategies used by individuals to manage their emails and analyzes which email usage factors

are determinants for their application. Furthermore, it studies which email management strategies influence email management performance positively or negatively.

In Table 1.5, the research questions and the related key findings of each research paper are illustrated.

Table 1.5: Summary of Key Findings

RP	Research Questions	Key Findings
1	1. What is the effect of time pressure on the amount of information acquired by individual decision makers? 2. Does the effect of time pressure on the amount of information acquired depend on different payoff schemes in a decision-making task? 3. Is the effect of time pressure on the amount of information acquired different for various levels of information acquisition costs?	• Under time pressure by itself, fewer pieces of information are acquired. Due to the present results and literature, participants under time pressure seems to perceive stress, to decided quickly, and to rely on System 1 processes. • Being confronted with a negative payoff scheme when being placed under time pressure has no effect on the information acquisition behavior of decision makers. • When decision makers are confronted with relatively low (compared to relatively high) information costs and being placed under time pressure, they acquire more information. It should be noted that relatively low information costs take an effect on the decision makers only when they are placed under time pressure. Under time pressure, information costs might appear so cheap so that more information pieces (than reasonable) are acquired.

2	1. What are the effects of being able to choose the presentation format on task performance in symbolic and spatial tasks?
	2. Do the effects of presentation format choice on task performance depend on the awareness of having a choice or of not having a choice?
	3. To what extent do perceptions of autonomy and competence as factors of intrinsic motivation play a role in the context of the effects of presentation format choice on task performance?
		• Choice by itself decreases task performance in symbolic tasks, since cognitive load might be increased and cannot be compensated by an increase in additional cognitive effort through the provision of choice.
		  • When the decision maker chooses tables in symbolic tasks, performance increases.
		  • When choice is given and the decision maker is made aware that s/he has a free choice, performance does not significantly increase in symbolic tasks.
		  • Whereas task performance increases in symbolic tasks when presentation format choice is provided and the decision maker perceives autonomy, it is not affected when the decision maker perceives competence in symbolic tasks.
		• Due to spatial tasks, the results yield no important effects.
		• Choice contributes to perceptions of autonomy and competence. Importantly, choice in conjunction with the awareness of having a choice increases perceptions of autonomy but decreases feelings of competence.

3	1. Are email management strategies measurable constructs? 2. Which email usage factors determine the use of a certain email management strategy? 3. Which email management strategies influence email management performance positively or negatively?	• Email management strategies can be measured through a range of validated scales consisting of multiple items. • The use of a strategy is determined by email usage factors, i.e. email volume and perceived usefulness of the email (client). • Using the client as a to-do list and keeping the email inbox at zero increase email management performance (at least two of the three measures). • Performance-enhancing strategies seem to reduce the cognitive load and to relieve the working memory.

1.5.2 Theoretical Implications

Since the changes in the information environment can increase an individual's cognitive load and lead to information overload, the need for an improvement of the information process stems to a large extent from the topic of increases in cognitive load and information overload.

The present dissertation provides a wide range of theoretical implications. First, the dissertation extends information overload research in many ways. The dissertation considers contextual factors, interaction terms of these, and decision makers' individual factors as influencing factors at different stages of the information process in order to identify how this process can be improved, and thereby, i.a., how information overload can be reduced. Time pressure effects have already been research broadly (for a review, see Lallement, 2010), but no research study has so far investigated the influences of interaction terms of time pressure with further contextual factors on measures within the information process. Even if the provision of choice has already been seen in the context of an overload (e.g., Bollen et al., 2010; Schick et al., 1990), no studies have so far analyzed interaction terms of choice and further factors. Moreover, the intrinsic motivation of an individual has not been within the scope of information overload research up to now. Besides, prior studies tried to examine the influence of email management strategies on email overload (Dabbish & Kraut, 2006), but since no studies have so far developed a range of well-validated email management strategies, this dissertation is the first that was able to draw conclusions about this relationship.

Second, by analyzing the influence of different contextual factors and decision makers' individual factors on measures of the information process at stages of information acquisition, information processing, and information management, the dissertation is able to provide a holistic view on how to improve this information process in corporate decision-making.

Third, the dissertation relies on cognitive theories in order to explain the effects of contextual and individual factors concerning the information process in the workplace. In particular, the dissertation combines several cognitive theories and extracts their implications for how to improve the process. With this, it deepens the understanding and application of these cognitive theories. In addition to this, SDT (Deci & Ryan, 1985; Ryan & Deci, 2017) has been set in the light of cognitive theories.

Fourth, the results of the dissertation at hand support newer cognitive science theories. In contrast to the view of traditional cognitive science theories, the extended cognition thesis supports the idea that cognition can extend beyond the skin (Clark & Chalmers, 1998). Several theories that are related to this idea exist, e.g. the theory of distributed cognition or of embodied cognition. The theory of distributed cognition does not only consider processes that are

cognitive and happen in the brain but also those that include interactions between the individual and items in the environment (Hollan et al., 2000). Therefore, cognitive processes are distributed across the brain and the environment (Hutchins, 2000). Moreover, the theory covers the idea that cognition is embodied (Hollan et al., 2000). The theory of embodied cognition assumes that cognitive systems are interacting with the environment through bodily sensors and effectors (Heylighen & Vidal, 2008) and it makes several claims. Against the background of the present dissertation, the most meaningful claim is claim number three 'We off-load cognitive work onto the environment' (Wilson, 2002). This means that the environment is used for the active holding of information in order to reduce the cognitive load that is imposed on the working memory. Importantly, this does not imply the use of the environment as a long-term archive in order for individuals to avoid having to memorize (Wilson, 2002).

1.5.3 Practical Implications

The dissertation provides practical implications for improvements in the information process in the workplace, particularly in a fast-moving and digitized world.

Regarding the amount of information acquired, time pressure should be induced to make subordinates acquire fewer pieces of information. Vice versa, time pressure should be avoided to make the subordinates acquire more information. Further, the superior must consider the level of information costs, since it substantially influences the amount of information acquired under time pressure. Under time pressure, low information costs might appear to be so cheap that subordinates purchase more information. They might neglect other aspects except for information costs when perceiving time pressure. Thus, relatively low information costs should be neglected under time pressure in order to make subordinates acquire fewer pieces of information. Vice versa, relatively low information costs should be highlighted under time pressure in order to make subordinates acquire more information.

According to the performance measure accuracy of the response, the superior must be cautious when providing a subordinate with presentation format choice in order to solve symbolic tasks. Choice negatively affects the cognitive load and subsequent performance, but this might be compensated by cognitive fit and cognitive effort (at least to some extent), so that the following implications result:

- When providing presentation format choice,
  1) the choice context should be designed insofar that the decision maker chooses tables in order to increase the accuracy of the response in symbolic tasks.

2) the decision-making task should be designed insofar that it increases feelings of autonomy in order to increase the accuracy of the response in symbolic tasks. Providing choice influences factors of intrinsic motivation (autonomy and competence). Moreover, when the decision maker is aware of the free choice, this increases feelings of autonomy and decreases feelings of competence. Therefore, a superior can provide choice and make subordinates aware of this choice in order to enhance feelings of autonomy.

- When no presentation format choice is provided, tables should be provided in order to increase task performance in terms of accuracy in symbolic tasks.

Regarding email management performance, the superior should strongly recommend the use of the zero-inbox and to-do list email management strategies, so that a good email management performance can be achieved (at least two of the three investigated performance measures were increased through both strategies). Email users should try to have all outstanding tasks available at one glance and to maintain a good overview where no concurrent activities are considered. In addition to this, trainings could be carried out that highlight the advantages of the email (client), since its perceived usefulness increases email management performance as well.

1.5.4 Limitations and Directions for Further Research

Besides the various implications drawn within the dissertation at hand, some potential limitations should be the subject of further research. In all research papers, it should be noted that data were collected at only one point in time. This procedure was selected in order to investigate the underlying research questions and hypotheses without the influence of further variables, such as experience. Nonetheless, when conducting the studies again after a while, experience with the experimental tasks or with tasks that are similar to those used within the experiments as well as experience in email management (in combination with the information of how long email users have been using the email in this way) could be elaborated and might be possible influencing factors.

Research Paper 1 of this dissertation analyzes the influence of time pressure by itself, in conjunction with different payoff schemes, and with different levels of information costs on the amount of information acquired. The paper reveals significant influences of time pressure as well as of the interaction of time pressure and information costs, but not of the different payoff schemes that were manipulated. Since many studies agree on the existence of a negativity bias (Baumeister et al., 2001; Kanouse & Hanson, 1987; Rozin & Royzman, 2001), it is conceivable

that payoff schemes with more distinct values would yield significant effects. Thus, it would be valuable to investigate how those payoff schemes influence information acquisition behavior under time pressure. In the experiments of Research Paper 1, participants were able to acquire information from a set of eleven pieces of information. Research has already found out that the amount of information that a decision maker is confronted with leads to different decision strategies (Fischer et al., 2008). Therefore, it would be fruitful to expand the present research by providing different amounts of information that can be acquired.

In addition to this, the present dissertation investigates in Research Paper 2 how the provision of presentation format choice as well as in conjunction with the awareness of having a choice influences intrinsic motivation and subsequent task performance. Thereby, Research Paper 2 consists of a task with four choice options for presentation formats. As color-enhanced presentation formats, at least in interaction with individual differences, have been found to influence the decision-making quality (Benbasat & Dexter, 1985), more variation, such as color, within the presentation formats provided or within further presentation formats could be implemented. Moreover, four choice options were provided in Research Paper 2, since previous research assumes that the effect of choice on autonomy is highest when three to five choice options are available (Patall et al., 2008). Nonetheless, besides autonomy, perceived competence is also measured, and the effect of the number of choice options on competence could differ from those on autonomy. Therefore, further research could expand the present research by testing the influence of even more presentation formats, apart from graphs and tables, on factors of intrinsic motivation and subsequent performance.

Research Paper 3 focuses on the identification of different email management strategies and with which strategy the email management performance is highest. In this context, the dissertation also investigates which email usage factors, e.g. the email volume that an individual is confronted with, determine the use of a certain strategy. It would be interesting to expand this research by analyzing the influence of individual differences, such as the occupation or the years of work experience, on the use of an email management strategy. The email communication tool was investigated because it is used massively in the workplace (e.g., Sobotta, 2016) and is thus seen as a major cause of overload (Bawden & Robinson, 2009). Besides email, other communication channels have been developed and are used within organizations. It would be worthwhile to analyze in future which strategies for organizing information gathered via these media exist and which of these lead to the most effective and efficient use.

Finally, Research Papers 1 and 2 have shown that not only interacting effects between influencing factors at different stages of the information process exist but also that these interaction effects can reverse the single effects. For example, the dissertation shows in Research Paper 1 that the effect of time pressure on the amount of information acquired can be abolished through relatively low information costs. It would be valuable to investigate further interacting effects between different factors influencing measures of the information process.

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Part 2: Research Papers

2.1 Effects of Time Pressure on the Amount of Information Acquired

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Abstract
Through digitization, more and more information is becoming available and can be used as a basis for decision-making. Consequently, questions about the behavioral control of how much information should be acquired in decision-making processes are becoming increasingly relevant in organizational contexts. Whereas research has already investigated the influence of time pressure for given amounts of information, the amount of information acquired for decision-making processes has not yet been widely examined. Therefore, we tested the influence of time pressure and to what extent time pressure interacts with the contextual factors 'payoff scheme' and 'level of costs for information that can be acquired' in three laboratory experiments. Participants had to decide how many pieces of information they wanted to purchase non-sequentially in order to make a production decision under uncertainty. Our findings indicate that under time pressure, individuals acquire less information. Moreover, while we found no effect of time pressure with a negative payoff scheme, higher levels of information costs suppress the willingness to acquire information. Interestingly, the effect of relatively low information costs only materializes when time pressure is present.

Keywords: Information acquisition, Decision-making, Amount of information, Time pressure, Payoff scheme, Information costs

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2.1.1 Introduction

Many economic decisions are accompanied by time restrictions (e.g., Kocher et al., 2019), such as trading, purchasing and sales, or production decisions. Particularly in times of digital media, more information is available for decision-making and needs immediate processing (e.g., Gawryluk & Krawczyk, 2017). In organizational contexts, where time plays a crucial role, questions about the behavioral control of how much information should be acquired and used in decision-making processes are highly relevant. However, research has not yet investigated the role of time pressure for non-sequential information acquisition behavior. Moreover, most studies manipulate time as the only variable across treatments even if it is possible that this variable interacts with other contextual factors (Spiliopoulos & Ortmann, 2018). Hence, the present study aims to identify how time pressure by itself and in conjunction with further contextual factors affects the amount of information acquired in a decision-making process.

For three reasons, the factor of primary interest in this paper is that of time pressure induced by time restrictions: First, time pressure is an important topic in everyday work life (Lallement, 2010). Second, time pressure is often strongly related to decision-making processes due to the pure amount of decisions that have to be made on a regular basis and that are often accompanied by strict deadlines (Geisler & Allwood, 2018). Third, time pressure is not only a natural factor within organizations, it is also a factor that can be artificially invoked by managers and it therefore can be used as a control instrument. For these reasons, we investigate the following research questions:

1. *What is the effect of time pressure on the amount of information acquired by individual decision makers?*
2. *Does the effect of time pressure on the amount of information acquired depend on different payoff schemes in a decision-making task?*
3. *Is the effect of time pressure on the amount of information acquired different for various levels of information acquisition costs?*

To answer these research questions, we conducted laboratory experiments and employed multivariate analyses.

The paper is structured as follows: In the next section, we summarize existing research on information acquisition in decision-making. We review related research on time pressure effects in the decision-making literature, as well as on payoff schemes and information costs. Then, we explain the protocols of our conducted experiments, the measures used, and the analysis methodology. Subsequently, we present and discuss the results of the three

experiments. Finally, we subsume the theoretical and practical implications as well as the limitation of our research and we outline future research implications.

2.1.2 Information Acquisition Research

Prior literature on the amount of information acquired for decision-making (e.g., Kerstholt, 1996; Mann & Tan, 1993; San Miguel, 1976) can be divided into two parts: the acquisition of sequential and of non-sequential information. The former investigates pieces of information that are acquired one after another. Research on non-sequential information acquisition deals with the process of obtaining varying amounts of information at only one point in time and is the underlying form of information acquisition in the present study. Studies in this field deal with a broad range of topics: San Miguel (1976) examined, among other things, the effect of psychological traits on the amount of information purchased before decision-making. Among other findings, the study shows that the mean amount of information purchased is higher for individuals low in flexibility (also described as being intolerant of ambiguity) and is very similar between different levels of intellectual efficiency, which describes how efficiently an individual uses her / his intellectual resources (Gough, 2000). The study by Fischer et al. (2008) investigated the amount of available information as an explanatory variable for the preference for decision-consistent versus decision-inconsistent information with the prior decision. Decision-consistent information would reinforce an individual's own previously formed decision, whereas decision-inconsistent information would provide information divergent from this. In the experimental task, participants made a decision on a legal case and each participant was requested to choose one piece of information that was consistent or inconsistent with her or his prior decision between a set of two or ten pieces of information (half of the set of two and half of the set of ten pieces of information was consistent and the other half was inconsistent). The results show a preference for inconsistent information when participants faced two pieces of information and for consistent information when they faced ten pieces. In the experiment by Uecker (1978), participants had to choose an amount of information in the form of a random sample size to be drawn from an urn containing a total of 100 marbles, some of them black and some of them white (as information systems). The urn was selectable from a set of 10 urns and the ratio of black to white marbles in the selected urn was unknown to the participants. They only knew that out of the 10 urns, 2 of them contained 90 black and 10 white marbles, 4 urns contained 70 black and 30 white marbles, 3 urns contained 50 black and 50 white marbles, and 1 urn contained 30 black and 70 white marbles. After specifying a random sample size, the marbles were shown to a simulated decision maker, executed through a

computer, programmed with either a Bayesian or a conservative decision model. Based on the sample results and its prior probability assessments, the simulated decision maker estimated the ratio of black to white marbles in that urn. The optimal information system for the Bayesian model comprised 16 marbles and for the conservative model, the sample size was 24 marbles. The participants were provided with a budget of $3.00, and the cost for sampling a marble was $0.01. In the case of a decision maker's correct decision, each participant received $0.50 less the costs for the marbles in the specified sample. In the case of a decision maker's incorrect decision, each participant lost $0.50 plus the costs for the marbles in the specified sample. However, the study was not primarily interested in the amount of information acquired. It was more interested in discovering whether the participants were able to choose an optimal information system for the decision maker, i.e. if s/he specified the sample size in accordance with the normative theory of information evaluation. Overall, there was no significant convergence on the optimal amount of marbles with the decision models. Moreover, participants specified smaller sample sizes than optimal for the conservative model. The results show that human beings have only limited ability to select an optimal information system.

In the present study, we aim to identify contextual factors that influence acquisition behavior rather than the way in which people deviate from an optimal information level. More precisely, we focus on the influence of time pressure on the amount of information acquired in a decision-making process. Further, we analyze to what extent this time pressure effect interacts with the contextual factors 'payoff scheme' and 'information costs'.

2.1.3 Time Pressure and its Effects on Decision-Making

Time pressure plays a crucial role in information acquisition and decision-making (e.g., Payne et al., 1988). Apart from negative effects of time pressure, studies highlight that time pressure influences individuals differently and outline positive effects of time pressure as well. Time restrictions leading to time pressure are often seen as factors that increase task complexity or difficulty (e.g., Chernev et al., 2015). Furthermore, it is assumed that individuals under time pressure tend to disregard relevant aspects and to use heuristic methods (e.g., Kruglanski & Freund, 1983). Besides these assumptions, time pressure may lead to disruptions because the remaining time is inspected visually (Mann & Tan, 1993) and has been found to lead to lower decision performance (e.g., De Paola & Gioia, 2016). In addition to this, it is common sense that perceived time pressure induces stress (e.g., Keinan et al., 1987). Importantly, Conte et al. (2015) state that when time pressure is present, performance of the majority of individuals may be negatively affected but not of all of them. This finding is also supported by the study results

of Kocher et al. (2019), who, in risky decision-making tasks, identified that individuals with the ability to cope with time restrictions perform differently when perceiving time pressure from those individuals without this ability. Apart from these negative time pressure effects dependent on individual traits, Lindner and Rose (2017) found that time pressure leads to less present-bias, which means that individuals pay more attention to the amount of payment instead of on the immediateness of the decision. Additionally, Ordóñez et al. (2015) infer from the literature that people work more smartly when a deadline is in place, thereby increasing efficiency.

Overall, much of the previous research explored the effects of time pressure on information processing (for a review, see Lallement, 2010). In particular, the following phenomena play a role when processing information under time pressure: individuals accelerate the decision process, pay more attention to negative information, and may selectively screen information since they focus on aspects they regard as being important (Ben Zur & Breznitz, 1981; Wright, 1974). For example, in the experiment by Mann and Tan (1993), participants were confronted with a decision dilemma. Before making a choice between two options, they had the possibility to inspect information sequentially in an information booklet. Results show that participants pressed for time read less information in the booklet because they focused on information that they perceived as being important.

The dual-system approach (Kahneman & Frederick, 2002; Stanovich & West, 2000) can help us to understand how time pressure impacts decision-making. It assumes that two systems of information processing and decision-making exist. These are defined, in particular, due to their characteristics of rapidity and controllability (Kahneman & Frederick, 2002). Thereby, System 1 is described by traits such as automatic, intuitive, or fast. In contrast, System 2 is characterized by traits such as controlled, deliberative, or slow. The interaction of the two systems is described in the literature as the following: System 1 suggests intuitive solutions immediately, while System 2 monitors and, if necessary, remediates these. Responses of an individual evolve either through automatic (System 1) or controlled (System 2) cognitive processes (e.g., Kahneman & Frederick, 2002). The operations of System 2 can be disrupted by external factors, such as time pressure, since there is less time for thinking deliberately and the remaining time needs to be monitored. Thus, the function of System 2 is weakened through the presence of time pressure and leads individuals to filter for only those aspects that appear to be most striking (Maule, Hockey, & Bdzola, 2000). As a result, judgement biases, which are not necessarily remediated by System 2, can occur and can interrupt decision-making. An example is the ‘weighting bias’, which is characterized by an over- or underweighting of a certain aspect

when making judgements (Kahneman & Frederick, 2002). Importantly, Glöckner and Betsch (2008) note that even if the presence of time pressure inhibits deliberate considerations, this does not need to impact automatic processes negatively. In the same vein, Kahneman (2003) states that automated decisions often lead to good results and can be even superior to System 2 thinking. Further, Kahneman (2003) regards the accessibility of information, which he describes as "the ease (or effort) with which particular mental contents come to mind" (Kahneman, 2003, p. 699), to be dependent on properties of the cognitive constitution and the context. Thus, the appearance of a judgment bias in only some cases can be attributed to accessibility factors (Kahneman, 2003). Therefore, we explore not only the influence of *time pressure* but also the influence of its interactions with the contextual factors *payoff scheme* and *information costs* on the *amount of information acquired*.

2.1.4 Payoff Schemes and Information Costs in Decision-Making under Time Pressure

Payoff schemes in conjunction with time pressure have mainly been researched in the context of risky gambles. For example, Ben Zur and Breznitz (1981) identified that participants under time pressure paid more attention to possible losses compared to gains and Gawryluk and Krawczyk (2017) found that more deliberation time leads to a more accurate weighting of the options in risky gambles. Moreover, studies have examined risk preferences under time pressure (e.g., Kirchler et al., 2017). Even if risk preferences for lotteries do not play a role in the context of the present study, the important take away is that time pressure affects lottery choices where payoff schemes play an important role. The study by Haesevoets et al. (2019) supports this notion, since they found that the payoff structure (i.e. endowment size) significantly influences choice behavior. This leads to the assumption that different payoff schemes invoke different information acquisition behaviors. Some studies have already shown that under time pressure, individuals give more weight to negative outcomes (Ben Zur & Breznitz, 1981; Huber & Kunz, 2007; Wright, 1974). The literature has revealed that a negativity bias exists i.e., negative information, also labeled as entity, event, stimuli, or aspect of an object, has a greater effect than positive information (Baumeister et al., 2001; Kanouse & Hanson, 1987; Peeters & Czapinski, 1990; Rozin & Royzman, 2001). Negative information comprises, for example, information about potentially losing money, or being criticized, whereas positive information, for example, refers to winning money or receiving acknowledgments (Baumeister et al., 2001). The literature also links the negativity bias to cognitive processes and states that negative information involves more (thorough and conscious) processing than positive information does, so that an individual's definite

impression builds more strongly on negative information (Baumeister et al., 2001; Ito & Cacioppo, 2000; Peeters & Czapinski, 1990). Although many studies provide evidence for a negativity bias, the strength of the evidence depends on various issues (Baumeister et al., 2001) and is therefore not a generic bias (Rozin & Royzman, 2001). So far, no prior research studies have investigated the effects of different payoff schemes, i.e. with either negative or positive expected values, in conjunction with time pressure on information acquisition behavior.

When sequential information is considered, only the study of Kerstholt (1996), at least to our knowledge, has investigated the effect of different levels of information costs under time pressure in a dynamic task. The study has shown that under time pressure, relatively low information costs lead people to acquire more information compared to relatively high information costs. Importantly, this result was found when it would have been better (because of a higher expected outcome) to apply an action immediately instead of requesting any (further) information. They inferred that people tend to decide based on a direct comparison of the costs for information and action and that further factors are not considered. Additionally, they concluded that relatively low information costs lead people to acquire information sooner in that task. The role of information costs was also the subject of the following studies which did not consider the influence time pressure: The experimental study by Baethge and Fiedler (2016), where participants were involved in an investment task with either free or costly information, has shown that when confronted with information costs, significantly less information was acquired. Besides, the researchers concluded that information costs lead people to spend more time on analyzing a certain piece of information. The study by Ambuehl et al. (2018) investigated the information acquisition behavior when information costs are non-monetary and are measured through experimental variation in the amount of calculations to be checked and participants' psychological costs, such as cognitive ability. They showed that higher non-monetary information costs lead people to acquire less information before making a decision. From the rational perspective, the costs for information must be compared with the benefit of its diagnostic value (Connolly & Thorn, 1987) and higher costs should lead people to purchase only the amount of information that has a higher or equal utility than related costs (Kraemer et al., 2006). The study by Kraemer et al. (2006) examined experimentally the information acquisition and Bayesian updating behavior of individuals. Participants were shown decisions of their predecessors and were allowed to acquire further information at a certain cost (without manipulating its level). The results of this study revealed that half of the participants did not decide rationally and purchased too much further information. Nonetheless, we are not interested in the deviations from an optimal amount of information. Rather, we want

to know in what way costs influence non-sequential individual acquisition behavior when time pressure is present.

2.1.5 Experimental Protocols

2.1.5.1 Procedure and Task Structure

We conducted three laboratory experiments to test the influence of *time pressure* and its interactions with the contextual factors *payoff scheme* and *information costs* on the *amount of information acquired* in a decision-making task. In each experiment, we varied the presence of *time pressure* (present, not present). Altogether, we had 6 treatments. Table 2.1 gives an overview of the considered factors in every experiment.

Table 2.1: Overview of Experiments of Research Paper 1

Experiment	Treatment	Time pressure	Payoff scheme	Information costs
1	1	yes	positive	relatively high
	2	no		
2	3	yes	negative	relatively high
	4	no		
3	5	yes	positive	relatively low
	6	no		

The use of experiments is most reasonable because we can implement manipulations of the explanatory factors directly which, in turn, minimizes problems with reverse inference (Croson & Gächter, 2010). The experiments were programmed in z-Tree (Fischbacher, 2007) and were conducted at a large German university. All participants were students and we ensured that they had approximately the same proportions of the subjects of studies (separated into either an engineering field of study or other subjects) in the different treatments to which participants were assigned randomly. All three experiments consisted of the same procedure and the same task structure which was divided into four parts: an introduction to the experiment, the main task, a questionnaire, and an arithmetic problem task.

In the introduction, participants learned about the main task and about the payment modalities. The main task was a decision task under uncertainty, inspired by Connolly and Thorn (1987). In our study, participants were told that they would be the production manager in a cake factory and would have to decide about whether an unused machine should be operated again. Re-operating made sense in case of a high future demand. As long as the test persons had no further information about the future demand, there was an equal likelihood of a high or a low demand. Pieces of information about the future demand trend for cakes were purchasable from eleven distribution centers. Each distribution center provided exactly one piece of information which was drawn at random in the experimental task. If at least six distribution

centers forecasted a high demand, the demand was then considered to be high, otherwise to be low. We chose to provide eleven pieces of information in order to have a complex task regarding the calculations of conditional expectations so that an optimal amount of information was not obvious. After one practice round, the task was repeated for twenty independent rounds. To perform the task, each participant received a budget of 15,000 ECU in every round. From this budget, a participant was able to buy information non-sequentially from the distribution centers at a certain cost. From the remaining budget, an additional payment was added or deducted. This additional payment, which was shown in the form of a payoff matrix, was based on a participant's decision to operate the machine (yes, no) and the overall future demand. The level of the task-based payment was dependent on the experimental condition. Similarly, to prior studies, we implemented time pressure by restricting the time available for each round. If participants needed more than 13 seconds for a round, the system made a random decision. The level of time pressure was chosen based on prior literature in this research field (e.g., Kerstholt, 1996) and on conducted pre-tests. After the main task, participants had to fill out a questionnaire, comprising a question for measuring their general risk aversion and demographic questions. Afterwards, participants had to perform as many calculations as possible in an arithmetic problem task (Ekstrom et al., 1976) for 5 minutes. After completing the experiment, participants received their individual payment, consisting of their performance in the decision task (one out of the twenty rounds was selected by lottery) and in the arithmetic problem task (depending on the correctly answered arithmetical operations) at an exchange rate of 2,000 ECU = 1 Euro. The experimental instructions are provided in Appendix A.1-1. 219 students took part in the experiments (88 females, 131 males). The average age of the participants was 23.44 years (SD = 3), ranging from 19 to 37 years. 155 participants were enrolled in different engineering disciplines and 64 students were studying economics, business administration, or political science. On average, the experimental sessions lasted for 47.58 minutes and the average payment was 9.46 Euro.

2.1.5.2 Measures

The dependent variable in the present paper is the *amount of information acquired*, ranging from 0 to 11. The independent variable of main interest in this study is *time pressure*, measured binarily (1 if present, 0 otherwise). In Experiment 2, we additionally included the variable *negative payoff scheme* (1 if confronted with a *negative payoff* scheme, 0 otherwise). Exclusively in Experiment 3, we added the variable *low costs* (1 for *low information costs*, 0 otherwise). To control whether the acquisition decisions are influenced by an individual's

general risk preference, we included the construct *general risk aversion* (Mandrik & Bao, 2005). The items were measured using a Likert scale, ranging from 1 to 7. A confirmatory factor analysis revealed factor loadings ranging from .4602 to .7284. The Cronbach's alpha coefficient was .7668. We included the variable *round*, with values ranging from 1 to 20, to account for learning effects. To test whether 'smart-decisions' influence the *amount of information acquired*, we generated two variables: *decision rule* and *uneven number*. *Decision rule* describes the application of a decision rule that would maximize the expected payoff, which means that the participant decided to operate the machine when more information forecasted a high rather than a low demand. If an equal amount of information indicated a high or low demand, participants confronted with a *positive payoff* scheme would maximize their expected payoff if they decided to operate the machine. Contrarily, participants confronted with a *negative payoff* scheme would then decide against operating the machine. The control variable *uneven number* indicates whether the test person acquired one, three, five, seven, nine, or eleven pieces of information. This selection is 'smart' because the actual information value is higher when a majority of positive or negative information exists. *Decision rule* and *uneven number* are measured binarily (1 if the *decision rule* was applied / an *uneven number* was acquired, 0 otherwise). Further, we included the control variables *score*, *age*, and *field of study*. *Score* is the sum of all points (measured in ECU) achieved in the arithmetic problem task. This variable was included to test whether quick calculation abilities play a role. As the literature assumes that differences due to time pressure perceptions exist between older and younger decision makers (Ordóñez et al., 2015), we controlled for *age* (measured in years) in our analyses. The *field of study* of the participants was (reflecting the nature of the university in question) either engineering or other fields of studies (measured binarily).

2.1.5.3 Analysis Methodology

For each experiment, we started with a descriptive data analysis and used two-sample t-tests for independent samples to test whether the average *amount of information acquired* was different between the treatments. Because the experimental tasks include repeated measures, we conducted a panel analysis and applied the Generalized Estimating Equation (GEE) method. The histograms indicate a normal distribution of the dependent variable. Hence, we specified the 'identity' link function, which is applied for data that are normally distributed (Ballinger, 2004). Besides, we employed an autoregressive correlation structure, which is applicable for time-dependent correlations (Ballinger, 2004). We performed supplementary analyses where we excluded subjects who acquired zero information over twenty rounds. In doing so, we

checked for the robustness of the results because we cannot rule out the possibility that selecting zero information means that some of the individuals did not participate seriously in the task.

2.1.6 Experiment 1

The aim of Experiment 1 was to test the influence of *time pressure* on the *amount of information acquired*. Consequently, one half of the participants was randomly assigned to the time pressure treatment (Treatment 1), whereas the other half was not (Treatment 2). Based on prior literature in this research field (e.g., Glöckner & Betsch, 2008; Lallement, 2010), we assumed that participants under *time pressure* decided quickly, without thinking deliberately about how much information to purchase. Derived from the theoretical lines or argumentation in the theory section, we argue that fewer information pieces are selected sequentially under time pressure, and we therefore tested the following hypothesis:

H1: Participants under time pressure acquire less information than participants without time restrictions.

2.1.6.1 Method

Participants

73 students participated in Experiment 1. Of these, 35 students (16 female, 19 male) were in the *time pressure* treatment and 38 students (11 female, 27 male) were in the *no time pressure* treatment. The participants were 19 to 37 years old (M = 24.27, SD = 3.13). 51 participants were enrolled in different engineering disciplines and 22 students studied economics, business administration, or political science.

Procedure and task structure

Based on the procedure and the task described above, participants in Experiment 1 were incentivized by the payoff scheme depicted in Table 2.2. This payoff scheme describes the additional payment that was added to the budget of 15,000 ECU less information costs for acquired information. In the case of the decision to operate the machine, the additional payment was 10,000 ECU for a high future demand, and -8,000 ECU for a low future demand, i.e. 8,000 ECU would be subtracted from their remaining budget. Since the probabilities for both conditions were 0.5 when deciding to operate the machine without further information, the expected value was 1,000 ECU, which is why we term this payoff scheme as ‘positive’. If the participants decided that the machine should not be operated, the additional payment was 0 ECU.

Table 2.2: Positive Payoff Scheme

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

The direct costs for an additional information increased with every piece of information by 68 ECU. To acquire a certain amount of information, the direct costs were added together. For example, to acquire two pieces of information the total costs were 204 (= 68 + 136) ECU. We chose these values so that the total costs for eleven pieces of information, which were 4,488 ECU, would be slightly under the expected value for the additional payoff if participants acquired all information. This expected additional payoff was 5,000 ECU, since the reasonable outcomes in the payoff matrix for participants with complete information about the future demand were either 10,000 ECU (the decision to operate the machine and a high future demand with a probability of 50 percent) or 0 ECU (the decision that the machine should not be operated).

2.1.6.2 Results

In the *time pressure* treatment, the mean *amount of information acquired* was 5.39 (SD = 3.22). In contrast, it was 6.18 (SD = 2.75) in the *no time pressure* treatment. To test whether the mean *amount of information acquired* is different between the *time pressure* and the *no time pressure* treatment, we executed a two-sample t-test for independent samples which indicates a statistically highly significant difference ($p < .001$). Accordingly, participants in the *time pressure* treatment acquired significantly less information.

Descriptive statistics of the variables *decision rule* and *uneven number* are reported in the respective columns in the Appendix A.1-2. The results show that participants without *time pressure* in Experiment 1 made use of the *decision rule* and selected an *uneven number* more frequently. The average time per round the participants needed to select information and to make the decision was 5.81 seconds in the *time pressure* treatment and 8.33 seconds in the *no time pressure* treatment. Only in five out of 700 rounds did participants fail to make a decision within the given time frame (only relevant for the *time pressure* treatment).

The results of the GEE regressions used to examine the influence of the independent variables, specifically of *time pressure*, on the *amount of acquired information* are presented for models 1 and 2 in the column 'all subjects' of table 3. When investigating the effect of *time pressure* only (model 1), the results reveal that significantly less information is acquired ($p <$

.1). When including control variables additionally in the regression analysis (model 2), the results show that *time pressure* still significantly decreases the *amount of information acquired* ($p < .05$). Accordingly, we find support for H1. Interestingly, neither the construct *general risk aversion* nor the interaction with *time pressure* is significant. The variable *round* shows also no significant influence. Applying the *decision rule* and selecting an *uneven number* both influence significantly and positively the *amount of information acquired* ($p < .001$; $p < .001$). Furthermore, *score* has no effect, *age* has a significant positive effect ($p < .01$), and *engineering studies* shows no effect on the *amount of information acquired*.

We report the results of the supplementary analyses for models 3 and 4 in the column 'without subjects that acquired zero information over twenty rounds' of Table 2.3. Altogether, the results show identical patterns. However, the *time pressure* effect is insignificant when regressed solely on the *amount of information acquired* (model 3) but remains significant when other variables are included in the regression analysis (model 4), even though the significance level becomes weaker ($p < .1$). Thus, these results support H1 only to a limited extent. In addition to this, the effect of *age* remains at the significance level of 5%.

Table 2.3: Regression Analyses on the Amount of Information Acquired – Experiment 1

	Hypotheses		All subjects		Without subjects who acquired 0 information over 20 rounds		
	Prediction	Finding	Model 1	Model 2	Finding	Model 3	Model 4
Time pressure	H1 (-)	✓	-0.767 (0.0587)	-0.896 (0.0137)	(✓)	-0.432 (0.1712)	-0.575 (0.0588)
General risk aversion				-0.0739 (0.8072)			-0.140 (0.5701)
Time pressure * general risk aversion				0.363 (0.3757)			0.463 (0.1721)
Round				-0.0109 (0.6237)			-0.0111 (0.5849)
Decision rule				0.627 (0.0000)			0.632 (0.0000)
Uneven number				1.136 (0.0000)			1.074 (0.0000)
Score				0.000190 (0.1011)			0.000102 (0.2871)
Age				0.173 (0.0028)			0.113 (0.0178)
Engineering studies				0.143 (0.7201)			0.234 (0.4818)
Constant			6.105 (0.0000)	0.325 (0.8190)		6.469 (0.0000)	2.294 (0.0518)
N			1460	1460		1340	1340

Note. The first observation in each cell is the estimate and the second observation (in parentheses) is the two-sided p-value.

2.1.7 Experiment 2

In Experiment 2, we altered the task conducted in Experiment 1 by varying the *payoff scheme* due to the negative possible outcome option: If participants decided to operate the machine and the overall future demand was low, their additional payment was -12,000 ECU instead of -8,000 ECU. This variation led to a negative expected value of -1,000 ECU (0.5*10,000 ECU - 0.5*12,000 ECU) when no information was acquired, i.e. leading to a *negative payoff scheme*. In Experiment 1, where participants faced a *positive payoff scheme*, we assumed that participants under *time pressure* would make use of System 1 thinking and that they would acquire significantly less information. Based on previous studies in this research field (e.g., Ben Zur & Breznitz, 1981; Haesevoets et al., 2019), we expected that a higher negative payment in possible negative outcomes would lead to a focus on this negative information and to a shift away from intuitive processes (induced by time pressure) towards more deliberate cognitive processes. In particular, we hypothesized the following:

H2: Participants confronted with a negative payoff scheme and being placed under time pressure acquire more information than participants confronted with a positive payoff scheme and being placed under time pressure.

2.1.7.1 Method

Participants

70 students took part in the second experiment. 35 students were assigned to the *time pressure* treatment (11 female, 24 male) and 35 students were assigned to the *no time pressure* treatment (18 female, 17 male). Participants ranged in age from 19 to 32 years (M = 23.41, SD = 2.98). 49 students were enrolled in different engineering disciplines, 21 students indicated to study economics or business administration.

Procedure and task structure

In Experiment 2, participants performed the same procedure and tasks as in Experiment 1. Again, in one treatment, students were placed under time pressure (Treatment 3) and in the other one they had no time restrictions (Treatment 4). In contrast to the positive payoff scheme before, participants were paid according to the negative payoff scheme, as illustrated in Table 2.4. This means that if they decided to operate the machine and the overall future demand was low, their additional payment would be -12,000 ECU. All other values in the payoff scheme remained unchanged.

Table 2.4: Negative Payoff Scheme

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-12,000
	Machine will not operate	0	0

2.1.7.2 Results

Descriptive statistics according to the *amount of information acquired* reveal the following: The mean amount is 5.52 pieces (SD = 3.01) for the *time pressure* treatment (Treatment 3) and 5.85 (SD = 2.73) for the *no time pressure* treatment (Treatment 4). We also employed a two-sample t-test which shows a significant difference between these two treatments ($p < .05$) with the *time pressure treatment* stimulating the participants to buy significantly less information. Taking the treatments of Experiment 1 and 2 together, we again performed two-sample t-tests. The test for differences in the *amount of information acquired* between the *time pressure*

treatments (Treatments 1 and 3) and the *no time pressure* treatments (Treatments 2 and 4) indicates again that the *time pressured* participants bought significantly less information ($p < .001$). In addition to this, we executed a two-sample t-test based on the *time pressure* treatments (Treatments 1 and 3) only. The test for differences in the *amount of information acquired* between time pressured participants confronted with the *positive payoff* scheme (Treatment 1) versus *negative payoff* scheme (Treatment 3) indicates no significant difference.

Descriptive statistics of the variables *decision rule* and *uneven number* in the treatments of Experiment 2 are reported in the Appendix A.1-2. As in Experiment 1, participants in the *no time pressure* treatment decided in line with the *decision rule* and chose an *uneven number* of pieces of information more frequently. The average time participants needed for every round was 6.1 seconds for the *time pressure* treatment and 8.21 seconds for the *no time pressure* treatment. Only in eight out of 700 rounds did participants fail to make a decision within the given time frame (only relevant for the *time pressure* treatment).

To examine the effects of the independent variables, specifically of *time pressure* in conjunction with a *negative payoff scheme*, we based the GEE regression analyses on the data from Experiments 1 and 2 together. The results are provided for models 5 and 6 in the column 'all subjects' of table 5. Model 5 covers the variables *time pressure*, *negative payoff scheme,* and the interaction of *time pressure* and *negative payoff scheme*. In model 6, control variables were additionally included. The effect of *time pressure* on the *amount of information acquired* is significantly negative in model 5 and 6 ($p < .1$; $p < .05$). The results show no significance for the effect of a *negative payoff scheme* alone in either model. The effect of the interaction of *time pressure* and *negative payoff scheme* is also not significant in models 5 and 6. Hence, H2 is not supported. An examination of the control variables allows us to draw the following conclusions: As in Experiment 1 alone, *general risk aversion* as well as the interaction with *time pressure* indicate no significant effects. *Round* has again no significant effect, but the variables *decision rule* and *uneven number* significantly increase the *amount of information acquired* ($p < .001$; $p < .001$). *Score* shows a significantly positive effect ($p < .05$), *age* indicates no effect, and *engineering studies* indicates a significantly positive effect ($p < .05$) as well.

We also ran regressions with the data from Experiment 2 only and can report significant differences compared to the regressions based on Experiments 1 and 2 together. However, we do not report these results in detail due to space limitations. An important difference in the regression results based on data of Experiment 2 only is that the effect of *time pressure* is not significant any more. This is reasonable, since the effect of the *negative payoff scheme* as well as its interaction with *time pressure* were already identified to be insignificant.

Models 7 and 8 in the column 'without subjects who acquired zero information over twenty rounds' in Table 2.5 report the results of the supplementary analyses. Differences compared to models 5 and 6 are that *time pressure* is not significant any more in models 7 and 8. Apart from this, the effect of *score* diminishes and the effect of *engineering studies* remains at the significance level of 5%.

Table 2.5: Regression Analyses on the Amount of Information Acquired – Experiment 2

	Hypotheses		All subjects		Without subjects who acquired 0 information over 20 rounds		
	Prediction	Finding	Model 5	Model 6	Finding	Model 7	Model 8
Time pressure			-0.764 (0.0718)	-0.777 (0.0490)		-0.418 (0.2645)	-0.472 (0.1919)
Negative payoff scheme			-0.218 (0.6072)	-0.154 (0.6944)		-0.403 (0.2705)	-0.416 (0.2371)
Time pressure * negative payoff scheme	H2 (+)	X	0.480 (0.4287)	0.461 (0.4116)	X	-0.0478 (0.9276)	0.101 (0.8412)
General risk aversion				-0.0504 (0.8357)			0.0161 (0.9408)
Time pressure * general risk aversion				0.134 (0.6867)			0.0969 (0.7435)
Round				-0.00531 (0.7459)			-0.00484 (0.7569)
Decision rule				0.424 (0.0000)			0.429 (0.0000)
Uneven number				0.906 (0.0000)			0.888 (0.0000)
Score				0.000203 (0.0442)			0.000140 (0.1191)
Age				0.0539 (0.2596)			0.00553 (0.8970)
Engineering studies				0.714 (0.0232)			0.712 (0.0118)
Constant			6.093 (0.0000)	2.925 (0.0114)		6.447 (0.0000)	4.604 (0.0000)
N			2860	2860		2720	2720

Note. The first observation in each cell is the estimate and the second observation (in parentheses) is the two-sided p-value.

2.1.8 Experiment 3

In Experiment 3, the *costs* of acquiring information were reduced by fifty percent compared to the previous experiments. Based on theory and prior studies in this field (e.g., Kerstholt, 1996; Kraemer et al., 2006), we assumed that *costs* would be an important factor for determining the

amount of information acquired and that they would lead participants to neglect other aspects of the choice context, such as time pressure. Moreover, in Experiment 3, *information costs* were so low that it is reasonable to assume that the cost factor would abrogate time pressure effects. Accordingly, we hypothesized the following:

H3: Participants facing relatively low information costs and being placed under time pressure acquire more information than participants facing relatively high information costs and being placed under time pressure.

2.1.8.1 Method

Participants

76 students participated in Experiment 3. Of these, 37 students were randomly assigned to the *time pressure* treatment (10 female, 27 male) and 39 students to the *no time pressure* treatment (22 female, 17 male). The age of the students ranged from 19 to 33 years (M = 22.67, SD = 2.65). 55 students indicated that they were studying an engineering discipline, 21 students indicated that they were studying economics or business administration.

Procedure and task structure

Participants in Experiment 3 had to perform the same procedure and tasks as in the previous Experiments. Again, one treatment was pressed for time (Treatment 5), whereas the other was not (Treatment 6). As in Experiment 1, the positive payoff scheme was employed. The difference in Experiment 3 compared to the former Experiments 1 and 2 was that the costs for information were halved. For example, the total costs for the acquisition of 2 pieces of information were 204 ECU (68 ECU + 136 ECU) in Experiment 1 and 102 ECU (34 ECU + 68 ECU) in Experiment 3.

2.1.8.2 Results

Descriptive statistics for the *amount of information acquired* indicate the following: The mean amount of acquired pieces of information is 6.7 (SD = 2.74) for the *time pressure* treatment (Treatment 5) and 6.34 (SD = 3.35) for the *no time pressure* treatment (Treatment 6). We performed a two-sample t-test to compare these two treatments. It shows, in contrast to the prior experiments, that the *no time pressure* treatment acquired significantly less information ($p < .05$). Taking the data of Experiment 1 and 3 together, the test for differences in the *amount of information acquired* between the *time pressure* treatments (Treatments 1 and 5) and the *no time pressure* treatments (Treatments 2 and 6) indicates that participants in the *time pressure*

treatments acquired significantly less information ($p < .05$). For the *time pressure* treatments (Treatments 1 and 5) only, the t-test for differences in the *amount of information acquired* between the treatments with relatively *high information costs* (Treatment 1) and relatively *low information costs* (Treatment 5) reveals that participants facing relatively *low information costs* acquired significantly more information ($p < .001$).

As in the previous studies, descriptive statistics of the variables *decision rule* and *uneven number* for the treatments of Experiment 3 are reported in the Appendix A.1-2. Unlike before, the participants of Treatments 5 and 6 used the *decision rule* almost equally frequently and participants under *time pressure* (Treatment 5) selected an *uneven number* more frequently. On average, participants under *time pressure* needed 6.69 seconds and those under *no time pressure* 9.36 seconds for every round in the decision task. In seven out of 740 rounds, individuals did not decide within the given time frame (again, only relevant for the *time pressure* treatment).

To identify the effects of *time pressure* in conjunction with *relatively low information costs*, we took the data of Experiments 1 and 3 together to calculate the respective GEE regressions. The results are displayed for models 9 and 10 in the column 'all subjects' of table 6. Model 9 comprises the variables *time pressure*, *low costs* as well as its interaction term with *time pressure*. Control variables were included additionally in model 10. We found a significantly negative *time pressure* effect on the *amount of information acquired* in models 9 and 10 ($p < .1$; $p < .05$). Whereas no effect of *low costs* can be found in either model, we can find a significantly positive effect of the interaction term of *time pressure* and *low costs* in models 9 and 10 ($p < .05$; $p < .05$), i.e. the combination of *time pressure* and *low costs* leads to more information acquisition. H3 is thus supported. Examining the influence of the control variables reveals the following: As in both previous experiments, *general risk aversion* by itself and in conjunction with *time pressure*, as well as *round* are insignificant. Again, the variables *decision rule* and *uneven number* significantly increase *the amount of information acquired* ($p < .001$; $p < .001$). *Score* has a significantly positive effect ($p < .01$) and *age* and *engineering studies* both have no significant influence.

Again, we also ran regressions with data from Experiment 3 only and report conspicuous changes compared to the results obtained from the data of Experiments 1 and 3 together: The effect of *time pressure* is not significant any more. This is likely to be caused by the low information costs which were halved, i.e. information costs were so low that the effect off time pressure faded in Experiment 3.

The supplementary analyses, depicted for models 11 and 12 in the column 'without subjects who acquired zero information over twenty rounds' of Table 2.6, show that the effects

of *time pressure* become insignificant in both models. Further, the influences of time pressure in interaction with *low costs* are not significant in models 11 and 12, so that H3 is not supported any more. The effect of *score* remains significant at the 1% level.

Table 2.6: Regression Analyses on the Amount of Information Acquired – Experiment 3

	Hypotheses		All subjects		Without subjects who acquired 0 information over 20 rounds		
	Prediction	Finding	Model 9	Model 10	Finding	Model 11	Model 12
Time pressure			-0.768 (0.0559)	-0.866 (0.0198)		-0.423 (0.2045)	-0.512 (0.1145)
Low costs			0.177 (0.6513)	0.302 (0.4056)		0.174 (0.5849)	0.260 (0.4025)
Time pressure * low costs	H3 (+)	✓	1.122 (0.0460)	1.066 (0.0399)	✗	0.621 (0.1779)	0.532 (0.2324)
General risk aversion				0.183 (0.3822)			0.149 (0.3988)
Time pressure * general risk aversion				0.229 (0.4349)			0.0942 (0.7110)
Round				0.00738 (0.6512)			0.00759 (0.6147)
Decision rule				0.559 (0.0000)			0.584 (0.0000)
Uneven number				1.098 (0.0000)			1.041 (0.0000)
Score				0.000204 (0.0062)			0.000206 (0.0055)
Age				0.0547 (0.2275)			0.00414 (0.9157)
Engineering studies				-0.0445 (0.8795)			0.210 (0.4043)
Constant			6.109 (0.0000)	3.000 (0.0072)		6.467 (0.0000)	4.445 (0.0000)
N			2980	2980		2800	2800

Note. The first observation in each cell is the estimate and the second observation (in parentheses) is the two-sided p-value.

2.1.9 Discussion of Results

The results of the regression analyses of the experiments show that *time pressure*, when considered alone, reduces the *amount of information* acquired when information acquisition is non-sequential. Based on the literature, we assume that participants under time pressure perceived stress, decided quickly, were interrupted through their checking of the remaining time, had no time to process information deliberately, and thus, relied on System 1 processes.

The fact that people under time pressure needed on average less time to make the decisions supports these conclusions.

No significant effect was found for participants who were placed under *time pressure* and who were influence by a *negative payoff scheme*. Thus, a higher potential loss in combination with time pressure does not generally seem to lead to a shift from System 1 thinking (through time pressure) to System 2 thinking (through the higher negative payment in the case of the decision to operate the machine and an overall low demand in the *negative payoff scheme*). The findings also reveal that being confronted with a *negative payoff scheme* instead of a *positive payoff scheme* has no effect on the *amount of information acquired*. These results suggest that the previous empirical findings from the literature that have supported this effect should be treated with caution.

Apart from this, the findings imply that being confronted with relatively *low information costs* under time pressure increases the *amount of information acquired*. Since the variable *low information costs* alone has no significant effect on the *amount of information acquired*, we infer that the weighting of *low information costs* has a significant effect only if *time pressure* is present. Under *time pressure*, i.e. when people do not think deliberately, relatively *low information costs* might appear to be so cheap that people will purchase more information (than is reasonable). Moreover, we conclude that the effect of time pressure, which leads people to acquire less information, is abrogated through relatively low information costs.

In addition to this, in Experiments 1 and 2, subjects who were not pressed for time (Treatments 2 and 4) made use of the *decision rule* and selected an *uneven number* more frequently than subjects with a time budget, suggesting that the former thought more consciously about a strategy for making a sound decision. In contrast to this, in Experiment 3, participants under *time pressure* (Treatment 5) made use of the *decision rule* equally often and selected an *uneven number* more often than participants without *time pressure* (Treatment 6). The cost factor might have been so strong that it led participants in both treatments (Treatments 5 and 6) to use different acquisition patterns or that it outweighed the effect of *time pressure*.

With regard to the control variables, we can conclude that these do play a role in the present context at least to some extent. People with calculation skills, older participants, or students of engineering studies might have thought more deliberately before making a decision, e.g. by trying to compute an economically reasonable solution.

2.1.10 Conclusions and Implications

We examined the effects of time pressure on the amount of information acquired non-sequentially in a decision-making process. Experiment 1 served as the basis and the results show that under time pressure, less information is acquired. We altered the choice context in Experiment 2 due to the payoff scheme, which yields a higher negative payment for the experiments' negative outcome (low demand) compared to Experiment 1. As a result, we found no significant effect of time pressure in conjunction with a negative payoff scheme on the amount of information acquired. In Experiment 3, we halved the information costs compared to the prior experiments. We found that the time pressure effect is conditional on the contextual factor *information costs.* Being pressed for time and faced with relatively low information costs simultaneously leads people to purchase more pieces of information that can be used for decision-making.

The present study contributes to theory and practice in several ways. First, it provides further insights into the psychological processes of individuals in decision-making: We discovered in the regression analyses that under time pressure by itself, less information is acquired non-sequentially and that participants under time pressure needed on average less time per round to select information and to make the decision. Due to our results and previous results from the literature, we assume System 1 thinking to be the underlying psychological process.

Second, while many studies have examined contradictory performance effects of time pressure (e.g., Glöckner & Betsch, 2008; Payne et al., 1988), we did not focus on an optimal amount of information. Rather, we identified how to control the amount of information acquired non-sequentially and used in decision-making processes under time pressure. Additionally, we investigated interaction effects of time pressure with contextual factors. We found, in fact, that the effects of time pressure are influenced by these contextual factors and that it cannot be concluded that time pressure always reduces the number of pieces of information acquired. In this vein, we found time pressure effects to be conditional on the level of information costs. Under time pressure, people set another focus or they weight contextual factors differently, leading to different cognitive processes. Particularly, information costs seem to be such an important factor that might reverse the primary time pressure effect.

Third, the result that less information is acquired under time pressure has been based on sequential information acquisition only (Mann & Tan, 1993). With the present study, we have transferred this conclusion to the non-sequential domain. The important difference between the two domains is that the argument that fewer pieces of information are purchased because

participants are not able to inspect all the information and they need a fast closure cannot be raised in our non-sequential acquisition context.

Fourth, we investigated for the first time the effects of a payoff scheme with negative versus positive expected values in conjunction with time pressure on information acquisition behavior. Before, payoff schemes have mainly been researched in the context of risky gambles. Our contribution to research is that we introduce payoff schemes as influencing factors to information acquisition research and that we uncover necessities for research in this domain.

Fifth, we found that individual factors of the decision maker also influence acquisition behavior. Thus, research should pay attention to these when further studying information acquisition behavior.

In addition, our study has several practical implications. In a setting in which a superior wants a subordinate to acquire just a few pieces of information before decision-making, the superior can control this requested behavior by influencing the information costs or the time frame within a decision having to be made. Importantly, the superior should pay attention to the contextual as well as the individual factors of the subordinate in order to influence acquisition behavior into a certain direction. In particular, information costs can influence the amount of information fundamentally acquired under time pressure.

However, our paper has some limitations. The experiments were conducted in a laboratory setting and the task is hypothetical. Future research could perform field studies to test the replicability of the results in a natural environment. Thereby, instead of monitoring students, the behavior of employees should be observed. Besides this, our sample is relatively well educated. Since cognitive abilities, i.e. how sophisticated information can be processed, have been found to determine how people cope with time pressure (Kocher et al., 2019), a sample composition with different characteristics might lead to different results. However, the educational background of people making economic decisions should be comparable to the students who took part in the experiments. In the present study, we found neither an effect of the interaction of time pressure with a negative payoff scheme nor an effect of a negative compared to a positive payoff scheme. Perhaps the difference between the two schemes was not distinct enough to yield significant effects. Future research should use payoff schemes that are more different in order to make inferences about a shift towards negative factors under time pressure. Future studies could investigate the effect of experience with time pressure and clarify its influence on acquisition behavior. Moreover, this could also be examined in longitudinal studies. Other contextual factors could be taken into account in future investigations as well, for example the amount of available information or the working environment.

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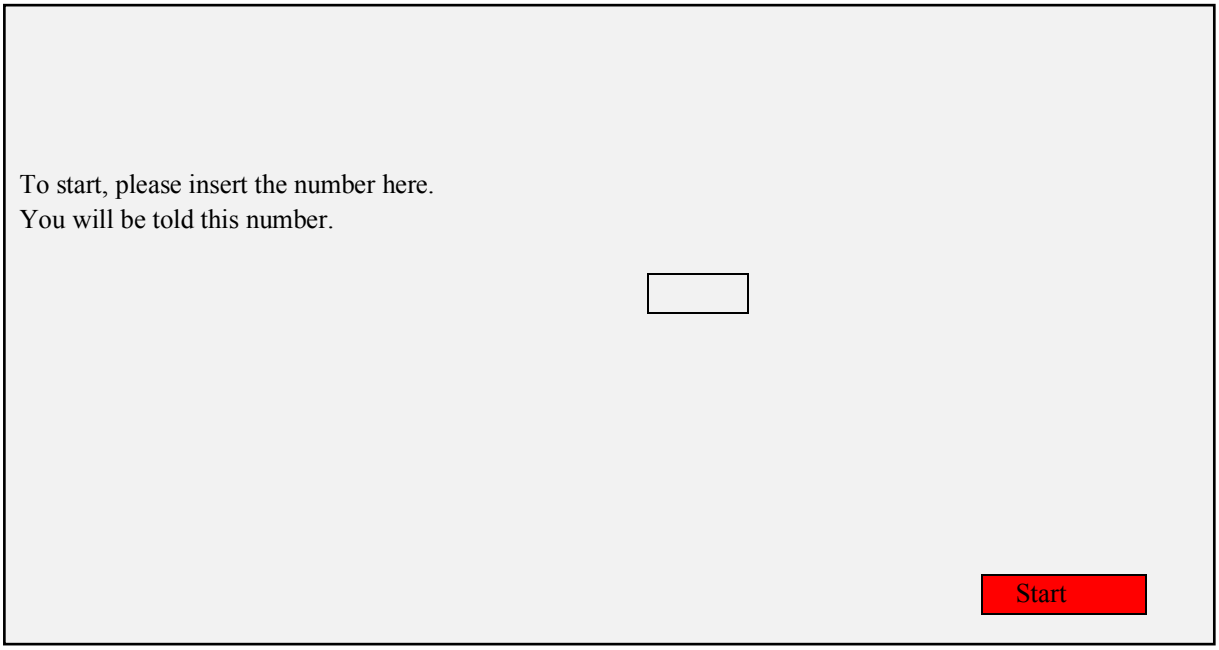
Appendix of Research Paper 1

A.1-1 Experimental Instructions

Notes:
The instructions have been translated from the German; the original instructions are available upon request.
Abbreviations for the six experimental treatments:

TP-POS-HCOSTS:	Time pressure was present, participants were facing a 'positive payoff scheme', and information costs were relatively high
NOTP-POS-HCOSTS:	Time pressure was not present, participants were facing a 'positive payoff scheme', and information costs were relatively high
TP-NEG-HCOSTS:	Time pressure was present, participants were facing a 'negative payoff scheme', and information costs were relatively high
NOTP-NEG-HCOSTS:	Time pressure was not present, participants were facing a 'negative payoff scheme', and information costs were relatively high
TP-POS-LCOSTS:	Time pressure was present, participants were facing a 'positive payoff scheme', and information costs were relatively low
NOTP-POS-LCOSTS:	Time pressure was not present, participants were facing a 'positive payoff scheme', and information costs were relatively low

Text in red lettering displays differences between the TP and NOTP treatments.
Text in blue lettering displays differences between the POS and NEG treatments.
Text in green lettering displays differences between the HCOSTS and LCOSTS treatments.


To start, please insert the number here.
You will be told this number.
Start


Welcome.
Start

The objective of this experiment is to identify how people make decisions in the workplace. The experiment consists of several parts:

A section containing information about today's task.

A section where you will learn about the composition of your payment.

A section where you can try out today's task in a practice round.

A section containing today's task where you can acquire pieces of information and make decisions based on these pieces of information.

A section containing a questionnaire.

A section where you will solve arithmetic problems.

A section where you will be informed of your payment.

Continue

INFORMATION ON: Your task for today

Imagine that you work as a production manager in a cake factory called TOKU which specializes in producing cakes. TOKU sells its cakes to 11 independent distribution centers.

The demand for cakes has been fluctuating over the last few quarters, so one machine has not been used for producing cakes during the last few weeks. Currently, TOKU has no information (yet) about future demand trends.

Continue

INFORMATION ON: Your task for today

In today's task you, in your role of production manager, will decide whether TOKU will start operating the machine again that has not been used in the past few weeks. Re-operating the machine makes sense if future demand is going to be high.

You will play 20 rounds of this decision task. Your goal is to maximize your profits.

For each round, you will receive from TOKU a budget of 15,000 ECU (= Experimental Currency Units). Out of this budget you will be able to buy information from the 11 distribution centers to which TOKU sells its produced cakes. This information can aid your decision-making. You can buy exactly one piece of information from each distribution center. The respective information will describe that particular distribution center's future demand for cakes. Correspondingly, 11 pieces of information will be available to you.

If at least 6 of the 11 distribution centers forecast a high demand, the demand is then considered to be high.
If at least 6 of the 11 distribution centers forecast a low demand, the demand is then considered to be low.

There is—without any further information—an equal likelihood of a high or a low demand actually occurring. The likelihood of either occurring is, then, 50% respectively—without any further information.

Continue

INFORMATION ON: Your task for today

In each round you will have 13 seconds in which to buy information, to make a decision, and to confirm your entry. The remaining time will be shown at the top right of the screen.

If you have not made your decision and confirmed it within the allotted time (13 seconds), 3,000 ECU will be deducted from your budget of 15,000 ECU and for this round the system will make a random decision about whether the machine should operate or not. Thus, it is always to your benefit to make your own decision about the amount of information that you need and whether the machine should operate or not.

Before you play the 20 rounds of the decision task, you will play one practice round which will not be relevant for your payment.

After you have played the 20 rounds of the payment-relevant decision task and have answered a questionnaire, you will then solve some arithmetic problems. This arithmetic problem task will also be payment-relevant.

Continue

For participants in the NOTP treatments, the sentences written in red were lacking.

Participants in the HCOSTS treatments were shown the following screen:

PAYMENT: Composition of your payment

Your payment will consist of three parts:
You will receive:
your budget of 15,000 ECU,
minus the costs for the acquired information,
plus an additional payment based on your decision

→ The direct costs for an additional piece of information will increase by 68 ECU for every further piece of information bought. This means that the first piece of information will cost 68 ECU. The second piece of information will cost 136 (= 68 + 68) ECU. The third piece of information will cost 204 (= 136 + 68) ECU, and so on.

The total costs for the acquisition of, for example, 3 pieces of information would be 408 ECU (= 68 ECU for the first piece of information + 136 ECU for the second piece of information + 204 ECU for the third piece of information).

→ The additional payment will be
10,000 ECU if you make a decision in favor of the machine operating and an overall high demand.
-8,000 ECU if you make a decision in favor of the machine operating and an overall low demand (8,000 ECU will then be deducted from your budget of 15,000 ECU)
0 ECU if you make a decision that the machine will not operate.

The following payoff matrix describes the decision options and the related payments in the case of a high or a low demand (independent of your budget and the costs for acquiring information):

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

At the end of the experiment, one out of the 20 rounds will be selected by lottery and based on this, your payment will be calculated. ECU will be converted into Euro at an exchange rate of 2,000 ECU = 1 Euro and will be rounded up or down to the first decimal place. Additionally, you will receive a payment based on your results in the arithmetic problem task. The composition of the arithmetic problem task will be explained to you later. At the end of the experiment you will receive a payment that is based on the 20 rounds of the decision task (by lottery) and on the arithmetic problem task.

Continue

For participants in the NEG treatments, the numbers in blue were replaced by 12,000.

Participants in the POS-LCOSTS treatments were shown the following screen:

PAYMENT: Composition of your payment

Your payment will consist of three parts:
You will receive:
your budget of 15,000 ECU,
minus the costs for the acquired information,
plus an additional payment based on your decision

→ The direct costs for an additional piece of information will increase by 34 ECU for every further piece of information bought. This means that the first piece of information will cost 34 ECU. The second piece of information will cost 68 (= 34 + 34) ECU. The third piece of information will cost 102 (= 68 + 34) ECU, and so on.

The total costs for the acquisition of, for example, 3 pieces of information would be 204 ECU (= 34 ECU for the first piece of information + 68 ECU for the second piece of information + 102 ECU for the third piece of information).

→ The additional payment will be
10,000 ECU if you make a decision in favor of the machine operating and an overall high demand.
-8,000 ECU if you make a decision in favor of the machine operating and an overall low demand (8,000 ECU will then be deducted from your budget of 15,000 ECU)
0 ECU if you make a decision that the machine will not operate.

The following payoff matrix describes the decision options and the related payments in the case of a high or a low demand (independent of your budget and the costs for acquiring information):

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

At the end of the experiment, one out of the 20 rounds will be selected by lottery and based on this, your payment will be calculated. ECU will be converted into Euro at an exchange rate of 2,000 ECU = 1 Euro and will be rounded up or down to the first decimal place. Additionally, you will receive a payment based on your results in the arithmetic problem task. The composition of the arithmetic problem task will be explained to you later. At the end of the experiment you will receive a payment that is based on the 20 rounds of the decision task (by lottery) and on the arithmetic problem task.

Continue

LEARNING PROCESS: Summary of your task for today

For cake production you will decide whether an unused machine should operate again or not. In order to make your decision, you will proceed as follows:

You will decide about the amount of information that you want to buy from the distribution centers. Each piece of information will reveal the future demand for cakes in one particular distribution center.

As soon as you have decided about the amount of information that you want to buy, you will be shown the result of the acquired information.

You will decide about whether the unused machine should operate again or not. To do so, you can make use of the acquired information.

You will play 20 rounds of this task.

The decision task will be finished as soon as you have decided about the amount of information to buy and, based on this, have made your decision in each of the 20 rounds about whether the unused machine should operate again or not.

At the end of the experiment one round will be selected by lottery (random sampling). Your decision about the amount of information to buy and about whether the unused machine should operate again or not will determine the amount of your payment.

Continue

Participants in the HCOSTS treatments were shown the following screen:

Please answer the following questions and click on "Continue" afterwards. You can only continue to the next screen when you have answered all questions correctly.

You work as a production manager in the TOKU cake factory and have to decide whether a machine that has been unused recently should operate again.	Yes No
Altogether, you will make 20 decisions about whether the unused machine should operate again or not.	Yes No
You already know the future demand trend for cakes without any information from the distribution centers.	Yes No
TOKU sells the produced cakes to 8 independent distribution centers.	Yes No
To help you make your decision, you can buy information from the 11 distribution centers about the future demand trend for cakes.	Yes No
Each piece of information costs 68 ECU.	Yes No
The direct costs for an additional piece of information increase with each further acquired piece of information by 68 ECU. The direct costs for the second piece of information acquired are 136 (= 68 + 68) ECU, and so on.	Yes No
Information costs are added together. For example, if you buy two pieces of information, you will have to pay 204 ECU (= 68 ECU for the first piece of information + 136 ECU for the second piece of information).	Yes No
You have to buy the information from all the distribution centers.	Yes No
Your payment depends on your decision and the amount of information you have bought from the distribution centers in order to make that decision.	Yes No

Continue

Participants in the POS-LCOSTS treatments were shown the following screen:

Please answer the following questions and click on "Continue" afterwards. You can only continue to the next screen when you have answered all questions correctly.

You work as a production manager in the TOKU cake factory and have to decide whether a machine that has been unused recently should operate again.	Yes No
Altogether, you will make 20 decisions about whether the unused machine should operate again or not.	Yes No
You already know the future demand trend for cakes without any information from the distribution centers.	Yes No
TOKU sells the produced cakes to 8 independent distribution centers.	Yes No
To help you make your decision, you can buy information from the 11 distribution centers about the future demand trend for cakes.	Yes No
Each piece of information costs 34 ECU.	Yes No
The direct costs for an additional piece of information increase with each further acquired piece of information by 34 ECU. The direct costs for the second piece of information acquired are 68 (= 34 + 34) ECU, and so on.	Yes No
Information costs are added together. For example, if you buy two pieces of information, you will have to pay 102 ECU (= 34 ECU for the first piece of information + 68 ECU for the second piece of information).	Yes No
You have to buy the information from all the distribution centers.	Yes No
Your payment depends on your decision and the amount of information you have bought from the distribution centers in order to make that decision.	Yes No

Continue

Please turn over the sheet of paper in front of you and take a look at it. Please wait until you have received further instructions.

Participants in the HCOSTS treatments were provided with the following sheet of paper:

Payoff matrix:

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

If at least 6 pieces of information forecast "high demand" → future demand is then considered to be high
If at least 6 pieces of information forecast "low demand" → future demand is then considered to be low

Overview of direct and total costs:

Infor-mation	**Direct costs of a particular piece of information**	**Total costs for the acquisition of an amount of information**
0	0	0 = 0
1	68	0 +68 = 68
2	136	0 +68 +136 = 204
3	204	0 +68 +136 +204 = 408
4	272	0 +68 +136 +204 +272 = 680
5	340	0 +68 +136 +204 +272 +340 = 1,020
6	408	0 +68 +136 +204 +272 +340 +408 = 1,428
7	476	0 +68 +136 +204 +272 +340 +408 +476 = 1,904
8	544	0 +68 +136 +204 +272 +340 +408 +476 +544 = 2,448
9	612	0 +68 +136 +204 +272 +340 +408 +476 +544 +612 = 3,060
10	680	0 +68 +136 +204 +272 +340 +408 +476 +544 +612 +680 = 3,740
11	748	0 +68 +136 +204 +272 +340 +408 +476 +544 +612 +680 +748 = 4,488

For participants in the NEG treatments, this number in blue was replaced by -12,000.

Participants in the POS-LCOSTS treatments were provided with the following sheet of paper:

Payoff matrix:

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

If at least 6 pieces of information forecast "high demand" → future demand is then considered to be high
If at least 6 pieces of information forecast "low demand" → future demand is then considered to be low

Overview of direct and total costs:

Infor-mation	**Direct costs of a particular piece of information**	**Total costs for the acquisition of an amount of information**
0	0	0 = 0
1	34	0 +34 = 34
2	68	0 +34 +68 = 102
3	102	0 +34 +68 +102 = 204
4	136	0 +34 +68 +102 +136 = 340
5	170	0 +34 +68 +102 +136 +170 = 510
6	204	0 +34 +68 +102 +136 +170 +204 = 714
7	238	0 +34 +68 +102 +136 +170 +204 +238 = 952
8	272	0 +34 +68 +102 +136 +170 +204 +238 +272 = 1,224
9	306	0 +34 +68 +102 +136 +170 +204 +238 +272 +306 = 1,530
10	340	0 +34 +68 +102 +136 +170 +204 +238 +272 +306 +340 = 1,870
11	374	0 +34 +68 +102 +136 +170 +204 +238 +272 +306 +340 +374 = 2,244

After 30 seconds have passed, the participants were shown the following screen:

To proceed, please click on “Continue”.

Continue

PRACTICE ROUND:

In preparation for the decision task you will be playing one practice round of the task. The result of this practice round will have no effect on your payment.

Please commence now with the practice round.

Start practice round

Participants in the HCOSTS treatments were shown the following screen:

PRACTICE ROUND

remaining time (secs): 10

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

If at least 6 pieces of information forecast "high demand" → future demand is then considered to be high
If at least 6 pieces of information forecast "low demand" → future demand is then considered to be low

Please select the amount of information you want to buy by clicking on one of the options:

Infor-mation	**Direct costs of a particular piece of information**	**Total costs for the acquisition of an amount of information**												
0	0	0											= 0	Buy 0 pieces of information for 0 ECU in total
1	68	0	+68										= 68	Buy 1 piece of information for 68 ECU in total
2	136	0	+68	+136									= 204	Buy 2 pieces of information for 204 ECU in total
3	204	0	+68	+136	+204								= 408	Buy 3 pieces of information for 408 ECU in total
4	272	0	+68	+136	+204	+272							= 680	Buy 4 pieces of information for 680 ECU in total
5	340	0	+68	+136	+204	+272	+340						= 1,020	Buy 5 pieces of information for 1,020 ECU in total
6	408	0	+68	+136	+204	+272	+340	+408					= 1,428	Buy 6 pieces of information for 1,428 ECU in total
7	476	0	+68	+136	+204	+272	+340	+408	+476				= 1,904	Buy 7 pieces of information for 1,904 ECU in total
8	544	0	+68	+136	+204	+272	+340	+408	+476	+544			= 2,448	Buy 8 pieces of information for 2,448 ECU in total
9	612	0	+68	+136	+204	+272	+340	+408	+476	+544	+612		= 3,060	Buy 9 pieces of information for 3,060 ECU in total
10	680	0	+68	+136	+204	+272	+340	+408	+476	+544	+612	+680	= 3,740	Buy 10 pieces of information for 3,740 ECU in total
11	748	0	+68	+136	+204	+272	+340	+408	+476	+544	+612	+680	+748	= 4,488	Buy 11 pieces of information for 4,488 ECU in total

For participants in the NOTP treatments, the text written in red was lacking.
For participants in the NEG treatments, this number in blue was replaced by -12,000.

Participants in the POS-LCOSTS treatments were shown the following screen:

PRACTICE ROUND

remaining time (secs): 10

		your additional payment in the case of a high demand	your additional payment in the case of a low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

If at least 6 pieces of information forecast "high demand" → future demand is then considered to be high
If at least 6 pieces of information forecast "low demand" → future demand is then considered to be low

Please select the amount of information you want to buy by clicking on one of the options:

Infor-mation	**Direct costs of a particular piece of information**	**Total costs for the acquisition of an amount of information**												
0	0	0											= 0	Buy 0 pieces of information for 0 ECU in total
1	34	0	+34										= 34	Buy 1 piece of information for 34 ECU in total
2	68	0	+34	+68									= 102	Buy 2 pieces of information for 102 ECU in total
3	102	0	+34	+68	+102								= 204	Buy 3 pieces of information for 204 ECU in total
4	136	0	+34	+68	+102	+136							= 340	Buy 4 pieces of information for 340 ECU in total
5	170	0	+34	+68	+102	+136	+170						= 510	Buy 5 pieces of information for 510 ECU in total
6	204	0	+34	+68	+102	+136	+170	+204					= 714	Buy 6 pieces of information for 714 ECU in total
7	238	0	+34	+68	+102	+136	+170	+204	+238				= 952	Buy 7 pieces of information for 952 ECU in total
8	272	0	+34	+68	+102	+136	+170	+204	+238	+272			= 1,224	Buy 8 pieces of information for 1,224 ECU in total
9	306	0	+34	+68	+102	+136	+170	+204	+238	+272	+306		= 1,530	Buy 9 pieces of information for 1,530 ECU in total
10	340	0	+34	+68	+102	+136	+170	+204	+238	+272	+306	+340	= 1,870	Buy 10 pieces of information for 1,870 ECU in total
11	374	0	+34	+68	+102	+136	+170	+204	+238	+272	+306	+340	+374	= 2,244	Buy 11 pieces of information for 2,244 ECU in total

For participants in the NOTP-POS-LCOSTS treatment, the text written in red was lacking.

PRACTICE ROUND

remaining time (secs): 4

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

If at least 6 pieces of information forecast "high demand" → future demand is then considered to be high
If at least 6 pieces of information forecast "low demand" → future demand is then considered to be low

Summary of the forecasts made by the distribution centers:

Number of pieces of information that forecast a high demand:	Number of pieces of information that forecast a low demand:
2	1

Please decide whether you want the unused machine to operate again or not by clicking on one of the two options:

The machine should operate again
The machine should not operate again

For participants in the NOTP treatments, the text written in red was lacking.
For participants in the NEG treatments, this number in blue was replaced by -12,000.

PRACTICE ROUND remaining time (secs.): 2

Please confirm your entry:

Do not submit entry

Submit entry

For participants in the NOTP treatments, the text written in red was lacking.

In the case that the participant purchased 3 pieces of information and that the participant decided that the machine should operate again and an overall low future demand, the following screen was shown:

Summary of the practice round:

You bought 3 pieces of information for 408 ECU.

You decided that the machine should operate again.

Overall, there is a low demand in this round.

For this reason, your payment for this round would be (please note that this practice round will not be payment-relevant):

15,000 ECU - 408 ECU + -8,000 ECU = 6,592 ECU

Continue

For participants in the NEG treatments, this number in blue was replaced by -12,000 and therefore, the payment for this round was 2,592 ECU.
For participants in the POS-LCOSTS treatments, these numbers in green were replaced by 204 ECU and therefore, the payment for this round was 6,796 ECU.

Your TASK for today:

In the following 20 rounds you will make a decision about the amount of information to be acquired and about whether the machine should operate or not on the basis of this information. Your decisions in each of the 20 rounds will be independent of each other.

Please click on “Continue”.

Continue

Please start now with round 1 of the decision task.

Start round 1

Participants in the HCOSTS treatments were shown the following screen:

ROUND 1 of 20

remaining time (secs): 11

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

If at least 6 pieces of information forecast "high demand" → future demand is then considered to be high
If at least 6 pieces of information forecast "low demand" → future demand is then considered to be low

Please select the amount of information you want to buy by clicking on one of the options:

Infor-mation	**Direct costs of a particular piece of information**	**Total costs for the acquisition of an amount of information**												
0	0	0											= 0	Buy 0 pieces of information for 0 ECU in total
1	68	0	+68										= 68	Buy 1 piece of information for 68 ECU in total
2	136	0	+68	+136									= 204	Buy 2 pieces of information for 204 ECU in total
3	204	0	+68	+136	+204								= 408	Buy 3 pieces of information for 408 ECU in total
4	272	0	+68	+136	+204	+272							= 680	Buy 4 pieces of information for 680 ECU in total
5	340	0	+68	+136	+204	+272	+340						= 1.020	Buy 5 pieces of information for 1,020 ECU in total
6	408	0	+68	+136	+204	+272	+340	+408					= 1,428	Buy 6 pieces of information for 1,428 ECU in total
7	476	0	+68	+136	+204	+272	+340	+408	+476				= 1,904	Buy 7 pieces of information for 1,904 ECU in total
8	544	0	+68	+136	+204	+272	+340	+408	+476	+544			= 2,448	Buy 8 pieces of information for 2,448 ECU in total
9	612	0	+68	+136	+204	+272	+340	+408	+476	+544	+612		= 3,060	Buy 9 pieces of information for 3,060 ECU in total
10	680	0	+68	+136	+204	+272	+340	+408	+476	+544	+612	+680	= 3,740	Buy 10 pieces of information for 3,740 ECU in total
11	748	0	+68	+136	+204	+272	+340	+408	+476	+544	+612	+680	+748	= 4,488	Buy 11 pieces of information for 4,488 ECU in total

For participants in the NOTP treatments, the text written in red was lacking.
For participants in the NEG treatments, this number in blue was replaced by -12,000

Participants in the POS-LCOSTS treatments were shown the following screen:

ROUND 1 of 20

remaining time (secs): 11

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

If at least 6 pieces of information forecast "high demand" → future demand is then considered to be high
If at least 6 pieces of information forecast "low demand" → future demand is then considered to be low

Please select the amount of information you want to buy by clicking on one of the options:

Infor-mation	**Direct costs of a particular piece of information**	**Total costs for the acquisition of an amount of information**												
0	0	0											= 0	Buy 0 pieces of information for 0 ECU in total
1	34	0	+34										= 34	Buy 1 piece of information for 34 ECU in total
2	68	0	+34	+68									= 102	Buy 2 pieces of information for 102 ECU in total
3	102	0	+34	+68	+102								= 204	Buy 3 pieces of information for 204 ECU in total
4	136	0	+34	+68	+102	+136							= 340	Buy 4 pieces of information for 340 ECU in total
5	170	0	+34	+68	+102	+136	+170						= 510	Buy 5 pieces of information for 510 ECU in total
6	204	0	+34	+68	+102	+136	+170	+204					= 714	Buy 6 pieces of information for 714 ECU in total
7	238	0	+34	+68	+102	+136	+170	+204	+238				= 952	Buy 7 pieces of information for 952 ECU in total
8	272	0	+34	+68	+102	+136	+170	+204	+238	+272			= 1,224	Buy 8 pieces of information for 1,224 ECU in total
9	306	0	+34	+68	+102	+136	+170	+204	+238	+272	+306		= 1,530	Buy 9 pieces of information for 1,530 ECU in total
10	340	0	+34	+68	+102	+136	+170	+204	+238	+272	+306	+340	= 1,870	Buy 10 pieces of information for 1,870 ECU in total
11	374	0	+34	+68	+102	+136	+170	+204	+238	+272	+306	+340	+374	= 2,244	Buy 11 pieces of information for 2,244 ECU in total

For participants in the NOTP-POS-LCOSTS treatment, the text written in red was lacking.

ROUND 1 of 20

remaining time (secs): 2

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

If at least 6 pieces of information forecast "high demand" → future demand is then considered to be high
If at least 6 pieces of information forecast "low demand" → future demand is then considered to be low

Summary of the forecasts made by the distribution centers:

Number of pieces of information that forecast a high demand:	Number of pieces of information that forecast a low demand:
2	4

Please decide whether you want the unused machine to operate again or not by clicking on one of the two options:

The machine should operate again
The machine should not operate again

For participants in the NOTP treatments, the text written in red was lacking.
For participants in the NEG treatments, this number in blue was replaced by -12,000.

Participants in the TP treatments were provided with the following screen if they did not make a decision within the allotted time (participants in the NOTP treatments were never provided with this screen since they were not restricted in the time available):

You have not made your decision within the allotted time. The system has decided for you. The result of this decision will be shown on the next screen.

Continue

Participants in the TP treatments were provided with the following screen if they did not make a decision within the allotted time (participants in the NOTP treatments were never provided with this screen since they were not restricted in the time available):

Summary of round 1:

The system decided that the machine should operate again.

Overall, there is a high demand in this round.

For that reason and because you did not make your decision within the allotted time, your payment for this round will be (if this round is selected by lottery at the end):

15,000 ECU – 3,000 ECU + 10,000 ECU = 22,000 ECU

Round 1 is finished. Please work on round 2 now.

Start next round

Participants repeated this task for 20 rounds.

Participants in the HCOSTS treatments were shown the following screen:

ROUND 20 of 20

remaining time (secs): 12

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

If at least 6 pieces of information forecast "high demand" → future demand is then considered to be high
If at least 6 pieces of information forecast "low demand" → future demand is then considered to be low

Please select the amount of information you want to buy by clicking on one of the options:

Infor-mation	**Direct costs of a particular piece of information**	**Total costs for the acquisition of an amount of information**												
0	0	0											= 0	Buy 0 pieces of information for 0 ECU in total
1	68	0	+68										= 68	Buy 1 piece of information for 68 ECU in total
2	136	0	+68	+136									= 204	Buy 2 pieces of information for 204 ECU in total
3	204	0	+68	+136	+204								= 408	Buy 3 pieces of information for 408 ECU in total
4	272	0	+68	+136	+204	+272							= 680	Buy 4 pieces of information for 680 ECU in total
5	340	0	+68	+136	+204	+272	+340						= 1.020	Buy 5 pieces of information for 1,020 ECU in total
6	408	0	+68	+136	+204	+272	+340	+408					= 1,428	Buy 6 pieces of information for 1,428 ECU in total
7	476	0	+68	+136	+204	+272	+340	+408	+476				= 1,904	Buy 7 pieces of information for 1,904 ECU in total
8	544	0	+68	+136	+204	+272	+340	+408	+476	+544			= 2,448	Buy 8 pieces of information for 2,448 ECU in total
9	612	0	+68	+136	+204	+272	+340	+408	+476	+544	+612		= 3,060	Buy 9 pieces of information for 3,060 ECU in total
10	680	0	+68	+136	+204	+272	+340	+408	+476	+544	+612	+680	= 3,740	Buy 10 pieces of information for 3,740 ECU in total
11	748	0	+68	+136	+204	+272	+340	+408	+476	+544	+612	+680	+748	= 4,488	Buy 11 pieces of information for 4,488 ECU in total

For participants in the NOTP treatments, the text written in red was lacking.
For participants in the NEG treatments, this number in blue was replaced by -12,000.

Participants in the POS-LCOSTS treatments were shown the following screen:

ROUND 20 of 20

remaining time (secs): 12

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

If at least 6 pieces of information forecast "high demand" → future demand is then considered to be high
If at least 6 pieces of information forecast "low demand" → future demand is then considered to be low

Please select the amount of information you want to buy by clicking on one of the options:

Infor-mation	**Direct costs of a particular piece of information**	**Total costs for the acquisition of an amount of information**	
0	0	0	= 0
1	34	0 +34	= 34
2	68	0 +34 +68	= 102
3	102	0 +34 +68 +102	= 204
4	136	0 +34 +68 +102 +136	= 340
5	170	0 +34 +68 +102 +136 +170	= 510
6	204	0 +34 +68 +102 +136 +170 +204	= 714
7	238	0 +34 +68 +102 +136 +170 +204 +238	= 952
8	272	0 +34 +68 +102 +136 +170 +204 +238 +272	= 1,224
9	306	0 +34 +68 +102 +136 +170 +204 +238 +272 +306	= 1,530
10	340	0 +34 +68 +102 +136 +170 +204 +238 +272 +306 +340	= 1,870
11	374	0 +34 +68 +102 +136 +170 +204 +238 +272 +306 +340 +374	= 2,244

Buy 0 pieces of information for 0 ECU in total
Buy 1 piece of information for 34 ECU in total
Buy 2 pieces of information for 102 ECU in total
Buy 3 pieces of information for 204 ECU in total
Buy 4 pieces of information for 340 ECU in total
Buy 5 pieces of information for 510 ECU in total
Buy 6 pieces of information for 714 ECU in total
Buy 7 pieces of information for 952 ECU in total
Buy 8 pieces of information for 1,224 ECU in total
Buy 9 pieces of information for 1,530 ECU in total
Buy 10 pieces of information for 1,870 ECU in total
Buy 11 pieces of information for 2,244 ECU in total

For participants in the NOTP-POS-LCOSTS treatment, the text written in red was lacking.

ROUND 20 of 20

remaining time (secs): 8

		your additional payment in the case of a	
		high demand	low demand
your decision:	Machine will operate	10,000	-8,000
	Machine will not operate	0	0

If at least 6 pieces of information forecast "high demand" → future demand is then considered to be high
If at least 6 pieces of information forecast "low demand" → future demand is then considered to be low

Summary of the forecasts made by the distribution centers:

Number of pieces of information that forecast a high demand:	Number of pieces of information that forecast a low demand:
5	4

Please decide whether you want the unused machine to operate again or not by clicking on one of the two options:

The machine should operate again
The machine should not operate again

For participants in the NOTP treatments, the text written in red was lacking.
For participants in the NEG treatments, this number in blue was replaced by -12,000.

Round 20 of 20 remaining time (secs.): 3

Please confirm your entry:

Do not submit entry
Submit entry

For participants in the NOTP treatments, the text written in red was lacking.

In the case that the participant purchased 9 pieces of information and that the participant decided that the machine should not operate again and an overall low future demand, the following screen was shown:

Summary of round 20:

You bought 9 pieces of information for 3,060 ECU.

You decided that the machine should not operate again.

Overall, there is a low demand in this round.

For this reason, your payment for this round will be (if this round is selected by lottery at the end):

15,000 ECU – 3,060 ECU + 0 ECU = 11,940 ECU

Round 20 is finished. Please work on the questionnaire now.

Continue with the questionnaire

For participants in the POS-LCOSTS treatments, these numbers in green were replaced by 1,530 ECU and therefore, the payment for this round was 13,470 ECU.

Please describe briefly what influenced you to buy a certain amount of information (max. 50 words):

Continue

Please indicate how much you agree with the following statements. There are no right or wrong answers. Therefore, please indicate what reflects your attitude best.

When I bought information, I felt influenced by the amounts shown in the payoff matrix (see table 1 on the sheet of paper in front of you).	strong rejection	o o o o o o o	strong agreement
When I bought information, the extent of the information costs influenced me.	strong rejection	o o o o o o o	strong agreement
I decided instinctively whether to buy a further piece of information or not.	strong rejection	o o o o o o o	strong agreement
I decided for mathematical and / or analytical reasons whether to buy further information or not.	strong rejection	o o o o o o o	strong agreement

Continue

Please indicate how much you agree with the following statements. There are no right or wrong answers. Therefore, please indicate what reflects your attitude best.

For complex tasks, analytical skills are needed.	strong rejection	o o o o o o o	strong agreement
The more information is available for decision-making, the more complex the decision-making process becomes.	strong rejection	o o o o o o o	strong agreement
The more complex the task, the more cognitive resources are needed.	strong rejection	o o o o o o o	strong agreement
To me, complexity means that the solution is not directly obvious.	strong rejection	o o o o o o o	strong agreement
I found the task very complex.	strong rejection	o o o o o o o	strong agreement

Continue

Please indicate how much you agree with the following statements. There are no right or wrong answers. Therefore, please indicate what reflects your attitude best.

I do not feel comfortable about taking risks.	strong rejection	o o o o o o o	strong agreement
I prefer situations that have foreseeable outcomes.	strong rejection	o o o o o o o	strong agreement
Before I make a decision, I like to be absolutely sure about what the result will be.	strong rejection	o o o o o o o	strong agreement
I avoid situations that have uncertain outcomes.	strong rejection	o o o o o o o	strong agreement
I feel comfortable improvising in new situations.	strong rejection	o o o o o o o	strong agreement
I feel nervous when I have to make decisions in uncertain situations.	strong rejection	o o o o o o o	strong agreement

Continue

Please indicate how much you agree with the following statements. There are no right or wrong answers. Therefore, please indicate what reflects your attitude best.

The experiment was fun for me.	strong rejection	o o o o o o o	strong agreement
I identified with the task of the production manager.	strong rejection	o o o o o o o	strong agreement
I tried hard when working on the task.	strong rejection	o o o o o o o	strong agreement
I felt bored when working on the task.	strong rejection	o o o o o o o	strong agreement
I have experience of this kind of task.	strong rejection	o o o o o o o	strong agreement
My mathematical skills are extremely good.	strong rejection	o o o o o o o	strong agreement
My analytical skills are extremely good.	strong rejection	o o o o o o o	strong agreement
The experiment was explained thoroughly.	strong rejection	o o o o o o o	strong agreement
The explanations for this experiment were easy to understand.	strong rejection	o o o o o o o	strong agreement

Continue

Please enter your gender:

- o male
- o female

Please enter your age:

Please enter your main field of study:

Please enter your "Abitur" [university entrance Qualification] grade (please use a dot rather than a comma)):

Please enter the number of months of practical Experience you have had in private or public companies (including the time spent on internships but not school and university study time)

Continue

You will now solve some ARITHMETIC PROBLEMS:

Your objective is to solve correctly as many arithmetic problems as possible within the allotted time of 5 minutes. A problem always involves one of the four basic arithmetic operations. The solution contains whole numbers only. Therefore, please enter your solution without decimal places.

Each screen will display 20 arithmetic problems. You can decide freely how many problems you solve on the displayed screen. You can skip over one or more problems and you do not have to do them in any particular order. As soon as you have completed the problems on one screen or if you cannot solve any more or them, please click on "Continue". Then you will get some new arithmetic problems. The "Back" button gives you the option of going back to earlier inputs or to any gaps in your answers. The arithmetic problems will be shown like this:

14 x 7 =

You can use the paper and writing material in front of you should you need to.

The composition of your payment of these arithmetic problems is shown on the next screen.

Continue

You will only receive ECU for correctly answered questions, depending on the arithmetic operation involved, as follows:

Addition:	40 ECU
Subtraction:	80 ECU
Multiplication:	120 ECU
Division:	160 ECU

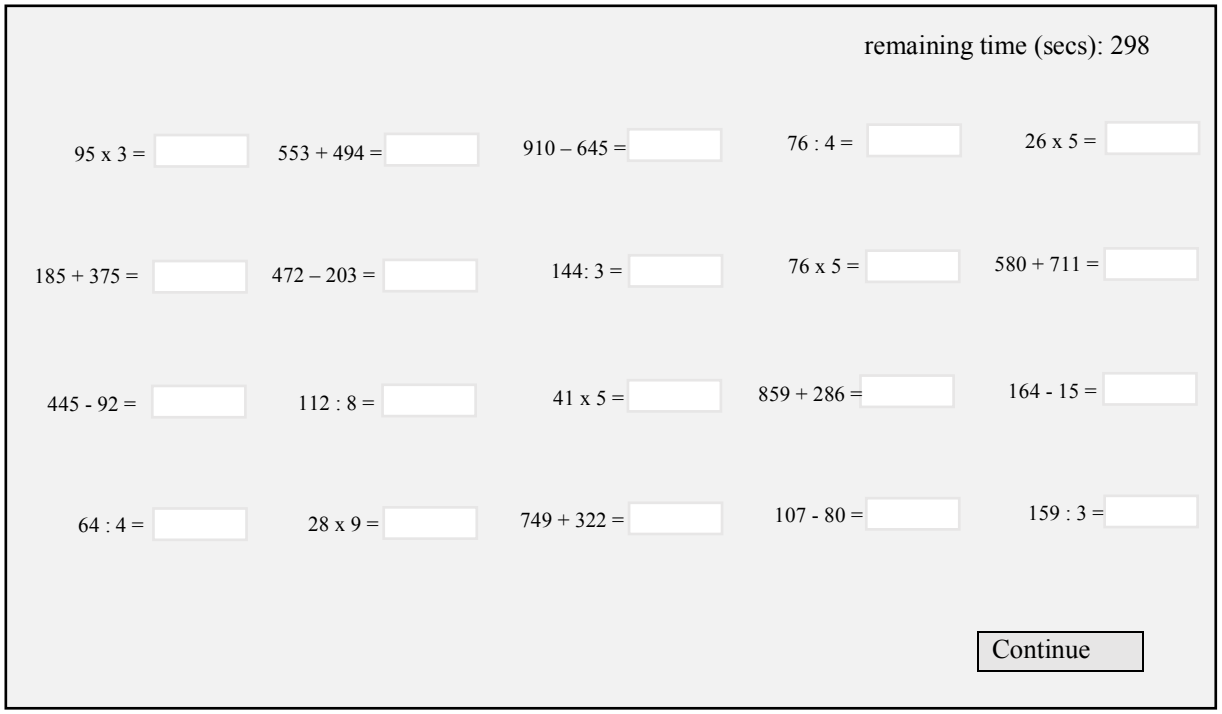
No ECU will be deducted for missing or wrong answers. ECU will be converted into Euro at an exchange rate of 2,000 ECU = 1 Euro, rounded up or down to the first decimal place. They will be paid out to you in addition to your payment based on the decision task (by lottery).

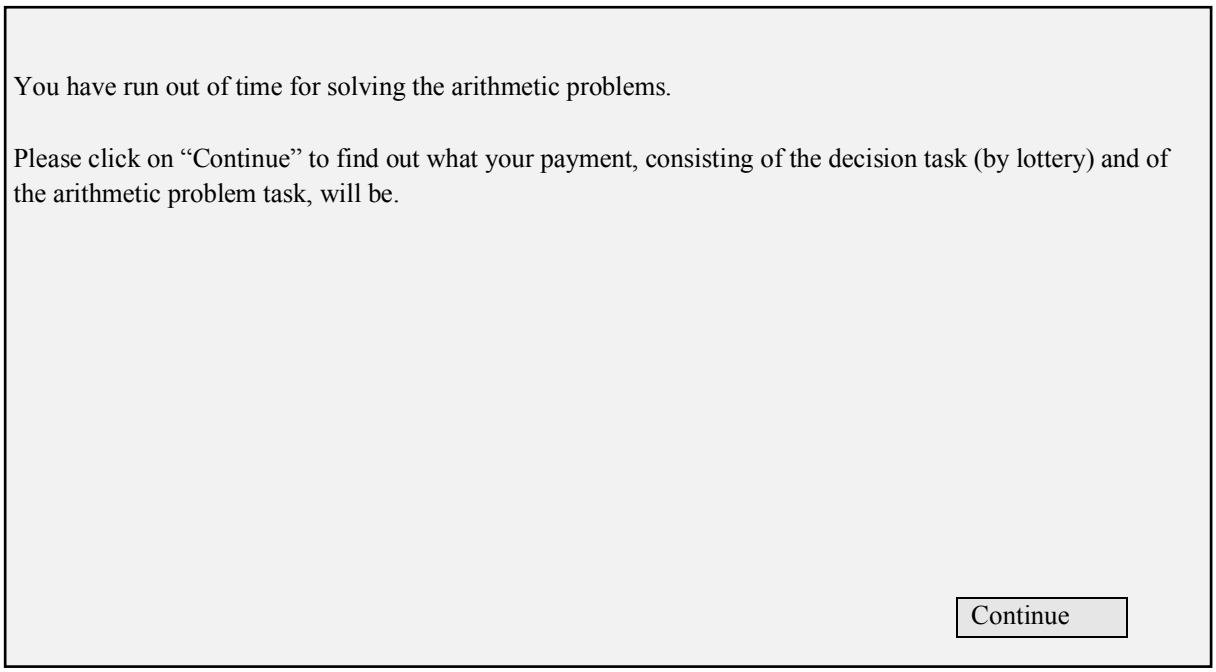
The remaining time for problem solving is shown at the top right of the screen. The time is determined in such a way that you cannot solve all the problems. So please work on as many problems as possible within the 5 minutes. As soon as the time has expired, you cannot solve any more problems. You will automatically find out about your results and your payment. For a good score you need to concentrate fully.

Please click on "Continue" to start solving the arithmetic problems.

Continue

Participants were provided with 8 screens containing arithmetic problems, such as displayed at the following screen:





Participants were provided with a results screen. The following screen displays an exemplary results screen of a participant in the TP-POS-HCOSTS treatment:

Round	Budget	- costs for acquired information	+ additional payment	= total payment
1	15,000	3,000	10,000	22,000
2	15,000	3,000	10,000	22,000
3	15,000	1,904	0	13,096
4	15,000	3,000	10,000	22,000
5	15,000	2,448	-8,000	4,552
6	15,000	1,904	0	13,096
7	15,000	3,740	10,000	21,260
8	15,000	680	10,000	24,320
9	15,000	2,448	10,000	22,552
10	15,000	1,428	-8,000	5,572
11	15,000	68	-8,000	6,932
12	15,000	68	10,000	24,932
13	15,000	204	-8,000	6,796
14	15,000	204	10,000	24,796
15	15,000	0	10,000	25,000
16	15,000	1,904	-8,000	5,096
17	15,000	408	10,000	24,592
18	15,000	0	-8,000	7,000
19	15,000	3,060	10,000	21,940
20	15,000	68	-8,000	6,932

Based on the decision task, your payment will be as follows:
Round 9 was selected by lottery.
Therefore, your payment will be: 22,552 ECU

Based on the arithmetic problems, your payment will be as follows:
You solved 23 problem correctly and will receive 2,040 ECU for it.

2,000 ECU are equivalent to 1 Euro.

Therefore, your total payment will be:
22,552 ECU + 2,040 ECU = 24,592 ECU
11.28 Euro + 1.02 Euro = 12.30 Euro

Please click on “Quit” now!

Quit

A.1-2 Descriptive Statistics

Table A.1-1.1: Descriptive Statistics

Independent variable			Experiment 1		Experiment 2		Experiment 3	
			Treatments					
			1*	2**	3*	4**	5*	6**
Decision rule	N		700	760	700	700	740	780
	Frequency in %	1	76.43	82.11	85.43	86.43	87.97	87.95
		0	23.57	17.89	14.57	13.57	12.03	12.05
Uneven number	N		700	760	700	700	740	780
	Frequency in %	1	42.86	51.84	45.71	52.00	62.57	53.59
		0	57.14	48.16	54.29	48.00	37.43	46.41

Note. * time pressure; ** no time pressure

2.2 Presentation Format Choice and Choice Awareness: Experimental Studies Analyzing the Effects on Underlying Factors of Intrinsic Motivation and Task Performance

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Abstract
Modern information technology systems enable decision makers to control how info is presented and offer them choice options for supporting their decision-making. So far, research on presentation format choice has focused mainly on aspects of cognitive fit. However, the effects of choice and of the awareness of having a choice on both the underlying factors of intrinsic motivation, i.e. autonomy and competence, and subsequent decision makers' task performance have not been analyzed. We incorporate aspects of cognitive fit and of cognitive effort into the investigations of these relationships. We performed online experiments for symbolic and spatial tasks with two kinds of presentation formats, i.e. graphs and tables. We manipulated the following conditions for symbolic and spatial tasks: the opportunity to choose the presentation formant (yes / no) and the awareness of having such a (no) choice (yes / no). Specifically for symbolic tasks, the opportunity to choose the presentation format generally lowers task performance. However, task performance increases when subjects choose tables as a presentation format when doing symbolic tasks. Performance also increases when subjects who have a choice perceive increased autonomy. In further analysis, we find that choice in general contributes to perceptions of autonomy and competence. Interestingly, in conjunction with the awareness of having a choice, it only increases perceptions of autonomy but it decreases feelings of competence.

Keywords: Presentation Format Choice, Choice Awareness, Task Performance, Intrinsic Motivation

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2.2.1 Introduction

Many organizations implement information technology to support decision makers by facilitating data and information processing. Such technology encompasses various types of information systems like Decision Support Systems, Management Information Systems or Executive Information Systems (e.g., Rikhardsson & Yigitbasioglu, 2018; Yigitbasioglu & Velcu, 2012). In recent times, advanced systems in terms of Business Intelligence and Analytics Systems have been developed which provide specific tools and features to collect, analyze, visualize, and report information in a highly sophisticated manner (e.g., Rikhardsson & Yigitbasioglu, 2018). The goal of the systems is to best support decision-making (e.g., Dilla et al., 2010; Yigitbasioglu & Velcu, 2012), in particular in terms of high accuracy, high quality, and decision-making time.

In this context, one of the most important aspects of information system design is the optimal presentation of relevant information to the decision maker. Information presentation format can be defined as the mode in which information is provided to the decision maker (e.g., Kelton et al., 2010). While different types of presentation formats regularly contain the same type and amount of information, research has highlighted the importance of the match between the decision-making task, the information presentation format, and the mental representation by the decision maker (e.g., Dilla et al., 2010; Kelton et al., 2010).

Vessey (1991) introduced the Theory of Cognitive Fit, which provides a theoretical basis for the understanding and explanation of information presentation format effects. CFT suggests that the fit between the decision-making task and the representation of the problem in terms of the information presentation format affects decision-making performance (Vessey, 1991). Shaft and Vessey (2006) extended the model of Vessey (1991) by separating the external problem representation (i.e., the information presentation format) from the internal representation of the problem domain (i.e., the individual's task knowledge). To accomplish a fit between the external and the internal representation of the task, flexibility of the information or the decision support system is required in order to adapt to the decision maker's needs and preferences. Modern information systems in general offer features that allow decision makers to control the presentation of the information, very often due to features of visualization and interactivity (e.g., Rikhardsson & Yigitbasioglu, 2018). Control is basically the result of various choice options offered to the decision maker. A higher degree of choice does not only help to improve cognitive fit; it also contributes to motivation and satisfaction of the decision maker (e.g., Chen & Koufaris, 2015; Rikhardsson & Yigitbasioglu, 2018). From a technological point of view, research has revealed that satisfaction of the decision maker with the decision support positively

affects decision-making performance in terms of efficiency and effectiveness because of information system acceptance (Rikhardsson & Yigitbasioglu, 2018). Satisfaction with the information system predominantly affects acceptance of the given support and provided information. It constitutes an external driver of performance. However, decision-making performance due to decision support system acceptance is also driven by the decision maker's intrinsic motivation (e.g., Venkatesh, 2000; Venkatesh et al., 2002). SDT (Deci & Ryan, 1985; Ryan & Deci, 2017) is the central and most prominent theory for explaining the inner drive and psychological forces of intrinsic motivation. Intrinsic motivation arises, inter alia, from perceptions of personal autonomy and competence and can be regarded as an internal driver of performance. Choice is a factor that can induce and support feelings of autonomy and competence (e.g., Patall, 2012, 2019). Information technology systems that provide choice options in terms of various types of presentation formats should therefore stimulate perceptions of freedom and autonomy. As a result, intrinsic motivation should increase. It is also driven by the perception of the decision maker to be given the competence to individually choose and influence the decision-making process.

Apart from analyzing different elements as part of presentation formats, such as interactivity or visualization elements, previous research has also studied the advantage of certain types of presentation formats in connection with decision-making task characteristics, but only partially in connection with the possibility to choose the presentation format by the decision maker (compare for a review, Dilla et al., 2010). In this regard, previous research has mainly dealt with a comparison between the effects of graphs versus tables as the dominant and widely used information formats in practice. Concerning presentation format choice, Roth et al. (1987) for example found that decision makers had a higher motivation to employ decision aids that allowed choice options compared to those decision aids without such options. While Wheeler and Jones (2003) revealed that the choice of decision-aid features positively relates to the perceived competence of decision makers, in particular for knowledgeable decision makers, other research (e.g., Peng et al., 2007) found that having the option to choose the presentation format also increases efficiency and accuracy when less complex tasks were performed. In an experimental study, Wilson and Zigurs (1999) revealed that decision makers accept support from the information system that does not limit their options in choosing how information is displayed. Furthermore, they have provided evidence that most subjects prefer to make their own choices instead of using choices preselected by the information system.

However, previous research has not provided a detailed analysis of the cause-and-effect chains between presentation format choice and choice awareness and their effects on underlying

factors of intrinsic motivation and task performance. In particular, the contribution of choice to cognitive effort, which can be referred to as the amount of attentive cognitive resources that a decision maker devotes to the task (e.g., Dull et al., 2003), has received little attention. Our aim is to address this research gap and to provide an integrated analysis that incorporates choice and choice awareness as influential factors for intrinsic motivation and subsequent performance effects. We integrate aspects of cognitive fit and cognitive effort into this analysis in order to explain performance effects. We refer to symbolic and spatial decision-making tasks and their representation options in terms of graphs and tables. Against this background, we analyze the effects on intrinsic motivation and decision-making performance when decision makers have the possibility to choose between different types of presentation formats (i.e., graphs versus tables). For this purpose, we put emphasis on the underlying factors of intrinsic motivation, i.e. autonomy and competence. Apart from choice itself, we also shed light on the effects of the awareness of having a choice in comparison to settings where decision makers are not explicitly aware of having a free choice. In sum, we focus on three research questions:

1. *What are the effects of being able to choose the presentation format on task performance in symbolic and spatial tasks?*
2. *Do the effects of presentation format choice on task performance depend on the awareness of having a choice or of not having a choice?*
3. *To what extent do perceptions of autonomy and competence as factors of intrinsic motivation play a role in the context of the effects of presentation format choice on task performance?*

Utilizing and matching different theoretical approaches, we explain impacts of choice on decision-making task performance. Our approach is relevant from a practical point of view because professionals very often have the possibility to choose among different information presentation formats when dealing with decision-making tasks. In particular, user interaction with decision support and information systems is highly relevant, as systems offering choice options can positively influence motivation and satisfaction of the decision maker which subsequently might stimulate higher task performance.

The remainder of this article is structured as follows. In the next section, we introduce the concept of cognitive fit as the relevant theory for the comparison of the performance effects of different presentation formats in the context of symbolic and spatial tasks. Moreover, we discuss the effects of presentation format choice and choice awareness on perceptions of autonomy and competence as factors of intrinsic motivation and task performance in theoretical depth and derive hypotheses to be empirically tested. The design of two experiments and the

measures and methods used are reported in section three. Research outcomes of experiments 1 and 2 are outlined and discussed in the fourth section. In section five, we discuss implications of our findings, present avenues for further research and finally, draw our conclusions.

2.2.2 Theory and Hypotheses

2.2.2.1 Relevance of Choice and Choice Awareness for Performance

While relevant information for decision-making tasks can be made available in multiple forms, information systems predominately present information in tables or graphs (Dilla et al., 2010; Yigitbasioglu & Velcu, 2012). In this context, research has intensively studied and compared the performance effects of graphs and tables (for reviews, confer Dilla et al., 2010; Kelton et al., 2010).

Most research in this field is based on CFT (Vessey, 1991) which explains information presentation effects on decision-making performance. The theory assumes that decision-making performance results from a fit between the decision-making task and the representation of the decision-making problem. Theory additionally suggests that a decision-making task requires a specific decision-making process, and cognitive fit occurs only when the problem representation supports this process. When the decision maker's cognitive structures in the context of the decision-making process are positively correlated with the retrieval of the task information, the degree of cognitive fit is high, but is attenuated when the degree of cognitive fit is low (Dunn et al., 2017). A high cognitive fit constitutes a consistent and accurate mental representation of the problem. Due to a lower cognitive load, the decision maker can utilize more (all) relevant information to derive the best possible task solution. As a consequence, a high task performance with high levels of accuracy is induced. On the contrary, when cognitive fit is poor, decision-making accuracy will suffer (Vessey, 1991; Vessey & Galletta, 1991).

The mental representation of the decision-making problem is also referred to as the internal problem representation (Becker, 1997; Lewis et al., 1988), which is to a high extent mediated and determined by the external problem representation (Bettman & Kakkar, 1977; Bettman & Zins, 1979) and refers to the manner in which task information is presented (Kelton et al., 2010). In this context, CFT most often refers to two types of decision-making tasks, i.e. symbolic and spatial task and their representations. While symbolic tasks encompass discrete and precise data values and cues of information, in spatial tasks decision makers have to evaluate a problem as a whole and compare various alternatives (Vessey & Galletta, 1991). Empirical research has found that symbolic tasks are best supported by tables (e.g., Umanath et al., 1990; Vessey & Galletta, 1991). This is because tables present symbolic information and

provide an analytical view of the tasks. In addition, tables help to extract specific values and to assess changes in variables (MacKay & Villarreal, 1987; Vessey, 1991). In contrast, spatial tasks are usually best represented by graphs (Vessey & Galletta, 1991).

When the decision maker has to deal with the decision-making problem as a first step, problem information enters her or his working memory. Having to choose between different types of presentation formats to solve the problem, the decision maker has to refer to her or his experience in a second step. For this purpose, the decision maker has to relate the actual task information to her or his existing knowledge about the task (e.g., Shaft & Vessey, 2006). In particular, s/he will evaluate whether the task structure is symbolic or spatial. During this cognitive process, knowledge from the long-term memory has to be matched with information from the working memory (Zhang, 1997). In the context of decision aids, Hoch and Schkade (1996) as well as Wheeler and Jones (2003) found that decision makers basically select those types of decision aids that support a decision maker's strongest cognitive abilities. However, this argumentation is restricted to the precondition that a decision maker can at least partially evaluate her or his abilities correctly. Even if cognitive fit does not occur because the decision maker has assessed her or his abilities incorrectly, and thus cognitive load is high, further cognitive effort may be raised due to self-regulatory processes (Kanfer & Ackerman, 1989).

When cognitive effort due to the availability of choice is high, a high penetration of (concentration on) the decision-making problem is given. Consequently, the decision maker invests more in sophisticated cognitive processes (e.g., Kanfer, 1990; Moller et al., 2006). This is due to the fact that a high persistence of cognitive effort positively affects task performance (e.g., Moller et al., 2006; Vallerand, 1997; Zapata-Phelan et al., 2009). Thus, cognitive load and cognitive effort, at least partially, interact with each other. In other words, when the decision maker realizes that the chosen presentation format is not adequate, s/he might be able to overcompensate the negative performance effects resulting from a higher cognitive load with the help of additional cognitive effort. Contrarily, decision makers that do not have a choice with regard to different types of presentation format, do not have the chance to modify the decision-making procedures in a similar manner to subjects having a choice. Consequently, their cognitive effort and performance are expected to be lower. Altogether, we hypothesize:

H1: Subjects who can choose the information presentation format perform better than subjects having no choice.

SDT has revealed that, among others, being aware of states and conditions, attention and interest rise towards the current situation (Ryan & Deci, 2008). In general, awareness is regarded as a definite and conscious perception and insight helping to continually monitor and

control the actual environment and events (Brown & Ryan, 2003; Ryan & Deci, 2008). This is due to the fact that attention influences the selection of information (e.g., Anderson, 2005) and therefore induces awareness towards the relevant information processing steps.

In contexts of decision-making tasks with presentation format choice, we can therefore state that choice awareness refers to the conscious perception to monitor and control the choice options concerning the presentation of the task as well as to the conscious reception of related task elements and options. The conscious reception is closely connected to mindfulness, which refers to a state of receptive attention of the actual situation and setting (Brown & Ryan, 2003; Deci et al., 2015). With the help of mindfulness and interest, a stronger emotional connection and attention to the action is present. This induces an active engagement and leads decision makers to pay more attention to the act of choosing relative to decision makers that do not have the awareness of having a choice (Brown & Ryan, 2003; Deci et al., 2015).

Research has further shown that priming, and in particular visual priming, serves as an important driver of awareness and helps to shape the perception and consciousness of objects (Lin & Murray, 2014; Wiggs & Martin, 1998). Priming refers to the presentation of a stimulus that influences and determines the individual's perception of a (choice) situation (Murphy & Zajonc, 1993). The presentation of clear visual information indicating the possibility of having a choice between different data presentation formats to solve a particular question may serve as such a relevant stimulus or perceptual prime. Consequently, we expect that decision makers who are aware of having a choice will exert a higher cognitive effort and subsequently achieve a higher performance compared to those decision makers who are not explicitly aware of having a choice when they perform the task. Therefore, we derive the following hypothesis:

H2: Subjects who are aware of having the opportunity to choose the information presentation format perform better than subjects who are not explicitly aware of having a choice.

2.2.2.2 Effects of Autonomy and Competence on Performance

We will now refine our analysis and discuss the relevance of the underlying factors of intrinsic motivation, because previous research has highlighted the influence of choice for these factors. We refer to SDT as the core theory in this context which emphasizes that perceived autonomy and competence are the inherent basic psychological needs of human beings, apart from relatedness (Deci & Ryan, 2000; Ryan & Deci, 2000). SDT refers to a framework of different types of motivation, with extrinsic and intrinsic motivation being the most fundamental forms.

Extrinsically motivated behaviors and actions are often stimulated by external regulations and induce certain consequences affecting the decision maker. Referring to an external locus of control, SDT distinguishes between different types of extrinsic motivation, with external regulation being the most controlled form (e.g., Deci et al., 2017). While extrinsic motivation can be traced back to an external locus of control, intrinsic motivation results from an internal locus of causality and feelings of enjoyment and deep interest (e.g., Deci & Ryan, 1985, 2000). Intrinsic motivation can be defined as performing an activity or a task for its own sake because of its inherent stimulation of satisfaction and enjoyment (Ryan & Deci, 2000). Thus, it serves the basic psychological needs of perceived autonomy and competence (Gagné & Deci, 2005), which are both positively linked to work performance (e.g., Cerasoli et al., 2016; Kuvaas et al., 2017). While feelings of competence (i.e., to act in line with the own strengths) are closely related to perceptions of autonomy and develop best in a situation of free behavior, perceptions of autonomy require that the individual acts "with a sense of volition and having the experience of choice" (Gagné & Deci, 2005, p. 333).

Against this background, Patall et al. (2008) argue that the provision of choice is a core factor to induce feelings and perceptions of autonomy. Autonomy relates to behavioral states that are aligned with a person's integrated feeling of the self while perceiving that the self is the driver of the individual's behavior (Deci & Ryan, 2000; Oliver et al., 2008; Reeve et al., 2003). The provision of choice increases the sense of personal control, because behavior is recognized and felt to be stemming from an internal locus of control (Patall, 2012, 2019). In the context of decision-making, decision makers thus perceive a task as more volitional and intrinsically motivating when they are provided with choices, with the consequence that they will perceive freedom rather than pressure to engage in the task due to external regulation (Patall, 2012, 2019). Reeve et al. (2003) emphasize that choices related to the method or manner of how to deal with a task are superior to specific task options. This insight is highly relevant in our context, as choosing between different types of presentation format refers to the manner in which a task is performed. Previous research has shown that the effect of choice on autonomy is highest when three to five choice options are given (Patall et al., 2008). However, too few options can undermine the perception of autonomy and too many options will enhance cognitive load and potentially result in ego-depletion (Chernev et al., 2015; Iyengar & Lepper, 2000; Patall et al., 2008).

Transferred to the context of presentation format, it is relevant for the stimulation of intrinsic motivation that decision makers are provided with the option to choose among an adequate and distinct number of different types of presentation format, in order to raise a high

perception of autonomy. Referring to the analysis by Patall et al. (2008), we conclude that an adequate number of choice alternatives will result in a higher perception of autonomy and subsequently in a higher decision-making performance.

H3a: Having a choice, subjects with a higher perception of autonomy perform better than subjects with a lower perception of autonomy.

Apart from autonomy, competence is a key driver of intrinsic motivation (e.g., Deci & Ryan, 1985). It encompasses the perception of the decision maker that s/he can effectively deal with the decision-making task and has the expertise and capacity to influence the task outcome (e.g., Deci & Ryan, 2000; Oliver et al., 2008). Previous research has emphasized that feelings of competence enhance intrinsic motivation if they are accompanied by a sense of autonomy, which manifests in a perceived internal locus of causality. Autonomy-supportive settings basically create an environment in which decision makers have the opportunity to satisfy their basic psychological need for competence, as they can choose procedures and courses of actions which are aligned with their own strength (e.g., Guay et al., 2001). Therefore, in the context of presentation format choice, the provision of an adequate number of choice alternatives is a supportive factor as shown above, and it has also the positive effect of a person's feeling competent with regard to the task at hand (Becker, 1997; Kernan et al., 1991). Against this background, being able to choose the information presentation format can also contribute to the feeling of being able to appropriately solve a given task (e.g., Patall, 2012; Patall et al., 2008). Accordingly, we conclude:

H3b: Having a choice, subjects with a higher perception of competence perform better than subjects with a lower perception of competence.

2.2.2.3 Effects of Choice and Choice Awareness on Autonomy and Competence

In our preceding analysis, we argued that neither too few nor too many choice alternatives are relevant to induce high perceptions of autonomy and competence. Based on previous research, we highlighted that a certain number of choice alternatives is important to best support factors of intrinsic motivation and finally decision-making performance. However, and in line with the psychological theory of personal control (e.g., Rotter, 1966; Ziller, 1990), it is – independently from the number of choice alternatives available – relevant to have a choice at all. Having a choice helps to qualify a decision as stemming from an internal locus of control and it helps to identify with the decision and therefore with the underlying decision-making task (Patall, 2019). We therefore conclude that in decision-making situations when presentation format choice is available, a perception of personal control rises and induces feelings of autonomy and

competence (Patall et al., 2008). It is obvious that such perceptions and feelings are missing when no choice is in place, so we conclude that:

H4a: Subjects who have a choice perceive a higher autonomy than subjects who have no choice.

H4b: Subjects who have a choice perceive a higher competence than subjects who have no choice.

Research has shown that the perception of choice awareness increases the decision maker's consciousness to act out of an internal locus of regulation without being externally controlled and finally facilitates her or his perception of autonomy (e.g., Deci et al., 2015; Weinstein et al., 2012). This perception of having a choice therefore positively relates to intrinsic motivation out of positive emotions towards the task (Krehbiel & Cropanzano, 2000; Zapata-Phelan et al., 2009). In other words, when performing the decision-making task, we expect that a previous priming and the subsequently awareness of having a choice will amplify autonomy and the intrinsic motivation of decision makers relative to those decision makers who will not explicitly be primed.

We therefore expect that choice awareness will directly affect a decision maker's intrinsic motivation. This effect will occur as a side effect of priming and, due to that, the decision maker will receive the information that s/he has the option to choose between different presentation formats in the current situation. While this information will stimulate a perception of freedom and autonomy for the actual task, it may also lead to the consideration of a potential future threat that choice options could be reduced or even removed. We know from RT (Brehm, 1966; Brehm & Brehm, 1981), that a motivational reaction is driven by such considerations. In particular, RT predicts that motivation should be high in cases when freedom or autonomy is threatened and regarded as difficult to restore (e.g., Miron & Brehm, 2006). Accordingly, we hypothesize:

H5a: Subjects who are aware of having a choice perceive a higher autonomy than subjects who are not explicitly made aware of having a choice.

Moreover, we assume that in the case of choice awareness, decision makers will perceive a higher competence compared to a setting without choice awareness, since choice allows individuals to make a better decision and to take into account their capabilities and competences (e.g., Guay et al., 2001). Choice awareness works in the same direction and it contributes to the perception of an individual's competence. In addition, RT states that in cases where the decision makers expect their freedom and autonomy to be threatened and which they regard as being

difficult to restore, they will also fear that their competence could be undermined. They might infer that such a removal would occur because of organizational or managerial distrust in their competence. We conclude:

H5b: Subjects who are aware of having a choice perceive a higher competence than subjects who are not explicitly made aware of having a choice.

Below in Figure 2.1, we provide our research model that summarizes the cause-and-effect chains between the theoretical constructs to be tested experimentally.

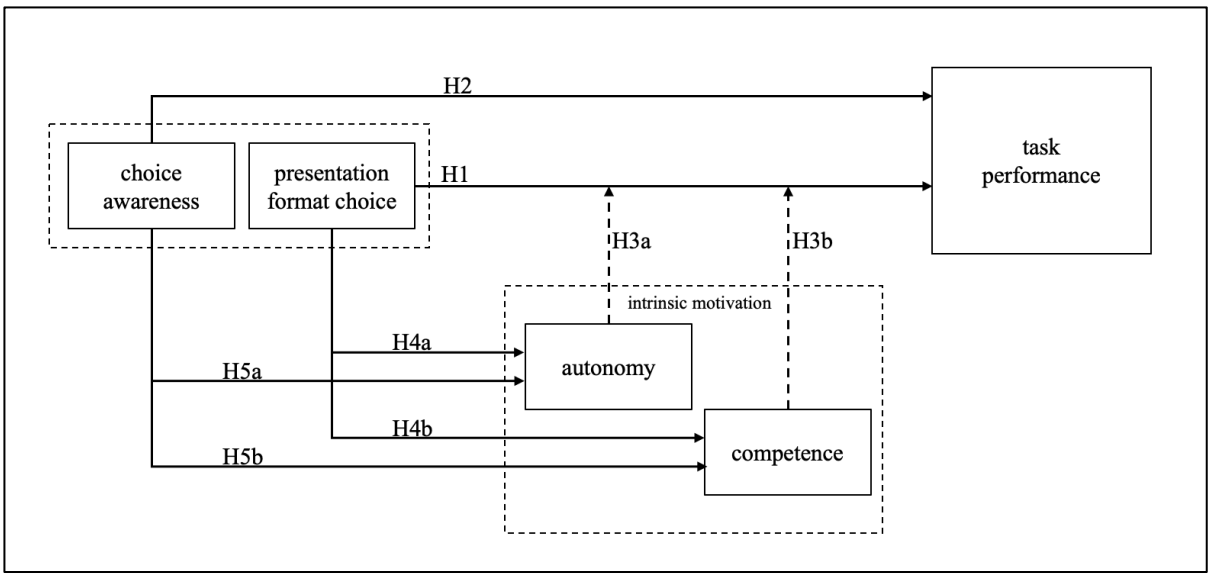

Figure 2.1: Research Model of Research Paper 2

2.2.3 Material and Method

2.2.3.1 Procedure and Task Structure

We performed two online experiments to investigate the effects of presentation format choice on task performance. The first experiment includes symbolic tasks, whereas the second experiment includes spatial tasks. Because each participant performed symbolic and spatial tasks (in a random order) within one session, both experiments consist of the same subjects and treatments. We differentiate the treatments due to the factors *choice* / *no choice* and *awareness of having (no) choice* / *no awareness of having (no) choice*. Thus, the experimental settings consist of the treatments *choice*choice awareness* (C-A), *no choice*choice awareness* (NOC-A), *choice*no choice awareness* (C-NOA), and *no choice*no choice awareness* (NOC-NOA). In the choice treatments, the subjects could choose between the provision of tables or graphs to perform the tasks. In the no-choice treatments, we split both formats and assigned them randomly. Altogether, the experiments comprise 6 treatments. Table 2.7 presents the manipulated factors and treatments of both experiments. One half of each treatment was

facing a choice picture with tables and the other half with graphs at the top of this picture. This was done to avoid a sequence effect within the choice design. In the NOC-NOA-treatments, this procedure was not necessary.

Table 2.7: Overview of the Treatments of Research Paper 2

		Choice awareness	No choice awareness
Choice		1	4
No choice	Graph format	2	5
	Table format	3	6

The experiments were programmed in unipark[5] and consisted of four parts: First, an introduction to the experiment, where subjects learned about the different parts of the experiment. Second, the experimental tasks, where subjects were shown different formats in which information was presented in order to perform the experimental tasks. Third, a post-experimental questionnaire that asked subjects questions related to the preceding tasks. Fourth, a task where subjects were requested to solve arithmetic problems.

In the experimental task, the subjects were told to be an apprentice in a small carpentry business and were prompted to answer correctly and as fast as possible different questions that their supervisor was asking regarding the quantity of chairs the carpentry had sold in the last year. These questions were based on those implemented in the study of Wilson and Zigurs (1999), which ask, e.g., for the combined quantity of January and July. The main differences between the two experiments in this study lay in the nature of the tasks that had to be performed by the subjects.

In the first experiment, the subjects were asked symbolic questions that required them to insert (decimal) numbers. Symbolic questions were similar to the following two kinds of questions: “What is the combined quantity sold in April and June?” (first kind of symbolic questions) and “What is the average quantity sold in October and December?” (second kind of symbolic questions). We drew random numbers to name the months of each question and implemented four questions for each of the two types of questions. In the second experiment, the subjects had to answer spatial questions with either “yes” or “no” and these were similar to the following two types of questions: “Does the quantity sold increase more (decrease less) from April to May than it does from September to October?” (first kind of spatial questions) and “Is February the month with the lowest (highest) quantity sold in the January to March

[5] https://www.unipark.com

period?" (second kind of spatial questions). Again, the particular months of each question were drawn by a random generator. The subjects were shown four questions for each of the two kinds of questions.

The subjects were not forbidden to use any aids (such as a pocket calculator or computer software) to answer the questions. This was reasonable, since they were instructed to answer correctly and as fast as possible; therefore, a correct result through the use of an aid would have come at the expense of lower response times. Based on the literature, graphs and tables were chosen as presentation formats in this study and we provided two types of graph formats and two types of table formats. Thus, four data presentation formats were included in the experimental tasks: A table with frame lines, a table without frame lines, a graph with data marking, and a graph without data marking. Before the experimental tasks started, subjects received explanations depending on the experimental setting they belonged to. For the *awareness*-treatments, these explanations served as a visual prime. In the C-A-treatments, the subjects were explicitly told that they would be allowed to choose one format for answering the particular question instead of being assigned one of the four different formats. In contrast to this, in the NOC-A-treatments, the subjects were explicitly told that they would not be allowed to choose a format and that they would be assigned one of the four different formats for answering the questions. The *no-awareness*-treatments received no stimulations of the *awareness* of having (no) choice. For all treatments, the explanations were repeated every time a new question appeared. Two screens were shown for each question. On the first screen there was a question, and for all but the NOC-NOA-treatments, the choice picture was presented. After 8 seconds had passed, subjects were requested to click directly on to the second screen. They were all informed about the fact that the time they required in addition to the given 8 seconds on the first screen would be added to the time that was taken to measure the performance on the second screen. On the second screen, the question from the first screen was again shown together with the chosen or assigned presentation format in which the data were presented. Subjects were than prompted to answer the questions correctly and as fast as possible about the quantity sold. An example of one question in the C-A-treatments and the two related screens is shown in Figure 2.2.

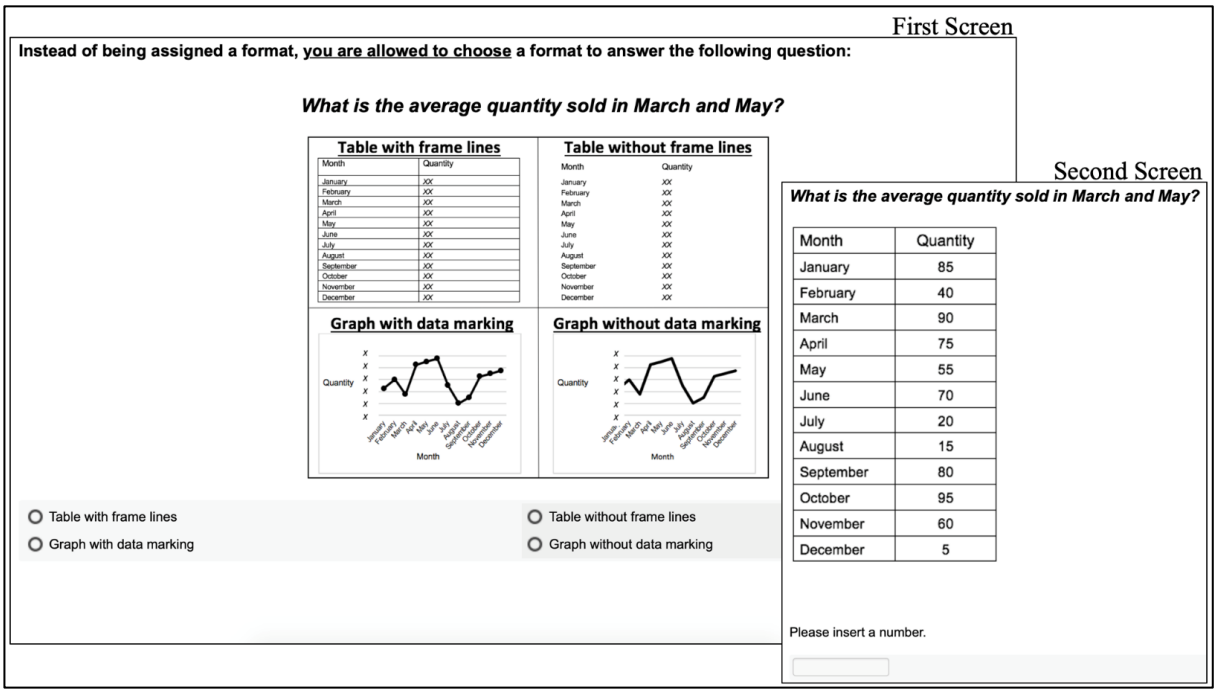

Figure 2.2: Example of the First and Second Screen in the C-A-Treatments

In the third part of the experiments, subjects had to answer questions from the post-experimental questionnaire. These included, among others, questions to measure the perceived autonomy, the perceived competence, and to find out if they had used any aids (such as a pocket calculator or computer software) to solve the tasks. In the fourth part, subjects had to calculate as many calculations as possible in an arithmetic problem task in order to control whether quick calculation abilities influenced the study results. The task was limited to 1 minute and the procedure was based on the kit of factor-referenced cognitive tests (Ekstrom et al., 1976). At the end, subjects were asked to indicate their (no) choice *awareness* during the experimental tasks. We placed this question at the end because we did not want to make them alert about their feelings of choice *awareness* within the task. The experimental instructions are available in Appendix A.2-1.

The experiments were conducted on the crowdsourcing platform Prolific[6]. Prolific was selected because it comprises good recruitment standards and is suitable for research purposes (Palan & Schitter, 2018). Within the platform, we filtered for certain characteristics of the subjects. To increase the probability that the subjects in the experiments were working people who face presentation formats and comparable tasks to those included in the experiments at least sometimes in their work life, we specified an age range (between 18 and 65 years) and the industry role of the subjects. The subjects' industry role had to be described as consultant, junior management, middle management, trained professional, upper management, or self-employed

[6] https://www.prolific.ac

/ partner. Moreover, we defined that subjects needed to speak English fluently to ensure that every participant understood the English contents of the experiments. After the experiments had been conducted, we collected the prescreening data and the socio-demographic data of the subjects. Based on pre-tests, we estimated that the subjects would need approximately 18 minutes to complete the experiments and we paid each participant a reward of 2.70 British pounds (this currency is prescribed by Prolific). We aimed to have 80 subjects in each treatment. Because some subjects timed-out within the allotted time but still completed the study in unipark, new subjects were recruited by Prolific. Altogether, we had 484 subjects who completed the six treatments. We had to drop 11 subjects due to technical incidents, i.e. they timed-out before performing the data analysis tasks. Hence, the sample consists of 473 subjects (210 females, 260 males, and three subjects who did not indicate their gender). The average age of the subjects was 35.33 years, with an age range from 18 to 64 years. On average, the subjects needed 15.26 minutes (SD 4.98) to perform the experiments. Appendix A.2-2 contains the descriptive data for each treatment separately.

2.2.3.2 Measures

To measure performance, we used the performance indicator *accuracy* of the response. *Accuracy* indicates whether the response of the subjects was correct or incorrect. Thus, it was measured binary (1 if the response is correct and 0 otherwise).

Due to the experimental conditions, we included the variables *choice* and *awareness* in the data analyses. When *choice* was given, we allowed the subjects to choose a presentation format to answer the particular question. *Choice* was measured binary (1 when presentation format *choice* was provided and 0 otherwise). The variable *awareness*, also named as 'choice *awareness*' *or 'awareness* of having a choice', referred to the stimulation of the *awareness* of having a choice or of not having a choice and was thus measured binary (1 when choice *awareness* was manipulated, and 0 otherwise).

According to the four data presentation formats, we distinguished only between graphs and tables, which is reasonable because we wanted to investigate performance effects of just these two and not between different forms of these two formats. Therefore, the variable was measured binary (1 if a *table* was chosen (provided) and 0 if a graph was chosen (provided) to answer the question).[7]

[7] To make sure that there are no important differences between the formats within the analyses, we also run regressions with three dummy variables (for table with frame lines, table without frame lines, graph without data marking and graph with data marking). The results were almost identical compared to the analyses with only one dummy variable.

Further, we included measures of the psychological forces of perceived *autonomy* and *competence* in this study. To measure *autonomy*, we employed the *autonomy* scale introduced by (Breaugh, 1999). To measure *competence*, we implemented the subscale for perceived *competence* from the intrinsic motivation inventory scale (e.g., Deci et al., 1994). We related the scales for *autonomy* and *competence* to the present task. The items of both scales were measured using a Likert scale, ranging from 1 to 7. We ran confirmatory factor analyses for both scales. These revealed two valid factors, and the Cronbach's alpha coefficients were 0.8668 for *autonomy* and 0.9057 for *competence*. Appendix A.2-3 depicts the corresponding items and the factor loadings for each factor.

In the context of the present study, we included five control variables: *time required, complexity, experimental aids*, *calculations*, and *age. Time required* was measured in seconds. It consists of the time the respondents required in addition to the given 8 seconds on the first screen plus the response time they needed on the second screen (the response screen). *Complexity* is related to the kind of questions the subjects were asked. As already stated, four questions for each of the two kinds of questions were shown in symbolic tasks as well as in spatial tasks. Complexity is measured binary (1 for the second kind of symbolic questions and the second kind of spatial questions, 0 otherwise). We included this variable to account for the effect that the questions by themselves could lead to different performance outcomes. *Experimental aids* described whether a participant had used any aids (such as a pocket calculator or computer software) to solve the tasks and was measured binary (1 if a participant used *aids* at least sometimes, and 0 otherwise). We included this variable to test whether the use of aids to form a response in the tasks played a role. In the same vein, we included the control variable *calculations* to test whether quick calculation abilities drove the study results. *Calculations* refers to the number of correctly solved *calculations* in the arithmetic problem task and is a metric variable. Besides this, we included *age* as a metric variable (measured in years) because decision-making processes were shown to be dependent on this individual factor (Geisler & Allwood, 2018).

To measure whether the stimulation of the *awareness* of having a choice or of not having a choice had an effect, the subjects were asked to indicate their (no) choice *awareness* on a 5-point-liket scale, ranging from strongly unaware to strongly aware.

2.2.3.3 Analysis

We started with descriptive statistics, inter alia by performing Mann-Whitney U tests, to test whether the visual prime served as a driver of *awareness* within the experiments, to test which

presentation format was chosen more often in which task, and with which (chosen) presentation format the subjects performed better in the respective task. Because each participant answered 16 questions one after another, we declared the data to be time series data and we performed GEE regression analysis. The variable *accuracy* was used to measure performance in the tasks. As *accuracy* was measured binary, we specified the binomial distribution with a binomial dominator of eight within the GEE regression. Further, we specified the "logit" link function, which is the common link function for binary dependent variables (Ballinger, 2004). For choosing an appropriate working correlation structure, we used the Stata program "qic", described in the paper by Cui (2007). We calculated the quasi-likelihood under the independence model criterion (QIC) value for the full specified model for all possible correlation structures and chose the correlation structure with the smallest QIC value for the GEE regression analyses. Moreover, we tested with GEE regressions whether the manipulation of choice and choice *awareness* were effectively influencing the perceptions of *autonomy* and *competence* as factors of intrinsic motivation. Thereby, we specified the normal distribution, the "identity" link function which is employed for normally distributed data (Ballinger, 2004), and again we chose the correlation structure with the smallest QIC value.

Since the subjects were requested to answer correctly and as fast as possible and were informed that the time they required in addition to the given 8 seconds on the first screen would be added to the response time they needed on the second screen (the response screen), we performed two supplementary analyses in order to check robustness of the obtained results: First, because many subjects took much longer than estimated on the first or the second screen of the experimental tasks, which could have influenced the results because the experimental conditions were not constant over all subjects, we dropped subjects who had an average time on the respective screen that was higher than the 95th percentile on that screen. Second, we performed GEE regressions on the variable *time required*. For this GEE regression analyses, we specified the "identity" link function, and chose the correlation structure with the smallest QIC value.

2.2.4 Data Analyses

2.2.4.1 Descriptive Statistics and Preliminary Analyses

Stimulation of the awareness of having (no) choice

First, we computed Mann-Whitney U Tests to test whether the stimulation of the *awareness* of having (no) *choice* influenced the subjects in the experiments. The results show that the *awareness*-treatments (C-A- and NOC-A-treatments) indicated a perception of more

awareness of having (no) *choice* ($p < .0001$). Thus, the visual priming was effective and served as a driver of *awareness* within the experiments. We also performed Mann-Whitney U Tests for the choice- and no choice-treatments separately. When subjects were given the *choice* to select a presentation format, the Mann-Whitney U Test shows a weakly significant difference between C-A- and C-NOA-treatments ($p < .1$), with the C-A-treatments indicating that subjects were more aware that they were allowed to choose. An explanation for this only weakly significant priming effect is that the sentence that highlighted the permission to choose was the only difference between the *choice* treatments (C-A- and C-NOA-treatments). The difference between NOC-A- and NOC-NOA-treatments when subjects were given no *choice* within the task was highly significant ($p < .001$), with subjects of the NOC-A-treatment feeling more aware that they were being denied the choice. When *choice* was not allowed, the NOC-A- and NOC-NOA-treatments differed not by one sentence only. In fact, the NOC-A-treatments were explicitly shown the choice picture but were told that they would not be allowed to choose a presentation format. Contrarily, the NOC-NOA-treatments had to solve the task with one assigned format without being shown the choice picture. As the statistical results indicate, this visual priming served more strongly as a driver of *awareness* for the subjects in the no-choice-treatments than for those in the choice-treatments.

Preference for graphs versus tables

For symbolic tasks, we checked whether subjects decided to choose *tables* more often, as predicted by CFT. The descriptive results show that in 85 % of the symbolic tasks, subjects did choose *tables* instead of *graphs*. This finding fits with results from previous studies which identified that the majority of people decide in favor of symbolic formats or at least switch less between formats when they are assigned symbolic tasks compared to spatial tasks (Vessey & Galletta, 1991; Wilson & Zigurs, 1999). A Mann-Whitney U test verifies that *tables* were chosen more often than *graphs* in symbolic tasks ($p < .001$).

Similarly, we examined whether *graphs* were chosen preferably in spatial tasks, as assumed by CFT. The descriptive results reveal that when *choice* was allowed, subjects decided in favor of *graphs* in a slight majority of spatial tasks (53.44 %) only. This is similar to the results of the study by Vessey and Galletta (1991). A Mann-Whitney U test also indicates that graphs were chosen more often than tables in spatial tasks ($p < .001$).

Vessey and Galletta (1991) assumed that decision makers prefer to solve symbolic tasks, and their study results revealed that symbolic tasks and representations influence the mental presentation more than spatial tasks and representations. The results obtained in the present study support these findings.

Performance with graphs versus tables

To test how subjects performed when they chose *tables* in symbolic tasks, we conducted Mann-Whitney U tests: When *tables* were provided to solve the symbolic task, the results show that subjects answered correctly significantly more often ($p < .0001$). We also performed Mann-Whitney U tests for the *choice* and no *choice*-treatments separately. Both tests indicate that subjects gave correct answers significantly more often ($p < .0001$; $p < .0001$) when they used a *table* to solve the task. These results are in line with CFT.

To test whether subjects perform better with *graphs* in spatial tasks, we performed Mann-Whitney U tests as well. Surprisingly, the test indicates no significant difference regarding the *accuracy* between the use of *graphs* and *tables*. We also performed Mann-Whitney U tests separately for subjects in the choice- and no-choice-treatments. When *graphs* were chosen, subjects answered correctly more often in spatial tasks ($p < .1$) which is in line with the theory. But when the presentation format was assigned within the experiment, the test shows no significant difference.

Control variables

Descriptive statistics of the control variables *experimental aids* and correctly solved *calculations*, which relate to both experiments, are reported in Appendix A.2-2. Altogether, the majority of the subjects across all treatments did not use any aids to solve the tasks. In addition to this, the mean amount of correctly solved *calculations* for the arithmetic problem task is between 12.27 and 13.78 across all treatments. Thus, there are no conspicuities between the various treatments referring to either variable.

2.2.4.2 Regression Analyses on Task Performance (Accuracy of the Response)

We regressed the use of graphs vs. *tables*, presentation format *choice,* choice *awareness,* and factors of intrinsic motivation, i.e. *autonomy* and *competence* on task performance in symbolic tasks (Experiment 1) and in spatial tasks (Experiment 2). Moreover, we took possible moderator variables and certain control variables into account. Because we included independent variables stepwise into the regression models, four models were estimated for each kind of task. The results of the regression analyses on *accuracy* in symbolic tasks are presented in models 1-4, and those on *accuracy* in spatial tasks in models 5-8, Table 2.8. In models 1 and 5, the independent variables comprise the manipulation variables in the experimental task, namely *table*, *choice*, *awareness.* The respective second models (models 2 and 6) add the relevant interaction terms *choice *table* and *choice*awareness*. In models 3 and 7, the two indicator variables for intrinsic motivation, *autonomy* and *competence*, and interaction terms of these

with *choice* were added into the regression analysis. Models 4 and 8 also include the control variables *time required, complexity, experimental aids*, *calculations*, and *age.*

Table 2.8: Regression Analyses on Performance Indicator Accuracy

	symbolic tasks				*spatial tasks*			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
table	0.408	0.309	0.280	0.277	0.0156	-0.000964	-0.00997	-0.00875
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.6716)	(0.9830)	(0.8278)	(0.8487)
choice	-0.0582	-0.607	-0.647	-0.579	-0.0132	-0.0353	-0.0520	-0.0505
	(0.2058)	(0.0000)	(0.0000)	(0.0001)	(0.7346)	(0.5858)	(0.4772)	(0.4928)
*choice*table*		0.638	0.638	0.552		0.0501	0.0539	0.0407
		(0.0000)	(0.0000)	(0.0002)		(0.5239)	(0.4979)	(0.6106)
awareness	-0.0886	-0.0955	-0.145	-0.139	-0.00858	-0.00906	-0.0237	-0.0230
	(0.0336)	(0.0655)	(0.0091)	(0.0136)	(0.8159)	(0.8411)	(0.6242)	(0.6352)
*choice*awareness*		0.00461	0.0591	0.0460		-0.00360	0.0136	0.0138
		(0.9579)	(0.5112)	(0.6125)		(0.9634)	(0.8659)	(0.8647)
autonomy			-0.0755	-0.0698			-0.0226	-0.0221
			(0.0079)	(0.0155)			(0.3675)	(0.3828)
competence			0.0960	0.0787			0.0294	0.0249
			(0.0008)	(0.0069)			(0.2303)	(0.3189)
*choice*autonomy*			0.154	0.156			0.0430	0.0459
			(0.0584)	(0.0575)			(0.5486)	(0.5245)
*choice*competence*			-0.0628	-0.0679			-0.0161	-0.0165
			(0.1930)	(0.1615)			(0.7020)	(0.6956)
time required				-0.00230				-0.000243
				(0.0798)				(0.5041)
complexity				-0.492				0.158
				(0.0000)				(0.0000)
experimental aids				0.128				0.0250
				(0.0180)				(0.6085)
calculations				0.0123				0.00306
				(0.0013)				(0.3651)
age				0.000958				-0.000854
				(0.6706)				(0.6658)
constant	-2.599	-2.540	-2.526	-2.474	-2.096	-2.088	-2.082	-2.173
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	3784	3784	3784	3784	3784	3784	3784	3784

Note. The first observation in each cell is the estimate and the second observation (in parentheses) is the two-sided p-value.

We started with the regression results on *accuracy* in symbolic tasks (models 1-4). The results comprise several significances. First, the regression models 1-4 show that *tables* significantly increase the *accuracy* of the response ($p < .0001$ for all models). It seems as if *tables* best support this kind of task, lead to a better cognitive fit, and hence, significantly increase the *accuracy* of the response.

Choice shows a significantly negative influence on *accuracy* in models 2-4 ($p < .0001$; $p < .0001$; $p < .0001$). Thus, we find no support for H1. It is likely that subjects in the choice treatments dealt with the task as a whole more intensively compared to subjects in the no choice-treatments. For the subjects who were allowed to choose the presentation format, the task consisted not only of answering the particular question but also of the selection of an adequate

presentation format. This might have increased the cognitive load and therefore, decreased the *accuracy* of the response. We infer that *choice*, when regarded solely, does not seem to result in a level of cognitive effort that is able to compensate the negative *choice* effects and in a subsequently better task performance. Furthermore, the interaction term of *choice* and *table* leads to a significant increase in *accuracy* in all three models 2-4 ($p < .0001$; $p < .0001$; $p < .001$). We conclude for symbolic tasks that *tables*, either chosen or assigned, seem to support a cognitive fit and result in a subsequent higher performance, but that *choice,* regarded solely, leads to a decrease in *accuracy*. However, having a choice pronounced the positive effect of using tables.

Awareness significantly decreases the *accuracy* of the responses in models 1-4 ($p < .05$; $p < .1$; $p < .01$; $p < .01$). By contrast, the interaction term of *choice* and *awareness* is not significant in any of the three models 2-4. Thus, H2 is not supported. We conclude that *choice,* either considered solely or in conjunction with choice *awareness,* does not raise enough cognitive effort to affect task performance positively.

With regard to both indicators of intrinsic motivation, *autonomy* and *competence*, the regression results reveal significant influences of these in models 3 and 4. But whereas higher perceptions of *autonomy* decrease the *accuracy* of the response ($p < .01$; $p < .05$), higher perceptions of *competence* increase the *accuracy* of the response ($p < .001$; $p < .01$). As argued before, subjects with higher perceptions of *autonomy* might have felt more freedom about the way in which to proceed with the task and focused on the selection of a presentation format rather than on the correct answering of the questions. Another explanation could be that the selection process required more time than expected so that the subsequent exercise, the answering of a particular question, was performed quickly but with negative effects on the *accuracy* of the response. Thus, we assume that this behavior came at the expense of decreased *accuracy*. In contrast to this, with higher perceptions of *competence*, the *accuracy* of the response increases significantly. The higher perceptions of *competence* could stem from actual (aside from only perceived) *competence* so that a better performance can be achieved.

The results show further that the interaction effect of *choice* and *autonomy* is indeed positively associated with *accuracy* in models 3 and 4 ($p < .1$; $p < .1$). We suppose that more cognitive effort is raised through *choice* and perceptions of *autonomy* simultaneously. This is because cognitive effort is closely connected with intrinsic motivation, which can be influenced, among other things, by the psychological forces of perceived *autonomy*. With this, H3a is supported. On the other hand, the results yield no significance for the interaction effect of *choice* and perceptions of *competence* in models 3 and 4. Thus, *competence* does not interact

with the effect of *choice* on performance (*accuracy*) in symbolic tasks. Accordingly, H3b is not supported.

The control variables, which were included in the regression analysis on *accuracy* in model 4, indicate the following: *Time required* decreases the accuracy of the response ($p < .1$). Thus, subjects who needed more time to calculate the results also achieved a worse performance (inaccurate results), which might stem from bad calculation abilities. It is also possible that these subjects were more distracted by other things and did not fully concentrate on the experimental task, so that the time they required to perform the task increased and the accuracy of the response decreased. *Complexity* influences the *accuracy* of the response ($p < .0001$) as well. The first four symbolic questions asked subjects to do additions, whereas the last four symbolic questions asked subjects to calculate averages. It seems as if the second kind of question (measured with 1) was perceived to be more challenging, since performance decreases. *Experiment aids* significantly increases the *accuracy* of the response in model 4 ($p < .05$). We expect that with the use of external *aids,* the responses were correct more often than without external *aids,* since these provide correct results, except for typing errors. *Calculations*, which consists of the number of correctly solved *calculations* in the arithmetic problem task, increases significantly the *accuracy* of the response in model 4 ($p < .001$), i.e. subjects with stronger calculation abilities made fewer incorrect responses than subjects with weaker calculation abilities. *Age* shows no significant effect in symbolic tasks.

In contrast to the regression results on *accuracy* in symbolic tasks, the only variable with significant influence within the regression analysis on *accuracy* in spatial tasks belongs to the set of control variables. Thus, we do not find support for either of the related Hypotheses (Hypotheses 1, 2, 3a, 3b). The control variable with significant influence is the variable *complexity*. When the last four spatial questions were asked (which are measured with 1), the *accuracy* of the responses increases ($p < .0001$) in model 8. The first four spatial questions ask, e.g., whether the quantity sold increases more (decrease less) from April to May than it does from September to October and the last four spatial questions ask, e.g., whether February is the month with the lowest (highest) quantity sold in the January to March period. The second kind of question might have been perceived easier to answer because only three months are addressed.

2.2.4.3 Regression Analyses on Autonomy and Competence

With the help of regression analyses, we analyzed whether the effects of *choice* and *choice*awareness* really determine the perceptions of *autonomy* and *competence* as factors of

intrinsic motivation in the present context. We formulated three models for each dependent variable. The results of the analyses are presented in Table 2.9 (the results of the regressions with *autonomy* as the dependent variable are depicted in the models 1-3, and those for *competence* are presented in the models 4-6).

The results reveal that *choice* positively influences both dependent variables significantly in all models ($p < .0001$ for models 1-3, 5-6 and $p < .01$ for model 4). These results fit the theoretical deduction and thus, H4a and H4b are supported. As *choice* induces feelings of *autonomy,* the decision maker perceives the task as intrinsically motivating and s/he perceives freedom in performing the task. Additionally, *choice* supports feelings of *competence,* which means that s/he perceives the ability to effectively solve the task.

Awareness, considered solely, is significantly negatively associated with *autonomy* in models 1-3 ($p < .0001$ for all models), and with *competence* in model 4 only ($p < .001$). Nonetheless, the interaction effect of *choice* and *awareness* is significant for both dependent variables. But whereas it increases perceptions of *autonomy* in models 2 and 3 ($p < .0001$; $p < .0001$), it decreases the perceived *competence* of the subjects in models 5 and 6 ($p < .01$; $p < .01$). Therefore, H5a is supported, which states that subjects who are aware of having a *choice* perceive a higher *autonomy* than subjects who are not explicitly made aware of having a choice. Contrarily, H5b, which states that subjects who are aware of having a *choice* perceive a higher *competence* than subjects who are not explicitly made aware of having a choice, is not supported. It seems obvious that the emphasis on presentation format *choice* promotes higher perceptions of *autonomy*. Further, it seems reasonable that no evidence was found for an increase in perceptions of *competence* through an emphasis on presentation format choice. An explanation for the significant decrease in *competence* might be that the participants are more aware that two task components have to be solved, namely selecting an adequate presentation format and solving the task, instead of solving the task only. Thus, they might feel less competent to perform both task components appropriately.

We also included the variable *experimental aids* from the set of control variables formulated above. *Experimental aids* significantly increases perceptions of *autonomy* in model 3 ($p < .0001$) but not the perceived *competence* in model 6. A reason could be that subjects who used aids perceived more freedom, but without feeling more competent, during the solving of the tasks.

Table 2.9: Regression Analyses on Intrinsic Motivation Indicators Autonomy and Competence

	autonomy			*competence*		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
choice	0.877	0.523	0.527	0.0736	0.146	0.147
	(0.0000)	(0.0000)	(0.0000)	(0.0015)	(0.0000)	(0.0000)
awareness	-0.445	-0.686	-0.679	-0.0866	-0.0370	-0.0353
	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.1701)	(0.1914)
*choice*awareness*		0.711	0.703		-0.147	-0.149
		(0.0000)	(0.0000)		(0.0016)	(0.0014)
experimental aids			0.113			0.0261
			(0.0000)			(0.3595)
constant	-0.0761	0.0423	0.0180	0.0179	-0.00644	-0.0120
	(0.0000)	(0.0070)	(0.2722)	(0.2993)	(0.7336)	(0.5452)
N	7568	7568	7568	7568	7568	7568

Note. The first observation in each cell is the estimate and the second observation (in parentheses) is the two-sided p-value.

2.2.4.4 Supplementary Analyses

To check the robustness of the results obtained in the experiments, we performed several supplementary analyses. First, subjects who took an average time on the first or second screen of one question in the experimental tasks that was higher than the 95th percentile on that respective screen were removed from the data set. The results of these supplementary analyses are reported in Appendix A.2-4. They show that the significance levels of some variables within the regression analyses on *accuracy* have slightly changed and that the variable *time required* has a negative significant influence on the *accuracy* of the response in spatial tasks now ($p < 0.05$). Altogether, the supplementary analyses confirm the formerly obtained results, so that we can expect to have robust results in the present study.

Second, we performed regression analyses on the variable *time required,* since the subjects were instructed to solve the task correctly within the shortest possible time. As before, we calculated four models referring to symbolic tasks (models 1-4) and four models referring to spatial tasks (models 5-8). Thereby, models 1 and 5 capture the variables *table*, *choice*, *awareness,* models 2 and 6 add the interaction terms *choice *table* and *choice*awareness,* models 3 and 7 additionally include the variables *autonomy* and *competence* as well as interaction terms of those with *choice*, and models 4 and 8 add the control variables *complexity, experimental aids*, *calculations*, and *age.* One must treat this measure with caution, as it captures differences in seconds only.

Due to symbolic tasks, the results of the regressions on the measure *time required* support the earlier obtained results from the regression analysis on the performance measure *accuracy* in total. Because decreased *accuracy* and increased *time required* to respond both indicate a lower performance, almost all significant variables within the regression on *time required* come to the same conclusion with respect to the regression on *accuracy*, except for the following: the

interaction term of *choice* and *table* as well as *autonomy* have no significant effect in model 4, *competence* as well as the interaction term of *choice* and *competence* have no significant influence on *time required* in models 3-4. In addition to this, a difference with respect to the regressions on *accuracy* is that the interaction term of *choice* and *awareness* is associated significantly negatively with the *time required* in models 2-4 ($p < .01$; $p < .01$; $p < .0001$) now. This finding indicates that the *awareness* of having a choice stimulates additional cognitive effort, compared to *choice* alone, and (partially) compensates the negative performance effects of *choice*. Moreover, the control variable *age* decreases significantly the *time required* in model 4 ($p < .05$). Besides, experimental aids do not only significantly increase the *accuracy* of the response, but also the *time required* ($p < .05$), which is reasonable, since the use of aids might lead to more accurate results but require more time, compared to mental calculations.

Compared to the regressions on the performance measure *time required* in spatial tasks with the results of the regression on the performance measure *accuracy* in spatial tasks, the results of some independent variables reveal significant influences now: *Choice* significantly increases the *time required* to complete the task in models 2-4 ($p < .05$; $p < .05$; $p < .1$). *Awareness* significantly increases the *time required* in models 3-4 ($p <.1$; $p < .1$). The interaction term of *choice* and *awareness* is significant and shows a negative influence on *time* in models 2-4 ($p <.05$; $p < .05$; $p <.05$), which leads to the conclusion that *choice* in conjunction with choice *awareness* provokes additional cognitive effort compared to the effect of *choice* alone. *Competence* leads to a significant increase in the *time required* in model 4 ($p < .1$). From the set of control variables, *complexity, calculations, and age* decrease significantly the *time required* in model 4 ($p < .1$; $p < .01$; $p < .01$).

2.2.5 General Discussion

2.2.5.1 Theoretical Implications

The study provides several theoretical implications.

First, previous studies have supported CFT in symbolic tasks but only partially for spatial tasks, as they concluded that decision makers tend to use tables in their daily life (Vessey, 1991). Our study confirms these results, as we have found that only *tables*, but not *graphs*, enhance performance (*accuracy* of the response) in symbolic tasks, and as we have not found that graphs, and not *tables*, enhance performance (*accuracy* of the response) in spatial tasks. This supports the notion that matching spatial tasks with *graphs* does not necessarily lead to mental processes that emphasize the same type of information. Thus, cognitive fit with subsequent better performance does not occur. The important take-away is that when designing

information systems, user preferences and user needs dependent on the type of task to be performed must be considered. The general utilization of specific tasks and information presentation formats that do not consider user characteristics can therefore be misleading.

Second, we have revealed that *choice* by itself decreases the *accuracy* of the response in symbolic tasks. We argued that *choice* increases the cognitive load of the decision maker because the task consists of two parts when *choice* is allowed given so that the decision maker must pay attention to several parts. From the results, we can infer that *choice* alone does not necessarily lead to a better cognitive fit or to cognitive effort sufficiently high to compensate the negative performance effects of an increased cognitive load.

Third, we have found for symbolic tasks that when *tables* are chosen, performance increases. We infer that the cognitive load induced by *choice* can be overcome by using a presentation format that is assumed to best support symbolic tasks.

Fourth, this study is the first that has investigated the effects of choice *awareness* on task performance empirically, even if we have found no significant effect of choice *awareness* on the performance indicator *accuracy* of the response. In the supplementary analyses, we found that choice *awareness* increases performance regarding the indicator *time required* to respond.

Fifth, we found that perceptions of *autonomy* decrease task performance (*accuracy*), but that *choice* in conjunction with *autonomy* perceptions increases task performance (*accuracy*) in symbolic tasks. Hence, *choice* in conjunction with *autonomy* perceptions seems to increase cognitive effort to a degree that the negative performance effects of *choice* can be compensated.

Sixth, while the influence of *choice* on factors of intrinsic motivation has been investigated in previous studies, none has analyzed empirically this relationship when the *awareness* of having a *choice* is stimulated through visual primes within the decision-making task. As expected, we found that presentation format *choice* contributes to perceptions of *autonomy* and *competence*. Interestingly, *choice* in conjunction with the *awareness* of having a choice increases perceptions of *autonomy* but decreases feelings of *competence*. We conclude that increased *autonomy* through *choice awareness* affects increased feelings of freedom about how to proceed within the task. Contrarily, *choice awareness* could have contributed to perceptions of decreased *competence* in the present task, because the task might have been perceived to be more difficult as it consists of two parts, i.e. the selecting of an adequate presentation format and the answering of the particular question.

Seventh, we took individual characteristics into account within the context of presentation format *choice* effects on task performance. We found that the degree of task difficulty, the use

of *experimental aids* to solve the task, and *calculation* abilities of the subjects are highly relevant in the present context.

2.2.5.2 Practical Implications

Our study provides practical implications as well. In the workplace, professionals very often have the possibility to choose among different presentation formats when dealing with decision-making tasks. Having a *choice* is generally assumed to affect factors of intrinsic motivation (*autonomy* and *competence*). The results show that attention must be paid if the decision maker is aware that s/he has a free *choice* because in the case of choice *awareness*, the effects on *autonomy* and *competence* differ. Thus, management can alter the *choice* context, for example with the help of visual primes, to support feelings of *autonomy*. Moreover, management should pay attention to the effects of *choice* on performance in general. *Choice* by itself seems to increase the cognitive load of decision makers, with negative effects on performance, but this effect can be compensated through the *choice* of *tables* in symbolic tasks and through *autonomy* perceptions when *choice* is available. Thus, management should highlight the *choice* for *tables* and should pay attention to provide an *autonomy*-enhancing choice environment to increase the *accuracy* of the response, at least for symbolic tasks. Otherwise, management should not provide *choice* options and should provide *tables* in order to increase task *accuracy* in symbolic tasks, which are very common in practice.

As the effects of *choice* strongly depend on the kind of task to be performed, enterprises should design the respective task contexts carefully in order to increase productivity.

2.2.5.3 Limitations and Future Research

In the context of the present study, some potential limitations should be considered. First, the study was conducted in a controlled setting and is based on hypothetical questions. In the future, field studies could strengthen the external validity of the results. Further, we implemented only two types of questions for each kind of task. This is justified, as we based the experimental task on previous studies in this field. Nonetheless, future research could implement more than two types of questions for each kind of task as well as a variety in complexity of these questions. Besides this, we implemented four choice options since prior studies have shown that too many and also too few choice options come to different results regarding the perception of autonomy and cognitive load. Further studies could verify these results by implementing more or fewer choice options. Based on pre-studies, we specified that subjects could inspect the first screen for 8 seconds only. The results have shown that many subjects took much longer than 8 seconds on this screen. To account for this, we performed supplementary analyses, and these prove that

the results are almost unchanged. Even though we accounted for this in the supplementary analyses, experiments could also be performed that allow the subjects to decide by themselves how much time they prefer to spend on a screen. This is reasonable, since employees often can allocate an allotted time by themselves to certain activities. Apart from this, the influence of individual characteristics of the decision maker could further be investigated in future research. We have already considered a variable describing the calculation abilities; this variable was highly significant. Moreover, since the influence of individual differences is assumed to be different between stable tasks and tasks with unforeseen changes (LePine, Colquitt, & Erez, 2000), the present tasks could also be altered in future studies. In addition, context specific variables could be taken into account, such as social recognition, which has already been shown to influence task performance (Stajkovic & Luthans, 2003).

2.2.5.4 Conclusion

This study provides an integrated analysis of presentation format choice effects on both the underlying factors of intrinsic motivation, i.e. autonomy and competence, and decision makers' task performance. Particularly, we did not only investigate choice by itself, but included additionally the awareness of having a choice. In this study, awareness refers to the settings where the decision maker was explicitly made aware of having a free choice or no choice. We performed separate analyses for symbolic and spatial tasks when choice options and two presentation formats, graphs and tables, were provided. In line with prior research, tables were found to lead to a better performance in symbolic tasks, which might result from an increase in cognitive fit. The results concerning presentation format choice reveal that it seems to increase cognitive load, since performance deteriorates. Further, it seems that the cognitive load induced by choice can be compensated in symbolic tasks through the selection of the presentation format that supports best this particular type of task, i.e. tables, since task performance is enhanced. In addition to this, when the subject perceives autonomy and is given presentation format choice in symbolic tasks, cognitive effort seems to be increased to a degree that the negative performance effects of choice can be compensated. According to the effects of presentation format choice on perceptions of autonomy and competence and in line with our expectations, the results show that choice increases both, leading to a higher intrinsic motivation. Through the provision of choice, the subject perceives freedom and can choose the presentation format with which s/he feels competent in performing the task. In contrast to this, the emphasis on presentation format choice seems, on the one hand, to further promote freedom in performing the task, and on the other hand, to make subjects feel less competent. This may be due to the

fact that they are aware that two task components have to be solved (choosing of a presentation format and task solving), with the consequence that subjects might feel less competent to perform both task components appropriately. It is important to note that the effects of choice in symbolic and spatial tasks differ essentially from one another. We can conclude that the effects of choice are task-dependent and should be investigated further in future studies.

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Appendix of Research Paper 2

A.2-1 Experimental Instructions

Notes:
Abbreviations for the six experimental treatments:

C-A:	Choice was provided and having this choice was emphasized.
NOCG-A:	Choice was not provided, the participants were shown graphs in order to solve the task, and not having the choice was emphasized.
NOCT-A	Choice was not provided, the participants were shown tables in order to solve the task, and not having the choice was emphasized.
C-NOA:	Choice was provided and having this choice was not emphasized.
NOCG-NOA:	Choice was not provided, the participants were shown graphs in order to solve the task, and not having the choice was not emphasized.
NOCT-NOA:	Choice was not provided, the participants were shown tables in order to solve the task, and not having the choice was not emphasized.

Text in green lettering displays differences between the treatments.

Welcome to this online experiment!

Dear Participant,

Thank you for your interest in this online experiment. It's a component of a research project on making good decisions, which is being conducted by RWTH Aachen University's Chair of Management Accounting.

The experiment consists of 3 parts:
1) A section containing a task that comprises different ways in which information is presented.
When you perform the task, your goal will be to answer each question correctly and as fast as possible!
2) A section containing a questionnaire where you are asked questions that are related to the preceding task.
3) A section where you solve arithmetic problems for 1 minute.

All data will remain **anonymous** and will be treated **strictly confidentially**. No individual data sets will be given to third parties.
If you have any questions or comments, please feel free to contact us directly on Prolific by using the messaging system.

We thank you for your support!

Why are we collecting and using your data?
You are part of a research project where we want to generate a data basis with the help of an online experiment. In this experiment, we would like you to perform a task involving different ways in which information is presented, to answer some questions related to the preceding task, and to solve arithmetic problems. This does mean that we will be capturing your task performance data and your indicated attitudes on some statements, but we will be using this information for research purposes only.

How to contact us
The person / entity responsible within the meaning of the General Data Protection Regulation and other national data protection laws of the Member States as well as other data protection regulations is: Chair of Management Accounting, RWTH Aachen University, Germany.
Peter Letmathe (chair holder of the Chair of Management Accounting)
Phone: +49 241 80 96164
Email: letmathe@controlling.rwth-aachen.de

Elisabeth Noll (research assistant)
Phone: +49 241 80 93541

Templergraben 64
52062 Aachen
Our EU representative
No EU representative available.

To obtain more information about the processing of your personal data, please click here

☐ **I have read and understood the information about data processing and I agree to the processing of my personal data in accordance with the information provided herein.**

Start the survey

→Link:

How long will your personal data be processed?
The data will be stored as long as needed for our research purposes.
The data will be deleted as soon as they are no longer needed for achieving the purpose of their collection.

What personal data will be collected and used?
-we ask for the Prolific ID of each participant; we will use this information to match the data set with the one we receive from Prolific containing prescreening information
-we will receive and use prescreening information on each participant through Prolific

What special categories of personal data will be collected and used?
We do not collect special categories of personal data.

Legal basis for processing your data
Declaration of Consent made by the participant.

Who will have access to your personal data?
Only the Chair of Management Accounting will get insights into the personalised data. No individual data sets will be given to third parties or persons. Data will be processed and remain anonymous.

Transfer of data to a non-EU/EEC country or international organisation, and safeguards
We will not transfer data to a non-EU/EEC country or international organisation, and safeguards.

Statutory or contractual requirement
No statutory or contractual requirement exists for the processing of the data collected in this survey.

Automated decision-making
No automated decision-making is present.

Your individual rights
Besides the information you already have on this site and in line with Art. 13(2) GDPR, we provide you with the following information:
-the existence of the right to request from the controller access to and rectification or erasure of personal data or restriction of processing concerning the data subject or to object to processing as well as the right to data portability;
-because the processing is based on point (a) of Article 6(1), the existence of the right to withdraw consent at any time, without affecting the lawfulness of processing based on consent before its withdrawal;
-the right to lodge a complaint with a supervisory authority;

Your right to withdraw consent
Because the processing is based on point (a) of Article 6(1), the existence of the right to withdraw consent at any time, without affecting the lawfulness of processing based on consent before its withdrawal

Supervisory authority
You have the right to lodge a complaint with a supervisory authority.

Our Data Protection Officer
Contact data of the officially appointed Data Protection Officer:
RWTH Data Protection Officer
Templergraben 55
52062 Aachen (physical address)
52056 Aachen (mailing address)
Germany
Phone: +49 241 80 93665
Fax: +49 241 80 92678
Email: dsb@rwth-aachen.de
Website: www.rwth-aachen.de/dataprotection

The experiment consists of 3 parts:
1) A section containing a task that comprises different ways in which information is presented.
When you perform the task, your goal will be to answer each question correctly and as fast as possible!
2) A section containing a questionnaire where you are asked questions that are related to the preceding task.
3) A section where you solve arithmetic problems for 1 minute.

Continue

For the C-A treatment, the sentence in green was replaced by: "A section containing a task where you can choose between different ways in which information is presented."

Please enter your Prolific ID

Continue

In the following task you will have the role of an apprentice in a small carpentry business and you have to answer different questions your boss is asking you about the quantity of chairs the carpentry has sold in the last year (from January until December). The questions are related to absolute values.

You will be asked **16 questions** (in random order) similar to the following:

What is the combined quantity sold in April and June?
What is the average quantity sold in October and December?
Does the quantity sold increase more (decrease less) from April to May than it does from September to October?
Is February the month with the lowest (highest) quantity sold in the January to March period?
To answer these questions, the computer system will provide four different ways in which information is presented.

Instead of being assigned one of these four different ways, you will be allowed to choose one format for each question.

PROCEDURE: For each question you will see 2 screens.

On the 1st screen you will be requested to choose **within 8 seconds** one way in which information is presented for answering a specific question. **As soon as the 8 seconds have passed**, please click on "continue" and you will see the 2nd screen. If you have not chosen one format within 8 seconds, please select one as fast as possible and click on "continue" afterwards. The time you require in addition to the given 8 seconds on the 1st screen will be added to the time that is taken to measure your performance on the 2nd screen.
On the 2nd screen you will see the question from the 1st screen again and the format you chose to present the data for answering a specific question. You are requested to **answer** the question about the quantity sold **correctly AND as fast as possible! Accuracy and time (which refers to the time you take on the 2nd screen) will be used to measure your performance.**

After clicking on "continue", you will start with the 1st question of the task.

Continue

For the NOCG-A and the NOCT-A treatments, the sentences in green were replaced by:

*"**Instead of being allowed to choose one of these four different ways, you will be assigned a format for each question.***
PROCEDURE: For each question you will see 2 screens.

***On the 1st screen** you will be shown the four different ways in which information is presented for answering a specific question **for 8 seconds**. **As soon as the 8 seconds have passed**, please click on "continue" and you will see the 2nd screen. The time you require in addition to the given 8 seconds on the 1st screen will be added to the time that is taken to measure your performance on the 2nd screen.*
***On the 2nd screen** you will see the question from the 1st screen again and the assigned way in which the data will be presented for answering the question. You are requested to **answer** the question about the quantity sold **correctly AND as fast as possible! Accuracy and time (which refers to the time you take on the 2nd screen) will be used to measure your performance.**"*

For the C-NOA treatment, the sentences in green were replaced by:
*"**You will choose a format for each question.***

PROCEDURE: For each question you will see 2 screens.

***On the 1st screen** you will be requested to choose **within 8 seconds** one way in which information is presented for answering a specific question. **As soon as the 8 seconds have passed**, please click on "continue" and you will see the 2nd screen. If you have not chosen one format within 8 seconds, please select one as fast as possible and click on "continue" afterwards. The time you require in addition to the given 8 seconds on the 1st screen will be added to the time that is taken to measure your performance on the 2nd screen.*
On the 2nd screen** you will see the question from the 1st screen again and the format you chose to present the data for answering a specific question. You are requested to **answer** the question about the quantity sold **correctly AND as fast as possible! Accuracy and time (which refers to the time you take on the 2nd screen) will be used to measure your performance."

For the NOCG-NOA and the NOCT-NOA treatments, the sentences in green are replaced by:
*"**You will be assigned a format for each question.***

PROCEDURE: For each question you will see 2 screens.

***On the 1st screen** you will be shown a specific question **for 8 seconds**. **As soon as the 8 seconds have passed**, please click on "continue" and you will see the 2nd screen. The time you require in addition to the given 8 seconds on the 1st screen will be added to the time that is taken to measure your performance on the 2nd screen.*
On the 2nd screen** you will see the question from the 1st screen again and the way in which the data will be presented for answering the question. You are requested to **answer** the question about the quantity sold **correctly AND as fast as possible! Accuracy and time (which refers to the time you take on the 2nd screen) will be used to measure your performance."

*Examples of the **1st and 2nd screen** for each treatment are presented in the following for the two types of questions:*
*What is the **combined** quantity sold in April and June?*
*What is the **average** quantity sold in October and December?*

*C-A treatment – **1st screen:***

Instead of being assigned a format, you are allowed to choose a format to answer the following question:

What is the combined quantity sold in July and September?

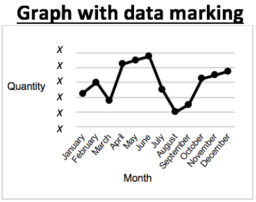
Table with frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

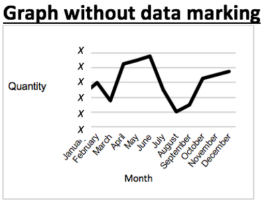
Table without frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

Graph with data marking



Graph without data marking



○ Table with frame lines ○ Table without frame lines
○ Graph with data marking ○ Graph without data marking

Continue

*C-A treatment – **2nd screen**, if "table with frame lines" was chosen:*

What is the combined quantity sold in July and September?

Month	Quantity
January	10
February	70
March	90
April	85
May	50
June	95
July	15
August	40
September	60
October	65
November	80
December	5

Please insert a number.

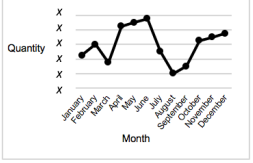
Continue

*NOCG-A treatment – **1st screen:***

<u>You are not allowed to choose</u> a format. Instead, <u>you are assigned a format</u> to answer the following question:

What is the combined quantity sold in July and September?

Graph with data marking



Graph without data marking

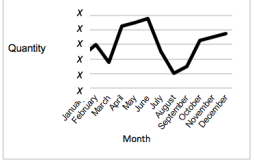


Table with frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

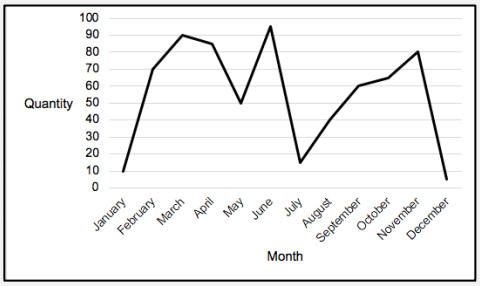
Table without frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

Continue

*NOCG-A treatment – **2nd screen:***

What is the combined quantity sold in July and September?



Please insert a number.

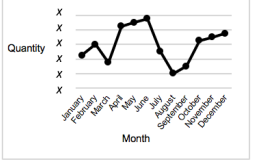
Continue

*NOCT-A treatment – **1st screen:***

<u>You are not allowed to choose</u> a format. Instead, <u>you are assigned a format</u> to answer the following question:

What is the combined quantity sold in July and September?

Graph with data marking



Graph without data marking

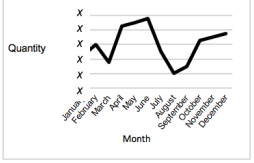


Table with frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

Table without frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

Continue

*NOCG-A treatment – **2nd screen**:*

What is the combined quantity sold in July and September?

Month	Quantity
January	10
February	70
March	90
April	85
May	50
June	95
July	15
August	40
September	60
October	65
November	80
December	5

Please insert a number.

Continue

*C-NOA treatment – **1st screen:***

Please choose a format to answer the following question:

What is the combined quantity sold in July and September?

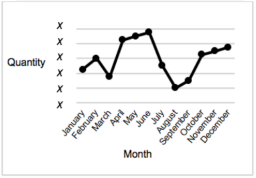
Table with frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

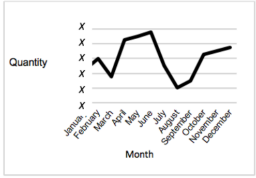
Table without frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

Graph with data marking



Graph without data marking



○ Table with frame lines ○ Table without frame lines

○ Graph with data marking ○ Graph without data marking

Continue

*C-NOA treatment – **2nd screen**, if "table with frame lines" was chosen:*

What is the combined quantity sold in July and September?

Month	Quantity
January	10
February	70
March	90
April	85
May	50
June	95
July	15
August	40
September	60
October	65
November	80
December	5

Please insert a number.

Continue

*NOCG-NOA treatment – **1st screen**:*

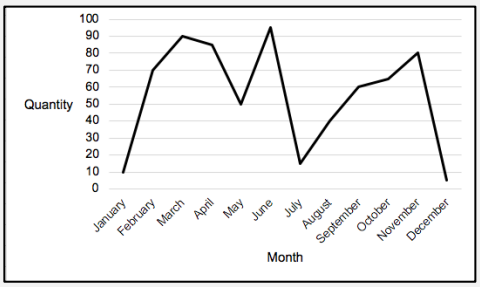
Please answer the following question on the next screen:

What is the combined quantity sold in July and September?

Continue

*NOCG-NOA treatment – **2nd screen**:*

What is the combined quantity sold in July and September?



Please insert a number.

Continue

*NOCT-NOA treatment – **1st screen**:*

Please answer the following question on the next screen:

What is the combined quantity sold in July and September?

Continue

*NOCT-NOA treatment – **2nd screen**:*

What is the combined quantity sold in July and September?

Month	Quantity
January	10
February	70
March	90
April	85
May	50
June	95
July	15
August	40
September	60
October	65
November	80
December	5

Please insert a number.

Continue

*Examples of the **1st and 2nd screen** for each treatment are presented in the following for the two types of questions:*
*Does the quantity sold **increase more / decrease less** from April to May than it does from September to October? Is February the month with the **lowest / highest** quantity sold in the January to March period?*

*C-A treatment – **1st screen:***

Instead of being assigned a format, you are allowed to choose a format to answer the following question:

Does the quantity sold increase more from February to March than it does from August to September?

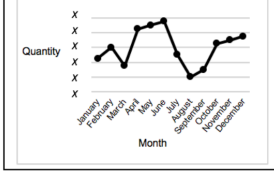
Table with frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

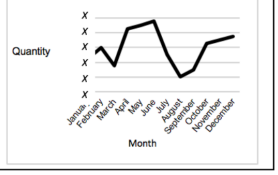
Table without frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

Graph with data marking



Graph without data marking

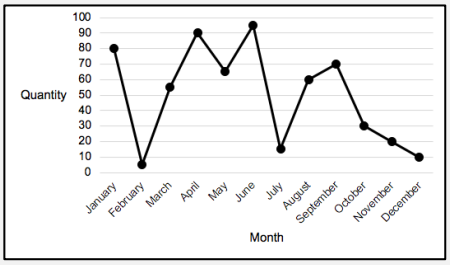


○ Table with frame lines ○ Table without frame lines
○ Graph with data marking ○ Graph without data marking

Continue

*C-A treatment – **2nd screen**, if "table with frame lines" was chosen:*

Does the quantity sold increase more from February to March than it does from August to September?



Please select "yes" or "no".
○ yes
○ no

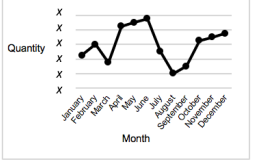
Continue

*NOCG-A treatment – **1st screen:***

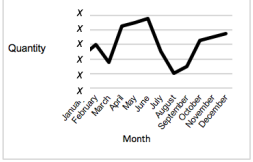
<u>You are not allowed to choose</u> a format. Instead, <u>you are assigned a format</u> to answer the following question:

Does the quantity sold increase more from February to March than it does from August to September?

<u>Graph with data marking</u>



<u>Graph without data marking</u>



<u>Table with frame lines</u>

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

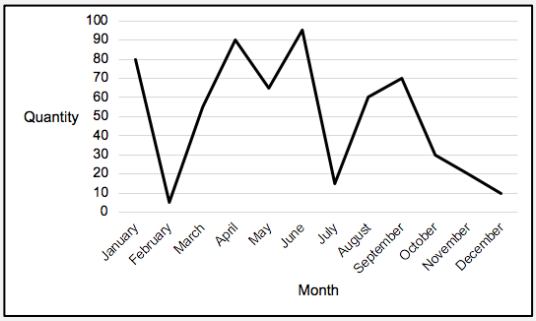
<u>Table without frame lines</u>

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

Continue

*NOCG-A treatment – **2nd screen:***

Does the quantity sold increase more from February to March than it does from August to September?



Please select "yes" or "no".

- yes
- no

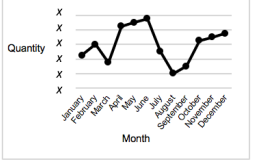
Continue

*NOCT-A treatment – **1st screen:***

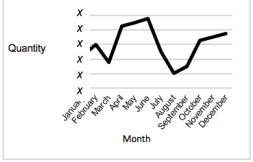
<u>You are not allowed to choose</u> a format. Instead, <u>you are assigned a format</u> to answer the following question:

Does the quantity sold increase more from February to March than it does from August to September?

<u>Graph with data marking</u>



<u>Graph without data marking</u>



<u>Table with frame lines</u>

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

<u>Table without frame lines</u>

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

Continue

*NOCT-A treatment – **2nd screen:***

Does the quantity sold increase more from February to March than it does from August to September?

Month	Quantity
January	80
February	5
March	55
April	90
May	65
June	95
July	15
August	60
September	70
October	30
November	20
December	10

Please select "yes" or "no".

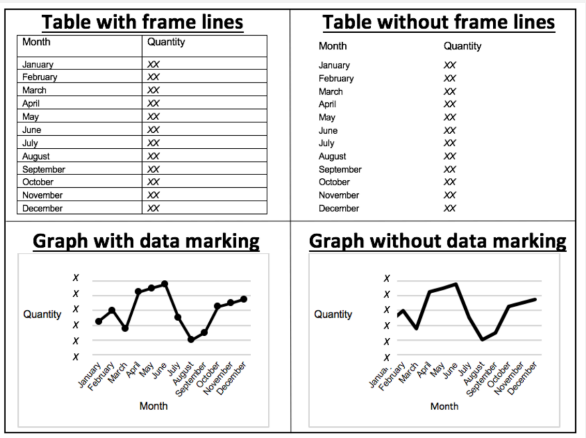
- ○ yes
- ○ no

Continue

*C-NOA treatment – **1st screen:***

Please choose a format to answer the following question:

Does the quantity sold increase more from February to March than it does from August to September?

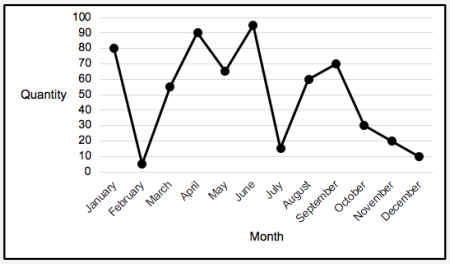


○ Table with frame lines ○ Table without frame lines
○ Graph with data marking ○ Graph without data marking

Continue

*C-NOA treatment – **2nd screen**, if "graph with data marking" was chosen:*

Does the quantity sold increase more from February to March than it does from August to September?



Please select "yes" or "no".

○ yes
○ no

Continue

*NOCG-NOA treatment – **1st screen**:*

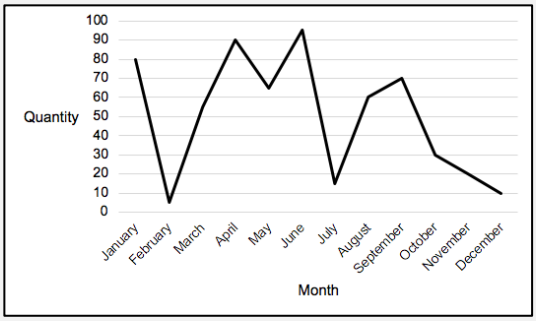
Please answer the following question on the next screen:

Does the quantity sold increase more from February to March than it does from August to September?

Continue

*NOCG-NOA treatment – **2nd screen**:*

Does the quantity sold increase more from February to March than it does from August to September?



Please select "yes" or "no".

- yes
- no

Continue

*NOCT-NOA treatment – **1st screen**:*

Please answer the following question on the next screen:

Does the quantity sold increase more from February to March than it does from August to September?

Continue

*NOCT-NOA treatment – **2nd screen**:*

Does the quantity sold increase more from February to March than it does from August to September?

Month	Quantity
January	80
February	5
March	55
April	90
May	65
June	95
July	15
August	60
September	70
October	30
November	20
December	10

Please insert a number.

Continue

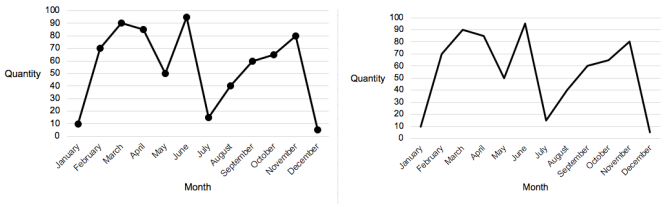
Full list of all 16 questions and their corresponding presentation formats:

1)

What is the combined quantity sold in July and September?

Month	Quantity
January	10
February	70
March	90
April	85
May	50
June	95
July	15
August	40
September	60
October	65
November	80
December	5

Month	Quantity
January	10
February	70
March	90
April	85
May	50
June	95
July	15
August	40
September	60
October	65
November	80
December	5

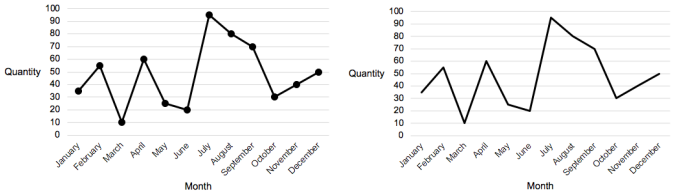


2)

What is the combined quantity sold in May and July?

Month	Quantity
January	35
February	55
March	10
April	60
May	25
June	20
July	95
August	80
September	70
October	30
November	40
December	50

Month	Quantity
January	35
February	55
March	10
April	60
May	25
June	20
July	95
August	80
September	70
October	30
November	40
December	50

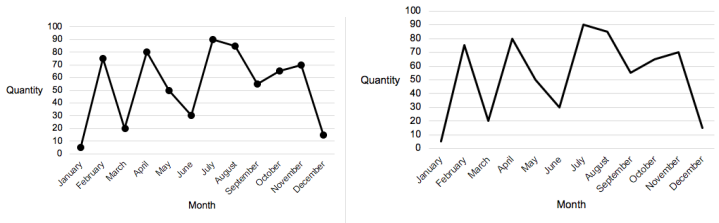


3)

What is the combined quantity sold in September and November?

Month	Quantity
January	5
February	75
March	20
April	80
May	50
June	30
July	90
August	85
September	55
October	65
November	70
December	15

Month	Quantity
January	5
February	75
March	20
April	80
May	50
June	30
July	90
August	85
September	55
October	65
November	70
December	15

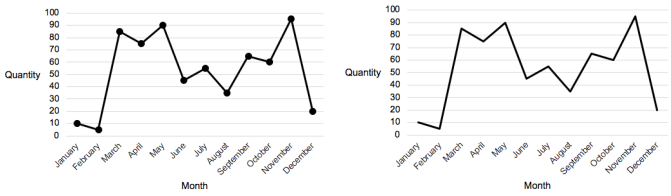


4)

What is the combined quantity sold in August and October?

Month	Quantity
January	10
February	5
March	85
April	75
May	90
June	45
July	55
August	35
September	65
October	60
November	95
December	20

Month	Quantity
January	10
February	5
March	85
April	75
May	90
June	45
July	55
August	35
September	65
October	60
November	95
December	20

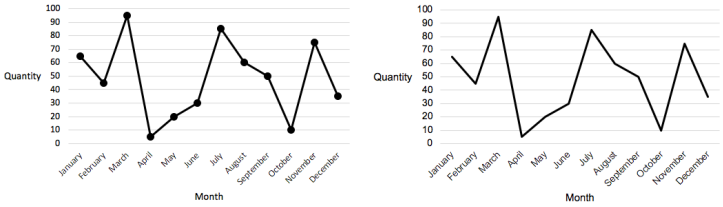


5)

What is the average quantity sold in June and August?

Month	Quantity
January	65
February	45
March	95
April	5
May	20
June	30
July	85
August	60
September	50
October	10
November	75
December	35

Month	Quantity
January	65
February	45
March	95
April	5
May	20
June	30
July	85
August	60
September	50
October	10
November	75
December	35

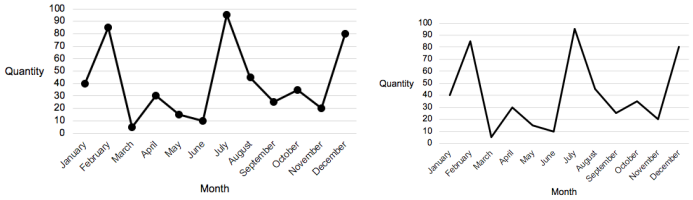


6)

What is the average quantity sold in February and April?

Month	Quantity
January	40
February	85
March	5
April	30
May	15
June	10
July	95
August	45
September	25
October	35
November	20
December	80

Month	Quantity
January	40
February	85
March	5
April	30
May	15
June	10
July	95
August	45
September	25
October	35
November	20
December	80

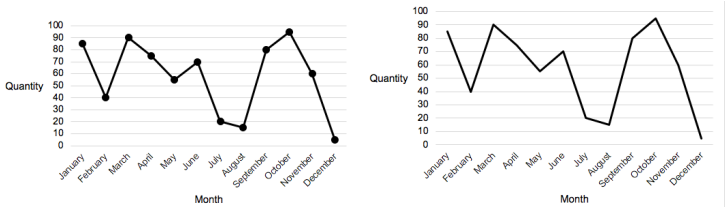


7)

What is the average quantity sold in March and May?

Month	Quantity
January	85
February	40
March	90
April	75
May	55
June	70
July	20
August	15
September	80
October	95
November	60
December	5

Month	Quantity
January	85
February	40
March	90
April	75
May	55
June	70
July	20
August	15
September	80
October	95
November	60
December	5

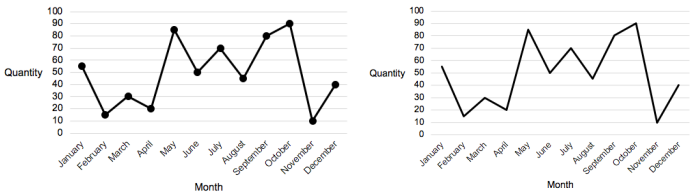


8)

What is the average quantity sold in January and March?

Month	Quantity
January	55
February	15
March	30
April	20
May	85
June	50
July	70
August	45
September	80
October	90
November	10
December	40

Month	Quantity
January	55
February	15
March	30
April	20
May	85
June	50
July	70
August	45
September	80
October	90
November	10
December	40

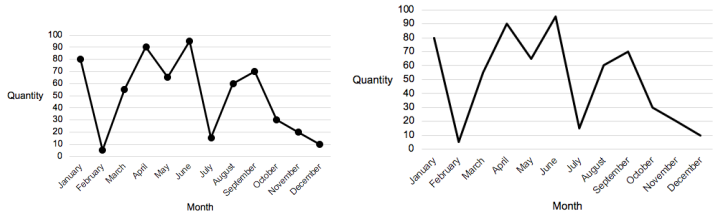


9)

Does the quantity sold increase more from February to March than it does from August to September?

Month	Quantity
January	80
February	5
March	55
April	90
May	65
June	95
July	15
August	60
September	70
October	30
November	20
December	10

Month	Quantity
January	80
February	5
March	55
April	90
May	65
June	95
July	15
August	60
September	70
October	30
November	20
December	10

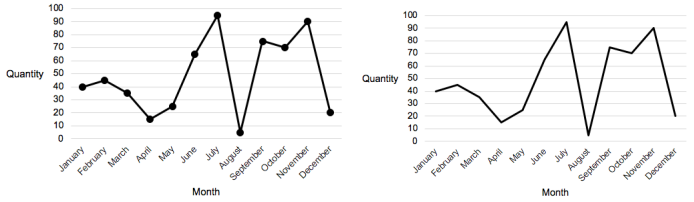


10)

Does the quantity sold decrease less from March to April than it does from July to August?

Month	Quantity
January	40
February	45
March	35
April	15
May	25
June	65
July	95
August	5
September	75
October	70
November	90
December	20

Month	Quantity
January	40
February	45
March	35
April	15
May	25
June	65
July	95
August	5
September	75
October	70
November	90
December	20

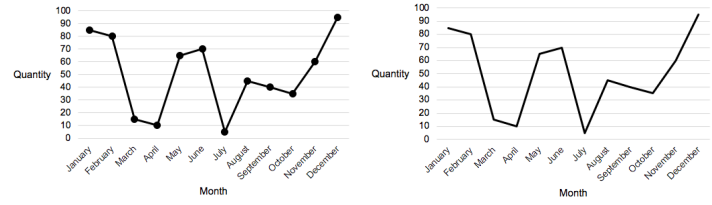


11)

Does the quantity sold increase more from May to June than it does from November to December?

Month	Quantity
January	85
February	80
March	15
April	10
May	65
June	70
July	5
August	45
September	40
October	35
November	60
December	95

Month	Quantity
January	85
February	80
March	15
April	10
May	65
June	70
July	5
August	45
September	40
October	35
November	60
December	95

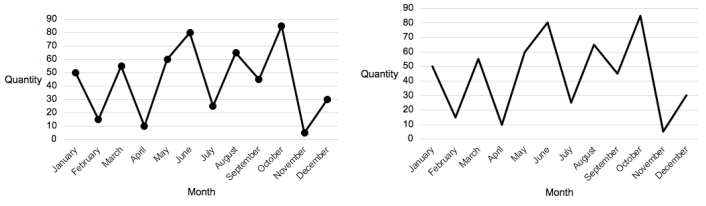


12)

Does the quantity sold decrease less from January to February than it does from August to September?

Month	Quantity
January	50
February	15
March	55
April	10
May	60
June	80
July	25
August	65
September	45
October	85
November	5
December	30

Month	Quantity
January	50
February	15
March	55
April	10
May	60
June	80
July	25
August	65
September	45
October	85
November	5
December	30

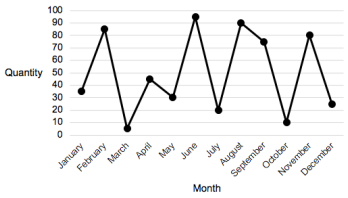


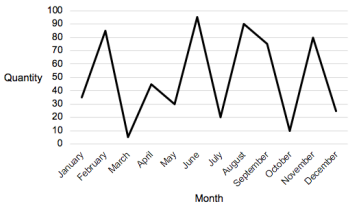
13)

Is March the month with the lowest quantity sold in the February to April period?

Month	Quantity
January	35
February	85
March	5
April	45
May	30
June	95
July	20
August	90
September	75
October	10
November	80
December	25

Month	Quantity
January	35
February	85
March	5
April	45
May	30
June	95
July	20
August	90
September	75
October	10
November	80
December	25



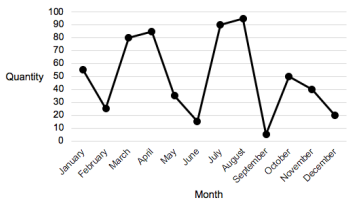


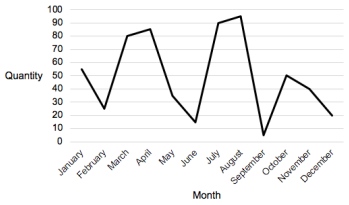
14)

Is April the month with the highest quantity sold in the April to June period?

Month	Quantity
January	55
February	25
March	80
April	85
May	35
June	15
July	90
August	95
September	5
October	50
November	40
December	20

Month	Quantity
January	55
February	25
March	80
April	85
May	35
June	15
July	90
August	95
September	5
October	50
November	40
December	20



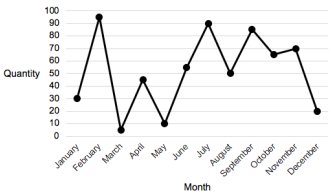


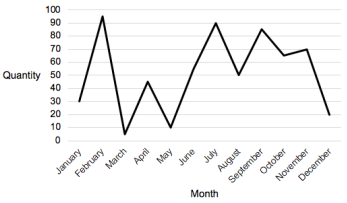
15)

Is September the month with the lowest quantity sold in the July to September period?

Month	Quantity
January	30
February	95
March	5
April	45
May	10
June	55
July	90
August	50
September	85
October	65
November	70
December	20

Month	Quantity
January	30
February	95
March	5
April	45
May	10
June	55
July	90
August	50
September	85
October	65
November	70
December	20



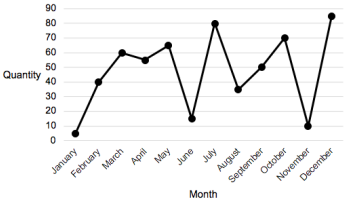


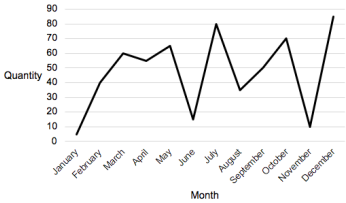
16)

Is October the month with the highest quantity sold in the September to November period?

Month	Quantity
January	5
February	40
March	60
April	55
May	65
June	15
July	80
August	35
September	50
October	70
November	10
December	85

Month	Quantity
January	5
February	40
March	60
April	55
May	65
June	15
July	80
August	35
September	50
October	70
November	10
December	85





After the task that comprised different ways in which information is presented, a questionnaire was provided with questions that were related to the preceding task, as shown on the following screens:

In the following section you will be asked questions that are related to the task you have just performed.

Did you use any aids (e.g. a pocket calculator, computer software, ...) to solve the task you have just performed?

- ○ yes
- ○ no
- ○ sometimes

Continue

Please indicate how strongly you disagree or agree with the following statements. There is no right or wrong answer.

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I was allowed to decide how to get the task done.	○	○	○	○	○
I was able to choose the way to go about the task.	○	○	○	○	○
I was free to choose the formats to use in carrying out the task.	○	○	○	○	○

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
While performing the task, I felt a relaxed sense of personal freedom.	○	○	○	○	○
During performing the task, I felt free.	○	○	○	○	○
During performing the task, I felt pressured.	○	○	○	○	○

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I felt I was doing only what the task wanted me to do.	○	○	○	○	○
I felt I was doing what I wanted to do.	○	○	○	○	○
I felt I was pursuing goals that were my own.	○	○	○	○	○

Continue

Please recall the following **two types of questions:**
What is the **combined** quantity sold in April and June?
What is the **average** quantity sold in October and December?
With regard to answering the above two types of questions, please indicate how strongly you disagree or agree with the following statements about the **TABLE** format. If you have never chosen a TABLE to answer these questions, you can select "not applicable".

A reminder: the table formats are shown in the picture below.

Table with frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

Table without frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

When answering the above two types of questions,...

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree	NOT APPLIC-ABLE
the TABLE format was very adequate.	○	○	○	○	○	○
the TABLE format was very appropriate.	○	○	○	○	○	○
the TABLE format was very useful.	○	○	○	○	○	○
the TABLE format was very compatible with the above two types of questions.	○	○	○	○	○	○
the TABLE format was very helpful.	○	○	○	○	○	○
the TABLE format was very sufficient.	○	○	○	○	○	○
the TABLE format made the above two types of questions very easy to answer.	○	○	○	○	○	○
in general, the TABLE format was the best fit for the above two types of questions.	○	○	○	○	○	○

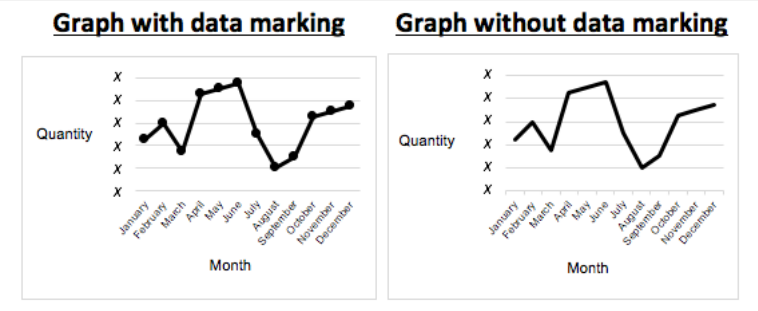
What kind of TABLE did you prefer for answering the above two types of questions?

Table with frame lines	Table without frame lines	Neither of the two kinds of table
○	○	○

Continue

Please recall the following **two types of questions:**
What is the **combined** quantity sold in April and June?
What is the **average** quantity sold in October and December?
With regard to answering the above two types of questions, please indicate how strongly you disagree or agree with the following statements about the **GRAPH** format. If you have never chosen a GRAPH to answer these questions, you can select "not applicable".

A reminder: the table formats are shown in the picture below.



When answering the above two types of questions,...

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree	NOT APPLIC-ABLE
the GRAPH format was very adequate.	○	○	○	○	○	○
the GRAPH format was very appropriate.	○	○	○	○	○	○
the GRAPH format was very useful.	○	○	○	○	○	○
the GRAPH format was very compatible with the above two types of questions.	○	○	○	○	○	○
the GRAPH format was very helpful.	○	○	○	○	○	○
the GRAPH format was very sufficient.	○	○	○	○	○	○
the GRAPH format made the above two types of questions very easy to answer.	○	○	○	○	○	○
in general, the GRAPH format was the best fit for the above two types of questions.	○	○	○	○	○	○

What kind of GRAPH did you prefer for answering the above two types of questions?

Graph with frame lines	Graph without frame lines	Neither of the two kinds of graph
○	○	○

Continue

Please recall the following **two types of questions:**
Does the quantity sold **increase more / decrease less** from April to May than it does from September to October? Is February the month with the **lowest / highest** quantity sold in the January to March period?
With regard to answering the above two types of questions, please indicate how strongly you disagree or agree with the following statements about the **TABLE** format. If you have never chosen a TABLE to answer these questions, you can select "not applicable".

A reminder: the table formats are shown in the picture below.

Table with frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

Table without frame lines

Month	Quantity
January	XX
February	XX
March	XX
April	XX
May	XX
June	XX
July	XX
August	XX
September	XX
October	XX
November	XX
December	XX

When answering the above two types of questions,...

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree	NOT APPLIC-ABLE
the TABLE format was very adequate.	○	○	○	○	○	○
the TABLE format was very appropriate.	○	○	○	○	○	○
the TABLE format was very useful.	○	○	○	○	○	○
the TABLE format was very compatible with the above two types of questions.	○	○	○	○	○	○
the TABLE format was very helpful.	○	○	○	○	○	○
the TABLE format was very sufficient.	○	○	○	○	○	○
the TABLE format made the above two types of questions very easy to answer.	○	○	○	○	○	○
in general, the TABLE format was the best fit for the above two types of questions.	○	○	○	○	○	○

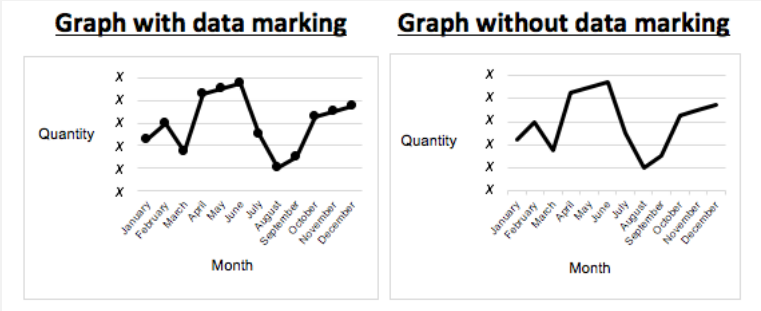
What kind of TABLE did you prefer for answering the above two types of questions?

Table with frame lines	Table without frame lines	Neither of the two kinds of table
○	○	○

Continue

Please recall the following **two types of questions:**
Does the quantity sold **increase more / decrease less** from April to May than it does from September to October? Is February the month with the **lowest / highest** quantity sold in the January to March period?
With regard to answering the above two types of questions, please indicate how strongly you disagree or agree with the following statements about the **GRAPH** format. If you have never chosen a GRAPH to answer these questions, you can select "not applicable".

A reminder: the table formats are shown in the picture below.



When answering the above two types of questions,...

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree	NOT APPLIC-ABLE
the GRAPH format was very adequate.	○	○	○	○	○	○
the GRAPH format was very appropriate.	○	○	○	○	○	○
the GRAPH format was very useful.	○	○	○	○	○	○
the GRAPH format was very compatible with the above two types of questions.	○	○	○	○	○	○
the GRAPH format was very helpful.	○	○	○	○	○	○
the GRAPH format was very sufficient.	○	○	○	○	○	○
the GRAPH format made the above two types of questions very easy to answer.	○	○	○	○	○	○
in general, the GRAPH format was the best fit for the above two types of questions.	○	○	○	○	○	○

What kind of GRAPH did you prefer for answering the above two types of questions?

Graph with frame lines	Graph without frame lines	Neither of the two kinds of graph
○	○	○

Continue

Please indicate how strongly you disagree or agree with the following statements. There is no right or wrong answer.

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I enjoyed doing this task very much.	○	○	○	○	○
This task was fun to perform.	○	○	○	○	○
I think this was a boring task.	○	○	○	○	○
This task did not hold my attention at all.	○	○	○	○	○
I would describe this task as very interesting.	○	○	○	○	○
I think this task was quite enjoyable.	○	○	○	○	○
While I was doing this task, I was thinking about how much I enjoyed it.	○	○	○	○	○

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I put a lot of effort into performing this task.	○	○	○	○	○
I didn‘t try very hard to perform well at this task.	○	○	○	○	○
I tried very hard to perform this task.	○	○	○	○	○
It was important to me to perform well at this task.	○	○	○	○	○
I didn‘t put much energy into performing this task.	○	○	○	○	○

Even if you do not know your real performance in the task, please provide your personal opinions by indicating how strongly you disagree or agree with the following statements.

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I think I was pretty good at this task.	○	○	○	○	○
I think I did pretty well at this task, compared to other people.	○	○	○	○	○
After working at this task for a while, I felt pretty competent.	○	○	○	○	○
I am satisfied with my performance at this task.	○	○	○	○	○
I was pretty skilled at this task.	○	○	○	○	○
This was a task that I couldn‘t do very well.	○	○	○	○	○

Continue

You will now solve some arithmetic problems.
Your objective is to correctly solve as many arithmetic problems as possible **within the allotted time of 1 minute.**
After clicking on "continue", you will have 1 minute to solve the arithmetic problems.

Continue

65+10=	130 : 2 =	80+90=
185:2=	75+65=	165 : 2 =
60+90=	60 : 2 =	50+75=
30 : 2 =	65+80=	65 : 2 =
85+55=	70 : 2 =	10+35=
35 : 2 =	80+35=	25 : 2 =
70+20=	50 : 2 =	25+15=
135:2=	60 + 5 =	170 : 2 =
85+30=	90 : 2 =	50+35=
120:2=	75 +85 =	45 : 2 =
10+15=	160 : 2 =	90+25=
100:2=	30+40=	55 : 2 =
15+50=	125 : 2 =	45+15=
75 : 2 =	75+95=	40:2=

After 60 seconds, the screen was submitted automatically and the next screen appeared.

Did you use any aids (e.g. a pocket calculator, computer software, ...) to solve the arithmetic problems?

- yes
- no
- sometimes

Continue

....and finally one last question:
How aware were you that you were allowed to choose one of the four different ways in which information was presented for answering the questions in the task?

strongly unaware ○ ○ ○ ○ ○ strongly aware

Continue

Thank you for your support!

Please verify via the following link that you have completed the study:

https://app.prolific.ac/submissions/complete?cc=86FYGKVF

(Please click, or copy and paste the following link into a new tab.)

A.2-2 Descriptive Statistics of the Sample

Table A.2-2.1 Descriptive Statistics of the Sample

Treat-ment	Sample Size	Gender		Age			Completion time			Aids experiment		Correctly solved calculations		
		Female (in %)	Male (in %)	M (SD)	Min	Max	M (SD)	Min	Max	Yes/at times (in %)	No (in %)	M (SD)	Min	Max
1	80	31 (38.75)	49 (61.25)	35.2 (9.43)	19	64	14.89 (3.66)	8.82	26.08	15 (18.75)	65 (81.25)	13.58 (4.86)	4	26
2	80	37 (46.25)	43 (53.75)	35.44 (10.19)	18	63	15.45 (5.79)	9.4	48.22	12 (15.00)	68 (85.00)	12.91 (6.17)	0	29
3	74	32 (43.24)	42 (56.76)	36.49 (8.77)	22	58	15.13 (5.28)	8.28	40.42	11 (14.86)	63 (85.14)	13.78 (6.42)	3	38
4	80	35 (43.75)	45 (56.25)	34 (8.71)	19	58	16.15 (5.31)	8.62	40.63	14 (17.50)	66 82.50)	13.78 (6.29)	4	40
5	80	38 (47.50)	42 (52.50)	36.06 (8.90)	22	61	15.3 (3.84)	9.1	26.83	16 (20.00)	64 (80.00)	12.94 (5.21)	1	34
6	79	37 (46.84)	39 (49.37)	34.86 (11.31)	19	63	14.80 (5.23)	9.23	35.87	18 (22.78)	61 (77.22)	12.27 (5.25)	1	35

Note. In treatment 3, the completion time of one participant was not recorded due to technical problems, and the descriptive values for the completion time are based on 73 subjects. In treatment 6, three subjects did not indicate their gender.

A.2-3 Items of and Factor Loadings on the Factors for Autonomy and Competence

Table A.2-3.1 Items of and Factor Loadings on the Factors for Autonomy and Competence

(N = 473)

Factors and related items	Factor loadings
Autonomy	
I was allowed to decide how to go about getting the task done.	0.8798
I was able to choose the way to go about the task.	0.8985
I was free to choose the formats to use in carrying out the task.	0.7096
Competence	
I think I am pretty good at this task.	0.9049
I think I did pretty well at this task, compared to other people.	0.7580
After working at this task for a while, I felt pretty competent.	0.7503
I am satisfied with my performance at this task.	0.8079
I was pretty skilled at this task.	0.8555
This was a task that I couldn't do very well. (R)	0.6390

Note. (R) shows that the item is reverse scaled.

A.2-4 Supplementary Analyses on Performance Indicator Accuracy

Table A.2-4.1 Supplementary Analyses on Performance Indicator Accuracy

	symbolic tasks				*spatial tasks*			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
table	0.392	0.287	0.256	0.236	0.0212	0.00691	-0.00240	-0.00909
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.5777)	(0.8828)	(0.9597)	(0.8489)
choice	-0.0441	-0.638	-0.682	-0.579	-0.0113	-0.0212	-0.0306	-0.0171
	(0.3552)	(0.0000)	(0.0000)	(0.0002)	(0.7792)	(0.7510)	(0.6837)	(0.8211)
*choice*table*		0.687	0.694	0.594		0.0451	0.0522	0.0368
		(0.0000)	(0.0000)	(0.0001)		(0.5777)	(0.5252)	(0.6556)
awareness	-0.0910	-0.102	-0.154	-0.142	-0.0120	-0.00604	-0.0186	-0.0112
	(0.0352)	(0.0598)	(0.0080)	(0.0149)	(0.7518)	(0.8974)	(0.7118)	(0.8237)
*choice*awareness*		0.00922	0.0660	0.0332		-0.0231	-0.00820	-0.0176
		(0.9185)	(0.4778)	(0.7239)		(0.7753)	(0.9215)	(0.8333)
autonomy			-0.0741	-0.0698			-0.0180	-0.0168
			(0.0122)	(0.0199)			(0.4868)	(0.5217)
competence			0.0954	0.0710			0.0277	0.0233
			(0.0013)	(0.0197)			(0.2747)	(0.3701)
*choice*autonomy*			0.147	0.151			0.0226	0.0277
			(0.0758)	(0.0718)			(0.7563)	(0.7048)
*choice*competence*			-0.0671	-0.0704			-0.0134	-0.0146
			(0.1773)	(0.1583)			(0.7577)	(0.7375)
time required				-0.00632				-0.00414
				(0.0015)				(0.0231)
complexity				-0.487				0.130
				(0.0000)				(0.0010)
experimental aids				0.160				0.0216
				(0.0046)				(0.6706)
calculations				0.0118				0.00153
				(0.0031)				(0.6683)
age				0.00149				-0.00110
				(0.5209)				(0.5893)
constant	-2.595	-2.532	-2.514	-2.408	-2.094	-2.090	-2.084	-2.065
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
N	3536	3536	3536	3536	3536	3536	3536	3536

Note. The first observation in each cell is the estimate and the second observation (in parentheses) is the two-sided p-value.

2.3 Email Management Strategies: Their Effects on Email Management Performance

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Abstract
Through digitization, communication in the workplace has changed massively, and email communication is nowadays one important—if not the most important—communication tool. Many employees feel overwhelmed by the sheer volume and content of the emails that they have to handle. Previous studies have investigated the factors influencing the perceived email overload (or related constructs) as well as specific email management strategies that individuals apply in order to handle emails. This paper identifies for the first time a full set of well-validated email management strategies and their effects on email management performance. Findings indicate that the aforementioned performance can be increased specifically by two strategies: By using the email client as a to-do list and by keeping the email inbox at zero. With higher levels of email volume and of perceived usefulness of the email client, email management strategies are applied more often.

Keywords: Email, Electronic mail, Email strategies, Email management performance, Email overload, Work effectiveness, Email volume, Perceived usefulness, Working memory

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2.3.1 Introduction

Most notably through digitization, the amount of information has increased rapidly, and individuals are facing a flood of information within business contexts as well as within private contexts (Benselin & Ragsdell, 2016). Additionally, the means of communication have changed. Particularly email communication has established itself in practice and has become an integral part of everyday communication (Kalman & Ravid, 2015; Wainer et al., 2011; Whittaker, 2005). Known, accepted, and even valued advantages of email communication are, for example, low costs, information on demand and quick world-wide communication (Wainer et al., 2011). However, people also complain about several email characteristics, such as an increase in interruptions and in the total amount of information received (Barley et al., 2011; Kupritz & Cowell, 2011). More dramatically, these negative email characteristics often cause a perceived email overload (Barley et al., 2011; Edmunds & Morris, 2000; Hemp, 2009; Szóstek, 2011). In the context of email communication, email overload is associated mostly with receiving too many emails. The effects of information or email overload are discussed broadly in the related literature: A study by Sevinc and D'Ambra (2010) states that if the email overload increases, the productivity of a person declines. Hence, email overload can have detrimental consequences not only on the individual level but also for the whole organization (Benselin & Ragsdell, 2016). Moreover, cognitive processes are affected through a perceived information overload and may lead to negative work performance (Ruff, 2002). This is caused by the fact that managing emails requires a cognitive effort (Gwizdka, 2004) and that their efficient processing is restricted by a limited cognitive capacity (Paas & Van Merriënboer, 1993). Thus, establishing effective email management strategies is described as a key challenge for knowledge workers nowadays (Kalman & Ravid, 2015). Cecchinato, Bird, and Cox (2014) state that email users could improve their overall performance by changing their email management behavior.

In this study, we aim to empirically determine which email management strategies of an email user affect email management performance the most. The term *"*email management performance" depicts how well (effectively and efficiently) an email user manages her or his own emails. "Email management strategies" denote a particular behavior of email users for managing their emails. Some studies call these strategies "techniques", "tactics", or "activities", or they use related terms (Bellotti et al., 2005; Dabbish & Kraut, 2006; Venolia et al., 2001). Most studies are concerned with the individual characteristics of an email, with problems that occur with certain emails, or with advice on how email users should deal with these particular problems. Because different single items for particular email management strategies but no

well-validated scales for universal email management strategies exist, we investigate email management strategies that are used universally for all emails that a user has to deal with. For this purpose, the first goal of this study is to find out whether email management strategies are measurable constructs (Research Question 1). Hence, we combine existing strategies from the literature and from practice to develop measurable scales. Based on these identified email management strategy scales, we examine which email usage factors determine a certain strategy (Research Question 2). Finally, we apply these constructs in order to analyze which email management strategies influence email management performance positively or negatively (Research Question 3). When testing these influences, we control for email usage factors as well as for individual factors of the email users. The results of the study provide recommendations for the application of specific email management strategies in order to increase email management performance.

The remainder of this paper is structured as follows: The section "Theory and Hypotheses" reviews previous studies from the related literature and develops hypotheses for the influences of different email management strategies on email management performance. The section "Material and Methods" describes in detail the sample and the data collection procedure, the variables used in the study, and the data analysis methods. The section "Data Analysis and Results" includes the statistical results. The "Discussion" section outlines the theoretical and practical implications of the findings of the study, the study's limitations and suggestions for future research, and finally, it draws conclusions.

2.3.2 Theory and Hypotheses

We begin this section by discussing the related literature on information overload or email overload respectively, and we present substantial literature on how email management performance is assumed to be influenced by email overload. Then, we analyze prior literature related to email management strategies, and we develop hypotheses for their influences on email management performance. Lastly, we describe literature regarding our control variables.

2.3.2.1 Information Overload and its Impact on Performance

When the amount of cognitive load that an individual perceives increases, performance increases as well. But after a certain point of cognitive load has been reached, performance deteriorates (Teigen, 1994). Thus, individuals are no longer able to process all pieces of information that they receive, resulting in information overload, which affects performance negatively (e.g., Eppler & Mengis, 2004; Ruff, 2002). The information supply or information processing requirements exceed the limited information processing capacity of an individual

(e.g., Eppler & Mengis, 2004; Kahneman, 1973; Meyer, 1998). Hence, in simplified terms, information overload means that individuals get more information than they can handle (Mano & Mesch, 2010; Ruff, 2002). The definition is also linked to time aspects insofar as the requirements need to be processed within a specific time frame. Otherwise, the individual experiences information overload (Schick et al., 1990). Besides this, information overload can also be caused by unclear contents of emails, by email that is not structured well, and by the many different ways in which an email client can be used (Thomas et al., 2006). It can also occur due to the requirements of the different but interdependent tasks of the email user (Bellotti et al., 2005) because the total value of attention that an individual applies is limited (Kahneman, 1973). In this vein, Eppler and Mengis (2004) coin five constructs as causes for an information overload. These are the amount of information to be processed, the characteristics of an individual, the tasks or processes that need to be executed, the organizational design, and the information technology. Generally, information overload occurs due to a mixture of all these causes (Eppler & Mengis, 2004). To reduce a perceived overload, individuals can increase their information processing capacity by applying appropriate strategies in order to handle information and / or can decrease the amount of information to be handled or the processing requirements (Thomas et al., 2006).

Publications on information overload from the field of accounting are mostly empirical and rather conceptual, and the theoretical background is mostly based on cognitive theories (Eppler & Mengis, 2004). In the present study, we build upon theories of attention and CLT and rely on empirical results from prior literature in this field as well. Kahneman (1973) outlined two different attention theories, a structural and a capacity theory. Both theories rely on the general assumption that the overall amount of attention that can be utilized for different items and actions at any one point in time is limited. Thus, actions that simultaneously require attention interfere with each other. Thereby, each theory describes the causes for interferences differently. The capacity model traces interferences to the situation when the requirements of two or more simultaneous activities are greater than the individual is able to process due to a limited cognitive capacity. Thus, interferences can be traced back to the requirements of these two or more activities. The structural model traces interferences to a situation where two incompatible activities need to be processed via the same psychological mechanisms simultaneously. For example, when a person is in a room where many loud conversations are taking place, the messages of several of these conversations reach that person's central nervous system, but a major part of them will get lost and, due to structural limits, the receiving person is not able to respond to several requests simultaneously (Kahneman, 1973). Kahneman (1973)

states that each interference style appears and that none of the two models is adequate only by itself. What is important to note in the present context is that interference increases the cognitive load, and this impels the individual to limit attention to one activity at the cost of another activity (Speier et al., 1999).

Cognitive load is described as the load on the cognitive system through the information processing of an individual when facing a decision-making task (Paas et al., 1994). According to CLT, three types of cognitive load are distinguished: intrinsic, extraneous, and germane (Paas et al., 2003). Intrinsic cognitive load refers to the degree of complexity of the information itself, extraneous cognitive load is traced to an inefficient presentation of the information and germane cognitive load occurs when new information is matched with already existing information for storage in the long-term memory and is therefore linked to information and behavior that supports automatic processes and schema construction (Paas et al., 2003; Sweller et al., 2011). Germane cognitive load describes working memory resources utilized for intrinsic cognitive load which is relevant for learning (Van Merriënboer & Sweller, 2010) and thus, it improves learning (Paas et al., 2004). Intrinsic load cannot be altered (Paas et al., 2003), but extraneous cognitive load can be decreased by altering the presentation format of the information (Sobotta, 2016). According to CLT, intrinsic and extraneous cognitive load are additive and have to be kept low in sum because learning is provoked only if there is capacity left (Van Merriënboer & Sweller, 2010). Accordingly, learning occurs when the conditions fit the cognitive architecture of the individual (Paas et al., 2004) which is separated into two parts: working memory and long-term memory (Sobotta, 2016). The former is regarded to be of limited capacity when an individual is faced with new pieces of information. In contrast to this, when an individual is faced with familiar information that is already located in the long-term memory that enables schema automation, the working memory can use mechanisms such as pattern recognition, which allows higher amounts of information to be processed unconsciously (Paas et al., 2004). CLT deals with the management of the working memory load so that automation and schema construction in the long-term memory are promoted (Paas et al., 2004). As soon as the cognitive load reaches the individual threshold of a decision maker, information overload becomes salient (e.g., Meyer, 1998).

The literature on email management consists to a great extent of studies on email overload. The construct “perceived email overload”, that has been used in other studies, but also related constructs play a major role in this study. Related constructs in the email management literature are, for example, email coping (Barley et al., 2011) or work performance (Mano & Mesch, 2010). Barley et al. (2011) investigated the influencing factors on the email-

related constructs "overload" and "coping". Email coping is associated with the ability to overcome stress induced by emails. They found that the number of emails handled and the related time involved with dealing with emails leads to a significantly higher perceived email overload. Mano and Mesch (2010) studied the effects of different email features on work performance, which they measured via three constructs: work effectiveness, work stress, and work distress. In general, distress relates to stressors that are perceived negatively (Le Fevre et al., 2003). The study's results show that the number of emails sent and received at work increases work effectiveness, but also work stress and work distress. In addition to this, the results from the regression analysis indicate that the frequency of checking emails before and after work positively influences work effectiveness. Kalman and Ravid (2015) examined the relation between different email inbox management activities and perceived email overload. Thereby, email overload is assumed to be caused by the increase in the inbox size, the number of unread emails, and the required response time. The results from the correlation analyses show that the users' daily inbox-clearing activity is negatively correlated with the variables which are assumed to represent email overload. Dabbish and Kraut (2006) investigated the effect of an individual's email use and email management tactics on perceived email overload. Email use is measured by an email volume scale that consists of the number of emails received, read, and sent per day. The email management tactics were analyzed in a regression model as single-item variables. The regression analysis on email overload showed that it increases significantly with the email volume of an email user, and decreases significantly with the single-item tactic "I try to keep my inbox size small." as well as with the single-item tactic "I check my email as soon as I see or hear that a new message has arrived.".

All of the studies are concerned with the relationship between various email features, such as the number of received / sent emails, and performance-related measures. Additionally, these studies demonstrate that some constructs for measuring performance-related email handling have already been tested in the literature. In our study, three email management performance measures were included: the *individual email management performance* scale, the *efficacy of email use* scale and the *work effectiveness* scale. The construct *efficacy of email use* introduced by Dabbish and Kraut (2006) and the *work effectiveness* scale introduced by Mano and Mesch (2010) can already be found in the email literature. We have included both of them because each of them consists of different performance-related items. While the former is concerned with email behavior and perceptions of emails, the latter deals with effects of email behavior. Moreover, neither of these scales includes items that target individual management performance, such as "personal goal achievement", so we have also included a modification of

the *individual management performance* scale of Muhammed (2006) in our study. In order to cover a broad range of items that are related to email management performance and are derived from the literature, and in order to strengthen the results and implications of this study, we have incorporated all of these three constructs.

2.3.2.2 Email Management Strategies

In the literature, a multitude of studies can be found that are concerned with advice on how to deal with emails in general or, in particular, with email overload (e.g., Pignata et al., 2015). Some studies propose switching off the alarm for notifications, processing all received emails in one go, writing emails in a clear and readable style, or avoiding the rash use of the "reply all" function (Jackson et al., 2003; Vidgen et al., 2011). Solutions recommended by email users include filtering information or prioritizing emails (Farhoomand & Drury, 2002). Other advice on how to deal with email overload includes email management capabilities, corporate strategies, or the enhancement of inbox usability (McMurtry, 2014). With regard to the latter point, several software firms offer technical solutions for managing emails efficiently (Edmunds & Morris, 2000; Hemp, 2009). Features offered include, e.g., email "tracking" for the user to know whether the recipient has opened an email, or "snooze" to make the email disappear out of the inbox for a certain amount of time. Additionally, email interfaces have been developed for helping people to manage their tasks (Bellotti et al., 2003), e.g., the "task" feature that connects emails to an external to-do list software.

In summary, none of these studies has included a full set of email management strategies, measured as multiple-item scales. Therefore, we investigate the email management strategies *zero-inbox*, *to-do list*, *alertness*, *prioritization*, and *folder organization,* now discuss the theoretical background for each of these strategies and develop hypotheses for their influences on the three measures of email management performance (*individual email management performance*, *efficacy of email use*, *work effectiveness*).

Zero-inbox strategy

The use of a *zero-inbox* strategy means that email users try to keep their inbox small, at best at zero, or at least as clean as possible (by deleting emails or filing emails into folders). As already depicted, Dabbish and Kraut (2006) found that the variable "keep inbox small" reduces the perceived email overload significantly. The study by Kalman and Ravid (2015) explored a negative linear correlation between the users' daily inbox-clearing activity and the variables they associate with email overload. Whittaker and Sidner (1996) classified email users as "No Filers", "Spring Cleaners", and "Frequent Filers". While No Filers are described as individuals

who do not clean up their email inbox and Spring Cleaners as individuals who do not clean up their inbox frequently yet on a regular basis, Frequent Filers are described as individuals who clean up their inbox daily. These Frequent Filers indicated their need to see all unfinished to-dos in their inbox at one glance (Whittaker & Sidner, 1996). Whittaker and Sidner (1996) related the use of the inbox as a to-do list to the strategy of achieving a zero-inbox and rated this behavior as the key advantage of Frequent Filers compared to Spring Cleaners and No Filers. In addition to this, Szóstek (2011) investigated user needs related to email handling and identified a user need for an informative overview of the system as being the most important one, especially for email retrieval. The visual reminder of emails in the inbox may be beneficial to email users (Whittaker & Sidner, 1996). Because the process of committing information to memory is restricted by the mental models of an individual (Ducheneaut & Watts, 2005), the visual reminder of emails in the inbox can be an alternative process. Email in its use as a storage place is regarded as extending cognitive information-processing abilities (Ducheneaut & Watts, 2005). In addition to this, prior literature has concluded that unfulfilled tasks can impede the focusing on further tasks (Masicampo & Baumeister, 2011). Accordingly, the *zero-inbox* strategy might help users to stay on top of things by resulting in fewer concurrent activities that need to be kept in mind. Hence, we predict that the *zero-inbox* strategy helps to reduce extraneous cognitive load and interferences, thereby relieving the brain's working memory.

H1a: The greater the use of the *zero-inbox* strategy, the higher the *individual email management performance*.

H1b: The greater the use of the *zero-inbox* strategy, the higher the *efficacy of email use*.

H1c: The greater the use of the *zero-inbox* strategy, the higher the *work effectiveness*.

To-do list strategy

Individuals tend to use the email client for task management. For example, they use the email inbox as a reminder of things that have to be done in the future or to track the work-state of certain activities (Ducheneaut & Bellotti, 2001; Whittaker et al., 2007). Because the working memory is regarded to be of limited capacity (Miller, 1956), information can be maintained to a limited extent only (Towse et al., 2000). Thus, such reminders can relieve the working memory (Whittaker & Sidner, 1996). Besides, resource theories argue that the working memory is a limited resource that is claimed by several representations at the same time (Ma et al., 2014). Accordingly, the *to-do list* strategy might help to avoid forgetting about things and, like the *zero-inbox* strategy, might lower the number of activities that have to be kept in mind simultaneously, and thereby might reduce the cognitive load.

H2a: The greater the use of the *to-do list* strategy, the higher the *individual email management performance*.

H2b: The greater the use of the *to-do list* strategy, the higher the *efficacy of email use*.

H2c: The greater the use of the *to-do list* strategy, the higher the *work effectiveness*.

Alertness strategy

In this study, *alertness* is described as the behavior of having the email client permanently open and of checking for new emails whenever possible. Dabbish and Kraut (2006) found that "check if new message" significantly reduces perceived email overload. Vice versa, their results reveal that "restrict checking" significantly increases perceived email overload. They explained this effect by the accumulation of emails, which results in the handling of huge email amounts at one point of time in the case of restricting checking behavior. In addition to this, Mano and Mesch (2010) included the variable "intensity", described as the "frequency of checking e-mails before and after work" (Mano & Mesch, 2010, p. 65), which they found to increase work effectiveness significantly. They explained this effect with the gathering of information that helps to get a job done (Mano & Mesch, 2010). These results show that frequent checking does not necessarily mean an increased email overload or a decreased work performance. In contrast to this, studies that deal with the topic of interruptions claim that a frequent checking of emails can result in more interruptions (Jackson et al., 2001; Jackson et al., 2003). Related to this finding, in a study by Mark et al. (2016), people relying on self-interruptions indicated a higher productivity than those who get interrupted by every notification. The literature has revealed that when interruptions lead people to work on several tasks at the same time, structural and capacity interferences emerge (Kahneman, 1973). These disruptions increase the cognitive load of an individual (Speier et al., 1999) and decrease an individual's concentration level (De Croon et al., 2005) and performance (Kahneman, 1973). In the same vein, interruption frequency was found to affect cognitive load negatively, which in turn affects performance (Basoglu et al., 2009). Therefore, we assume that an *alertness* strategy leads to a high number of interruptions, which in turn increase the cognitive load and impact work performance negatively. We predict that these factors outweigh any possible positive effects of an *alertness* strategy, such as the helpfulness of new emails in the case of checking behavior not being restricted.

H3a: The greater the use of the *alertness* strategy, the lower the *individual email management performance.*

H3b: The greater the use of the *alertness* strategy, the lower the *efficacy of email use*.

H3c: The greater the use of the *alertness* strategy, the lower the *work effectiveness*.

Prioritization strategy

Several options for prioritizing emails exist, such as the offered email client functions to mark emails as "unread" or "important". Even if these are not provided by the email client, individuals can prioritize by deciding when to reply to an email or which email to reply to first (Ducheneaut & Watts, 2005). Mackay (1988) concentrated on the classification of email users into "Archivers" and "Prioritizers". She described the latter as valuing most a reduction in the time spent on email handling as well as an increased email management efficiency. Prioritizers try to work as time-efficiently as possible (they read important emails directly but delete unimportant ones and want to work on the others later), but this behavior comes at the expense of losing important emails (Mackay, 1988). Another negative aspect is that categorization of emails is regarded as a cognitively demanding task, but information systems can help to overcome these challenges (Ducheneaut & Watts, 2005). Apart from this, it has already been explored that employees appreciate getting information, even if it is not fundamental to getting a job done, because they value the information as a sign of their being respected (White et al., 2010). Thus, if besides important emails also emails are exchanged which inform others about less important topics, it might be crucial to prioritize in order to increase email management performance. In addition to this, Mackay (1988) characterized Prioritizers, inter alia, as those individuals who make use of a restricting checking behavior. In summary, we assume that through prioritization individuals keep fewer things in mind, can reduce their cognitive load, and pay close attention to specific activities.

H4a: The greater the use of the *prioritization* strategy, the higher the *individual email management performance*.

H4b: The greater the use of the *prioritization* strategy, the higher the *efficacy of email use*.

H4c: The greater the use of the *prioritization* strategy, the higher the *work effectiveness*.

Folder organization strategy

In contrast to the Prioritizers described above, Archivers put up with the extra effort involved in inspecting all received emails because they want to avoid overlooking important emails (Mackay, 1988). As mentioned in the context of the *zero-inbox* strategy, Whittaker and Sidner (1996) classified email users into No Filers, Spring Cleaners, and Frequent Filers. Characteristics according to their folder organization are the following: No Filers do not use any folders, spring Cleaners make use of a wide range of folders, and Frequent Filers make increased use of folders (Whittaker & Sidner, 1996). Even if Frequent Filers experience control over their emails, the negative side-effects of this behavior are that crucial emails may be hidden

in folders and that it requires a lot of cognitive effort to set up specific folders (Whittaker & Sidner, 1996) and also to recall the definitions of those folders in order to retrieve certain information (Ducheneaut & Watts, 2005). In contrast to simple filing approaches corresponding to a particular sender, filing emails by projects or individual interests requires complex decision-making (Ducheneaut & Bellotti, 2001). Moreover, Whittaker et al. (2011) state that retrieval based on self-created complex folders is inefficient. A countermeasure may provide innovative email clients that are search-oriented and that structure emails automatically into threaded conversations. We infer that filing may have some advantages, such as the feeling of having control over the emails, but it also has disadvantages, such as the cognitive effort which is needed to create folders and to sort emails into these folders. When weighting the arguments for and against folder organization strategies, we assume that the disadvantages of the required cognitive effort outweigh the advantages.

H5a: The greater the use of the *folder organization* strategy, the lower the *individual email management performance*.

H5b: The greater the use of the *folder organization* strategy, the lower the *efficacy of email use*.

H5c: The greater the use of the *folder organization* strategy, the lower the *work effectiveness*.

Figure 2.3 summarizes the hypothesized linkages between the particular email management strategy and the three measures of email management performance.

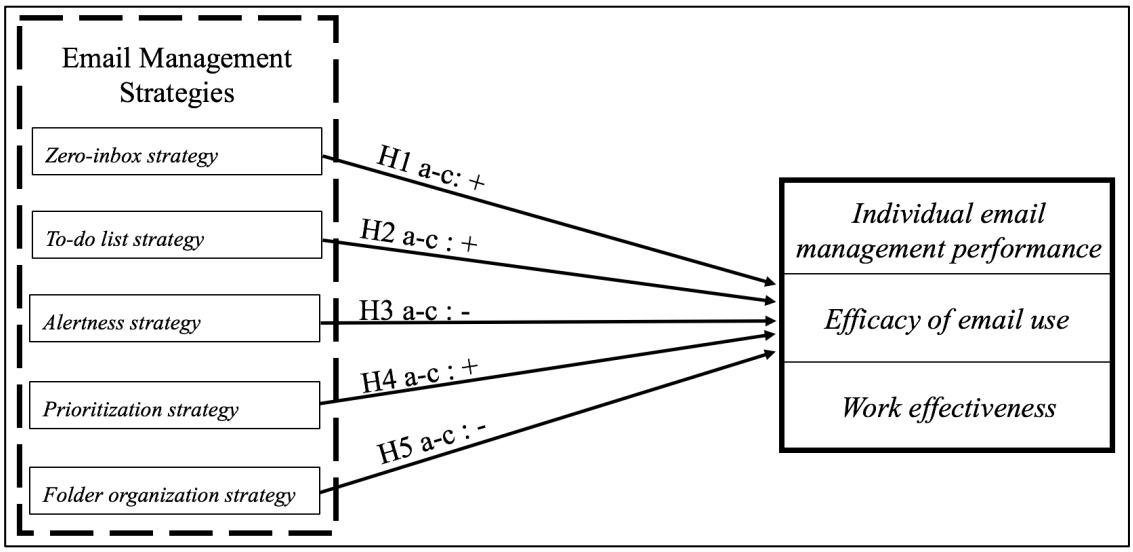

Figure 2.3: Hypothesized Linkages

2.3.2.3 Control Variables

When studying the effect of certain email management strategies on the email management performance, certain control factors have to be included in the analysis. In the present study, these comprise email usage factors and individual factors of the email user.

Email usage factors

We consider the *email volume* as well as the indicated *perceived usefulness* of the email client as email usage factors. *Email volume* describes characteristics of email use, such as the amount of emails received, read, or sent per day. We have already discussed studies that have investigated the effects of different email usage statistics, for example the influence of emails sent and received on the perceived email overload or related constructs. The results of the different studies reveal, on the one hand, that email volume, or the time spent on emails, increases perceived email overload, work stress, and work distress (Barley et al., 2011; Dabbish & Kraut, 2006; Mano & Mesch, 2010) and decreases perceived productivity (Mark et al., 2016). On the other hand, a higher email volume, or the number of emails processed, improves work effectiveness and the ability to cope with emails (Barley et al., 2011; Mano & Mesch, 2010). Based on these previous studies, there might be an influence of *email volume* on email management performance. That is why we have included *email volume* as a control variable in our analysis. Because email users apply certain email management strategies in order to manage the amount of emails, a relationship might also exist between the *email volume* of an email user and the applied strategy for handling it.

The *perceived usefulness* of the email client describes the personal feeling that this medium will increase individual job performance (Davis, 1989). If email users regard the email client as useful and believe that it helps them to get tasks at work done, they might also put more effort into managing their emails and thus increase their email management performance. Therefore, we have also controlled for the *perceived usefulness* of the email client.

Individual factors

Individual factors of email users that are considered in the analysis are the three constructs *autonomy*, *competence*, and *relatedness* that measure the main human psychological needs according to SDT, the demographic factors *gender* and *age*, and the *weekly working hours*. SDT distinguishes between different types of motivation, ranging from amotivation to autonomous motivation. In the case of amotivation, an individual perceives no self-determination, whereas autonomous motivation, as intrinsic motivation, illustrates the opposite case (Gagné & Deci, 2005). It has been shown that the cognitive effort of an individual is greatest in the case of

autonomous motivation (Deci & Flaste, 1996). In turn, with high cognitive effort, a decision maker is more willing to solve a specific problem, which leads to a higher performance (Kanfer, 1990). Hence, a higher individual task motivation is associated with a higher individual performance (Baard et al., 2004). In the work context, SDT assumes that the satisfaction of the psychological needs for autonomy, competence, and relatedness of an individual increases intrinsically motivated behavior (Deci et al., 2001). Thereby, *autonomy* describes the extent to which people can decide about their choices and activities and whether these choices are consistent with a person's own self-perception. *Competence* describes a person's feeling of performing her or his tasks effectively. *Relatedness* describes the desire to feel close, or at least connected, to others (Deci et al., 2001; Ryan & Deci, 2000). In the context of email management, autonomy has already been investigated as an explanatory variable for perceived email overload and was found to decrease this feeling (Dabbish & Kraut, 2006). Communication competence has already been found to positively influence communication success (Oppat, 2008). Hence, we presume that the more competent someone feels in a certain field, the better that person's performance in this particular field is, and likewise in the email management context. Further, for *relatedness*, we assume that the more that people feel connected with others, especially with colleagues in the work context, the greater the number of emails is that someone receives or sends. Since *relatedness* could be associated with items of the *email volume* scale (e.g., the number of received emails) and with items of the work effectiveness scale (e.g., "increases the number of people I communicate with"), we have implemented *relatedness* in our study.

Prior studies on email usage have also used the variables age and gender for measuring individual differences (e.g., Barley et al., 2011; Gwizdka, 2004). Although the empirical results for both variables are inconclusive, we have included them as control variables in our analysis. We have also included the variable *weekly working hours*, because we assume that a high number of *weekly working hours* impels people to apply efficient email management strategies.

2.3.3. Material and Methods

To address the research questions empirically, we have conducted an online survey including constructs on all research variables and we have performed factor, parametric, and regression analyses. Accordingly, we first describe the sample and the data collection procedure. Second, the measures that were used in the survey are developed, and the data analysis methodology is then explained.

2.3.3.1 Sample and Procedure

To obtain the data basis, an online-survey was conducted on the crowdsourcing platform Prolific[8] in 2018. Prolific was chosen because it has good recruitment standards and informs people who register that they will be participating for research purposes. This means that researchers are explicitly targeted (Palan & Schitter, 2018). To increase the probability of respondents using email clients at work to a certain extent, we filtered the participant pool for their "industry role", their "employment status", and their "weekly working hours". The industry role of the respondents was described as consultant, junior management, middle management, trained professional, or upper management. The employment status of the participants was either full-time or part-time. For the weekly working hours, we only included people who indicated that they worked more than twenty hours per week. The estimated completion time for the questionnaire was 10 minutes and every participant who completed the study received a reward of 1.50 pounds sterling. The questionnaire itself was programmed in Unipark[9]. Before analyzing the data, we reconciled the survey data with the data provided by Prolific, which comprise all prescreening data and certain socio-demographic data on the respondents. The questionnaire is provided in Appendix A.3-1. A total of 300 individuals took part in the online-survey. We had to exclude one dataset due to inconsistencies in the respondent's answers between the two data sets. Thus, the sample for the data analysis consists of 299 individuals (144 females, 155 males). Because we had two missing entries due to *age* and *weekly working hours*, the number of individuals with full data sets was 297. The average age of the participants was 35.24 years, ranging from 18 to 65 years. The majority of the participants (184 participants) indicated that they worked between 21 and 40 hours per week, 93 participants that they worked between 41 and 50 hours per week, and 21 participants that they worked more than 50 hours per week.

2.3.3.2 Measures

As an overview, all conducted research variables are provided in the research model in Figure 2.4. It illustrates the investigated relationships between the five different email management strategies and the three measures of email management performance. In this context, we control for email usage factors and individual factors. Questions within the survey were posed in the form of constructs. For all questions that asked for personal assessments of a statement (item),

[8] https://www.prolific.ac
[9] https://www.unipark.com

a five-point Likert-scale (1: "strongly disagree" to 5: "strongly agree") was used. Appendix A.3-2 lists all scales and items that were used in the survey.

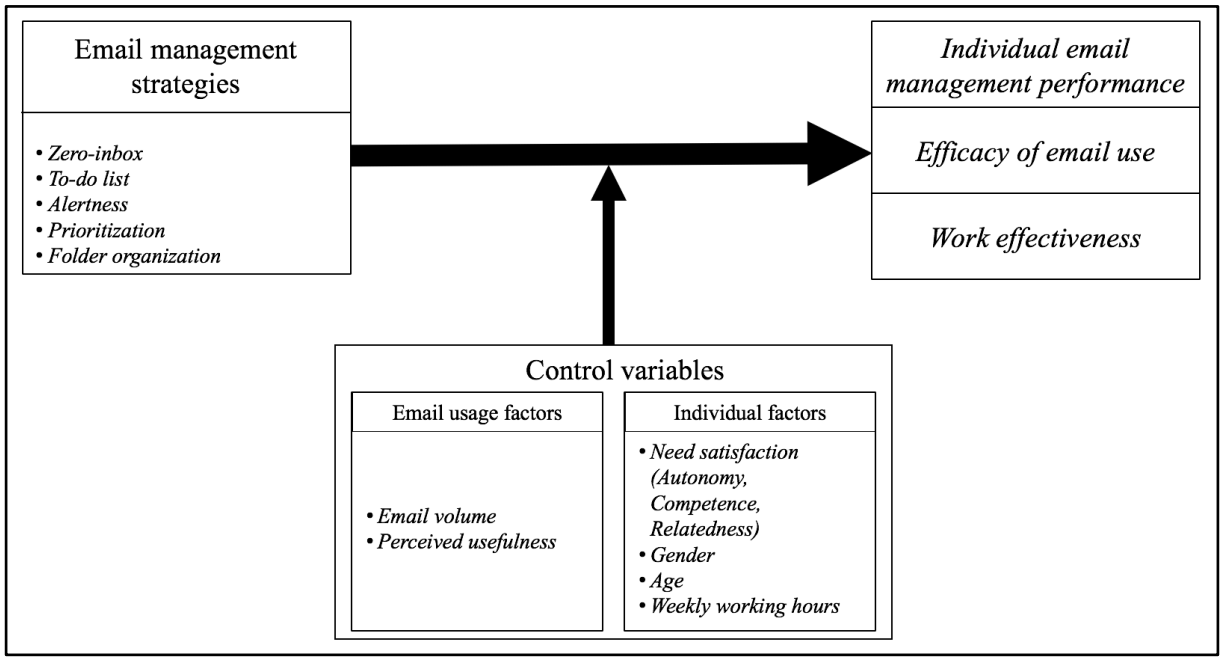

Figure 2.4: Proposed Research Model of Research Paper 3

Email management performance

Performance constructs that have already been used and established within the email literature are the two constructs *efficacy of email use* of Dabbish and Kraut (2006) and *work effectiveness* of Mano and Mesch (2010). The former has been used with reversed items as a construct to measure email overload and targets assessments of whether a person's own email behavior is efficient. Therefore, it comprises items about perceptions of an individual's own handling (e.g., "I can easily deal with the amount of email I receive.") (Dabbish & Kraut, 2006). In contrast to this, work effectiveness deals with effects of email behavior (e.g., "Using e-mail improved teamwork" or "Using e-mail saved time") (Mano & Mesch, 2010). Since both constructs comprise different performance-related items and in order to provide comprehensive results and implications about the influences of different email management strategies on email management performance, we have included both in this study. For this reason, we also wanted to include a construct that covers items on the individual performance, such as personal goal achievement. Such items can be found in the *individual management performance* scale of Muhammed (2006) (e.g., "I easily met my goals " or "My work was of very high quality"). Hence, we have incorporated a modification of this scale additionally into our study.

Email management strategies

Because no validated scales for email management strategies exist in the literature and in order to establish measurable scales, we have identified items for the distinct email management

strategies in two ways: First, we have reviewed the related email management literature for single items. Dabbish and Kraut (2006) have already developed a set of items of email management strategies and categorized those into the groups “checking mail”, “managing the inbox”, and “filing”, but their confirmatory analysis did not confirm these groups. Having collected further items from various studies, we combined and arranged them and assumed the items to group into the following constructs, each of them characterizing one of the five distinct email management strategies: *zero-inbox, to-do list, alertness, prioritization*, and *folder organization*. According to this structure, we have adopted the items from the previous literature with minimal modifications. An exemplary modification of the items by Dabbish and Kraut (2006) is the division of the item “I try to keep my inbox size small”, into two items “I try to keep my inbox as clean as possible” and “I voluntarily try to keep my inbox size small (rather than being “forced to” by the email client)”. For the item “I keep my email client permanently open” (based on Venolia et al., 2001) we assume that this is an indicator of email alertness instead of having the client just open in the background. Second, we have searched for functions and linkages that are (partially) offered by email clients or by extensions for email clients. Examples of these are the option of marking emails as important or the function for scheduling emails to be sent on a particular date and at a particular time.

To ensure the validity of these constructs, we conducted a pre-study with 72 students, who had to assign the single items to one of the given constructs. The assignment of items to constructs is one known procedure to analyze validity (Koller et al., 2017; Moore & Benbasat, 1991; Newman et al., 2013). For this pre-study, we formulated all reversed items positively, so that the students were able to assign those into a specific category. Appendix A.3-3 shows the frequency of the assignment. Altogether, we found support for the assumed constructs. Only four items were not assigned to the assumed construct by the majority. Thus, these items as well as items that only a small majority assigned as assumed were rephrased. Furthermore, the item “I have linked the email client to a task service, e.g., Wunderlist, Reminder, Todoist, or Asana (if this is provided by the email client)” was removed from the pool of items because we could not ensure that everyone would understand what this item implied. Table 2.10 displays the derivation of the final items of the different email management strategy constructs that were included in the survey.

Table 2.10: Derivation of the Final Items of the Different Email Management Strategies

Item in our survey	Item derived from the following literature / email client functions
Zero-inbox	
I voluntarily try to keep my inbox size small (rather than being "forced to" by the mail client).	Dabbish and Kraut (2006, p. 434): "I try to keep my inbox size small."
I try to keep my inbox as clean as possible.	
I clean up my inbox constantly (by deleting emails or filing emails into folders).	Whittaker and Sidner (1996, p. 280): "3 strategies: no filers (no use of folders); frequent filers (folder users who try and clean up their inbox daily); spring cleaners (folder users who clean up their inbox only periodically)."
I do not clean up my inbox.	
I leave emails in the inbox after I have processed them.	Dabbish and Kraut (2006, p. 434): "I leave messages in the inbox after I have read them."; Venolia et al. (2001, p. 4): "leave in inbox"
I delete or file emails outside the inbox after I have processed them.	Dabbish and Kraut (2006, p. 434): "I delete work-related email messages after I read them."
To-do list	
I keep emails in my inbox as a reminder of things I need to do.	Dabbish and Kraut (2006, p. 434): "I keep messages in my inbox as a reminder of things I need to do."; Venolia et al. (2001, p. 2) "Task management: People often use email to remind them what they need to do, and to help them get tasks done."
I use the email client to preserve the ongoing work-state of incomplete activities.	Bellotti et al. (2005, p. 101): "Preserve the ongoing work-state of incomplete activities."
I use the email client to keep relevant content at hand for things I need to do in the future.	Bellotti et al. (2005, p. 101): "Keep relevant content at hand."; Bellotti et al. (2005, p. 101): "Remind themselves of things to do in the future."
I schedule a follow-up reminder that will remind me to contact the recipient when I have no response to a specific email	Venolia et al. (2001, p. 4): "mark with a flag icon for follow-up"
Alertness	
When I have been away from my email client for a period of time, the first thing I do is to check for new emails.	Venolia et al. (2001, p. 2): "Triage: After people are away from their email for a period of time, they need to catch up and deal with all the email that accumulated while they were away."
I check my emails as soon as I see or hear that a new email has arrived.	Dabbish and Kraut (2006, p. 434): "I check my email as soon as I see or hear that a new message has arrived."
I restrict myself to checking my emails at specific times of the day.	Dabbish and Kraut (2006, p. 434): "I restrict myself to checking my email at specific times of the day."
I keep my email client permanently open.	Venolia et al. (2001, p. 2):"Flow: As people are working on other tasks, they want to keep up with the flow of incoming messages as they arrive."
Prioritization	
I prioritize the "must-dos" over the "would-be-nice-to-dos."	Bellotti et al. (2005, p. 101): "Prioritize the "must-dos" against the "would-be-nice-to-dos."
I prioritize emails by marking certain emails as "unread".	Venolia et al. (2001, p. 4): "mark as unread"
I mark emails as "important" to find them again later.	Based on (partially offered) email client functions and linkages.
I classify emails as either requiring an immediate reply, or a postponed reply, or no reply.	Dabbish et al. (2005, p. 698): "We included dummy variables for whether a user replied to the message immediately or postponed reply to the message."
I schedule emails to be sent at a particular date and time.	Based on (partially offered) email client functions and linkages.
Folder organization	
I file my emails into separate folders.	Dabbish and Kraut (2006, p. 434): "I file my messages into separate folders."
I manually file my emails into folders as soon as they come in (read or unread).	Dabbish and Kraut (2006, p. 434): "I manually file my messages as soon as they come in."
I store emails in separate folders so I can refer to them later.	Venolia et al. (2001, p. 2): "Archive: People store email so they can refer to it later."; Bellotti et al. (2005, p. 101): "Save content that might be needed again in the future."
I delete emails to get rid of irrelevant, distracting emails.	Bellotti et al. (2005, p. 101): "Get rid of irrelevant content"

Control variables

The set of control variables in the present study comprises email usage factors and individual factors of the email users. Email usage factors comprise the scales *email volume* and *perceived usefulness* of the email client. The scale for *email volume* includes items of the email volume scale of Dabbish and Kraut (2006). Moreover, we have extended this scale by two related items that were identified in the literature. The first item is: "On an average workday, what percentage of your working time do you spend reading and writing emails (including work related and private emails)?" which is based on Barley et al. (2011) and Sullivan (1995). The second item is: "What is the number of people you have regular exchange of email with?" which is based on Mano and Mesch (2010). The scale for *perceived usefulness* was adopted from Davis (1989) and was modified, as we related all questions to the email client. We did not distinguish between internet and desktop email applications.

The relevant individual factors in this study include, among others, the basic psychological need satisfaction at work scale (Deci et al., 2001; Ilardi et al., 1993; Kasser et al., 1992) which consists of three subscales: *autonomy, competence,* and *relatedness*. Socio-demographic factors analyzed in this study are *gender* and *age*. Moreover, we included the variable *weekly working hours* in the analyses. These variables were already recorded and provided by Prolific. In the analysis, we used *gender* as a binary variable (female = 1, male = 0) and *age* as a metric variable (measured in years). The categorical variable *weekly working hours* was measured by five categories: 21-30 hours, 31-40 hours, 41-50 hours, 51-60 hours, and more than 60 hours. Hence, the group 21-30 hours served as the reference category and we set up dummy variables for the other groups (all coded with 1 if true; 0 otherwise).

2.3.3.3 Analysis Methodology

The statistical analysis of the survey data consists of three parts. In order to test whether the developed constructs have the required validity (Research Question 1), we first conducted a factor analysis for each construct. Second, we performed parametric tests to identify which email usage factors determine the use of a certain email management strategy (Research Question 2). Third, we used regression analyses to examine the influences of these strategies on the three email management performance measures (Research Question 3).

All constructs included in the research model were validated using confirmatory factor analysis (CFA). The principal factor matrix was rotated using the orthogonal varimax method for all constructs. We removed items with factor loadings smaller than 0.4 from the respective

factor. After removing an item, we re-ran the CFA and varimax rotation. Finally, the Cronbach's alpha coefficient was calculated for each obtained factor.

We used two-sample t-tests for independent samples to test whether the use of a certain email management strategy depends on the level of *email volume* and / or on the indicated *perceived usefulness* of the email client. Therefore, we categorized *email volume* and *perceived usefulness* by a median split and performed a comparison of the means for the groups low / high *email volume* as well as for the groups low / high *perceived usefulness* of the email client. For the groups low / high *email volume*, the t-test for unequal variances was used for the strategies *alertness* and *prioritization* because the Levene's test indicated unequal variances ($p < .05$). All other t-tests for the groups low / high *email volume* and all t-tests for the groups low / high *perceived usefulness* were performed with t-tests for equal variances ($p > .05$).

Hierarchical, ordinary least squares (OLS) regressions were applied in order to investigate the effects of the email management strategies on the three email management performance measures. For each dependent variable, we tested whether the results would hold under the inclusion of control variables. The assumptions of the linear regression were tested. These revealed that only heteroscedasticity is a matter of concern in the present study. Therefore, we computed the OLS regressions using robust standard errors.

2.3.4 Data Analysis and Results

2.3.4.1 Factor Analysis

The factor analysis revealed that all constructs are internally consistent. As described in the subsection "Analysis methodology", items with factor loadings lower than 0.4 were excluded from the analysis. For this reason, items from the following factors were removed: *efficacy of email use* (1 of 7 items removed), *to-do list* (1 of 4 items removed), *folder organization* (1 of 4 items removed), *autonomy* (2 of 7 items removed). The Cronbach's alphas of all factors range between 0.6647 and 0.9397. Based on Robinson et al. (1991), who rate values above 0.6 as moderate, we focus on all factors in the subsequent analyses. Appendix A.3-2 displays the Cronbach's alphas of all factors.

2.3.4.2 Parametric Tests

The results of the two-sample t-tests show that email management strategies are applied significantly more often for high levels of *email volume* (*zero-inbox* $p < .05$, *to-do list* $p < .05$, *alertness* $p < .001$, *prioritization* $p < .001$, *folder organization* $p < .001$) as well as for high levels of *perceived usefulness* (*zero-inbox* $p < .01$, *to-do list* $p < .001$, *alertness* $p < .001$,

prioritization $p < .01$, *folder organization* $p < .01$). Thus, if an email user is confronted with high amounts of *email volume*, compared to low amounts, that user is more likely to apply an email management strategy. Likewise, for high rather than low amounts of indicated *perceived usefulness* of the email client, email management strategies are applied more often.

2.3.4.3 Regression Analysis

We tested the hypotheses of the present study using multivariate regression analyses. As we included the control variables stepwise in the regressions, three models for each performance measure were computed and are presented in Table 2.11 (the results of the OLS regressions for the *individual email management performance* scale are shown in models 1-3, those for the *efficacy of email use* scale are presented in models 4-6, and those for the *work effectiveness* scale are shown in models 7-9).

Models 1, 4, and 5 show the results of the regression for the respective email management performance scale when the independent variables comprise the five email management strategies. Results reveal significance for the *zero-inbox* strategy, which is positively associated with *individual email management performance* ($p < .01$), with *efficacy of email use* ($p < .001$), as well as with *work effectiveness* ($p < .1$). Accordingly, H1a, H1b, and H1c are supported. The *to-do list* strategy significantly increases *individual email management performance* ($p < .01$) and *work effectiveness* ($p < .001$) but yields no effect on *efficacy of email use*. Therefore, we find support for H2a and H2c, but not for H2b. The *alertness* strategy is positively associated with *individual email management performance* and *efficacy of email use*, but these relationships are both of very weak significance ($p < .1$; $p < .1$). Because we hypothesized negative influences of this strategy on email management performance measures, H3a and H3b are not supported. Moreover, the *alertness* strategy has no effect on the *work effectiveness* so that H3c is also not supported. Whereas the *prioritization* strategy significantly decreases the *efficacy of email use* ($p < .05$), it significantly increases the *work effectiveness* ($p < .001$) and has no significant effect on the *individual email management performance*. Therefore, we find support only for H4c, but not for H4a and H4b. The strategy *folder organization* does not show any significant effect on either of the three models. H5a, H5b and, H5c are thus not supported. Altogether, the email management strategies have a significant overall influence on *individual email management performance* (adj. $R^2 = 0.1814$), *efficacy of email use* (adj. $R^2 = 0.1316$), and on *work effectiveness* (adj. $R^2 = 0.2105$).

In the second set of models (models 2, 5, and 8) email usage factors were included additionally in the regression analyses. Altogether, the results related to the email management

strategies show identical patterns to the previous models 1, 4, and 7. What is striking in comparison to the previous models is the following result: the influence of the *zero-inbox* strategy on *work effectiveness* is no longer significant. Hence, H1c is not supported any more. The effects of the to-do list strategy on *individual email management performance* and on *work effectiveness* remain significant ($p < .05$; $p < .01$). The influences of the *alertness* strategy on *individual email management performance* and *efficacy of email use* are no longer significant. The negative significant effect of the *prioritization* strategy on *efficacy of email use* gets stronger ($p < .001$) and its positive significant effect on *work effectiveness* is significant at the 1%-level. Due to the email usage factors, the following is observable: whereas *email volume* has no significant effect on *individual email management performance*, it does have a negative significant effect on *efficacy of email use* ($p < .1$) and a positive significant effect on *work effectiveness* ($p < .05$). *Perceived usefulness* of the email client significantly increases all three measures of email management performance ($p < .001$; $p < .001$; $p < .001$). Altogether, the inclusion of the two control variables for email usage improves the overall model fit substantially for *individual email management performance* (adj. $R^2 = 0.4210$), *efficacy of email use* (adj. $R^2 = 0.2147$), and *work effectiveness* (adj. $R^2 = 0.3205$).

The third set of models (models 3, 6, and 9) present the regression results of the influences of email management strategies, email usage factors, as well as individual factors on the respective measure of email management performance. Striking differences in these models arising from the results of the email management strategies obtained in models 2, 5, and 8 are the following: the effect of the *zero-inbox* strategy on *individual email management performance* weakens moderately ($p < .05$), as does also the effect of the *prioritization* strategy on *work effectiveness* ($p < .05$). According to the email usage, the regression results reveal that the influence of *email volume* on *efficacy of email use* gets stronger ($p < .05$) and the significant effect of *perceived usefulness* on the *efficacy of email use* weakens slightly ($p < .01$). From the set of individual factors, the need for *competence* has a positive significant influence on *individual email management performance* as well as on *efficacy of email use* ($p < .001$; $p < .001$). *Age* significantly decreases *individual email management performance* ($p < .01$) and *working more than 60 hours per week* significantly decreases the *efficacy of email use* ($p < .001$) in comparison with *working 21-30 hours per week*. All other control variables do not show any significant influence. The inclusion of all control variables investigated in the study increases again the overall model fit regarding *individual email management performance* (adj. $R^2 = 0.4646$), *efficacy of email use* (adj. $R^2 = 0.3118$), and *work effectiveness* (adj. $R^2 = 0.3230$).

In summary, the regression analyses show that the two strategies *zero-inbox* and *to-do list* were found to increase email management performance (or at least to increase two of the three measures) and we conclude that the application of either strategy may function as an external extension of the working memory. Both of these strategies allow email users to see at one glance all unanswered emails or tasks that need to be worked on. This reduces the extraneous cognitive load because the email presentation is not overwhelming or confusing. In the same vein, the number of structural or capacity interferences decreases because fewer concurrent activities have to be kept in mind. Interestingly, the *zero-inbox* strategy has non-significant influences on *work effectiveness* when controlled for email usage and individual factors. This could be because email users file the to-dos in appropriate folders in order to obtain a zero-inbox, without actually having worked on them. Furthermore, an explanation for the non-significant results when regressing the *to-do list* strategy on *efficacy of email use* might be that the sight of all outstanding emails in one go is overwhelming when applying the *to-do list* strategy only and that the inbox is not necessarily kept small. According to the *alertness* strategy, the results show a positive influence on *individual email management performance* and on *efficacy of email use* only to a certain extent. Regarding *work effectiveness*, the *alertness* strategy has no significant influence. Overall, the influence of the *alertness strategy* is not conclusive and further context-dependent investigations are needed. Regarding the *prioritization* strategy, the risk of overlooking emails as well as the cognitive effort needed for categorizing emails may impair the *efficacy of email use*. Vice versa, the *prioritization strategy* may lead to the execution of the most important emails first and to a person keeping fewer things in mind so that her or his attention can be given to specific activities, which in turn can support the effectiveness of a person's work. The results of the *folder organization* strategy indicate that it probably depends on how deeply this strategy is applied; for instance, whether many or only a few folders are used and whether filing entails a lot of cognitive effort for the individual email user.

Table 2.11: Regression Analyses on Individual Email Management Performance, Efficacy of Email Use, and on Work Effectiveness

	Hypotheses	*Individual email management performance*				*Efficacy of email use*				*Work effectiveness*			
	Prediction	Finding	Model 1	Model 2	Model 3	Finding	Model 4	Model 5	Model 6	Finding	Model 7	Model 8	Model 9
Zero-inbox	H1 (+)	✓	0.199 (0.0068)	0.158 (0.0084)	0.141 (0.0199)	✓	0.355 (0.0000)	0.338 (0.0000)	0.296 (0.0000)	(✓)	0.123 (0.0777)	0.0892 (0.1646)	0.0926 (0.1655)
To-do list	H2 (+)	✓	0.251 (0.0015)	0.137 (0.0269)	0.122 (0.0451)		-0.0493 (0.4871)	-0.107 (0.1084)	-0.0827 (0.2546)	✓	0.331 (0.0000)	0.247 (0.0013)	0.247 (0.0025)
Alertness	H3 (-)		0.121 (0.0877)	-0.0220 (0.7443)	-0.0296 (0.6598)		0.102 (0.0822)	0.0400 (0.4936)	0.0391 (0.4731)		0.0875 (0.1822)	-0.0277 (0.6691)	-0.0401 (0.5546)
Prioritization	H4 (+)		0.0751 (0.3502)	-0.0459 (0.4750)	-0.0370 (0.5546)		-0.175 (0.0180)	-0.237 (0.0004)	-0.210 (0.0005)	✓	0.278 (0.0004)	0.190 (0.0073)	0.180 (0.0119)
Folder organization	H5 (-)		0.0955 (0.2134)	0.0650 (0.3090)	0.0824 (0.2049)		-0.0716 (0.3437)	-0.0805 (0.2660)	-0.0615 (0.3602)		0.0164 (0.8285)	-0.0123 (0.8578)	-0.0112 (0.8733)
Email volume				0.0158 (0.6952)	0.0262 (0.4908)			-0.0849 (0.0720)	-0.109 (0.0271)			0.0982 (0.0467)	0.112 (0.0412)
Perceived usefulness				0.536 (0.0000)	0.464 (0.0000)			0.291 (0.0000)	0.201 (0.0049)			0.377 (0.0000)	0.328 (0.0000)
Autonomy					-0.00575 (0.9256)				-0.00901 (0.8860)				0.0703 (0.3055)
Competence					0.250 (0.0000)				0.338 (0.0000)				0.0724 (0.2908)
Relatedness					0.0314 (0.5677)				0.0370 (0.5000)				0.0368 (0.5715)
Female					-0.102 (0.2202)				0.0703 (0.4661)				-0.0994 (0.3506)
Age					-0.0126 (0.0048)				-0.00213 (0.6764)				-0.00714 (0.1896)
Working 31-40 hours per week					-0.169 (0.1510)				-0.117 (0.4040)				-0.185 (0.2001)
Working 41-50 hours per week					-0.139 (0.2791)				-0.0514 (0.7404)				-0.166 (0.2845)
Working 51-60 hours per week					-0.283 (0.2189)				-0.216 (0.3218)				-0.481 (0.1408)
Working > 60 hours per week					-0.0413 (0.8071)				-0.784 (0.0006)				-0.0317 (0.9155)
Constant			-1.87e-09 (1.0000)	-7.64e-09 (1.0000)	0.631 (0.0022)		4.10e-09 (1.0000)	9.14e-10 (1.0000)	0.141 (0.5711)		-2.52e-09 (1.0000)	-6.51e-09 (1.0000)	0.470 (0.0508)
N			299	299	297		299	299	297		299	299	297
adjusted R^2			0.1814	0.4210	0.4646		0.1316	0.2147	0.3118		0.2105	0.3205	0.3230

Note. The first observation in each cell is the estimate and the second observation (in parentheses) is the two-sided p-value.

2.3.4.4 Supplementary Analysis

When testing whether *email volume* and *perceived usefulness* affect the respective email management strategy significantly, the regression results show that *email volume* has positive and significant effects on the strategies *zero-inbox*, *to-do list*, *alertness*, and *folder organization* ($p < .05$; $p < .1$; $p < .01$; $p < .05$). Thus, only the strategy *prioritization* is not affected significantly by *email volume*. In contrast to this, *perceived usefulness* has positive and significant effects on all email management strategies that are investigated (*zero-inbox* $p < .01$; *to-do list* $p < .001$; *alertness* $p < .001$; *prioritization* $p < .001$; *folder organization* $p < .001$). In summary, the results from the supplementary analyses support (except for the effect of *email volume* on the *prioritization* strategy) the results from the t-tests which were conducted in order to address Research Question 2.

2.3.5 Discussion

In the present study, we have identified a broad set of validated email management strategies (zero-inbox, to-do list, alertness, prioritization, folder organization) and have tested empirically their influences on three measures of email management performance (individual email management performance, efficacy of email use, work effectiveness). We have found in particular that the strategies zero-inbox and to-do list increase email management performance (or at least increase two of the three measures). Additionally, we have tested the relation between the strategies and email usage factors. Our study has shown that the application of email management strategies is determined by email usage factors. With these findings, our study contributes to the literature in several ways.

First, while most of the previous studies deal with single problems that are related to certain context factors of emails, such as interruptions (Jackson et al., 2001, 2003), or with single-item strategies that are applied by email users (e.g., Bellotti et al., 2005; Dabbish & Kraut, 2006; Venolia et al., 2001), none of these studies has identified a set of measurable email management strategies. Hence, our study expands the existing approaches of previous studies and has developed a full set of validated constructs for different email management strategies which can be used for further investigations in this field.

Second, since prior studies have empirically investigated only the influence of single-item strategies on performance-related constructs, our study is the first to reveal empirically which multi-item email management strategies lead to statistically significant increases in email management performance. By doing so, the study contributes to the organizational and the employee behavior literature.

Third, the present study has shown that the use of email management strategies depends on the email usage factor email volume. Apart from this, email volume was found to decrease efficacy of email use and to increase work effectiveness. With these results, the present study supports the results from previous studies (Dabbish & Kraut, 2006; Mano & Mesch, 2010) and extends these through the regression analyses on individual email management performance.

Fourth, while email volume items have already been within the scope of prior studies, none has included perceived usefulness of the email (client). By contrast, this study has outlined that perceived usefulness influences the application of email management strategies and that it increases all investigated performance measures.

Fifth, the study has identified that the two strategies zero-inbox and to-do list increase email management performance (or at least strongly increase two of the three measures). We conclude that the use of these two strategies may function as an external extension of the working memory, so that fewer concurrent activities have to be kept in mind and cognitive load can be decreased. Thus, we base our explanations on cognitive theories and we contribute to these insofar as the results of the present study support these theories.

Sixth, the results and conclusions of the application of the two strategies zero-inbox and to-do list support newer cognitive science theories as well. Unlike traditional cognitive science theories, these newer theories follow the idea that cognition is not only related to processes inside the body but that it can also be driven by an active environment (Clark & Chalmers, 1998). For example, the Theory of Embodied Cognition assumes that cognitive systems interact with the environment through bodily sensors and effectors (Heylighen & Vidal, 2008) so that one claim of the theory is “We off-load cognitive work onto the environment” (Wilson, 2002), which is in line with our conclusion in the present study.

Seventh, our study introduces a new theoretical approach to email management research, since SDT is used to explain email management performance. Whereas the influence of autonomy on the perceived email overload has already been investigated (Dabbish & Kraut, 2006), no email research studies have so far analyzed all three constructs (autonomy, competence, and relatedness), which measure the main human psychological needs according to SDT. Thus, the three constructs autonomy, competence, and relatedness were examined in the analysis. The results show that at least the need for competence is of high value for considerations on email management performance.

Practical implications derived from this study are recommended actions for email users on how to manage their own email flow. Keeping the knowledge about the effects of email management strategies in mind, organizations can provide their employees with

recommendations for actions with regard to managing their emails and improving email management performance. This in turn can affect, on a global level, organizational functioning and, on an individual level, employee well-being and productivity. Particularly companies with employees who receive high amounts of emails could provide guidelines and trainings in order to illuminate the positive effects of the zero-inbox and to-do list strategies in particular. Additionally, seminars that explain the advantages of the email (client) in general are strongly recommended in order to increase email management performance. Besides these implications, software firms that develop new email features can benefit from the study results, as they can better target empirically validated features that improve the effectiveness and efficiency of email use. Moreover, such firms can specifically promote these developed features.

2.3.5.1 Limitations and Future Research

As with every study, some potential limitations should be considered. Due to the survey method, common-method bias and a potential selection bias may affect the results. The study was conducted online on the crowdsourcing platform Prolific, and this might have influenced the results to the effect that only people who are familiar with the internet and online-surveys took part in the study. Further, we only included people in the survey who hold management positions and work at least twenty hours per week. In the present context, this is reasonable because people who are requested to answer email-related questions will also be familiar with the internet and use emails more frequently compared to those who are not familiar with it. Although Prolific is actively engaged in identifying dishonest people and blocking them from the respondents' pool (Moodie, 2018) , a further aspect of surveys might be that of the accuracy of self-reports. Besides this, the questions regarding the amount of emails the respondents received, read, and sent per day are only based on individual estimations, and some respondents might have difficulties in estimating such numbers. To account for this, we also asked respondents to indicate the percentage of their working time they spend reading and writing emails, as well as to indicate the number of people that they have a regular exchange of email with. All of these items were than analyzed and created the corresponding factor.

In the future, studies could extend the investigations of influencing factors on the use of different email management strategies, such as individual characteristics of the users. It could be identified as to which user should use which email management strategies to improve her or his own email management performance. In the same vein, cultural and cross-country differences could be explored because different communication policies and practices exist across cultures and countries. Additionally, the investigations could include organizational

policies. Most organizations expect a certain communication behavior from their employees. Since the email client providers are continuously developing new features, it could be explored in an ongoing process which features the email clients provide and whether their provision influences the use of email management strategies and the related email management performance. Furthermore, future research could investigate interaction effects of using different email management strategies simultaneously. Moreover, most studies on email overload or email management in general are empirical rather than conceptual (Eppler & Mengis, 2004). Thus, in the future, more theoretical studies could analyze phenomena and problems in this domain. In addition to this, studies on how the use of emails affects cognitive processes are scarce in the literature (Sobotta, 2016). CLT, being used as the main theoretical basis of our study, has only been used by Sobotta (2016), who aims to explain how email threads lead to email overload. Hence, future studies should focus on and implement cognitive approaches, especially newer cognitive science theories, in order to provide a deeper understanding of how the cognitive system is affected and of the resulting behavior.

2.3.5.2 Conclusions

Email is one of the most commonly used communication tools in the workplace nowadays, and countless emails are received, sent, and managed every single day. Different possibilities and email management strategies exist in practice for managing a person's own email volume. Particular strategies for an effective and efficient email management are discussed broadly. However, prior to our study, statistically reliable multi-item scales for email management strategies had not been developed and the influence of these strategies on the email management performance had not been validly tested.

The study has achieved its aim of answering the present research questions. First, we have combined existing items from the literature, identified new items, and were able to validate empirically tested measures of five different email management strategies (*zero-inbox*, *to-do list*, *alertness*, *prioritization*, *folder organization*). Second, we have shown that with increased levels of *email volume* and *perceived usefulness* of the email client, the investigated email management strategies are applied more often. Finally, we have found that email management performance can be increased by the *zero-inbox* strategy as well as by the *to-do list* strategy. We argue that these strategies help email users to reduce the cognitive load and, therefore, to relieve their working memory so that they can concentrate on specific tasks without having to keep other things in mind. Overall, the results of our study have strong theoretical implications, such as the development of validated constructs for a variety of email management strategies.

Additionally, they have important practical implications, such as recommended actions for email users as to how to manage their emails in order to improve their own email management performance.

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Appendix of Research Paper 3

A.3-1 Survey

Welcome to this online survey!
Dear Participant,
Thank you for your interest in this online survey. It is a component of a research project on people's **individual email management in the workplace** which is being conducted by RWTH Aachen University's Chair of Management Accounting.
There are no right or wrong answers. Data will remain **anonymous** and will be treated **strictly confidentially**. No individual data sets will be given to third parties.
If you have any questions or comments, please feel free to contact me directly on Prolific using the messaging system.
We thank you for your support!

Start the survey

Please enter your Prolific ID

Continue

The following statements concern facts about your email usage at work. (1/2)
How many new emails have you received in the past 24 hours (including work related and private emails)?
If the past 24 hours do not correspond to a workday, please refer to the last workday. Please insert an integral number.
emails

How many new emails have you read in the past 24 hours (including work related and private emails)?
If the past 24 hours do not correspond to a workday, please refer to the last workday. Please insert an integral number.
emails

How many emails have you sent in the past 24 hours (including work related and private emails)?
This includes also responses to emails received.
If the past 24 hours do not correspond to a workday, please refer to the last workday. Please insert an integral number.
emails

Continue

The following statements concern facts about your email usage at work. (2/2)

How many unread emails do you have at the end of an average workday (including work related and private emails)?

This refers only to the number of unread emails and not the number of unanswered emails. Please insert an integral number.

_____ emails

On an average workday, what percentage of your working time do you spend reading and writing emails (including work related and private emails)?

(The length of the average workday might be different from your employment contract.) Please insert an integral number.

_____ %

On average, how long does a sender wait for your response after the sender has sent you an email?

- ○ up to 1 hour
- ○ more than 1 hour and up to 3 hours
- ○ more than 3 hours and up to 6 hours
- ○ more than 6 hours and up to 24 hours
- ○ more than 24 hours and up to 48 hours
- ○ more than 48 hours

Continue

The following statements concern your personal email management at work. (1/3)

Note: Some questions refer to the email itself, and others refer to the email client which is the program that you use to access, read, send, and manage your emails.

Please indicate how much you disagree or agree with the following statements.

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
When I have been away from my email client for a period of time, the first thing I do is to check for new emails.	○	○	○	○	○
I check my emails as soon as I see or hear that a new email has arrived.	○	○	○	○	○
I restrict myself to checking my emails at specific times of the day.	○	○	○	○	○
I keep my email client permanently open.	○	○	○	○	○

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I prioritize the “must-dos” over the “would-be-nice-to-dos”.	○	○	○	○	○
I prioritize emails by marking certain emails as "unread”.	○	○	○	○	○
I mark emails as “important” to find them again later.	○	○	○	○	○
I classify emails as either requiring an immediate reply, or a postponed reply, or no reply.	○	○	○	○	○
I schedule emails to be sent at a particular date and time.	○	○	○	○	○

Continue

The following statements concern your personal email management at work. (2/3)
Please indicate how much you disagree or agree with the following statements.

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I voluntarily try to keep my inbox size small (rather than being "forced" to by the email client).	○	○	○	○	○
I try to keep my inbox as clean as possible.	○	○	○	○	○
I clean up my inbox constantly (by deleting emails or filing emails into folders).	○	○	○	○	○
I do not clean up my inbox.	○	○	○	○	○
I leave emails in the inbox after I have processed them.	○	○	○	○	○

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I file my emails into separate folders.	○	○	○	○	○
I manually file my emails into folders as soon as they come in (read or unread).	○	○	○	○	○
I store emails in separate folders so I can refer to them later.	○	○	○	○	○
I delete emails to get rid of irrelevant, distracting emails.	○	○	○	○	○

Continue

The following statements concern your personal email management at work. (3/3)
Please indicate how much you disagree or agree with the following statements.

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I keep emails in my inbox as a reminder of things I need to do.	○	○	○	○	○
I use the email client to preserve the ongoing work-state of incomplete activities.	○	○	○	○	○
I use the email client to keep relevant content at hand for things I need to do in the future.	○	○	○	○	○
I schedule a follow-up reminder that will remind me to contact the recipient when I have no response to a specific email.	○	○	○	○	○

Continue

The following statements concern consequences of your personal email management.
Please indicate how much you disagree or agree with the following statements.
My personal email management behavior...

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
...increases the number of people I communicate with.	○	○	○	○	○
...improves teamwork.	○	○	○	○	○
...makes it easier to stay on top of current events at work.	○	○	○	○	○
...saves time.	○	○	○	○	○
...makes me more available to my colleagues.	○	○	○	○	○

My personal email management behavior means that...

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
...I am very efficient at my work (which means I achieve planned results with minimal effort).	○	○	○	○	○
...I am very effective in my work (which means I achieve my goals).	○	○	○	○	○
...I achieve a very high work quality. ...I easily meet my goals.	○	○	○	○	○
...I usually finish my tasks within the expected time limit.	○	○	○	○	○

Continue

The following statements concern your personal email management.
Please indicate how much you disagree or agree with the following statements.

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I can handle my emails efficiently.	○	○	○	○	○
I have trouble finding information in my emails.	○	○	○	○	○
I can easily deal with the amount of emails I receive.	○	○	○	○	○
I sometimes miss important emails.	○	○	○	○	○
I reply quickly to the emails which require my response.	○	○	○	○	○
Dealing with my emails disrupts my ongoing work.	○	○	○	○	○
I find dealing with my emails overwhelming.	○	○	○	○	○

Continue

The following statements concern the email client itself.
Please indicate how much you disagree or agree with the following statements.

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
Using the email client in my job enables me to accomplish tasks more quickly.	○	○	○	○	○
Using the email client improves my job performance.	○	○	○	○	○
Using the email client in my job increases my productivity.	○	○	○	○	○
Using the email client enhances my effectiveness on my job.	○	○	○	○	○
Using the email client makes it easier to do my job.	○	○	○	○	○
I find the email client useful in my job.	○	○	○	○	○

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
Usage of the email client is clear and understandable.	○	○	○	○	○
I do not have to spend much time learning how to use the email client.	○	○	○	○	○
Learning to operate the email client is easy for me.	○	○	○	○	○
It's easy for me to use the various functions of the email client.	○	○	○	○	○

Continue

The following questions are related to your work.

What is the number of people you have regular exchange of email with?

Please insert an integral number.

_____ people

How many days per week do you work on average (this might differ from your employment contract)?

_____ days

What percentage of your actual working time do you work in your office at your company / from home / on the go?

Please allocate 100 % (which indicates your actual working time) across the following 3 options. The 100 % must be fully allocated.

In the last row the percentage that you have already allocated is shown. At the end, this must be 100 %.

working in your office at your company _____

working from home _____

working on the go _____

Continue

The following statements concern your feelings about your job during the last year. (1/3) Remember that your boss / colleagues will never know how you have responded to the questions.

Given your experiences in this job, please indicate how much you disagree or agree with the following statements. (Even if you have been in this job for less than one year, please respond as far as possible.)

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I do not feel very competent when I am at work.	○	○	○	○	○
People at work tell me I am good at what I do.	○	○	○	○	○
I have been able to learn interesting new skills in my job.	○	○	○	○	○
Most days I feel a sense of accomplishment from working.	○	○	○	○	○
In my job I do not get much of a chance to show how capable I am.	○	○	○	○	○
When I am working I often do not feel very capable.	○	○	○	○	○

Continue

The following statements concern your feelings about your job during the last year. (2/3) Remember that your boss / colleagues will never know how you have responded to the questions.

Given your experiences in this job, please indicate how much you disagree or agree with the following statements. (Even if you have been in this job for less than one year, please respond as far as possible.)

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I feel like I can make a lot of inputs to deciding how my job gets done.	○	○	○	○	○
I feel pressured at work.	○	○	○	○	○
I am free to express my ideas and opinions in my job.	○	○	○	○	○
When I am at work, I have to do what I am told.	○	○	○	○	○
My feelings are taken into consideration at work.	○	○	○	○	○
I feel like I can pretty much be myself at work.	○	○	○	○	○
There is not much opportunity for me to decide for myself how to go about my work.	○	○	○	○	○

Continue

The following statements concern your feelings about your job during the last year. (3/3) Remember that your boss / colleagues will never know how you have responded to the questions.

Given your experiences in this job, please indicate how much you disagree or agree with the following statements. (Even if you have been in this job for less than one year, please respond as far as possible.)

	strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
I really like the people I work with. I get along with people at work.	○	○	○	○	○
I pretty much keep to myself when I am at work.	○	○	○	○	○
I consider the people I work with to be my friends.	○	○	○	○	○
People at work care about me.	○	○	○	○	○
There are not many people at work that I am close to.	○	○	○	○	○
The people I work with do not seem to like me much.	○	○	○	○	○
People at work are pretty friendly towards me.	○	○	○	○	○

Continue

Just a few last questions...

How would you describe your skill level with computers?

- very low
- low
- medium
- high
- very high

I use email mostly for...

- ...business purposes.
- ...private purposes.
- I use email equally often for both purposes.

Continue

Thank you for your support!

Please prove that you have completed the study via the following link:

https://www.prolific.ac/submissions/complete?cc=JVW8LVM4

(Please click, or copy and paste the following link into a new tab.)

A.3-2 Scales Used in the Study

Individual email management performance (α = 0.9064)
My personal email management behavior means that…
(1) …I am very efficient at my work (which means I achieve planned results with minimal effort).
(2) …I am very effective in my work (which means I achieve my goals).
(3) …I achieve a very high work quality.
(4) …I easily meet my goals.
(5) …I usually finish my tasks within the expected time limit.

Efficacy of email use (α = 0.7972)
(1) I can handle my emails efficiently.
(2) I have trouble finding information in my emails. (R)
(3) I can easily deal with the amount of emails I receive.
(4) I sometimes miss important emails. (R)
(5) I reply quickly to the emails which require my response.
(6) Dealing with my emails disrupts my ongoing work. (R)
(7) I find dealing with my emails overwhelming. (R)

Work effectiveness (α = 0.7540)
My personal email management behavior…
(1) …increases the number of people I communicate with.
(2) …improves teamwork.
(3) …makes it easier to stay on top of current events at work.
(4) …saves time.
(5) …makes me more available to my colleagues.

Zero-inbox strategy (α = 0.9012)
(1) I voluntarily try to keep my inbox size small (rather than being "forced to" by the mail client).
(2) I try to keep my inbox as clean as possible.
(3) I clean up my inbox constantly (by deleting emails or filing emails into folders).
(4) I do not clean up my inbox. (R)
(5) I leave emails in the inbox after I have processed them. (R)
(6) I delete or file emails outside the inbox after I have processed them.

To-do list strategy (α = 0.7287)
(1) I keep emails in my inbox as a reminder of things I need to do.
(2) I use the email client to preserve the ongoing work-state of incomplete activities.
(3) I use the email client to keep relevant content at hand for things I need to do in the future.
(4) I schedule a follow-up reminder that will remind me to contact the recipient when I have no response to a specific email.

Alertness strategy (α = 0.7013)

(1) When I have been away from my email client for a period of time, the first thing I do is to check for new emails.
(2) I check my emails as soon as I see or hear that a new email has arrived.
(3) I restrict myself to checking my emails at specific times of the day. (R)
(4) I keep my email client permanently open.

Prioritization strategy (α = 0.6647)

(1) I prioritize the "must-dos" over the "would-be-nice-to-dos."
(2) I prioritize emails by marking certain emails as "unread".
(3) I mark emails as "important" to find them again later.
(4) I classify emails as either requiring an immediate reply, or a postponed reply, or no reply.
(5) I schedule emails to be sent at a particular date and time.

Folder organization strategy (α = 0.8235)

(1) I file my emails into separate folders.
(2) I manually file my emails into folders as soon as they come in (read or unread).
(3) I store emails in separate folders so I can refer to them later.
(4) I delete emails to get rid of irrelevant, distracting emails.

Email volume (α = 0.6650)

(1) How many new emails have you received in the past 24 hours (including work related and private emails)?
(2) How many new emails have you read in the past 24 hours (including work related and private emails)?
(3) How many new emails have you sent in the past 24 hours (including work related and private emails)?
(4) On an average workday, what percentage of your working time do you spend reading and writing emails (including work related and private emails)?
(5) What is the number of people you have regular exchange of email with?

Perceived usefulness (α = 0.9397)

(1) Using the email client in my job enables me to accomplish tasks more quickly.
(2) Using the email client improves my job performance.
(3) Using the email client in my job increases my productivity.
(4) Using the email client enhances my effectiveness on my job.
(5) Using the email client makes it easier to do my job.
(6) I find the email client useful in my job.

Autonomy (α = 0.7906)

(1) I feel like I can make a lot of inputs to deciding how my job gets done.
(2) I feel pressured at work. (R)
(3) I am free to express my ideas and opinions in my job.
(4) When I am at work, I have to do what I am told. (R)
(5) My feelings are taken into consideration at work.
(6) I feel like I can pretty much be myself at work.
(7) There is not much opportunity for me to decide for myself how to go about my work. (R)

Competence (α = 0.7340)

(1) I do not feel very competent when I am at work. (R)
(2) People at work tell me I am good at what I do.
(3) I have been able to learn interesting new skills in my job.
(4) Most days I feel a sense of accomplishment from working.
(5) In my job I do not get much of a chance to show how capable I am. (R)
(6) When I am working I often do not feel very capable. (R)

Relatedness (α = 0.8217)

(1) I really like the people I work with.
(2) I get along with people at work.
(3) I pretty much keep to myself when I am at work. (R)
(4) I consider the people I work with to be my friends.
(5) People at work care about me.
(6) There are not many people at work that I am close to. (R)
(7) The people I work with do not seem to like me much. (R)
(8) People at work are pretty friendly towards me.

Note. (R) shows that the item is reverse scaled.

A.3-3 Assignment of Items to Constructs

Table A.3-3.1: Frequency of the Assignment

	Item	Email management strategies						
		Zero-inbox	*To-do list*	*Alert-ness*	*Prioritization*	*Folder organization*	Sum	N
1	I keep my email client permanently open.	6%	8%	**82%**	1%	3%	100%	71
2	I mark emails as "unread" to remind myself to look at them again.	14%	42%	3%	39%	3%	100%	72
3	I keep emails in my inbox as a reminder of things I need to do.	4%	**70%**	6%	7%	13%	100%	71
4	When I have been away from my email client for a period of time, the first thing I do is to catch up and deal with all the emails that have accumulated while I was away.	43%	13%	20%	16%	7%	100%	69
5	I do not restrict myself to checking my email at specific times of the day.	12%	12%	**53%**	11%	12%	100%	66
6	I use the email client to preserve the ongoing work-state of incomplete activities.	6%	**71%**	3%	9%	12%	100%	68
7	I file my emails into separate folders.	4%	3%	4%	4%	**85%**	100%	72
8	I clean up my inbox.	**74%**	8%	4%	10%	4%	100%	72
9	I schedule a follow-up reminder that will inform me when I have received no response to a specific email (if this is provided by the email client).	6%	**29%**	32%	23%	10%	100%	69
10	I do not leave emails in the inbox after I have processed them.	**78%**	6%	6%	10%	0%	100%	69
11	I classify emails as either requiring an immediate reply, or a postponed reply, or no reply.	4%	6%	7%	**44%**	38%	100%	68
12	I mark emails as “important” to find them again later.	4%	6%	6%	**74%**	10%	100%	70
13	I delete emails to remove irrelevant, distracting emails.	50%	9%	3%	26%	13%	100%	70
14	I schedule emails to be sent at a particular date and time (if this is provided by the email client).	3%	42%	11%	11%	33%	100%	64
15	I use the email client to keep relevant content at hand.	4%	**40%**	9%	31%	16%	100%	68
16	I manually file my emails as soon as they come in (read or unread).	4%	12%	31%	9%	**44%**	100%	68
17	I store emails so I can refer to them later.	3%	22%	10%	16%	**49%**	100%	69
18	I prioritize the “must-dos” over the “would-be-nice-to-dos.”	3%	27%	1%	**63%**	6%	100%	71
19	I voluntarily try to keep my inbox size small (rather than being "forced" to by the email client).	**72%**	8%	9%	3%	8%	100%	65
20	I try to keep my inbox as clean as possible.	**79%**	3%	5%	5%	9%	100%	66
21	I check my emails as soon as I see or hear that a new email has arrived.	6%	8%	**79%**	3%	5%	100%	66
22	I have linked the email client with a task service, e.g., Wunderlist, Reminder, Todoist or Asana (if this is provided by the email client).	4%	**52%**	10%	9%	24%	100%	67
23	I clean up my inbox constantly (by deleting emails or filing emails into folders).	**66%**	7%	6%	7%	13%	100%	68
24	I delete or file emails outside the inbox after I have processed them.	**48%**	14%	2%	14%	23%	100%	66

Note. Items that were assigned to the assumed construct by the majority are marked in bold numbers.